APPENDIX L

Terrestrial and Aquatic Ecology Technical Report

Part 3 of 7

BORDER TO GOWRIE REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

Inland Rail is a subsidiary of
Australian Rail Track Corporation

INLAND RAIL

APPENDIX L

Terrestrial and Aquatic Ecology Technical Report

Appendix A Additional ecological investigations

CONTINUED

BORDER TO GOWRIE REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

Inland Rail is a subsidiary of
Australian Rail Track Corporation

INLAND RAIL

APPENDIX

E

GROUND TRUTHED RES & TECS

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Vegetation Management Act 1999 Status

- Of Concern
- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

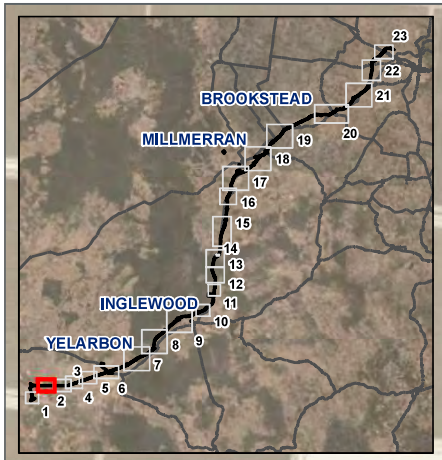
Page 1

1:10,000 Scale at A3

m
0
225

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



YELARBON

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community

Suburb labels as per Australian Bureau of Statistics (2011)

Page 2

1:20,000 Scale at A3

m
0 250

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community

Ground-truthed non-remnant

- Mapped by State as Endangered - dominant

Vegetation Management Act 1999 Status

- Endangered

Suburb labels as per Australian Bureau of Statistics (2011)

Page 3

1:20,000 Scale at A3

m
0 250

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community

Ground-truthed non-remnant

- Mapped by State as Endangered - dominant

Vegetation Management Act 1999 Status

- Endangered

Suburb labels as per Australian Bureau of Statistics (2011)

1:20,000 Scale at A3

m
0 250

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community

Ground-truthed non-remnant

- Mapped by State as Endangered - dominant

Vegetation Management Act 1999 Status

- Endangered

Suburb labels as per Australian Bureau of Statistics (2011)

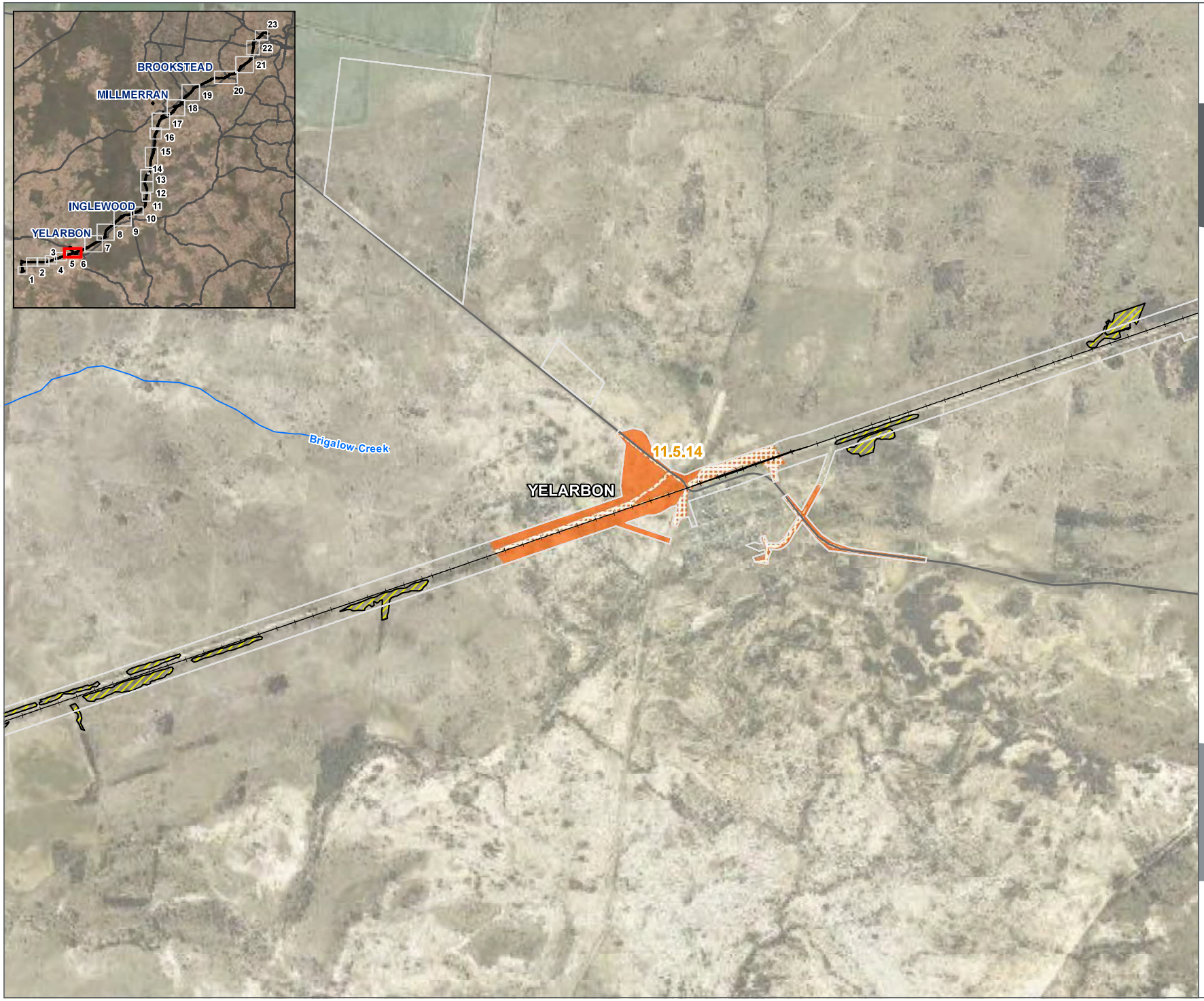
Page 5

1:17,500 Scale at A3

m
0 250

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community

Ground-truthed non-remnant

- Mapped by State as Of Concern - dominant

Vegetation Management Act 1999 Status

- Of Concern

Suburb labels as per Australian Bureau of Statistics (2011)

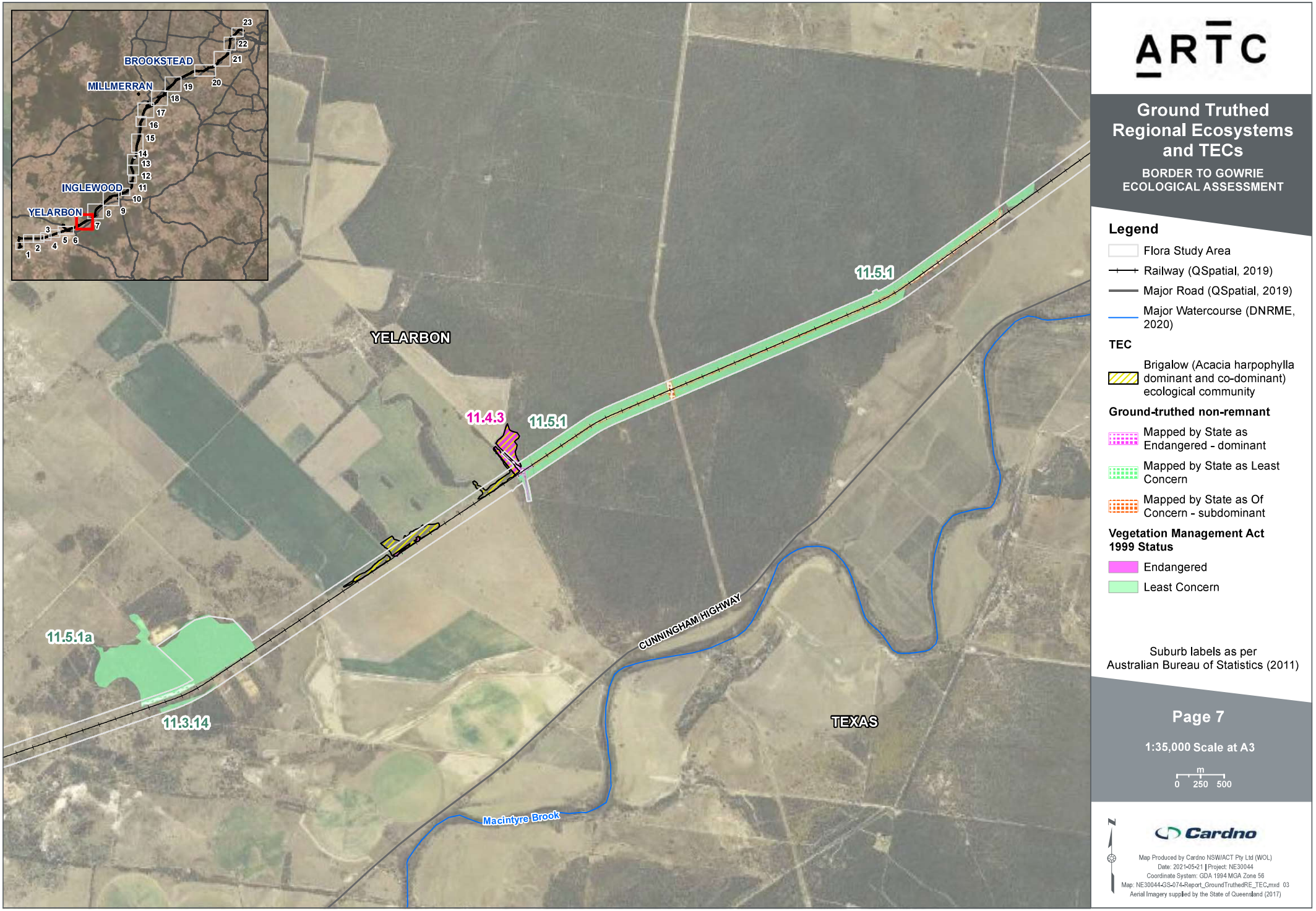
Page 6

1:27,500 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community

Ground-truthed non-remnant

- Mapped by State as Endangered - dominant
- Mapped by State as Least Concern
- Mapped by State as Of Concern - subdominant

Vegetation Management Act 1999 Status

- Endangered
- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Ground-truthed non-remnant

- Mapped by State as Least Concern
- Mapped by State as Of Concern - subdominant

Vegetation Management Act 1999 Status

- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Ground-truthed non-remnant

- Mapped by State as Least Concern
- Mapped by State as Of Concern - subdominant

Vegetation Management Act 1999 Status

- Of Concern
- Of Concern - Subdominant
- Least Concern

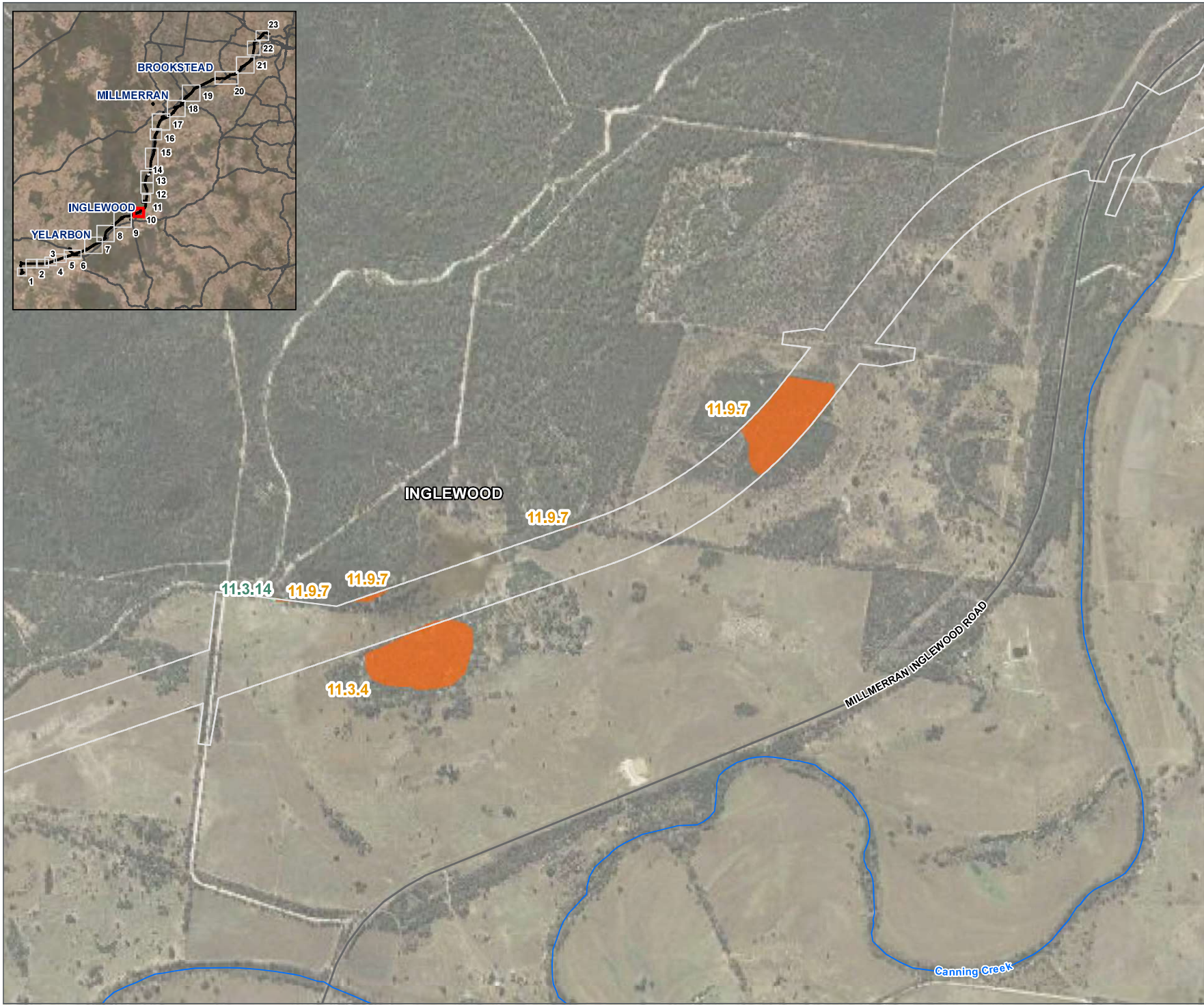
Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Vegetation Management Act 1999 Status

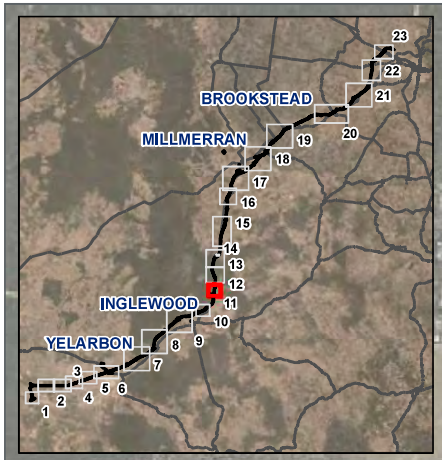
- Of Concern
- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

1:15,000 Scale at A3

m
0 250

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



INGLEWOOD

Canning Creek

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Ground-truthed non-remnant

- Mapped by State as Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

Page 11

1:15,000 Scale at A3

m
0
250

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Ground-truthed non-remnant

- Mapped by State as Endangered - subdominant
- Mapped by State as Least Concern
- Mapped by State as Of Concern - dominant

Vegetation Management Act 1999 Status

- Of Concern
- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community
- Poplar Box Grassy Woodland on Alluvial Plains

Ground-truthed non-remnant

- Mapped by State as Endangered - subdominant
- Mapped by State as Least Concern
- Mapped by State as Of Concern - dominant

Vegetation Management Act 1999 Status

- Endangered
- Of Concern
- Least Concern

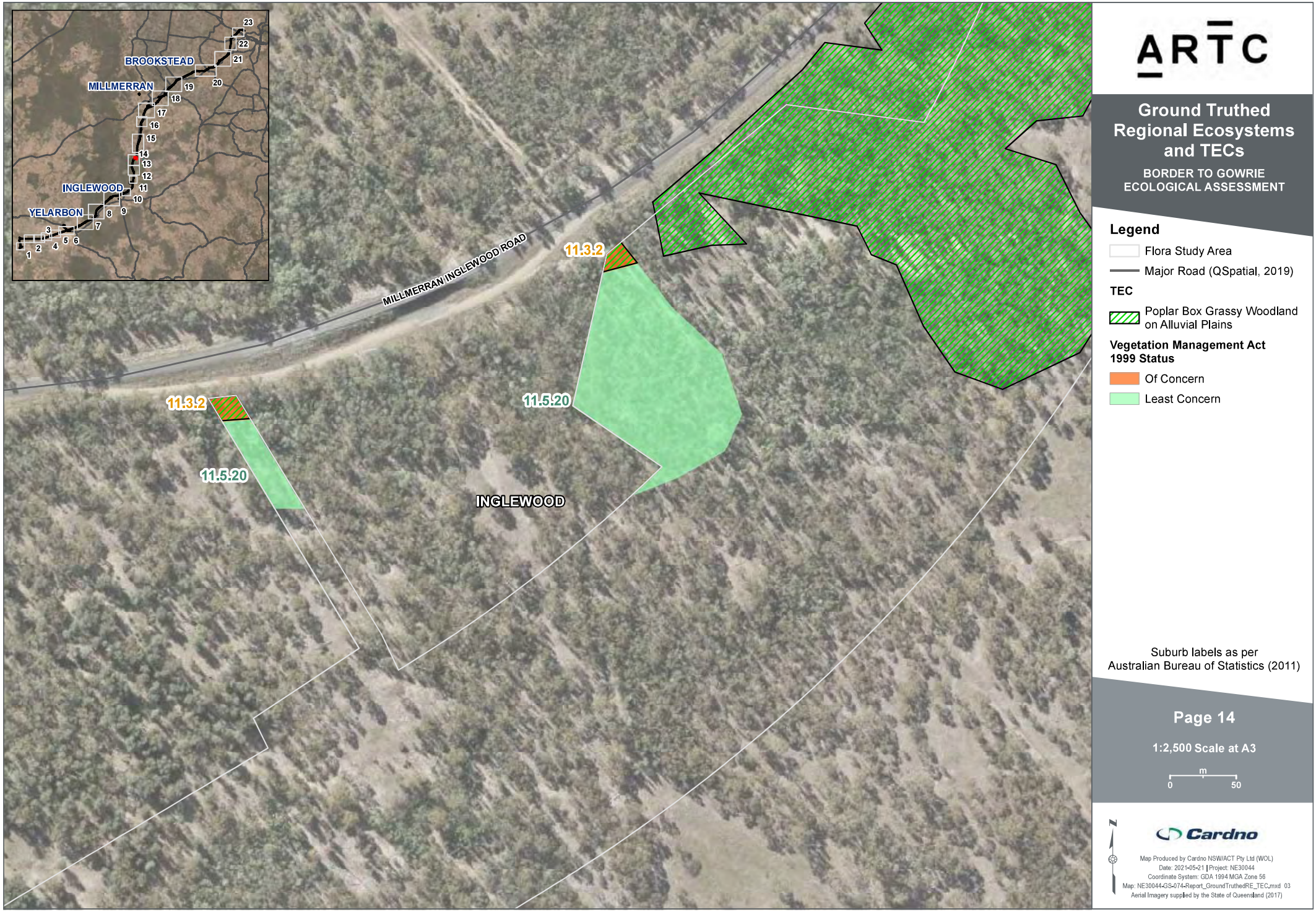
Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)

TEC

- Poplar Box Grassy Woodland on Alluvial Plains

Vegetation Management Act 1999 Status

- Of Concern
- Least Concern

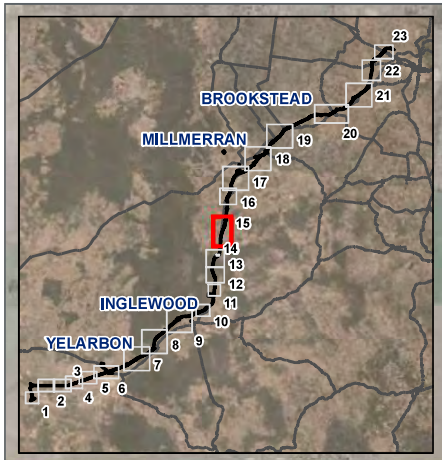
Suburb labels as per Australian Bureau of Statistics (2011)

1:2,500 Scale at A3

m
0 50

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



MILLMERRAN INGLEWOOD ROAD

TUMMAVILLE

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community
- Poplar Box Grassy Woodland on Alluvial Plains

Suburb labels as per Australian Bureau of Statistics (2011)

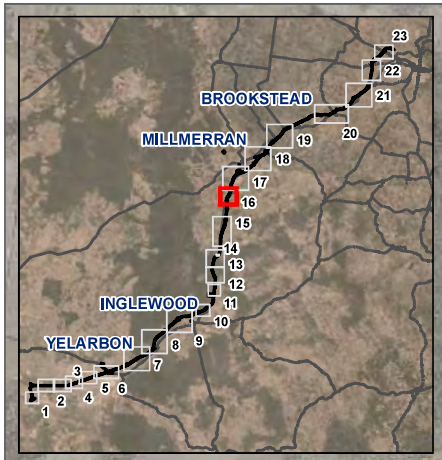
Page 15

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



MILLMERRAN

MILLMERRAN/INGLEWOOD ROAD

TUMMAVILLE

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)

TEC

- Brigalow (Acacia harpophylla dominant and co-dominant) ecological community
- Poplar Box Grassy Woodland on Alluvial Plains
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Ground-truthed non-remnant

- Mapped by State as Of Concern - dominant

Vegetation Management Act 1999 Status

- Of Concern
- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

TEC

- Poplar Box Grassy Woodland on Alluvial Plains

Ground-truthed non-remnant

- Mapped by State as Least Concern

Vegetation Management Act 1999 Status

- Of Concern
- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

TEC

- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland

Vegetation Management Act 1999 Status

- Least Concern

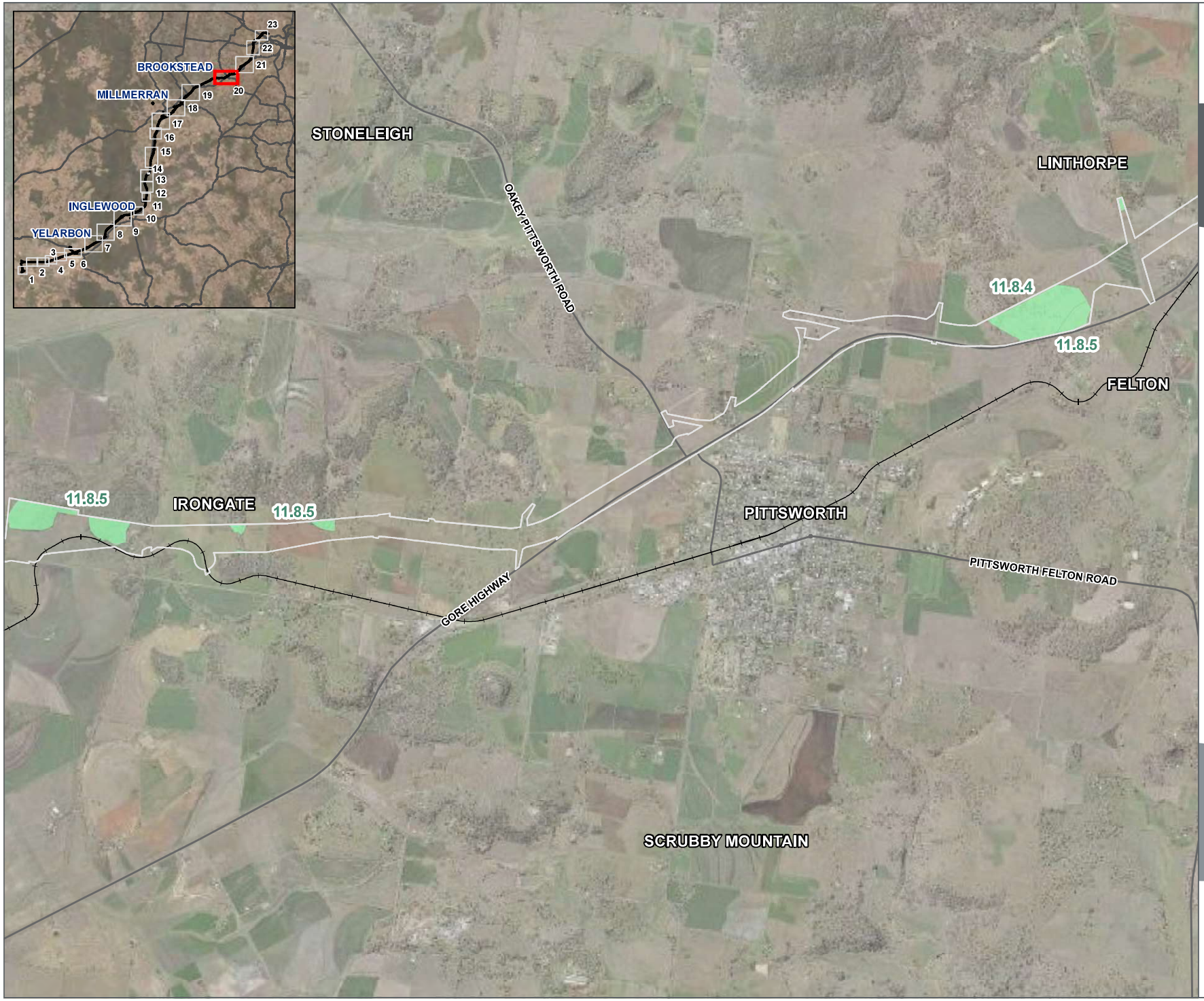
Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)

Vegetation Management Act 1999 Status

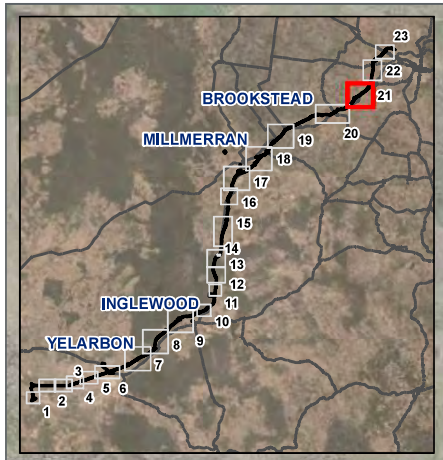
- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 250 500

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)



BIDDESTON

LINTHORPE

ATHOL

SOUTHBROOK

FELTON

GORE HIGHWAY

11.8.5

11.8.4

11.8.5

11.8.5

11.8.4

11.8.5

11.8.4

11.8.4

11.8.5

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Railway (QSpatial, 2019)
- Major Road (QSpatial, 2019)

Vegetation Management Act 1999 Status

- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

Page 21

1:35,000 Scale at A3

m
0 250 500

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)

TEC

- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland

Vegetation Management Act 1999 Status

- Of Concern
- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

1:25,000 Scale at A3

m
0 250 500

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

Ground Truthed Regional Ecosystems and TECs

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)

Vegetation Management Act 1999 Status

- Least Concern

Suburb labels as per Australian Bureau of Statistics (2011)

Page 23

1:5,000 Scale at A3

m
0
110

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-074-Report_GroundTruthedRE_TEC.mxd 03
Aerial Imagery supplied by the State of Queensland (2017)

APPENDIX

F

BIOCONDITION SCORING

Spring biocondition data

SITE ID: 1BA			Vegetation status: Remnant			
Regional Ecosystem: 11.4.3						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	6	80	7.5	15	5
Canopy	Median height (m)	10	24	41.7	5	3
	Cover (%)	34.8	70	49.7	5	2
Recruitment of dominant canopy species %		33	100	33.0	5	3
Shrubs	Native shrub cover (%)	1.4	48	2.9	5	0
Coarse woody debris	Total length per hectare (m)	200	1752	11.4	5	2
Native plant species richness	Trees	4	2	200.0	5	5
	Shrub	11	10	110.0	5	5
	Grass	5	4	125.0	5	5
	Forbs etc.	13	13	100.0	5	5
Non-native plant cover (%)		8	0	N/A	10	5
Ground cover	Native perennial grass cover (%)	1.2	6	20.0	5	1
	Organic litter cover (%)	59.4	75	79.2	5	5
Size of Patch					10	7
Context					5	2
Connectivity					5	2
Total weighted score					100	**57**
BioCondition score (=Total score /100)					1	**0.57**

SITE ID: 1BD						
Regional Ecosystem: 11.7.7		Vegetation status: Remnant				
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	6	26	23.1	15	5
Canopy	Median height (m)	18	19	94.7	5	5
	Cover (%)	29.5	40	73.8	5	5
Recruitment of dominant canopy species %		25	100	25.0	5	3
Shrubs	Native shrub cover (%)	1	15	6.7	5	0
Coarse woody debris	Total length per hectare (m)	165	157	105.1	5	5
Native plant species richness	Trees	8	5	160.0	5	5
	Shrub	6	9	66.7	5	2.5
	Grass	5	4	125.0	5	5
	Forbs etc.	11	9	122.2	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	58.2	4	1455.0	5	5
	Organic litter cover (%)	21.6	68	31.8	5	3
Size of Patch					10	10
Context					5	4
Connectivity					5	4
Total weighted score					100	**76.5**
BioCondition score (=Total score /100)					1	**0.765**

SITE ID: 2BC		Vegetation status: Remnant				
Regional Ecosystem: 11.3.4						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	28	35	80.0	15	10
Canopy	Median height (m)	13	22	59.1	5	3
	Cover (%)	42.1	17	247.6	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0.2	1	20.0	5	3
Coarse woody debris	Total length per hectare (m)	405	384	105.5	5	5
Native plant species richness	Trees	5	4	125.0	5	5
	Shrub	1	2	50.0	5	2.5
	Grass	15	7	214.3	5	5
	Forbs etc.	15	10	150.0	5	5
Non-native plant cover (%)		3.1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	35.6	43	82.8	5	3
	Organic litter cover (%)	53	20	265.0	5	3
Size of Patch					10	10
Context					5	5
Connectivity					5	5
Total weighted score					100	**82.5**
BioCondition score (=Total score /100)					1	**0.825**

SITE ID: 1BF		Vegetation status: Remnant				
Regional Ecosystem: 11.5.4						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	182	17	1070.6	15	15
Canopy	Median height (m)	12	21	57.1	5	3
	Cover (%)	60.5	30	201.7	5	3
Recruitment of dominant canopy species %		40	100	40.0	5	3
Shrubs	Native shrub cover (%)	0.4	7	5.7	5	0
Coarse woody debris	Total length per hectare (m)	970	204	475.5	5	2
Native plant species richness	Trees	5	4	125.0	5	5
	Shrub	1	3	33.3	5	2.5
	Grass	3	13	23.1	5	2.5
	Forbs etc.	14	18	77.8	5	2.5
Non-native plant cover (%)		0.01	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	15.4	30	51.3	5	3
	Organic litter cover (%)	59	58	101.7	5	5
Size of Patch					10	10
Context					5	5
Connectivity					5	5
Total weighted score					100	**76.5**
BioCondition score (=Total score /100)					1	**0.765**

SITE ID: 1BB		Vegetation status: Remnant				
Regional Ecosystem: 11.4.3						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	34	80	42.5	15	5
Canopy	Median height (m)	18	24	75.0	5	5
	Cover (%)	67	70	95.7	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	48	0.0	5	0
Coarse woody debris	Total length per hectare (m)	1060	1752	60.5	5	5
Native plant species richness	Trees	1	2	50.0	5	2.5
	Shrub	4	10	40.0	5	2.5
	Grass	2	4	50.0	5	2.5
	Forbs etc.	15	13	115.4	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	9.4	6	156.7	5	5
	Organic litter cover (%)	81.2	75	108.3	5	5
Size of Patch					10	7
Context					5	2
Connectivity					5	2
Total weighted score					100	**68.5**
BioCondition score (=Total score /100)					1	**0.685**

SITE ID: 2BA		Vegetation status: Remnant				
Regional Ecosystem: 11.5.1						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	40	17	235.3	15	15
Canopy	Median height (m)	12	20	60.0	5	3
	Cover (%)	16.9	25	67.6	5	5
Recruitment of dominant canopy species %		75	100	75.0	5	5
Shrubs	Native shrub cover (%)	0.6	6	10.0	5	3
Coarse woody debris	Total length per hectare (m)	1130	135	837.0	5	3
Native plant species richness	Trees	10	5	200.0	5	5
	Shrub	3	5	60.0	5	2.5
	Grass	7	8	87.5	5	2.5
	Forbs etc.	8	10	80.0	5	2.5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	57.4	23	249.6	5	5
	Organic litter cover (%)	21.4	45	47.6	5	3
Size of Patch					10	10
Context					5	5
Connectivity					5	4
Total weighted score					100	**83.5**
BioCondition score (=Total score /100)					1	**0.835**

SITE ID: 2BD		Vegetation status: Remnant				
Regional Ecosystem: 11.7.7						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	18	26	69.2	15	10
Canopy	Median height (m)	23	19	121.1	5	5
	Cover (%)	50.4	40	126.0	5	5
Recruitment of dominant canopy species %		0	100	0.0	5	0
Shrubs	Native shrub cover (%)	5.2	15	34.7	5	3
Coarse woody debris	Total length per hectare (m)	345	157	219.7	5	2
Native plant species richness	Trees	6	5	120.0	5	5
	Shrub	6	9	66.7	5	2.5
	Grass	5	4	125.0	5	5
	Forbs etc.	9	9	100.0	5	5
Non-native plant cover (%)		0.01	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	52.2	4	1305.0	5	5
	Organic litter cover (%)	37.4	68	55.0	5	5
Size of Patch					10	10
Context					5	5
Connectivity					5	4
Total weighted score					100	**81.5**
BioCondition score (=Total score /100)					1	**0.815**

SITE ID: 2BE		Vegetation status: Remnant				
Regional Ecosystem: 11.3.25						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	44	21	209.5	15	15
Canopy	Median height (m)	26.8	23	116.5	5	5
	Cover (%)	91.1	22	414.1	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0.2	1	20.0	5	3
Coarse woody debris	Total length per hectare (m)	316	375	84.3	5	5
Native plant species richness	Trees	3	4	75.0	5	2.5
	Shrub	2	2	100.0	5	5
	Grass	2	8	25.0	5	2.5
	Forbs etc.	22	12	183.3	5	5
Non-native plant cover (%)		0.1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	1	12	8.3	5	0
	Organic litter cover (%)	43.8	15	292.0	5	3
Size of Patch					10	10
Context					5	5
Connectivity					5	5
Total weighted score					100	**84**
BioCondition score (=Total score /100)					1	**0.84**

SITE ID: 1BC		Vegetation status: Remnant				
Regional Ecosystem: 11.5.1						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	6	17	35.3	15	5
Canopy	Median height (m)	13	20	65.0	5	3
	Cover (%)	58.5	25	234.0	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	1.4	6	23.3	5	3
Coarse woody debris	Total length per hectare (m)	940	135	696.3	5	2
Native plant species richness	Trees	2	5	40.0	5	2.5
	Shrub	8	5	160.0	5	5
	Grass	6	8	75.0	5	2.5
	Forbs etc.	15	10	150.0	5	5
Non-native plant cover (%)		0.1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	4	23	17.4	5	1
	Organic litter cover (%)	68	45	151.1	5	5
Size of Patch					10	10
Context					5	5
Connectivity					5	5
Total weighted score					100	**72**
BioCondition score (=Total score /100)					1	**0.72**

SITE ID: 2BB		Vegetation status: Remnant				
Regional Ecosystem: 11.3.14						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	34	40	85.0	15	10
Canopy	Median height (m)	14	14	100.0	5	5
	Cover (%)	56.9	26.5	214.7	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	1.8	7	25.7	5	3
Coarse woody debris	Total length per hectare (m)	1690	525	321.9	5	2
Native plant species richness	Trees	7	5	140.0	5	5
	Shrub	5	0	N/A	5	0
	Grass	9	12	75.0	5	2.5
	Forbs etc.	12	3	400.0	5	5
Non-native plant cover (%)		0.1	0		10	10
Ground cover	Native perennial grass cover (%)	4.6	26	17.7	5	1
	Organic litter cover (%)	85.2	48	177.5	5	5
Size of Patch					10	10
Context					5	2
Connectivity					5	4
Total weighted score					100	**72.5**
BioCondition score (=Total score /100)					1	**0.725**

SITE ID: 1BE		Vegetation status: Remnant				
Regional Ecosystem: 11.9.5						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	22	98	22.4	15	5
Canopy	Median height (m)	15	25	60.0	5	3
	Cover (%)	53.5	59	90.7	5	5
Recruitment of dominant canopy species %		60	100	60.0	5	3
Shrubs	Native shrub cover (%)	0	11	0.0	5	0
Coarse woody debris	Total length per hectare (m)	1690	616	274.4	5	2
Native plant species richness	Trees	4	2	200.0	5	5
	Shrub	3	10	30.0	5	2.5
	Grass	2	4	50.0	5	2.5
	Forbs etc.	13	9	144.4	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	1.6	4	40.0	5	1
	Organic litter cover (%)	72.8	66	110.3	5	5
Size of Patch					10	10
Context					5	5
Connectivity					5	4
Total weighted score					100	**68**
BioCondition score (=Total score /100)					1	**0.68**

SITE ID: 2BF		Vegetation status: Remnant				
Regional Ecosystem: 11.8.5						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	12	6	200.0	15	15
Canopy	Median height (m)	16	15	106.7	5	5
	Cover (%)	24.5	13	188.5	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	19	2	950.0	5	3
Coarse woody debris	Total length per hectare (m)	970	250	388.0	5	2
Native plant species richness	Trees	11	2	550.0	5	5
	Shrub	8	3	266.7	5	5
	Grass	3	6	50.0	5	2.5
	Forbs etc.	15	16	93.8	5	5
Non-native plant cover (%)		7.1	0	N/A	10	5
Ground cover	Native perennial grass cover (%)	1.8	60	3.0	5	0
	Organic litter cover (%)	38.8	25	155.2	5	5
Size of Patch					10	5
Context					5	2
Connectivity					5	2
Total weighted score					100	**71.5**
BioCondition score (=Total score /100)					1	**0.715**

Post-wet biocondition data

SITE ID: 1BA		Vegetation status: Remnant				
Regional Ecosystem: 11.5.1						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	5	17	29.4	15	5
Canopy	Median height (m)	15	20	75.0	5	5
	Cover (%)	54.7	25	218.8	5	3
Recruitment of dominant canopy species %		33	100	33.0	5	3
Shrubs	Native shrub cover (%)	0	6	0.0	5	0
Coarse woody debris	Total length per hectare (m)	1510	135	1118.5	5	2
Native plant species richness	Trees	7	5	140.0	5	5
	Shrub	6	5	120.0	5	5
	Grass	13	8	162.5	5	5
	Forbs etc.	18	10	180.0	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	23	23	100.0	5	5
	Organic litter cover (%)	40	45	88.9	5	5
Size of Patch					10	5
Context					5	0
Connectivity					5	4
Total weighted score					100	67
BioCondition score (=Total score /100)					1	**0.67**

SITE ID: 1BD		Vegetation status: Remnant				
Regional Ecosystem: 11.3.14						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	42	40	105.0	15	15
Canopy	Median height (m)	20	14	142.9	5	5
	Cover (%)	66.8	26.5	252.1	5	3
Recruitment of dominant canopy species %		67	100	67.0	5	3
Shrubs	Native shrub cover (%)	0	7	0.0	5	0
Coarse woody debris	Total length per hectare (m)	720	525	137.1	5	5
Native plant species richness	Trees	1	5	20.0	5	0
	Shrub	0	0	100.0	5	5
	Grass	9	12	75.0	5	5
	Forbs etc.	13	3	433.3	5	5
Non-native plant cover (%)		10	0	N/A	10	
Ground cover	Native perennial grass cover (%)	40	26	153.8	5	5
	Organic litter cover (%)	47	48	97.9	5	5
Size of Patch					10	10
Context					5	2
Connectivity					5	2
Total weighted score					100	70
BioCondition score (=Total score /100)					1	0.7

SITE ID: 2BB		Vegetation status: Remnant				
Regional Ecosystem: 11.3.14						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	0	40	0.0	15	0
Canopy	Median height (m)	8	14	57.1	5	3
	Cover (%)	11.1	26.5	41.9	5	2
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	7	0.0	5	0
Coarse woody debris	Total length per hectare (m)	680	525	129.5	5	5
Native plant species richness	Trees	2	5	40.0	5	2.5
	Shrub	6	0		5	0
	Grass	7	12	58.3	5	2.5
	Forbs etc.	3	3	100.0	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	48	26	184.6	5	5
	Organic litter cover (%)	11	48	22.9	5	1
Size of Patch					10	2
Context					5	0
Connectivity					5	0
Total weighted score					100	43
BioCondition score (=Total score /100)					1	**0.43**

SITE ID: 1BH		Vegetation status: Remnant				
Regional Ecosystem: 11.3.4						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	26	35	74.3	15	10
Canopy	Median height (m)	20	22	90.9	5	5
	Cover (%)	45.2	17	265.9	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	1	0.0	5	0
Coarse woody debris	Total length per hectare (m)	1420	384	369.8	5	2
Native plant species richness	Trees	3	4	75.0	5	2.5
	Shrub	1	2	50.0	5	2.5
	Grass	11	7	157.1	5	5
	Forbs etc.	12	10	120.0	5	5
Non-native plant cover (%)		2	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	19	43	44.2	5	1
	Organic litter cover (%)	27	20	135.0	5	5
Size of Patch					10	2
Context					5	2
Connectivity					5	4
Total weighted score					100	64
BioCondition score (=Total score /100)					1	**0.64**

SITE ID: 2BC		Vegetation status: Remnant				
Regional Ecosystem: 11.3.2						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	24	22	109.1	15	15
Canopy	Median height (m)	15	18	83.3	5	5
	Cover (%)	48.9	40	122.3	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	2	0.0	5	0
Coarse woody debris	Total length per hectare (m)	395	307	128.7	5	5
Native plant species richness	Trees	6	2	300.0	5	5
	Shrub	7	2	350.0	5	5
	Grass	14	9	155.6	5	5
	Forbs etc.	18	17	105.9	5	5
Non-native plant cover (%)		2	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	34	35	97.1	5	5
	Organic litter cover (%)	36	30	120.0	5	5
Size of Patch					10	2
Context					5	4
Connectivity					5	0
Total weighted score					100	81
BioCondition score (=Total score /100)					1	0.81

SITE ID: 1BM		Vegetation status: Remnant				
Regional Ecosystem: 11.8.5						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	20	6	333.3	15	15
Canopy	Median height (m)	16	15	106.7	5	5
	Cover (%)	56	13	430.8	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	7	2	350.0	5	3
Coarse woody debris	Total length per hectare (m)	455	250	182.0	5	5
Native plant species richness	Trees	10	2	500.0	5	5
	Shrub	6	3	200.0	5	5
	Grass	7	6	116.7	5	5
	Forbs etc.	22	16	137.5	5	5
Non-native plant cover (%)		5	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	25	60	41.7	5	1
	Organic litter cover (%)	28	25	112.0	5	5
Size of Patch					10	5
Context					5	2
Connectivity					5	2
Total weighted score					100	81
BioCondition score (=Total score /100)					1	0.81

SITE ID: 1BN		Vegetation status: Remnant				
Regional Ecosystem: 11.5.20						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	0	24	0.0	15	0
Canopy	Median height (m)	16	23	69.6	5	3
	Cover (%)	76.6	43	178.1	5	5
Recruitment of dominant canopy species %		50	100	50.0	5	3
Shrubs	Native shrub cover (%)	0	5	0.0	5	0
Coarse woody debris	Total length per hectare (m)	535	178	300.6	5	2
Native plant species richness	Trees	3	3	100.0	5	5
	Shrub	0	4	0.0	5	0
	Grass	10	7	142.9	5	5
	Forbs etc.	17	13	130.8	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	30	8	375.0	5	5
	Organic litter cover (%)	21	57	36.8	5	3
Size of Patch					10	2
Context					5	2
Connectivity					5	0
Total weighted score					100	50
BioCondition score (=Total score /100)					1	0.5

SITE ID: 2BG		Vegetation status: Remnant				
Regional Ecosystem: 11.8.5						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	18	6	300.0	15	15
Canopy	Median height (m)	14	15	93.3	5	5
	Cover (%)	50.9	13	391.5	5	3
Recruitment of dominant canopy species %		0	100	0.0	5	0
Shrubs	Native shrub cover (%)	0	2	0.0	5	0
Coarse woody debris	Total length per hectare (m)	70	250	28.0	5	2
Native plant species richness	Trees	2	2	100.0	5	5
	Shrub	0	3	0.0	5	0
	Grass	5	6	83.3	5	2.5
	Forbs etc.	5	16	31.3	5	0
Non-native plant cover (%)		70	0	N/A	10	0
Ground cover	Native perennial grass cover (%)	6	60	10.0	5	1
	Organic litter cover (%)	11	25	44.0	5	3
Size of Patch					10	0
Context					5	0
Connectivity					5	0
Total weighted score					100	36.5
BioCondition score (=Total score /100)					1	0.365

SITE ID: 1BR		Vegetation status: Remnant				
Regional Ecosystem: 11.3.25						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	34	21	161.9	15	15
Canopy	Median height (m)	25	23	108.7	5	5
	Cover (%)	57.4	22	260.9	5	3
Recruitment of dominant canopy species %		75	100	75.0	5	5
Shrubs	Native shrub cover (%)	0	1	0.0	5	0
Coarse woody debris	Total length per hectare (m)	675	375	180.0	5	5
Native plant species richness	Trees	9	4	225.0	5	5
	Shrub	0	2	0.0	5	0
	Grass	2	8	25.0	5	2.5
	Forbs etc.	5	12	41.7	5	2.5
Non-native plant cover (%)		95	0	N/A	10	0
Ground cover	Native perennial grass cover (%)	0	12	0.0	5	0
	Organic litter cover (%)	34	15	226.7	5	3
Size of Patch					10	10
Context					5	4
Connectivity					5	2
Total weighted score					100	**62**
BioCondition score (=Total score /100)					1	**0.62**

SITE ID: 2BK		Vegetation status: Remnant				
Regional Ecosystem: 11.5.4						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	6	17	35.3	15	5
Canopy	Median height (m)	23	21	109.5	5	5
	Cover (%)	13.3	30	44.3	5	2
Recruitment of dominant canopy species %		50	100	50.0	5	3
Shrubs	Native shrub cover (%)	0	7	0.0	5	0
Coarse woody debris	Total length per hectare (m)	1430	204	701.0	5	2
Native plant species richness	Trees	5	4	125.0	5	5
	Shrub	0	3	0.0	5	0
	Grass	6	13	46.2	5	2.5
	Forbs etc.	14	18	77.8	5	2.5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	10	30	33.3	5	1
	Organic litter cover (%)	71	58	122.4	5	5
Size of Patch					10	7
Context					5	2
Connectivity					5	2
Total weighted score					100	**54**
BioCondition score (=Total score /100)					1	**0.54**

SITE ID: 1BB		Vegetation status: Remnant				
Regional Ecosystem: 11.5.1						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	62	17	364.7	15	15
Canopy	Median height (m)	12	20	60.0	5	3
	Cover (%)	39	25	156.0	5	5
Recruitment of dominant canopy species %		75	100	75.0	5	5
Shrubs	Native shrub cover (%)	2	6	33.3	5	3
Coarse woody debris	Total length per hectare (m)	355	135	263.0	5	2
Native plant species richness	Trees	5	5	100.0	5	5
	Shrub	3	5	60.0	5	2.5
	Grass	6	8	75.0	5	2.5
	Forbs etc.	15	10	150.0	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	28	23	121.7	5	5
	Organic litter cover (%)	46	45	102.2	5	5
Size of Patch					10	10
Context					5	5
Connectivity					5	4
Total weighted score					100	87
BioCondition score (=Total score /100)					1	**0.87**

SITE ID: 2BA		Vegetation status: Remnant				
Regional Ecosystem: 11.3.14						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	40	40	100.0	15	15
Canopy	Median height (m)	14	14	100.0	5	5
	Cover (%)	26.5	26.5	100.0	5	5
Recruitment of dominant canopy species %		40	100	40.0	5	3
Shrubs	Native shrub cover (%)	7	7	100.0	5	5
Coarse woody debris	Total length per hectare (m)	525	525	100.0	5	5
Native plant species richness	Trees	5	5	100.0	5	5
	Shrub	0	0	100.0	5	5
	Grass	12	12	100.0	5	5
	Forbs etc.	3	3	100.0	5	5
Non-native plant cover (%)		2	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	26	26	100.0	5	5
	Organic litter cover (%)	48	48	100.0	5	5
Size of Patch					10	5
Context					5	0
Connectivity					5	2
Total weighted score					100	85
BioCondition score (=Total score /100)					1	0.85

SITE ID: 1BF		Vegetation status: Remnant				
Regional Ecosystem: 11.3.2						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	38	22	172.7	15	15
Canopy	Median height (m)	20	18	111.1	5	5
	Cover (%)	76.6	40	191.5	5	5
Recruitment of dominant canopy species %		50	100	50.0	5	3
Shrubs	Native shrub cover (%)	0	2	0.0	5	0
Coarse woody debris	Total length per hectare (m)	875	307	285.0	5	2
Native plant species richness	Trees	4	2	200.0	5	5
	Shrub	2	2	100.0	5	5
	Grass	8	9	88.9	5	2.5
	Forbs etc.	13	17	76.5	5	2.5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	37	35	105.7	5	5
	Organic litter cover (%)	46	30	153.3	5	5
Size of Patch					10	7
Context					5	2
Connectivity					5	4
Total weighted score					100	78
BioCondition score (=Total score /100)					1	0.78

SITE ID: 1BI		Vegetation status: Remnant				
Regional Ecosystem: 11.9.5						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	12	98	12.2	15	5
Canopy	Median height (m)	10	25	40.0	5	3
	Cover (%)	45.2	59	76.6	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	6	11	54.5	5	5
Coarse woody debris	Total length per hectare (m)	720	616	116.9	5	5
Native plant species richness	Trees	6	2	300.0	5	5
	Shrub	12	10	120.0	5	5
	Grass	5	4	125.0	5	5
	Forbs etc.	17	9	188.9	5	5
Non-native plant cover (%)		30	0	N/A	10	3
Ground cover	Native perennial grass cover (%)	23	4	575.0	5	5
	Organic litter cover (%)	30	66	45.5	5	3
Size of Patch					10	0
Context					5	0
Connectivity					5	0
Total weighted score					100	59
BioCondition score (=Total score /100)					1	0.59

SITE ID: 1BK		Vegetation status: Remnant				
Regional Ecosystem: 11.3.2						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	30	22	136.4	15	15
Canopy	Median height (m)	17	18	94.4	5	5
	Cover (%)	51.7	40	129.3	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	2	0.0	5	0
Coarse woody debris	Total length per hectare (m)	1065	307	346.9	5	2
Native plant species richness	Trees	3	2	150.0	5	5
	Shrub	1	2	50.0	5	2.5
	Grass	9	9	100.0	5	5
	Forbs etc.	10	17	58.8	5	2.5
Non-native plant cover (%)		10	0	N/A	10	5
Ground cover	Native perennial grass cover (%)	40	35	114.3	5	5
	Organic litter cover (%)	21	30	70.0	5	5
Size of Patch					10	7
Context					5	4
Connectivity					5	2
Total weighted score					100	75
BioCondition score (=Total score /100)					1	0.75

SITE ID: 2BE		Vegetation status: Non-remnant				
Regional Ecosystem: 11.8.4						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	10	14	71.4	15	10
Canopy	Median height (m)	15	14	107.1	5	5
	Cover (%)	23.1	27	85.6	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	2	0.0	5	0
Coarse woody debris	Total length per hectare (m)	345	128	269.5	5	2
Native plant species richness	Trees	6	4	150.0	5	5
	Shrub	5	6	83.3	5	2.5
	Grass	8	5	160.0	5	5
	Forbs etc.	14	6	233.3	5	5
Non-native plant cover (%)		30	0	N/A	10	3
Ground cover	Native perennial grass cover (%)	11	53	20.8	5	1
	Organic litter cover (%)	22	24	91.7	5	5
Size of Patch					10	2
Context					5	4
Connectivity					5	2
Total weighted score					100	61.5
BioCondition score (=Total score /100)					1	0.615

SITE ID: 1BO		Vegetation status: Remnant				
Regional Ecosystem: 11.5.14						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	10	10	100.0	15	15
Canopy	Median height (m)	8	8	100.0	5	5
	Cover (%)	7.2	7.2	100.0	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	0	#DIV/0!	5	5
Coarse woody debris	Total length per hectare (m)	85	85	100.0	5	5
Native plant species richness	Trees	3	3	100.0	5	5
	Shrub	1	1	100.0	5	5
	Grass	3	3	100.0	5	5
	Forbs etc.	12	12	100.0	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	41	41	100.0	5	5
	Organic litter cover (%)	11	11	100.0	5	5
Size of Patch					10	10
Context					5	5
Connectivity					5	5
Total weighted score					100	100
BioCondition score (=Total score /100)					1	1

SITE ID: 2BH		Vegetation status: Remnant				
Regional Ecosystem: 11.8.5						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	10	6	166.7	15	15
Canopy	Median height (m)	14	15	93.3	5	5
	Cover (%)	52.2	13	401.5	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	2	0.0	5	0
Coarse woody debris	Total length per hectare (m)	145	250	58.0	5	5
Native plant species richness	Trees	1	2	50.0	5	2.5
	Shrub	2	3	66.7	5	2.5
	Grass	18	6	300.0	5	5
	Forbs etc.	11	16	68.8	5	2.5
Non-native plant cover (%)		15	0	N/A	10	5
Ground cover	Native perennial grass cover (%)	45	60	75.0	5	3
	Organic litter cover (%)	27	25	108.0	5	5
Size of Patch					10	5
Context					5	2
Connectivity					5	2
Total weighted score					100	67.5
BioCondition score (=Total score /100)					1	0.675

SITE ID: 1BS		Vegetation status: Remnant				
Regional Ecosystem: 11.4.3						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	4	80	5.0	15	5
Canopy	Median height (m)	18	24	75.0	5	5
	Cover (%)	46.9	70	67.0	5	3
Recruitment of dominant canopy species %		0	100	0.0	5	0
Shrubs	Native shrub cover (%)	0	48	0.0	5	0
Coarse woody debris	Total length per hectare (m)	115	1752	6.6	5	0
Native plant species richness	Trees	5	2	250.0	5	5
	Shrub	8	10	80.0	5	2.5
	Grass	6	4	150.0	5	2.5
	Forbs etc.	19	13	146.2	5	5
Non-native plant cover (%)		10	0	N/A	10	5
Ground cover	Native perennial grass cover (%)	35	6	583.3	5	3
	Organic litter cover (%)	15	75	20.0	5	3
Size of Patch					10	0
Context					5	0
Connectivity					5	0
Total weighted score					100	39
BioCondition score (=Total score /100)					1	0.39

SITE ID: 1BC		Vegetation status: Remnant				
Regional Ecosystem: 11.4.3						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	32	80	40.0	15	5
Canopy	Median height (m)	15	24	62.5	5	3
	Cover (%)		70	0.0	5	
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	2	48	4.2	5	0
Coarse woody debris	Total length per hectare (m)	890	1752	50.8	5	5
Native plant species richness	Trees	9	2	450.0	5	5
	Shrub	6	10	60.0	5	2.5
	Grass	7	4	175.0	5	5
	Forbs etc.	22	13	169.2	5	5
Non-native plant cover (%)		2	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	26	6	433.3	5	5
	Organic litter cover (%)	21	75	28.0	5	3
Size of Patch					10	10
Context					5	4
Connectivity					5	4
Total weighted score					100	71.5
BioCondition score (=Total score /100)					1	0.715

SITE ID: 1BE		Vegetation status: Remnant				
Regional Ecosystem: 11.5.1						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	4	17	23.5	15	5
Canopy	Median height (m)	12	20	60.0	5	3
	Cover (%)	53	25	212.0	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	6	0.0	5	0
Coarse woody debris	Total length per hectare (m)	620	135	459.3	5	2
Native plant species richness	Trees	2	5	40.0	5	2.5
	Shrub	1	5	20.0	5	0
	Grass	9	8	112.5	5	5
	Forbs etc.	11	10	110.0	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	9	23	39.1	5	1
	Organic litter cover (%)	58	45	128.9	5	5
Size of Patch					10	7
Context					5	5
Connectivity					5	4
Total weighted score					100	62.5
BioCondition score (=Total score /100)					1	**0.625**

SITE ID: 1BG		Vegetation status: Remnant				
Regional Ecosystem: 11.9.7						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	74	16	462.5	15	15
Canopy	Median height (m)	16	16	100.0	5	5
	Cover (%)	84.8	27	314.1	5	3
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	2	1	200.0	5	5
Coarse woody debris	Total length per hectare (m)	625	287	217.8	5	2
Native plant species richness	Trees	7	3	233.3	5	5
	Shrub	3	5	60.0	5	2.5
	Grass	8	9	88.9	5	2.5
	Forbs etc.	30	28	107.1	5	5
Non-native plant cover (%)		1	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	8	26	30.8	5	1
	Organic litter cover (%)	77	16	481.3	5	3
Size of Patch					10	10
Context					5	4
Connectivity					5	4
Total weighted score					100	82
BioCondition score (=Total score /100)					1	**0.82**

SITE ID: 1BJ		Vegetation status: Remnant				
Regional Ecosystem: 11.3.2						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	28	22	127.3	15	15
Canopy	Median height (m)	20	18	111.1	5	5
	Cover (%)	27.8	40	69.5	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	0	2	0.0	5	0
Coarse woody debris	Total length per hectare (m)	320	307	104.2	5	5
Native plant species richness	Trees	3	2	150.0	5	5
	Shrub	1	2	50.0	5	2.5
	Grass	12	9	133.3	5	5
	Forbs etc.	21	17	123.5	5	5
Non-native plant cover (%)		50	0	N/A	10	3
Ground cover	Native perennial grass cover (%)	24	35	68.6	5	3
	Organic litter cover (%)	20	30	66.7	5	5
Size of Patch					10	5
Context					5	4
Connectivity					5	2
Total weighted score					100	74.5
BioCondition score (=Total score /100)					1	0.745

SITE ID: 2BD		Vegetation status: Non-remnant				
Regional Ecosystem: 11.3.25						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	22	21	104.8	15	15
Canopy	Median height (m)	16	23	69.6	5	3
	Cover (%)	41.1	22	186.8	5	5
Recruitment of dominant canopy species %		0	100	0.0	5	0
Shrubs	Native shrub cover (%)	0	1	0.0	5	0
Coarse woody debris	Total length per hectare (m)	165	375	44.0	5	2
Native plant species richness	Trees	2	4	50.0	5	2.5
	Shrub	2	2	100.0	5	5
	Grass	4	8	50.0	5	2.5
	Forbs etc.	8	12	66.7	5	2.5
Non-native plant cover (%)		2	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	55	12	458.3	5	5
	Organic litter cover (%)	12	15	80.0	5	5
Size of Patch					10	10
Context					5	2
Connectivity					5	2
Total weighted score					100	71.5
BioCondition score (=Total score /100)					1	0.715

SITE ID: 2BF		Vegetation status: Remnant				
Regional Ecosystem: 11.8.4						
BIOCONDITION ATTIRBUTE		Measurement			MAX SCORE	WEIGHTED SCORE
		Score	RE Benchmark	Pecentage of Benchmark		
Large trees	Total large trees per hectare	20	14	142.9	15	15
Canopy	Median height (m)	20	14	142.9	5	5
	Cover (%)	43.1	27	159.6	5	5
Recruitment of dominant canopy species %		100	100	100.0	5	5
Shrubs	Native shrub cover (%)	8	2	400.0	5	3
Coarse woody debris	Total length per hectare (m)	790	128	617.2	5	2
Native plant species richness	Trees	8	4	200.0	5	5
	Shrub	5	6	83.3	5	2.5
	Grass	7	5	140.0	5	5
	Forbs etc.	11	6	183.3	5	5
Non-native plant cover (%)		5	0	N/A	10	10
Ground cover	Native perennial grass cover (%)	38	53	71.7	5	3
	Organic litter cover (%)	12	24	50.0	5	5
Size of Patch					10	10
Context					5	4
Connectivity					5	4
Total weighted score					100	88.5
BioCondition score (=Total score /100)					1	0.885

APPENDIX

G

FLORA SPECIES LIST

Family	Scientific Name	Common Name	Nature Conservation Act 1992 Status	Environment Protection and Biodiversity Conservation Act 1999 Status	Exotic?
Acanthaceae	*Brunoniella australis*	Blue trumpet	C	-	-
Acanthaceae	*Pseuderanthemum variabile*	Pastel flower	C	-	-
Acanthaceae	*Rostellularia adscendens*	-	C	-	-
Acanthaceae	*Xerothamnella herbacea*	-	E	E	-
Aizoaceae	*Tetragonia tetragonoides*	New Zealand spinach	C	-	-
Amaranthaceae	*Alternanthera denticulata*	Lesser joyweed	C	-	-
Amaranthaceae	*Gomphrena celosioides*	Gomphrena weed	-	-	Yes
Amaranthaceae	*Nyssanthes erecta*	-	C	-	-
Amaranthaceae	*Ptilotus exaltatus*	-	-	-	-
Amaranthaceae	*Ptilotus nobilis*	-	C	-	-
Amaryllidaceae	*Calostemma luteum*	-	C	-	-
Anacardiaceae	*Schinus molle*	-	-	-	Yes
Apiaceae	*Actinotus gibbonsii*	Dwarf flannel flower	C	-	-
Apiaceae	*Centella asiatica*	-	C	-	-
Apiaceae	*Cyclospermum leptophyllum*	-	-	-	Yes
Apocynaceae	*Alstonia constricta*	Bitterbark	C	-	-
Apocynaceae	*Asclepias curassavica*	Red-head cottonbush	-	-	Yes
Apocynaceae	*Carissa ovata*	Currantbush	C	-	-
Apocynaceae	*Cynanchum viminale*	-	C	-	-
Apocynaceae	*Gomphocarpus physocarpus*	Balloon cottonbush	-	-	Yes
Apocynaceae	*Marsdenia viridiflora*	-	C	-	-
Apocynaceae	*Marsdenia viridiflora* subsp. *viridiflora*	-	C	-	-
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	C	-	-
Araliaceae	*Hydrocotyle acutiloba*	-	C	-	-
Asparagaceae	*Asparagus africanus*	Ornamental asparagus	-	-	Yes
Asphodelaceae	*Bulbine bulbosa*	Golden lily	C	-	-
Asphodelaceae	*Bulbine semibarbata*	Wild onion	C	-	-
Asteraceae	*Bidens pilosa*	-	-	-	Yes
Asteraceae	*Brachyscome dentata*	-	C	-	-
Asteraceae	*Brachyscome multifida*	-	C	-	-
Asteraceae	*Calotis cuneata*	-	C	-	-
Asteraceae	*Calotis cuneifolia*	Burr daisy	C	-	-
Asteraceae	*Calotis hispidula*	Bogan flea	C	-	-
Asteraceae	*Calotis lappulacea*	Yellow burr daisy	C	-	-
Asteraceae	*Cassinia laevis*	-	C	-	-
Asteraceae	*Centipeda minima*	-	C	-	-
Asteraceae	*Chrysocephalum apiculatum*	Yellow buttons	C	-	-
Asteraceae	*Cirsium vulgare*	Spear thistle	-	-	Yes
Asteraceae	*Erigeron bonariensis*	-	-	-	Yes
Asteraceae	*Euchiton sphaericus*	-	C	-	-
Asteraceae	*Lactuca serriola forma serriola*	-	-	-	Yes

Asteraceae	*Leiocarpa brevicompta*	-	C	-	-
Asteraceae	*Leiocarpa websteri*	-	C	-	-
Asteraceae	*Leontodon rhagadioloides*	-	-	-	Yes
Asteraceae	*Picris barbarorum*	-	V	-	-
Asteraceae	*Picris evae*	-	V	V	-
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey cudweed	C	-	-
Asteraceae	*Rhaponticum australe*	-	V	V	-
Asteraceae	*Senecio lautus*	-	C	-	-
Asteraceae	*Senecio queenslandicus*	-	C	-	-
Asteraceae	*Senecio tenuiflorus*	-	C	-	-
Asteraceae	*Sigesbeckia orientalis*	Indian weed	C	-	-
Asteraceae	*Silybum marianum*	Variegated thistle	-	-	Yes
Asteraceae	*Sonchus asper*	Rough sowthistle	-	-	Yes
Asteraceae	*Sonchus oleraceus*	Common sowthistle	-	-	Yes
Asteraceae	*Tagetes minuta*	Stinking roger	-	-	Yes
Asteraceae	*Verbesina encelioides*	Crownbeard	-	-	Yes
Asteraceae	*Vittadinia cuneata*	-	C	-	-
Asteraceae	*Vittadinia cuneata* var. *hirsuta*	-	C	-	-
Asteraceae	*Vittadinia sulcata*	Native daisy	C	-	-
Asteraceae	*Vittadinia tenuissima*	Western New Holland daisy	C	-	-
Asteraceae	*Xanthium occidentale*	-	-	-	Yes
Asteraceae	*Xanthium spinosum*	Bathurst burr	-	-	Yes
Asteraceae	*Zinnia peruviana*	Wild zinnia	-	-	Yes
Bignoniaceae	*Dolichandra unguis-cati*	Cat's claw creeper	-	-	Yes
Bignoniaceae	*Pandorea jasminoides*	-	C	-	-
Bignoniaceae	*Pandorea pandorana*	Wonga vine	C	-	-
Bignoniaceae	*Tecoma stans*	Tecoma	-	-	Yes
Boraginaceae	*Echium plantagineum*	Paterson's curse	-	-	Yes
Boraginaceae	*Ehretia membranifolia*	Weeping koda	C	-	-
Boraginaceae	*Hackelia suaveolens*	-	C	-	-
Boraginaceae	*Heliotropium amplexicaule*	Blue heliotrope	-	-	Yes
Brassicaceae	*Lepidium africanum*	Common peppercress	-	-	Yes
Brassicaceae	*Lepidium bonariense*	Argentine peppercress	-	-	Yes
Brassicaceae	*Lepidium monoplocoides*	Winged peppercress	C	E	-
Brassicaceae	*Rapistrum rugosum*	-	-	-	Yes
Brassicaceae	*Sisymbrium erysimoides*	Smooth mustard	-	-	Yes
Brassicaceae	*Sisymbrium irio*	London rocket	-	-	Yes
Brassicaceae	*Sisymbrium officinale*	Hedge mustard	-	-	Yes
Brassicaceae	*Sisymbrium orientale*	Indian hedge mustard	-	-	Yes
Byttneriaceae	*Seringia collina*	-	C	-	-
Byttneriaceae	*Seringia corollata*	-	C	-	-
Cactaceae	*Cereus uruguayanus*	-	-	-	Yes
Cactaceae	*Harrisia martinii*	-	-	-	Yes
Cactaceae	*Harrisia pomanensis*	-	-	-	Yes
Cactaceae	*Harrisia tortuosa*	-	-	-	Yes
Cactaceae	*Opuntia aurantiaca*	Tiger pear	-	-	Yes

Cactaceae	*Opuntia stricta*	-	-	-	Yes
Cactaceae	*Opuntia tomentosa*	Velvety tree pear	-	-	Yes
Caesalpiniaceae	*Senna artemisioides*	-	C	-	-
Campanulaceae	*Lobelia concolor*	-	C	-	-
Campanulaceae	*Wahlenbergia capillaris*	-	C	-	-
Campanulaceae	*Wahlenbergia ceracea*	-	C	-	-
Campanulaceae	*Wahlenbergia fluminalis*	River bluebell	C	-	-
Campanulaceae	*Wahlenbergia graniticola*	Granite bluebell	C	-	-
Campanulaceae	*Wahlenbergia littoricola*	-	C	-	-
Campanulaceae	*Wahlenbergia stricta*	-	C	-	-
Campanulaceae	*Wahlenbergia tumidifructa*	-	C	-	-
Capparaceae	*Capparis anomala*	-	C	-	-
Capparaceae	*Capparis lasiantha*	Nipan	C	-	-
Capparaceae	*Capparis loranthifolia*	-	C	-	-
Capparaceae	*Capparis mitchellii*	-	C	-	-
Caryophyllaceae	*Paronychia brasiliana*	Brazilian whitlow	-	-	Yes
Caryophyllaceae	*Petrorhagia dubia*	-	-	-	Yes
Casuarinaceae	*Allocasuarina inophloia*	-	C	-	-
Casuarinaceae	*Allocasuarina luehmannii*	Bull oak	C	-	-
Casuarinaceae	*Casuarina cristata*	Belah	C	-	-
Celastraceae	*Denhamia silvestris*	-	C	-	-
Celastraceae	*Elaeodendron australe*	-	C	-	-
Celastraceae	*Elaeodendron australe* var. *australe*	-	C	-	-
Celastraceae	*Elaeodendron australe* var. *integrifolium*	-	C	-	-
Celastraceae	*Elaeodendron melanocarpum*	-	C	-	-
Chenopodiaceae	*Dysphania carinata*	-	C	-	-
Chenopodiaceae	*Dysphania cristata*	-	C	-	-
Chenopodiaceae	*Dysphania melanocarpa*	-	C	-	-
Chenopodiaceae	*Einadia hastata*	-	C	-	-
Chenopodiaceae	*Einadia nutans*	-	C	-	-
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	-	C	-	-
Chenopodiaceae	*Enchylaena tomentosa*	-	C	-	-
Chenopodiaceae	*Maireana enchylaenoides*	-	C	-	-
Chenopodiaceae	*Maireana microphylla*	-	C	-	-
Chenopodiaceae	*Rhagodia parabolica*	-	C	-	-
Chenopodiaceae	*Rhagodia spinescens*	Thorny saltbush	C	-	-
Chenopodiaceae	*Salsola australis*	-	C	-	-
Chenopodiaceae	*Sclerolaena birchii*	Galvanised burr	C	-	-
Chenopodiaceae	*Sclerolaena deserticola*	-	C	-	-
Chenopodiaceae	*Sclerolaena muricata*	-	C	-	-
Chenopodiaceae	*Sclerolaena muricata* var. *villosa*	-	C	-	-
Chenopodiaceae	*Sclerolaena tetracuspis*	Brigalow burr	C	-	-
Chenopodiaceae	*Sclerolaena tricuspis*	Giant red burr	C	-	-
Commelinaceae	*Commelina diffusa*	Wandering jew	C	-	-
Commelinaceae	*Commelina lanceolata*	-	C	-	-
Commelinaceae	*Murdannia graminea*	Murdannia	C	-	-

Convolvulaceae	*Convolvulus graminetinus*	-	C	-	-
Convolvulaceae	*Dichondra repens*	Kidney weed	C	-	-
Convolvulaceae	*Evolvulus alsinoides*	-	C	-	-
Convolvulaceae	*Evolvulus alsinoides* var. *decumbens*	-	C	-	-
Convolvulaceae	*Ipomoea purpurea*	Common morning glory	-	-	Yes
Crassulaceae	*Bryophyllum daigremontianum*	-	-	-	Yes
Crassulaceae	*Bryophyllum delagoense*	-	-	-	Yes
Cupressaceae	*Callitris endlicheri*	Black cypress pine	C	-	-
Cupressaceae	*Callitris glaucophylla*	White cypress pine	C	-	-
Cyperaceae	*Carex appressa*	-	C	-	-
Cyperaceae	*Cyperus bifax*	Western nutgrass	C	-	-
Cyperaceae	*Cyperus clarus*	-	V	-	-
Cyperaceae	*Cyperus exaltatus*	Tall flatsedge	C	-	-
Cyperaceae	*Cyperus fulvus*	-	C	-	-
Cyperaceae	*Cyperus gracilis*	-	C	-	-
Cyperaceae	*Eleocharis plana*	Ribbed spikerush	C	-	-
Cyperaceae	*Gahnia aspera*	-	C	-	-
Cyperaceae	*Scleria mackaviensis*	-	C	-	-
Dilleniaceae	*Hibbertia cistoidea*	-	C	-	-
Ericaceae	*Monotoca scoparia*	Prickly broom heath	C	-	-
Euphorbiaceae	*Euphorbia dallachyana*	-	C	-	-
Euphorbiaceae	*Euphorbia drummondii*	-	C	-	-
Fabaceae	*Cullen tenax*	Emu-foot	C	-	-
Fabaceae	*Daviesia genistifolia*	Broom bitter pea	C	-	-
Fabaceae	*Glycine clandestina*	-	C	-	-
Fabaceae	*Glycine latifolia*	-	C	-	-
Fabaceae	*Glycine tabacina*	Glycine pea	C	-	-
Fabaceae	*Glycine tomentella*	Woolly glycine	C	-	-
Fabaceae	*Indigofera baileyi*	-	C	-	-
Fabaceae	*Jacksonia scoparia*	-	C	-	-
Fabaceae	*Lotus australis*	Australian trefoil	C	-	-
Fabaceae	*Medicago lupulina*	Black medic	-	-	Yes
Fabaceae	*Medicago minima*	Small burr medic	-	-	Yes
Fabaceae	*Melilotus albus*	Sweet clover	-	-	Yes
Fabaceae	*Rhynchosia minima*	-	C	-	-
Fabaceae	*Swainsona galegifolia*	Smooth Darling pea	C	-	-
Fabaceae	*Swainsona oroboides*	Variable swainsona	C	-	-
Fabaceae	*Templetonia stenophylla*	Leafy templetonia	C	-	-
Fabaceae	*Vicia monantha*	-	-	-	Yes
Fabaceae	*Vicia sativa*	-	-	-	Yes
Fabaceae	*Vigna radiata*	-	C	-	-
Geraniaceae	*Erodium crinitum*	Blue crowfoot	C	-	-
Geraniaceae	*Geranium solanderi*	-	C	-	-
Goodeniaceae	*Goodenia glabra*	-	C	-	-
Goodeniaceae	*Goodenia rotundifolia*	-	C	-	-
Goodeniaceae	*Scaevola spinescens*	Prickly fan flower	C	-	-

Haloragaceae	*Haloragis aspera*	Raspweed	C	-	-
Hemerocallidaceae	*Dianella longifolia*	-	C	-	-
Hemerocallidaceae	*Dianella revoluta*	-	C	-	-
Hemerocallidaceae	*Geitonoplesium cymosum*	Scrambling lily	C	-	-
Juncaceae	*Juncus continuus*	-	C	-	-
Juncaceae	*Juncus usitatus*	-	C	-	-
Lamiaceae	*Coleus australis*	-	C	-	-
Lamiaceae	*Lamium amplexicaule*	Deadnettle	-	-	Yes
Lamiaceae	*Mentha satureioides*	Native pennyroyal	C	-	-
Lamiaceae	*Salvia reflexa*	-	-	-	Yes
Lamiaceae	*Stachys arvensis*	Stagger weed	-	-	Yes
Lamiaceae	*Teucrium junceum*	-	C	-	-
Lamiaceae	*Westringia parvifolia*	-	V	V	-
Laxmanniaceae	*Laxmannia gracilis*	Slender wire lily	C	-	-
Laxmanniaceae	*Lomandra confertifolia* subsp. *pallida*	-	C	-	-
Laxmanniaceae	*Lomandra filiformis*	-	C	-	-
Laxmanniaceae	*Lomandra leucocephala*	-	C	-	-
Laxmanniaceae	*Lomandra longifolia*	-	C	-	-
Laxmanniaceae	*Lomandra multiflora*	-	C	-	-
Loranthaceae	*Amyema cambagei*	-	C	-	-
Loranthaceae	*Amyema congener* subsp. *congener*	-	C	-	-
Loranthaceae	*Amyema linophylla* subsp. *orientalis*	-	C	-	-
Loranthaceae	*Amyema quandang* var. *quandang*	-	C	-	-
Malvaceae	*Abutilon fraseri*	Dwarf lantern flower	C	-	-
Malvaceae	*Abutilon oxycarpum*	-	C	-	-
Malvaceae	*Anoda cristata*	Anoda weed	-	-	Yes
Malvaceae	*Hibiscus sturtii*	-	C	-	-
Malvaceae	*Hibiscus tridactylites*	-	C	-	-
Malvaceae	*Malva parviflora*	Small-flowered mallow	-	-	Yes
Malvaceae	*Malvastrum americanum*	-	-	-	Yes
Malvaceae	*Malvastrum americanum* var. *americanum*	-	-	-	Yes
Malvaceae	*Malvastrum coromandelianum*	Prickly malvastrum	-	-	Yes
Malvaceae	*Modiola caroliniana*	Red-flowered mallow	-	-	Yes
Malvaceae	*Sida Cordifolia*	-	-	-	Yes
Malvaceae	*Sida cunninghamii*	-	C	-	-
Malvaceae	*Sida fibulifera*	-	C	-	-
Malvaceae	*Sida hackettiana*	-	C	-	-
Malvaceae	*Sida rhombifolia*	-	-	-	Yes
Malvaceae	*Sida rohlenae*	-	C	-	-
Marsileaceae	*Marsilea drummondii*	Common nardoo	C	-	-
Marsileaceae	*Marsilea hirsuta*	Hairy nardoo	C	-	-
Mimosaceae	*Acacia concurrens*	-	C	-	-
Mimosaceae	*Acacia conferta*	-	C	-	-
Mimosaceae	*Acacia crassa*	-	C	-	-
Mimosaceae	*Acacia decora*	Pretty wattle	C	-	-
Mimosaceae	*Acacia excelsa*	-	C	-	-

Mimosaceae	*Acacia harpophylla*	Brigalow	C	-	-
Mimosaceae	*Acacia leiocalyx*	-	C	-	-
Mimosaceae	*Acacia maidenii*	Maiden's wattle	C	-	-
Mimosaceae	*Acacia neriifolia*	Pechey wattle	C	-	-
Mimosaceae	*Acacia omalophylla*	-	C	-	-
Mimosaceae	*Acacia oswaldii*	Miljee	C	-	-
Mimosaceae	*Acacia pendula*	Myall	C	-	-
Mimosaceae	*Acacia salicina*	Doolan	C	-	-
Mimosaceae	*Acacia shirleyi*	Lancewood	C	-	-
Mimosaceae	*Acacia stenophylla*	Belalie	C	-	-
Mimosaceae	*Neptunia gracilis*	-	C	-	-
Mimosaceae	*Vachellia farnesiana*	-	-	-	Yes
Molluginaceae	*Glinus lotoides*	Hairy carpet weed	C	-	-
Myrsinaceae	*Lysimachia arvensis*	-	-	-	Yes
Myrtaceae	*Angophora floribunda*	Rough-barked apple	C	-	-
Myrtaceae	*Angophora leiocarpa*	Rusty gum	C	-	-
Myrtaceae	*Angophora subvelutina*	-	C	-	-
Myrtaceae	*Calytrix longiflora*	Pink fringe myrtle	C	-	-
Myrtaceae	*Corymbia clarksoniana*	-	C	-	-
Myrtaceae	*Corymbia tessellaris*	Moreton Bay ash	C	-	-
Myrtaceae	*Corymbia trachyphloia*	-	C	-	-
Myrtaceae	*Eucalyptus albens*	White box	C	-	-
Myrtaceae	*Eucalyptus argophloia*	Queensland western white gum	V	V	-
Myrtaceae	*Eucalyptus camaldulensis*	-	C	-	-
Myrtaceae	*Eucalyptus chloroclada*	Baradine red gum	C	-	-
Myrtaceae	*Eucalyptus conica*	Inland grey box	C	-	-
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved red ironbark	C	-	-
Myrtaceae	*Eucalyptus fibrosa*	-	C	-	-
Myrtaceae	*Eucalyptus fibrosa* subsp. *nubilis*	-	C	-	-
Myrtaceae	*Eucalyptus melanophloia*	-	C	-	-
Myrtaceae	*Eucalyptus moluccana*	Gum-topped box	C	-	-
Myrtaceae	*Eucalyptus orgadophila*	Mountain coolibah	C	-	-
Myrtaceae	*Eucalyptus populnea*	Poplar box	C	-	-
Myrtaceae	*Eucalyptus tereticornis*	-	C	-	-
Myrtaceae	*Eucalyptus tereticornis* subsp. *basaltica*	-	C	-	-
Myrtaceae	*Eucalyptus viridis*	-	C	-	-
Myrtaceae	*Eucalyptus woollsiana*	-	C	-	-
Myrtaceae	*Kunzea opposita* var. *opposita*	-	C	-	-
Myrtaceae	*Leptospermum brevipes*	-	C	-	-
Myrtaceae	*Leptospermum lamellatum*	-	C	-	-
Myrtaceae	*Leptospermum polygalifolium*	Tantoon	C	-	-
Myrtaceae	*Melaleuca densispicata*	-	C	-	-
Myrtaceae	*Melaleuca lanceolata*	-	C	-	-
Myrtaceae	*Melaleuca nodosa*	-	C	-	-
Myrtaceae	*Melaleuca trichostachya*	-	C	-	-

Nyctaginaceae	*Boerhavia dominii*	-	C	-	-
Oleaceae	*Jasminum dianthifolium*	-	C	-	-
Oleaceae	*Jasminum didymum*	-	C	-	-
Oleaceae	*Jasminum didymum* subsp. *lineare*	-	C	-	-
Oleaceae	*Jasminum simplicifolium* subsp. *australiense*	-	C	-	-
Oleaceae	*Notelaea microcarpa*	-	C	-	-
Oleaceae	*Olea europaea*	Common olive	-	-	Yes
Onagraceae	*Ludwigia peploides*	-	-	-	-
Orchidaceae	*Diuris tricolor*	-	C	-	-
Oxalidaceae	*Oxalis perennans*	-	C	-	-
Oxalidaceae	*Oxalis radicosa*	-	C	-	-
Pentapetaceae	*Melhania oblongifolia*	-	C	-	-
Phyllanthaceae	*Breynia oblongifolia*	-	C	-	-
Phyllanthaceae	*Phyllanthus fuernrohrii*	-	C	-	-
Phyllanthaceae	*Phyllanthus maderaspatensis*	-	C	-	-
Phyllanthaceae	*Phyllanthus virgatus*	-	C	-	-
Phyllanthaceae	*Poranthera microphylla*	Small poranthera	C	-	-
Picrodendraceae	*Petalostigma pubescens*	Quinine tree	C	-	-
Pittosporaceae	*Auranticarpa rhombifolia*	-	C	-	-
Pittosporaceae	*Bursaria spinosa* subsp. *spinosa*	-	C	-	-
Pittosporaceae	*Pittosporum angustifolium*	-	C	-	-
Pittosporaceae	*Pittosporum spinescens*	-	C	-	-
Plantaginaceae	*Misopates orontium*	Lesser snapdragon	-	-	Yes
Plantaginaceae	*Plantago debilis*	Shade plantain	C	-	-
Plantaginaceae	*Plantago lanceolata*	-	-	-	Yes
Poaceae	*Alloteropsis semialata*	Cockatoo grass	C	-	-
Poaceae	*Ancistrachne uncinulata*	Hooky grass	C	-	-
Poaceae	*Anthosachne plurinervis*	-	C	-	-
Poaceae	*Aristida benthamii*	-	C	-	-
Poaceae	*Aristida calycina*	-	C	-	-
Poaceae	*Aristida caput-medusae*	-	C	-	-
Poaceae	*Aristida jerichoensis*	-	C	-	-
Poaceae	*Aristida latifolia*	Feathertop wiregrass	C	-	-
Poaceae	*Aristida leptopoda*	White speargrass	C	-	-
Poaceae	*Aristida queenslandica*	-	C	-	-
Poaceae	*Aristida ramosa*	Purple wiregrass	C	-	-
Poaceae	*Arundinella nepalensis*	Reedgrass	C	-	-
Poaceae	*Astrebla elymoides*	Hoop mitchell grass	C	-	-
Poaceae	*Austrostipa aristiglumis*	Plains grass	C	-	-
Poaceae	*Austrostipa scabra*	-	C	-	-
Poaceae	*Austrostipa verticillata*	Slender bamboo grass	C	-	-
Poaceae	*Bothriochloa biloba*	-	C	-	-
Poaceae	*Bothriochloa bladhii*	-	C	-	-
Poaceae	*Bothriochloa decipiens*	-	C	-	-
Poaceae	*Bothriochloa erianthoides*	Satintop grass	C	-	-

Poaceae	*Bothriochloa pertusa*	-	-	-	Yes
Poaceae	*Cenchrus ciliaris*	-	-	-	Yes
Poaceae	*Cenchrus clandestinus*	-	-	-	Yes
Poaceae	*Cenchrus longisetus*	-	-	-	Yes
Poaceae	*Chloris divaricata*	-	C	-	-
Poaceae	*Chloris gayana*	Rhodes grass	-	-	Yes
Poaceae	*Chloris truncata*	-	C	-	-
Poaceae	*Chloris ventricosa*	Tall chloris	C	-	-
Poaceae	*Chloris virgata*	Feathertop rhodes grass	-	-	Yes
Poaceae	*Chrysopogon fallax*	-	C	-	-
Poaceae	*Cleistochloa subjuncea*	-	C	-	-
Poaceae	*Cymbopogon refractus*	Barbed-wire grass	C	-	-
Poaceae	*Cynodon dactylon*	-	-	-	Yes
Poaceae	*Dactyloctenium radulans*	Button grass	C	-	-
Poaceae	*Dichanthium aristatum*	Angleton grass	-	-	Yes
Poaceae	*Dichanthium queenslandicum*	-	V	E	-
Poaceae	*Dichanthium sericeum*	-	C	-	-
Poaceae	*Digitaria brownii*	-	C	-	-
Poaceae	*Digitaria diminuta*	-	C	-	-
Poaceae	*Digitaria divaricatissima*	Spreading umbrella grass	C	-	-
Poaceae	*Digitaria porrecta*	-	NT	-	-
Poaceae	*Dinebra divaricatissima*	-	C	-	-
Poaceae	*Enneapogon avenaceus*	-	C	-	-
Poaceae	*Enteropogon acicularis*	Curly windmill grass	C	-	-
Poaceae	*Enteropogon ramosus*	-	C	-	-
Poaceae	*Entolasia marginata*	Bordered panic	C	-	-
Poaceae	*Entolasia minutifolia*	-	C	-	-
Poaceae	*Eragrostis brownii*	Brown's lovegrass	C	-	-
Poaceae	*Eragrostis cilianensis*	-	-	-	Yes
Poaceae	*Eragrostis curvula*	-	-	-	Yes
Poaceae	*Eragrostis lacunaria*	Purple lovegrass	C	-	-
Poaceae	*Eragrostis leptostachya*	-	C	-	-
Poaceae	*Eragrostis parviflora*	Weeping lovegrass	C	-	-
Poaceae	*Eragrostis sororia*	-	C	-	-
Poaceae	*Eragrostis spartinoides*	-	C	-	-
Poaceae	*Eragrostis trichophora*	-	-	-	Yes
Poaceae	*Eriochloa crebra*	Spring grass	C	-	-
Poaceae	*Eulalia aurea*	Silky browntop	C	-	-
Poaceae	*Heteropogon contortus*	Black speargrass	C	-	-
Poaceae	*Homopholis belsonii*	-	E	V	-
Poaceae	*Hordeum vulgare*	-	-	-	Yes
Poaceae	*Hyparrhenia hirta*	Coolati grass	-	-	Yes
Poaceae	*Leersia hexandra*	Swamp rice grass	C	-	-
Poaceae	*Leptochloa digitata*	-	C	-	-
Poaceae	*Megathyrsus maximus*	-	-	-	Yes
Poaceae	*Megathyrsus maximus* var. *pubiglumis*	-	-	-	Yes

Poaceae	*Melinis repens*	Red natal grass	-	-	Yes
Poaceae	*Oplismenus imbecillis*	-	C	-	-
Poaceae	*Panicum decompositum*	-	C	-	-
Poaceae	*Panicum effusum*	-	C	-	-
Poaceae	*Panicum queenslandicum*	-	C	-	-
Poaceae	*Paspalidium caespitosum*	Brigalow grass	C	-	-
Poaceae	*Paspalidium distans*	Shotgrass	C	-	-
Poaceae	*Paspalidium gracile*	Slender panic	C	-	-
Poaceae	*Perotis rara*	Comet grass	C	-	-
Poaceae	*Phalaris paradoxa*	Paradoxa grass	-	-	Yes
Poaceae	*Phragmites australis*	Common reed	C	-	-
Poaceae	*Sarga leiocladum*	-	C	-	-
Poaceae	*Setaria incrassata*	-	-	-	Yes
Poaceae	*Setaria sphacelata*	-	-	-	Yes
Poaceae	*Setaria surgens*	-	C	-	-
Poaceae	*Sorghum bicolor*	Forage sorghum	-	-	Yes
Poaceae	*Sorghum halepense*	Johnson grass	-	-	Yes
Poaceae	*Sporobolus caroli*	Fairy grass	C	-	-
Poaceae	*Sporobolus creber*	-	C	-	-
Poaceae	*Themeda avenacea*	-	C	-	-
Poaceae	*Themeda triandra*	Kangaroo grass	C	-	-
Poaceae	*Thyridolepis xerophila*	-	C	-	-
Poaceae	*Tragus australianus*	Small burr grass	C	-	-
Poaceae	*Triodia scariosa*	-	C	-	-
Poaceae	*Triticum aestivum*	Wheat	-	-	Yes
Poaceae	*Urochloa mosambicensis*	Sabi grass	-	-	Yes
Poaceae	*Walwhalleya proluta*	-	C	-	-
Poaceae	*Walwhalleya subxerophila*	-	C	-	-
Polygonaceae	*Persicaria prostrata*	Creeping knotweed	C	-	-
Polygonaceae	*Polygonum aviculare*	Wireweed	-	-	Yes
Polygonaceae	*Polygonum plebeium*	Small knotweed	C	-	-
Polygonaceae	*Rumex brownii*	Swamp dock	C	-	-
Polygonaceae	*Rumex crispus*	Curled dock	-	-	Yes
Polygonaceae	*Rumex hypogaeus*	-	-	-	Yes
Portulacaceae	*Calandrinia pickeringii*	-	C	-	-
Portulacaceae	*Portulaca australis*	-	C	-	-
Portulacaceae	*Portulaca filifolia*	-	C	-	-
Portulacaceae	*Portulaca oleracea*	Pigweed	-	-	Yes
Portulacaceae	*Portulaca pilosa*	-	-	-	Yes
Proteaceae	*Xylomelum cunninghamianum*	-	C	-	-
Pteridaceae	*Cheilanthes brownii*	-	C	-	-
Pteridaceae	*Cheilanthes distans*	Bristly cloak fern	C	-	-
Pteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	-	C	-	-
Rhamnaceae	*Alphitonia excelsa*	Soap tree	C	-	-
Rhamnaceae	*Cryptandra amara*	-	C	-	-
Rosaceae	*Pyracantha angustifolia*	-	-	-	Yes

Rubiaceae	*Asperula conferta*	-	C	-	-
Rubiaceae	*Knoxia sumatrensis*	-	C	-	-
Rubiaceae	*Pomax umbellata*	-	C	-	-
Rubiaceae	*Psydrax odorata*	-	C	-	-
Rubiaceae	*Psydrax odorata forma buxifolia*	-	C	-	-
Rubiaceae	*Psydrax oleifolia*	-	C	-	-
Rutaceae	*Boronia bipinnata*	Rock boronia	C	-	-
Rutaceae	*Citrus glauca*	-	C	-	-
Rutaceae	*Geijera parviflora*	Wilga	C	-	-
Rutaceae	*Geijera salicifolia*	Brush wilga	C	-	-
Santalaceae	*Choretrum candollei*	White sour bush	C	-	-
Santalaceae	*Santalum lanceolatum*	-	C	-	-
Sapindaceae	*Alectryon diversifolius*	Scrub boonaree	C	-	-
Sapindaceae	*Alectryon oleifolius* subsp. *elongatus*	-	C	-	-
Sapindaceae	*Atalaya hemiglauca*	-	C	-	-
Sapindaceae	*Dodonaea triangularis*	-	C	-	-
Sapindaceae	*Dodonaea viscosa*	-	C	-	-
Sapindaceae	*Dodonaea viscosa* subsp. *angustifolia*	-	C	-	-
Sapindaceae	*Dodonaea viscosa* subsp. *spatulata*	-	C	-	-
Scrophulariaceae	*Eremophila debilis*	Winter apple	C	-	-
Scrophulariaceae	*Eremophila deserti*	-	C	-	-
Scrophulariaceae	*Eremophila mitchellii*	-	C	-	-
Scrophulariaceae	*Myoporum acuminatum*	Coastal boobialla	C	-	-
Solanaceae	*Capsicum annuum* var. *glabriusculum*	-	-	-	Yes
Solanaceae	*Lycium ferocissimum*	African boxthorn	-	-	Yes
Solanaceae	*Physalis angulata*	-	-	-	Yes
Solanaceae	*Physalis lanceifolia*	-	-	-	Yes
Solanaceae	*Solanum americanum*	-	-	-	Yes
Solanaceae	*Solanum chenopodioides*	Whitetip nightshade	-	-	Yes
Solanaceae	*Solanum ellipticum*	Potato bush	C	-	-
Solanaceae	*Solanum esuriale*	Quena	C	-	-
Solanaceae	*Solanum ferocissimum*	-	C	-	-
Solanaceae	*Solanum nigrum*	-	-	-	Yes
Solanaceae	*Solanum parvifolium*	-	C	-	-
Solanaceae	*Solanum semiarmatum*	Prickly nightshade	C	-	-
Solanaceae	*Solanum stelligerum*	Devil's needles	C	-	-
Solanaceae	*Solanum tetrathecum*	-	C	-	-
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*	-	C	-	-
Thymelaeaceae	*Pimelea linifolia*	-	C	-	-
Thymelaeaceae	*Pimelea neoanglica*	Poison pimelea	C	-	-
Thymelaeaceae	*Pimelea trichostachya*	Flaxweed	C	-	-
Ulmaceae	*Celtis sinensis*	Chinese elm	-	-	Yes
Verbenaceae	*Glandularia aristigera*	-	-	-	Yes
Verbenaceae	*Lantana montevidensis*	Creeping lantana	-	-	Yes
Verbenaceae	*Phyla canescens*	-	-	-	Yes
Verbenaceae	*Verbena gaudichaudii*	-	C	-	-

Verbenaceae	*Verbena litoralis*	Verbena	-	-	Yes
Viscaceae	*Korthalsella rubra* subsp. *rubra*	-	C	-	-
Vitaceae	*Clematicissus opaca*	-	C	-	-
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	-	C	-	-
Zygophyllaceae	*Tribulus micrococcus*	Yellow vine	C	-	-
Zygophyllaceae	*Tribulus minutus*	-	C	-	-
Zygophyllaceae	*Tribulus terrestris*	Caltrop	C	-	-
Zygophyllaceae	*Zygophyllum apiculatum*	Gall weed	C	-	-

APPENDIX H

THREATENED FLORA RECORDS

ARTC

Flora EVNT Page 1

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)

Spring Survey

- *Xerothamnella herbacea*

Suburb labels as per Australian Bureau of Statistics (2011)

1:10,000 Scale at A3

m
0 100 200 300

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Flora EVNT Page 2

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Post-Wet Survey

- *Lepidium monoplocoides*
- *Westringia parvifolia*

Spring Survey

- *Lepidium monoplocoides*
- *Westringia parvifolia*

Suburb labels as per Australian Bureau of Statistics (2011)

1:30,000 Scale at A3

m
0 300 600 900

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Flora EVNT Page 3

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Post-Wet Survey

- *Digitaria porrecta*
- *Homopholis belsoni*

Suburb labels as per Australian Bureau of Statistics (2011)

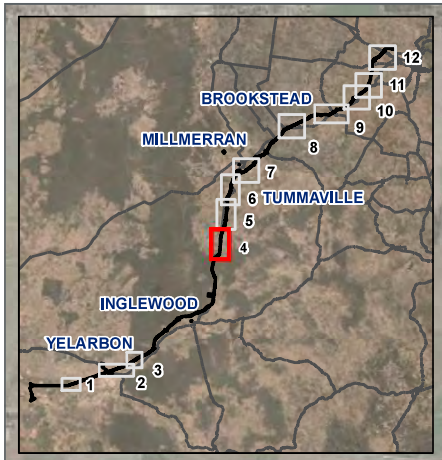
1:20,000 Scale at A3

m
0 200 400 600 800

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



TUMMAVILLE

INGLEWOOD

Canning Creek

ARTC

Flora EVNT Page 4

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Post-Wet Survey

- *Homopholis belsoni*

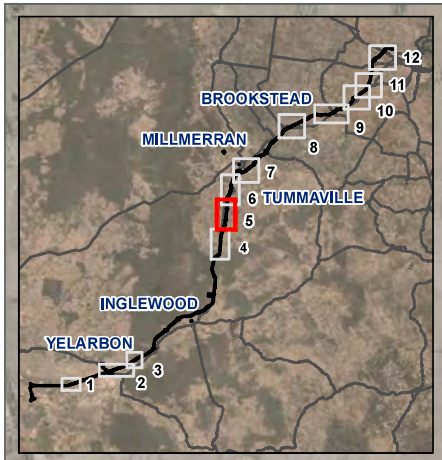
Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 400 800 1,200

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



MILLMERRAN/INGLEWOOD ROAD

TUMMAVILLE

ARTC

Flora EVNT Page 5

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)

Post-Wet Survey

- *Digitaria porrecta*
- *Homopholis belsoni*

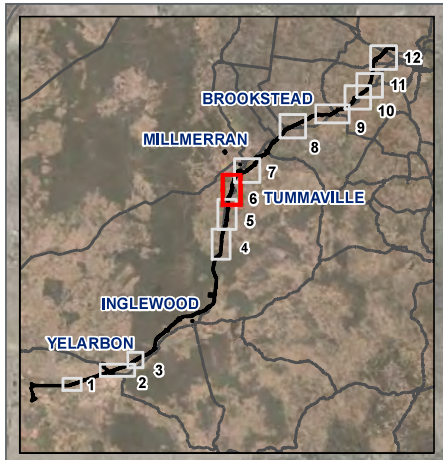
Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 400 800 1,200

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



MILLMERRAN

TUMMAVILLE

MILLMERRAN INGLEWOOD ROAD

ARTC

Flora EVNT Page 6

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)

Post-Wet Survey

- *Homopholis belsoni*

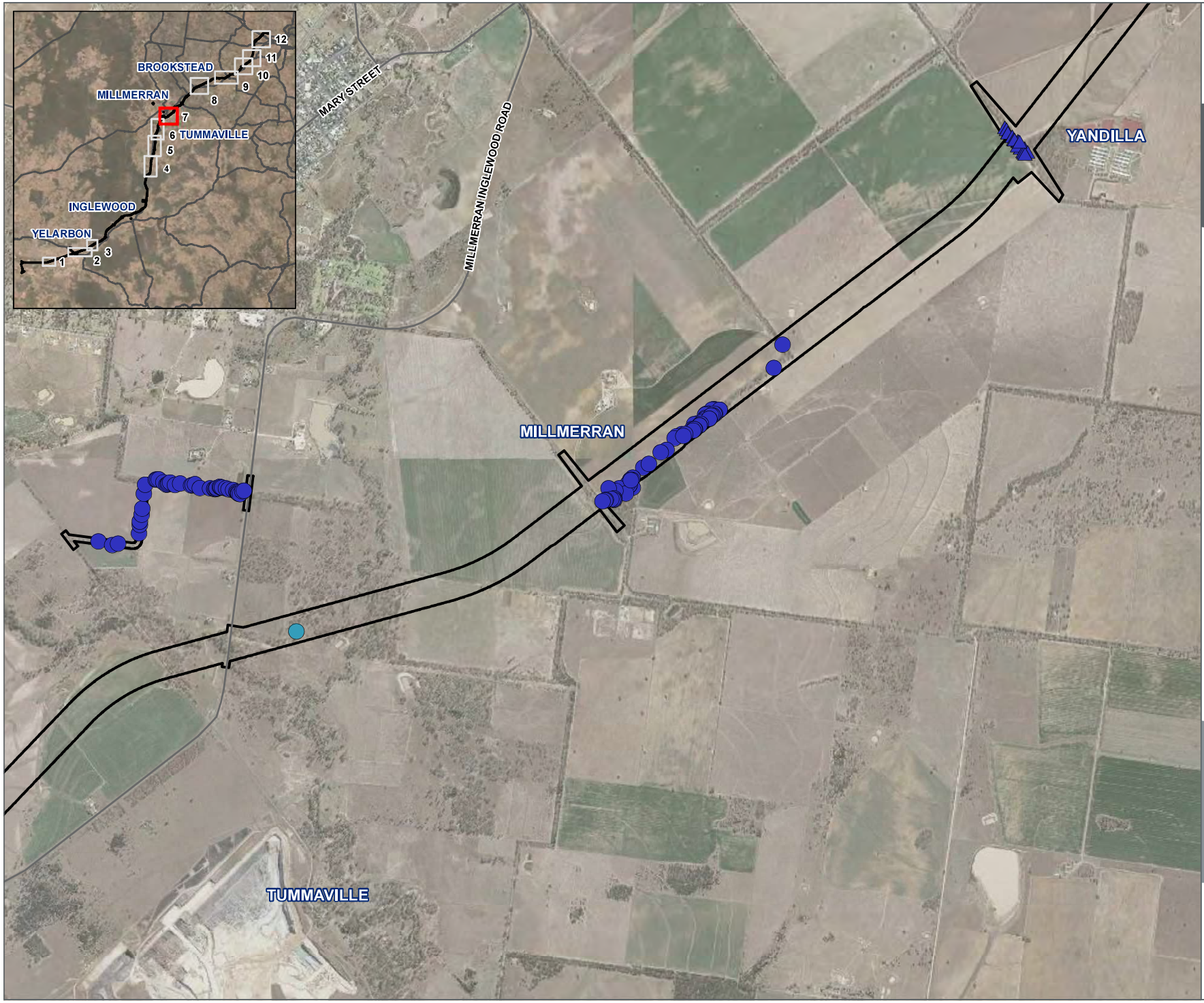
Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 400 800 1,200

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Flora EVNT Page 7

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)

Post-Wet Survey

- *Digitaria porrecta*
- *Homopholis belsoni*

Geotech Survey

- *Homopholis belsonii*

Suburb labels as per Australian Bureau of Statistics (2011)

1:25,000 Scale at A3

m
0 200 400 600 800

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

Flora EVNT Page 8

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Road (QSpatial, 2019)
- Major Watercourse (DNRME, 2020)

Post-Wet Survey

- *Digitaria porrecta*

December Geotech Survey

- Picris barbarorum

Spring Survey

- *Digitaria porrecta*
- *Picris barbarorum*

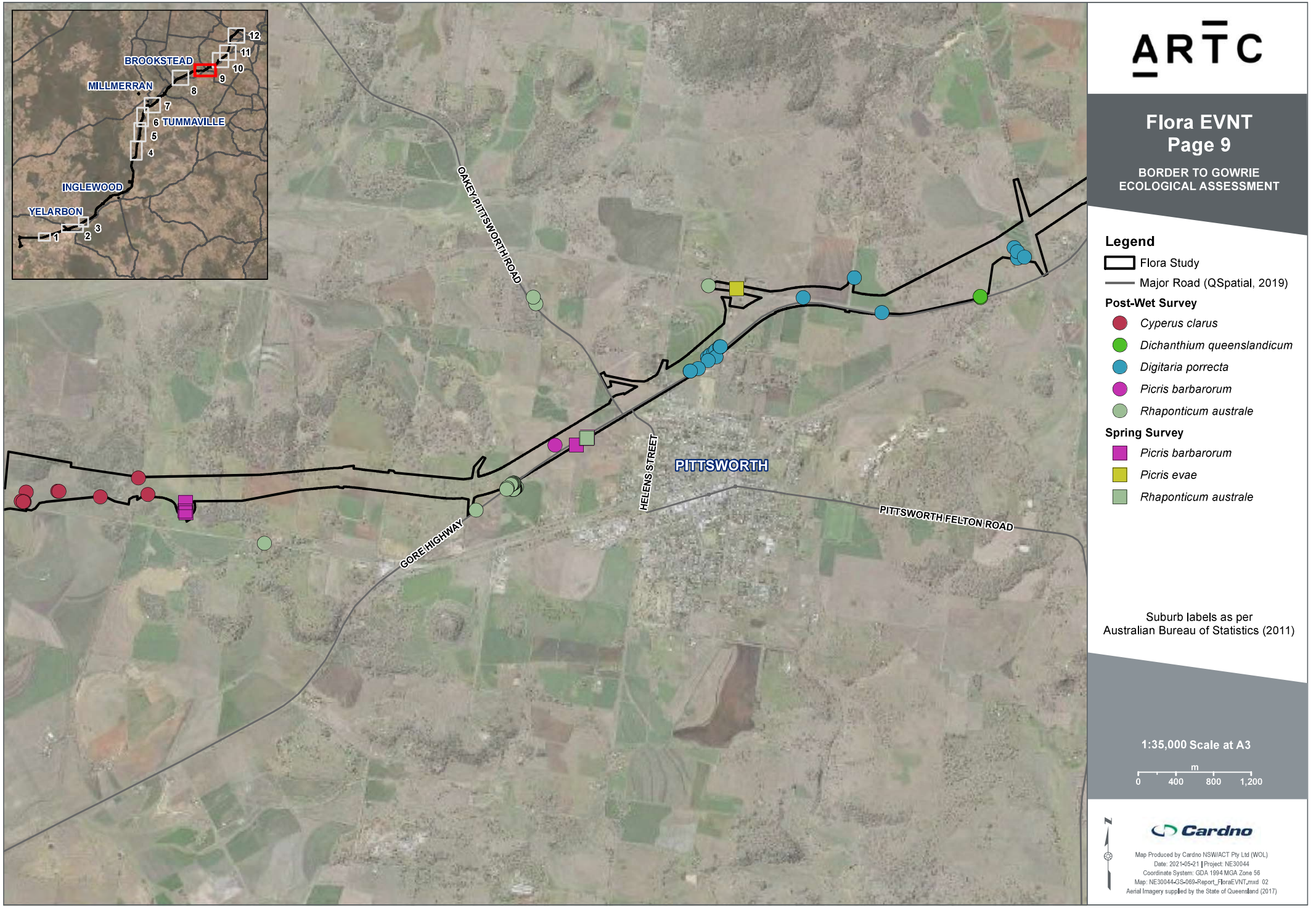
Suburb labels as per Australian Bureau of Statistics (2011)

1:30,000 Scale at A3

m
0 300 600 900

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Flora EVNT Page 9

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)

Post-Wet Survey

- *Cyperus clarus*
- *Dichanthium queenslandicum*
- *Digitaria porrecta*
- *Picris barbarorum*
- *Rhaponticum australe*

Spring Survey

- *Picris barbarorum*
- *Picris evae*
- *Rhaponticum australe*

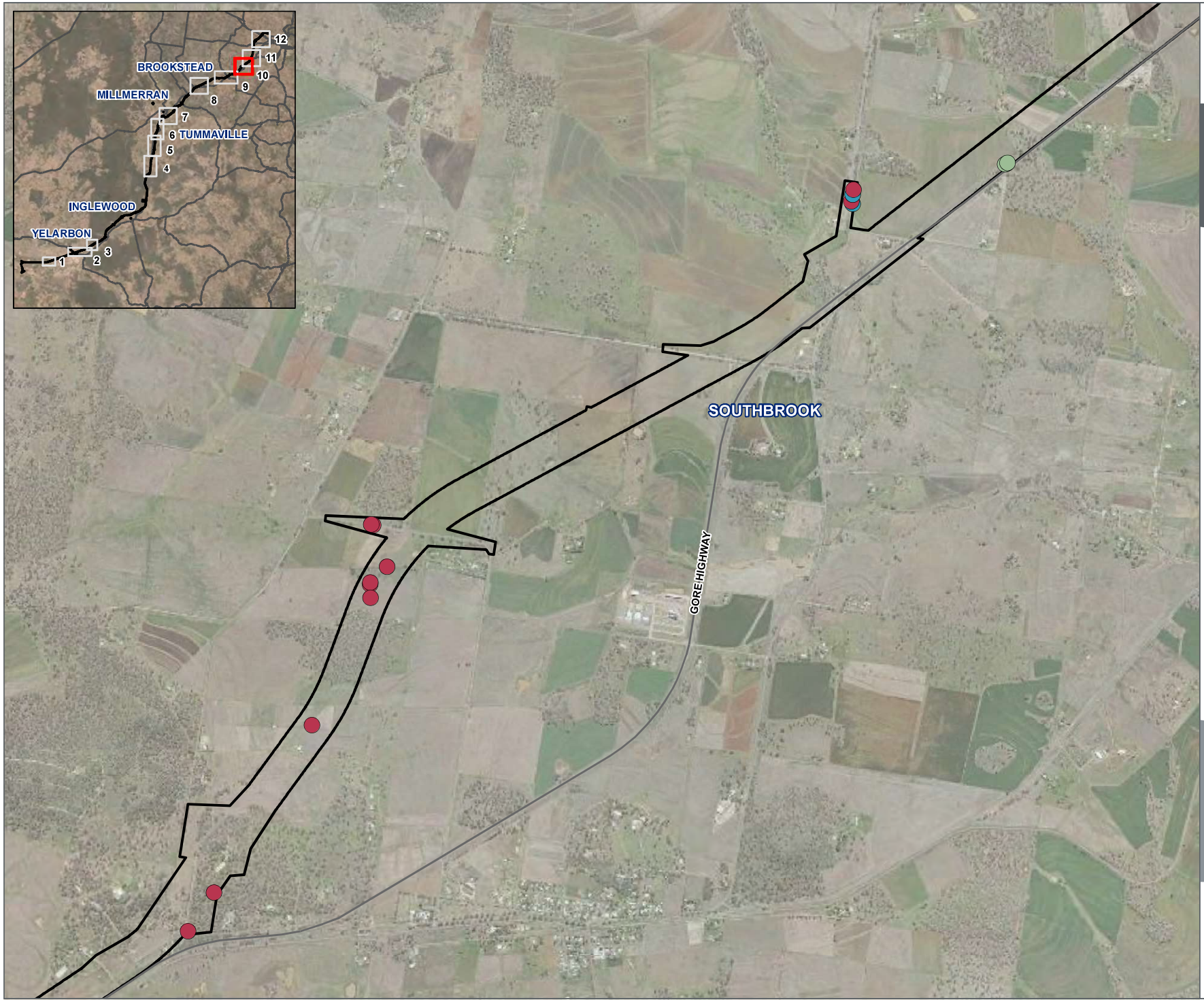
Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 400 800 1,200

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Flora EVNT Page 10

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)

Post-Wet Survey

- *Cyperus clarus*
- *Digitaria porrecta*
- *Rhaponticum australe*

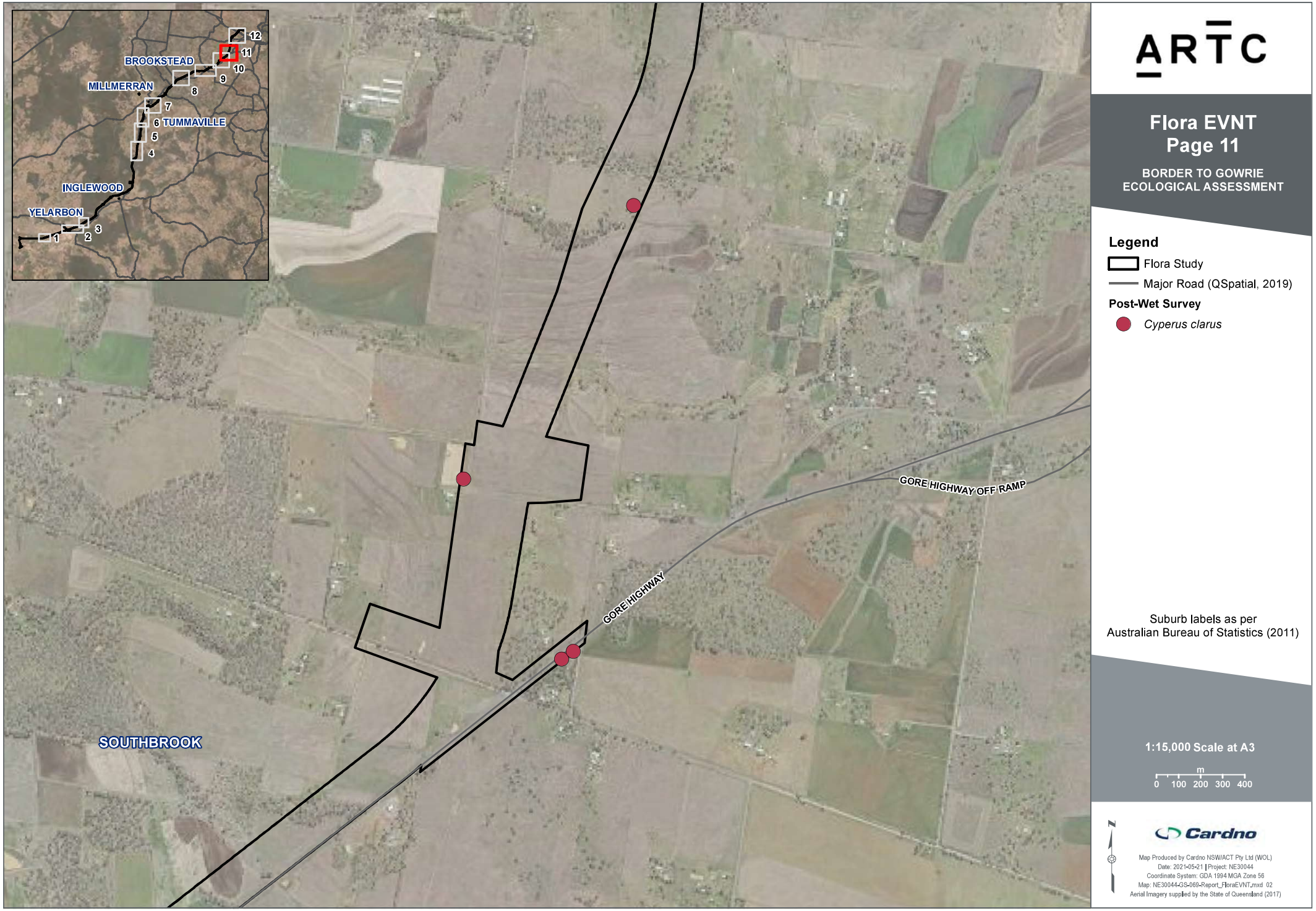
Suburb labels as per Australian Bureau of Statistics (2011)

1:20,000 Scale at A3

m
0 200 400 600 800

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Flora EVNT Page 11

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)

Post-Wet Survey

- *Cyperus clarus*

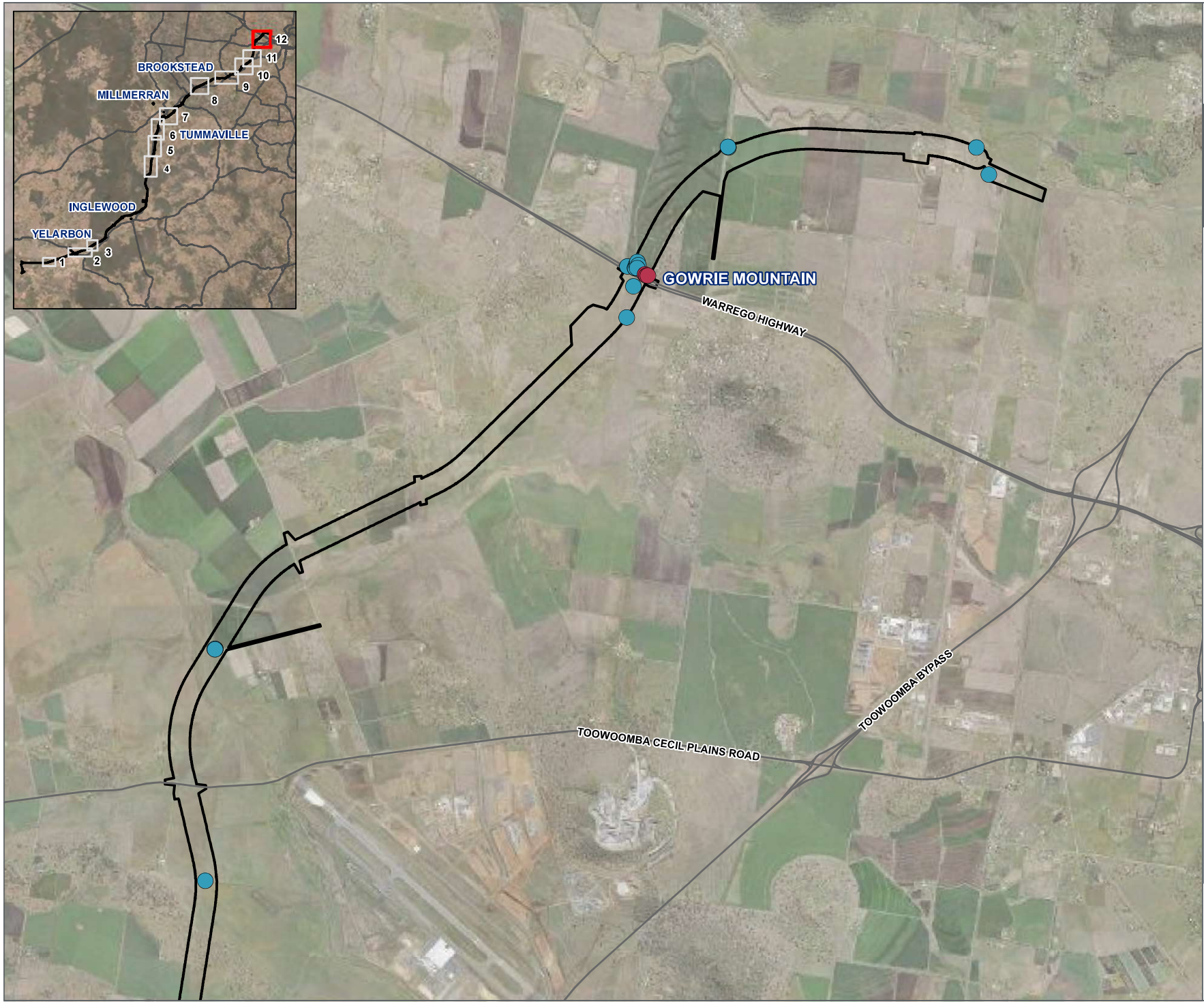
Suburb labels as per Australian Bureau of Statistics (2011)

1:15,000 Scale at A3

m
0 100 200 300 400

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Flora EVNT Page 12

BORDER TO GOWRIE ECOLOGICAL ASSESSMENT

Legend

- Flora Study
- Major Road (QSpatial, 2019)

Post-Wet Survey

- *Cyperus clarus*
- *Digitaria porrecta*

Suburb labels as per Australian Bureau of Statistics (2011)

1:35,000 Scale at A3

m
0 400 800 1,200

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-069-Report_FloraEVNT.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)

APPENDIX

I

THREATENED FAUNA RECORDS

ARTC

FIGURE 1

1:15,000 Scale at A3

m

0 100 200 300

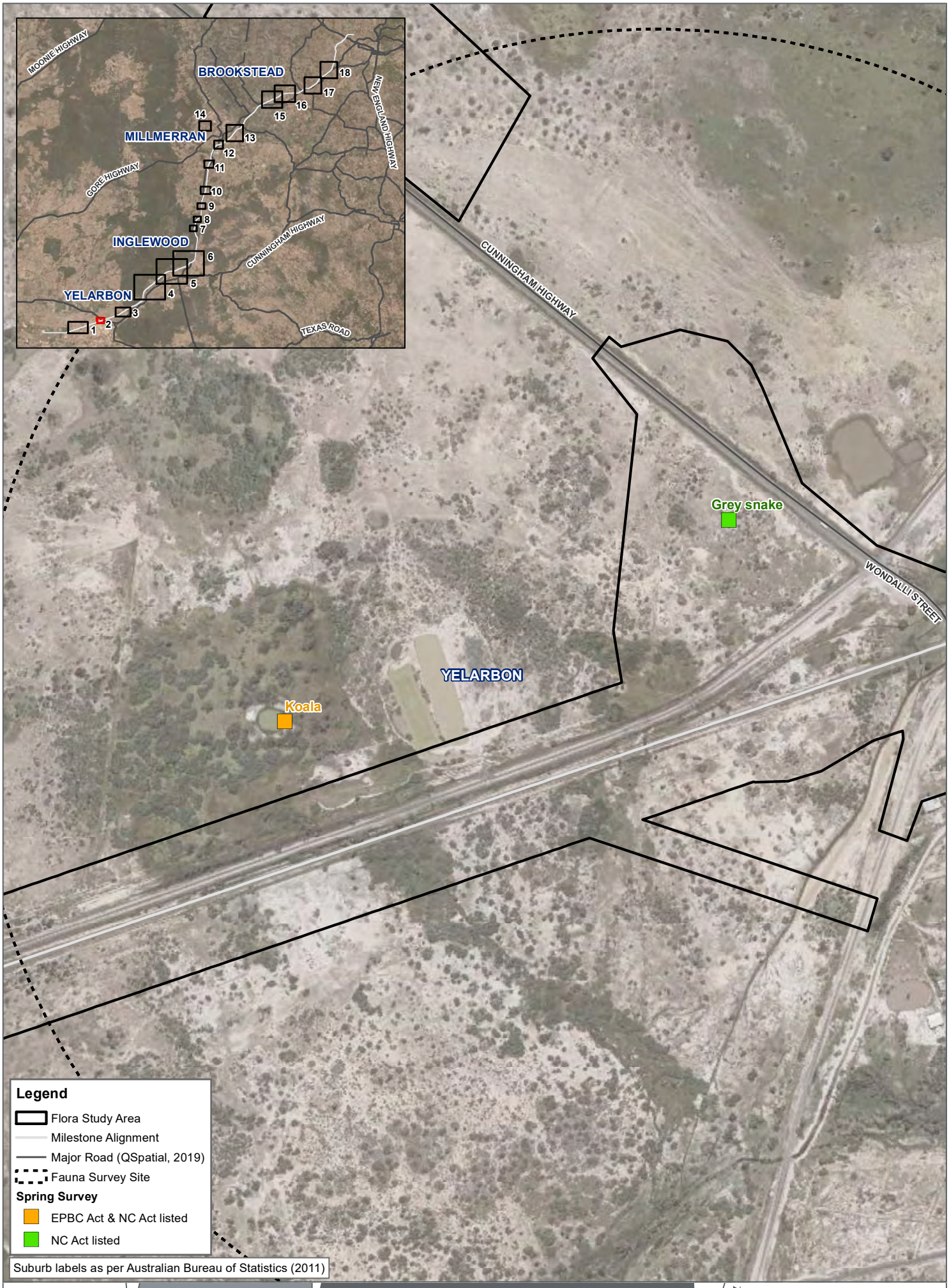
Fauna EVNT
Page 1

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:5,000 Scale at A3

m

0 100

Fauna EVNT Page 2

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

FIGURE 1

1:15,000 Scale at A3

m

0 100 200 300

Fauna EVNT
Page 3

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

FIGURE 1

1:25,000 Scale at A3

m

0 200 400 600

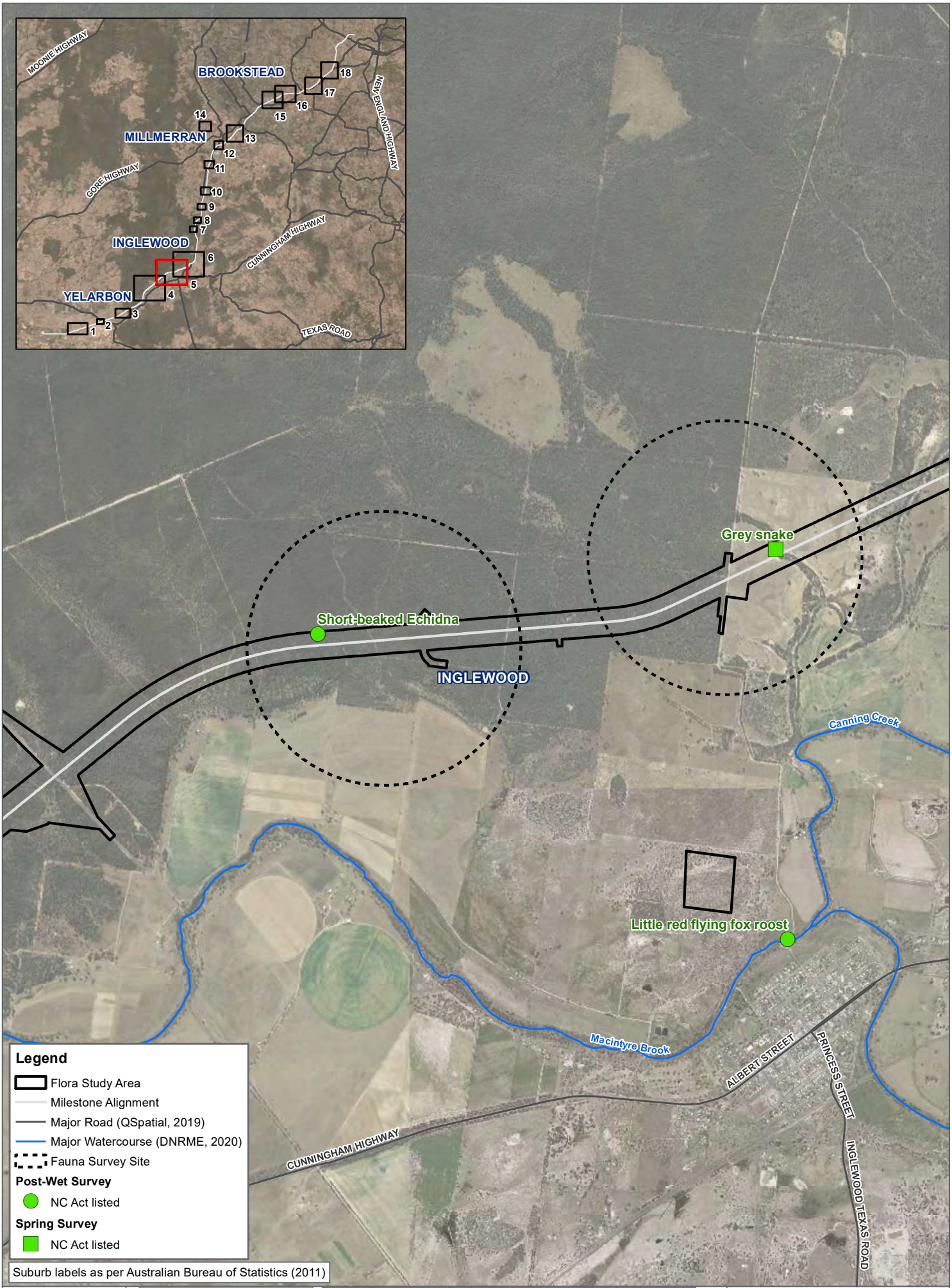
Fauna EVNT
Page 4

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:25,000 Scale at A3

m

0 200 400 600

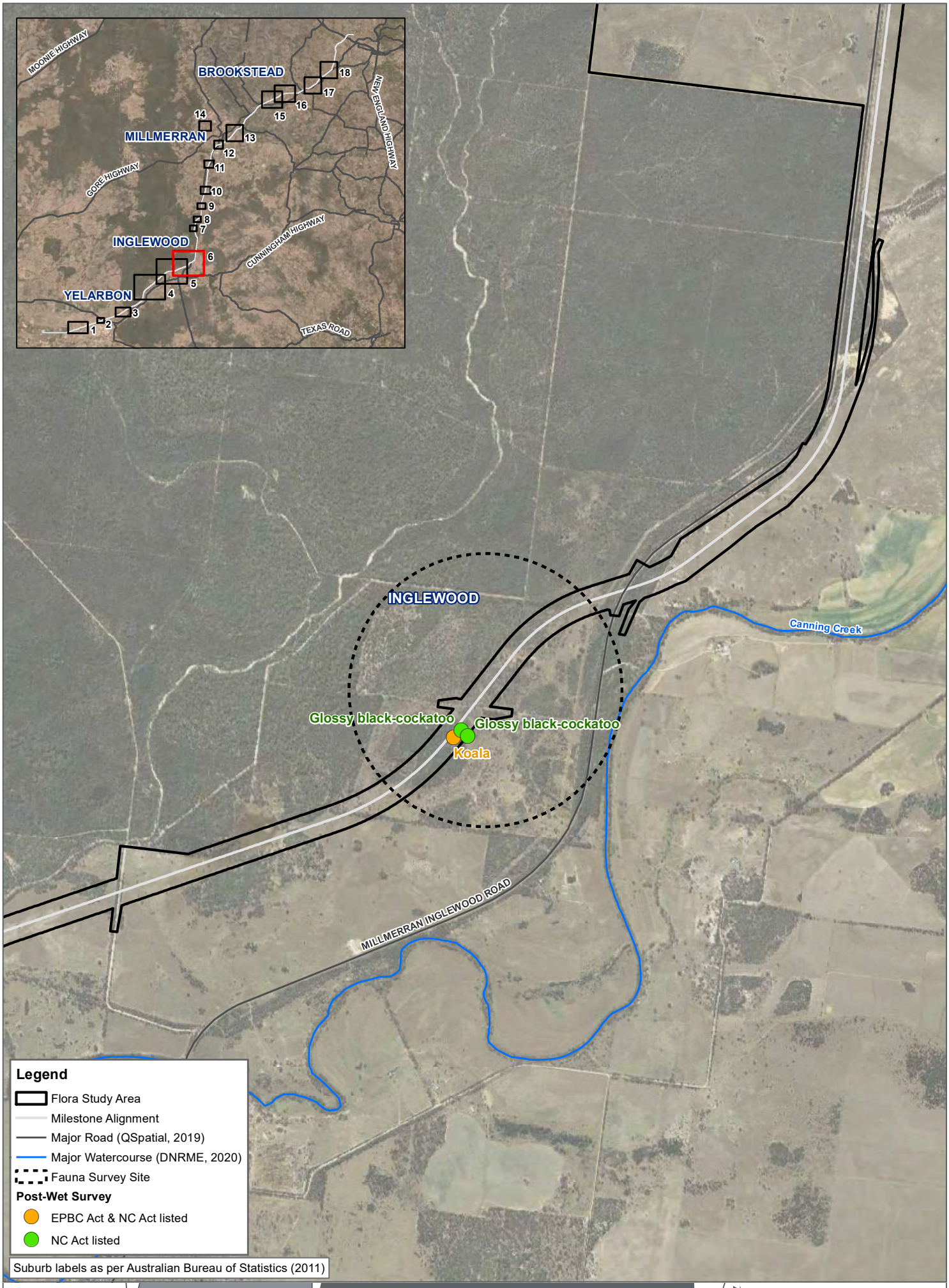
Fauna EVNT
Page 5

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:25,000 Scale at A3

m

0 200 400 600

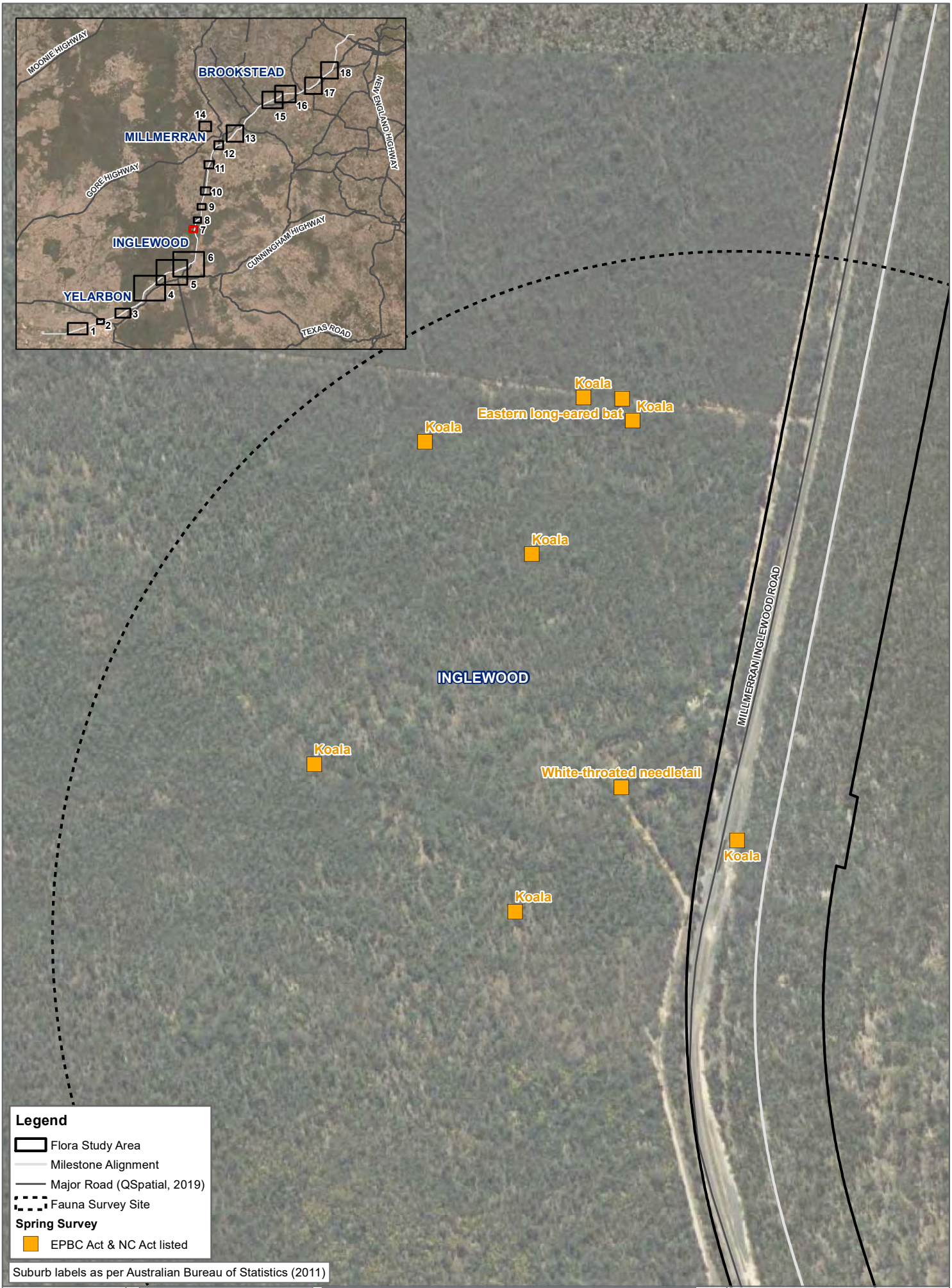
Fauna EVNT
Page 6

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:5,000 Scale at A3

m

0 100

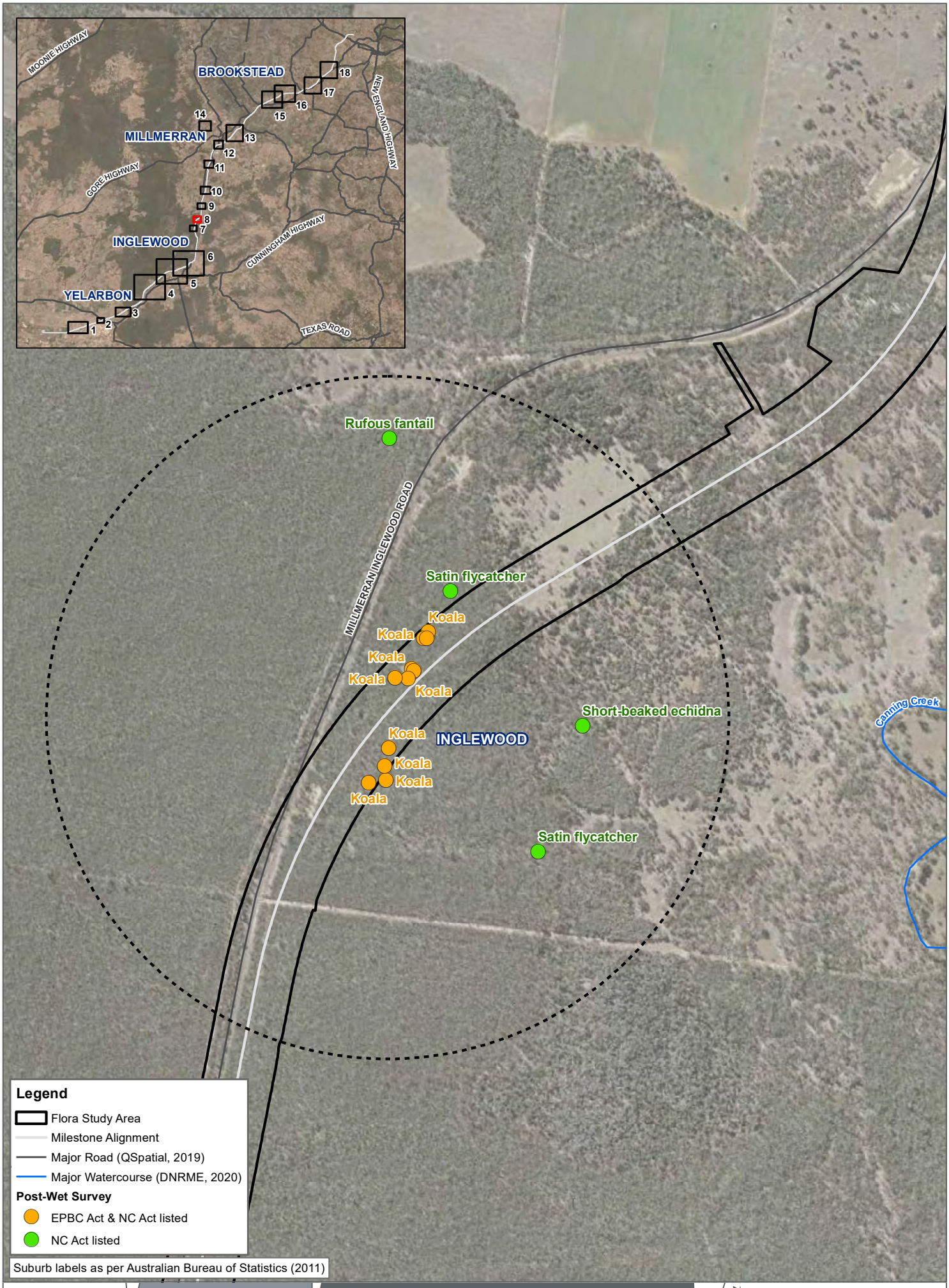
Fauna EVNT
Page 7

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:10,000 Scale at A3

m

0 100 200

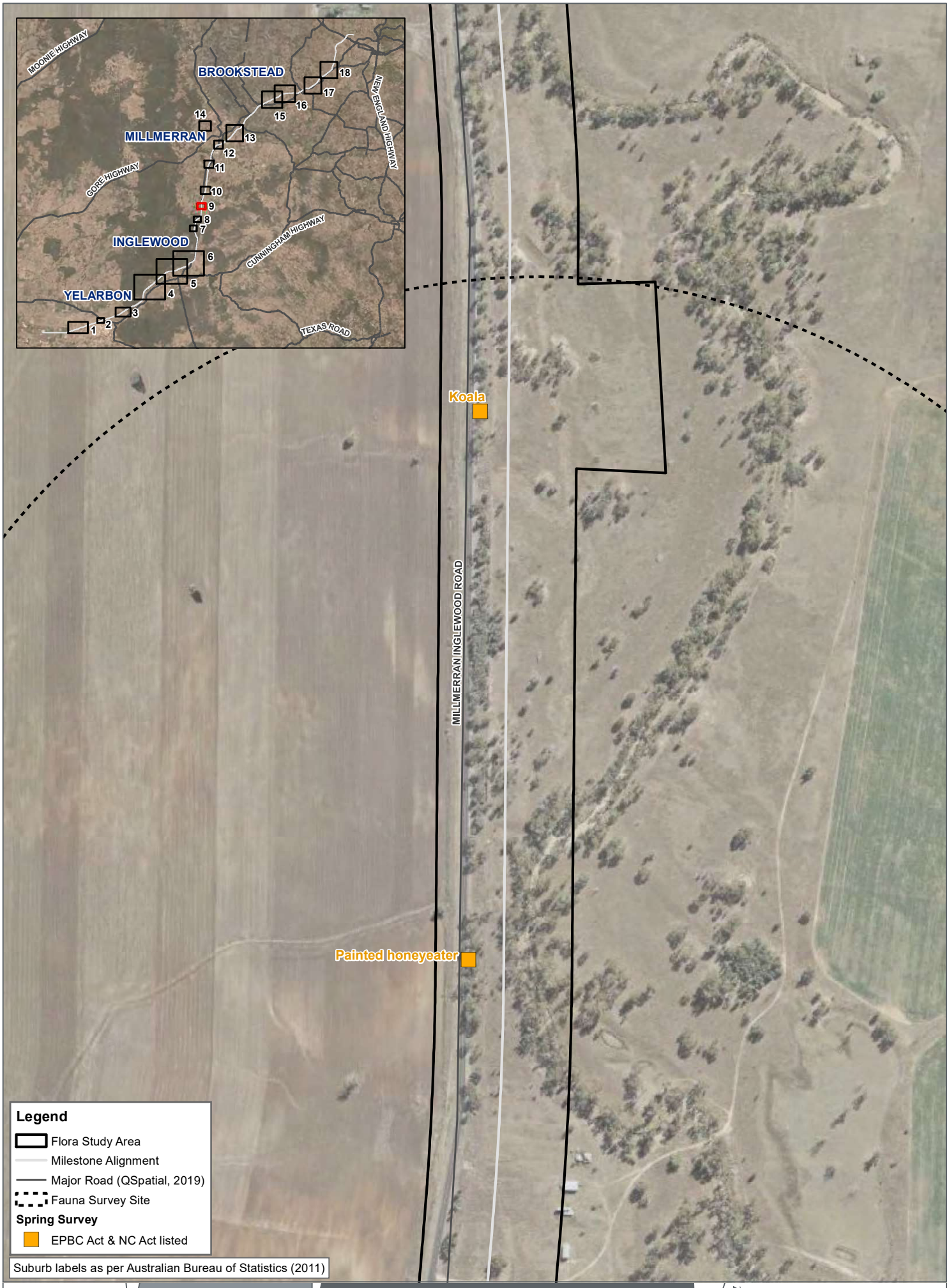
Fauna EVNT
Page 8

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:5,000 Scale at A3

m

0 100

Fauna EVNT Page 9

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

FIGURE 1

1:5,000 Scale at A3

m

0 100

Fauna EVNT
Page 10

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)

ARTC

FIGURE 1

1:5,000 Scale at A3

m

0 100

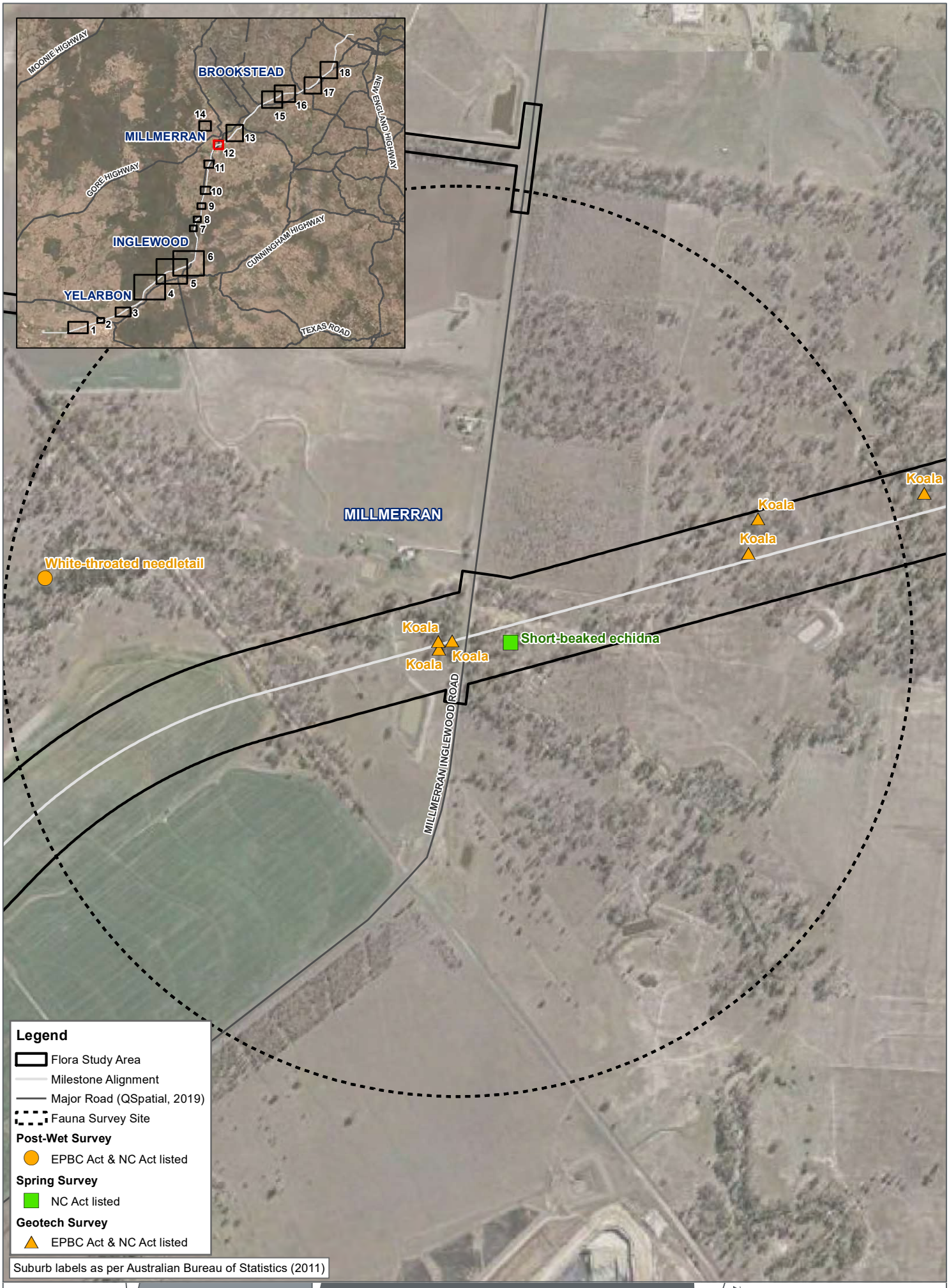
Fauna EVNT Page 11

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:7,500 Scale at A3

m

0 100 200

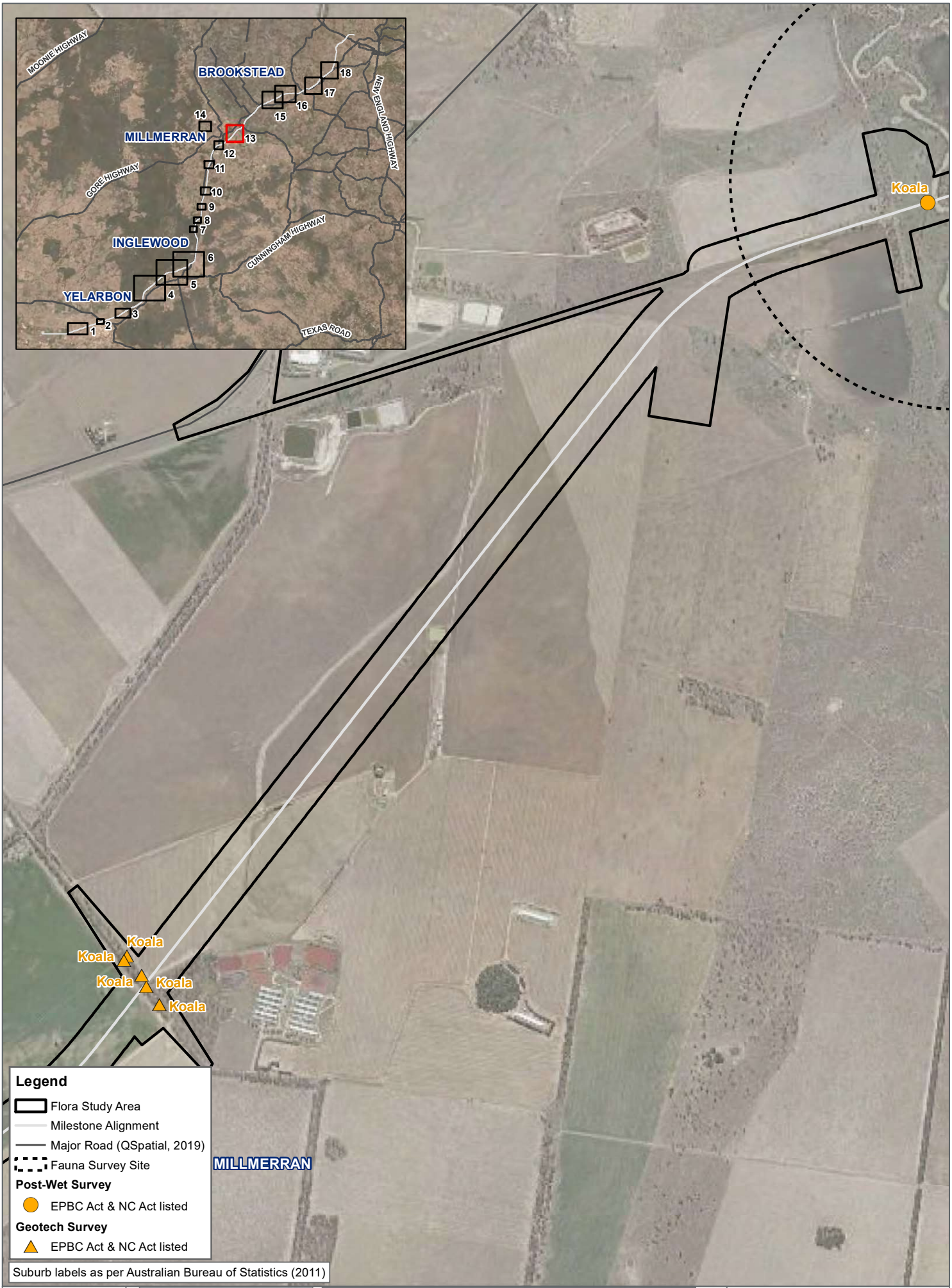
Fauna EVNT
Page 12

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:15,000 Scale at A3

m

0 100 200 300

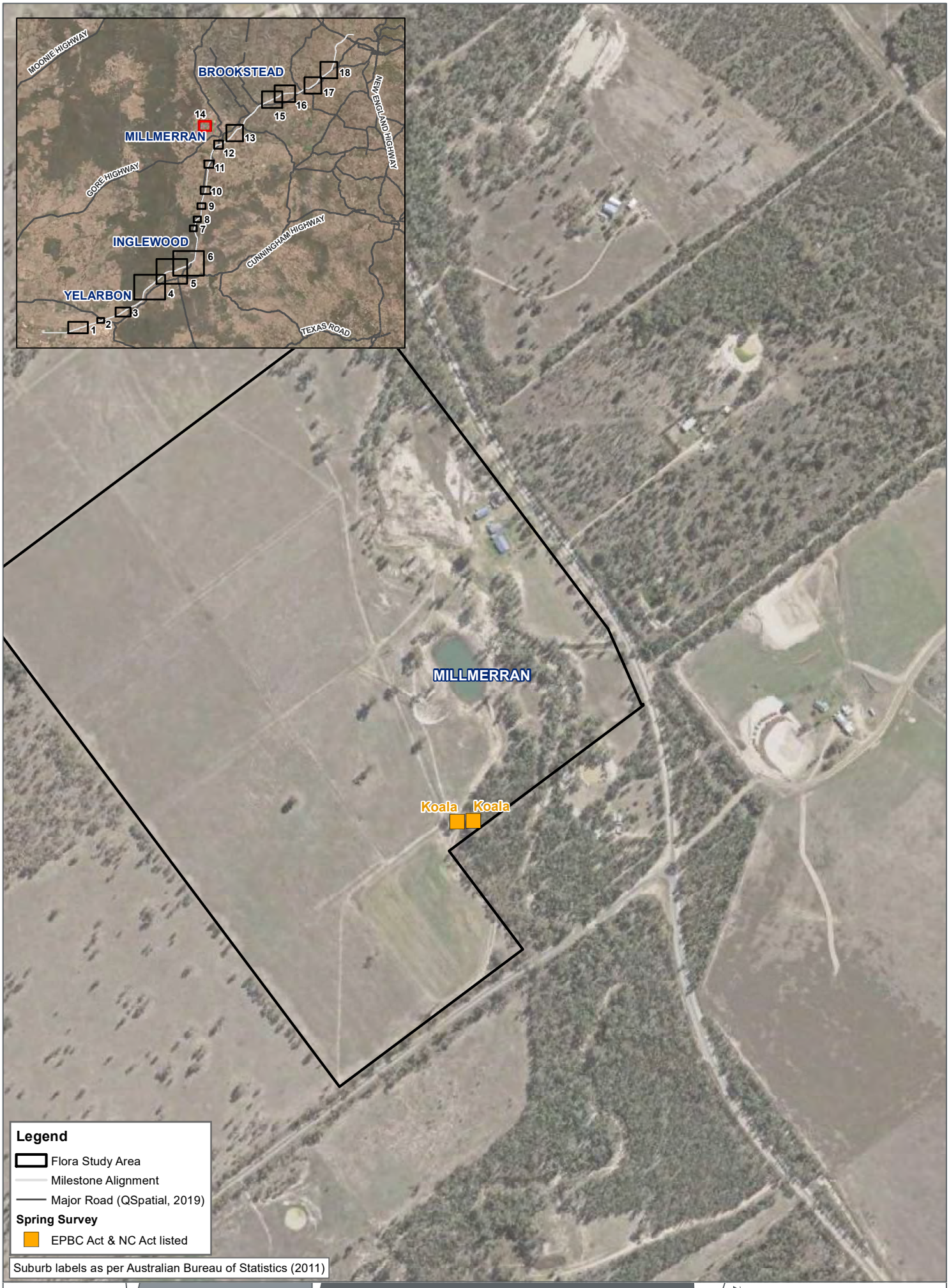
Fauna EVNT
Page 13

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:5,000 Scale at A3

m

0 100

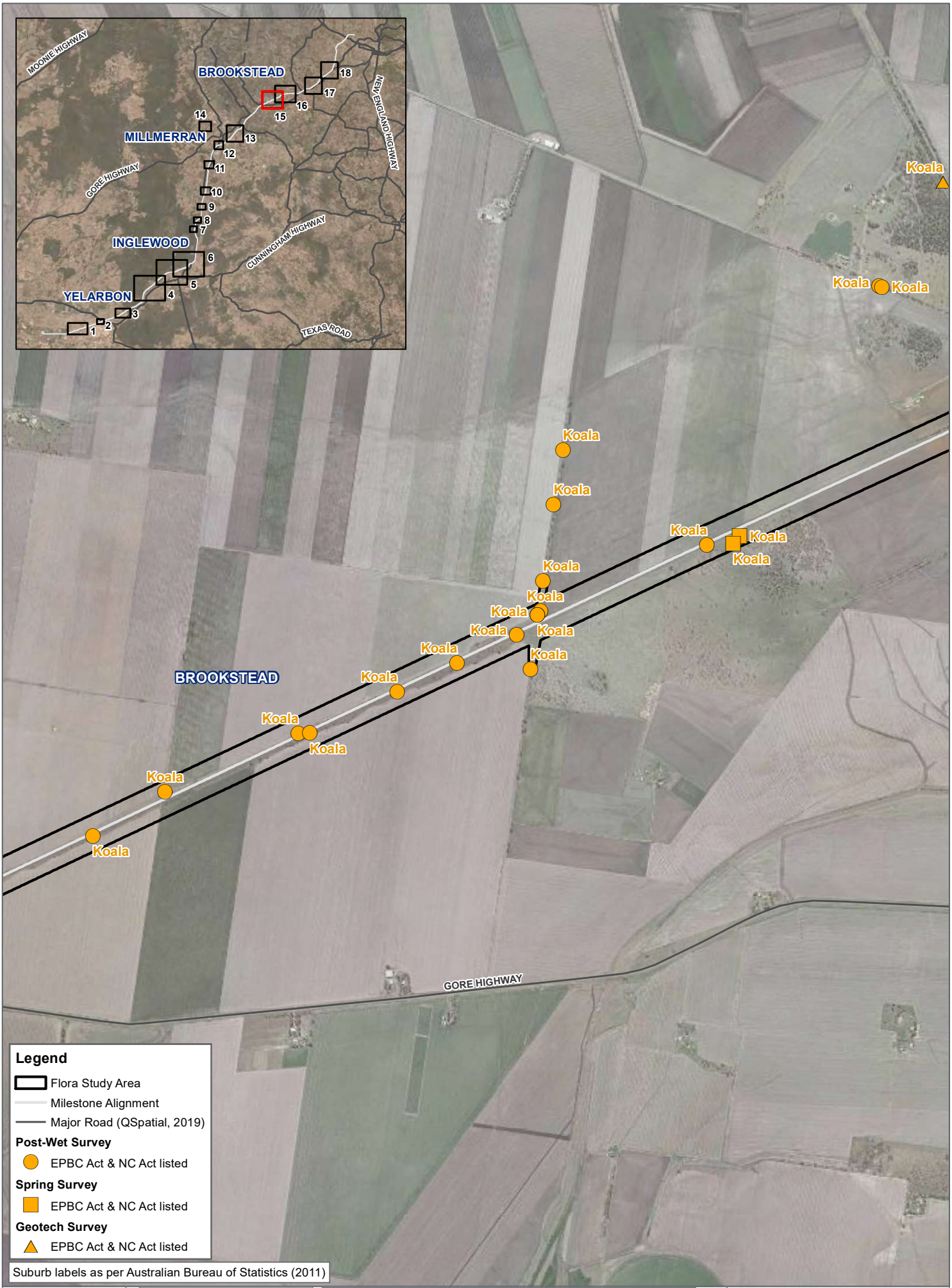
Fauna EVNT
Page 14

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:20,000 Scale at A3

m

0 100 200 300

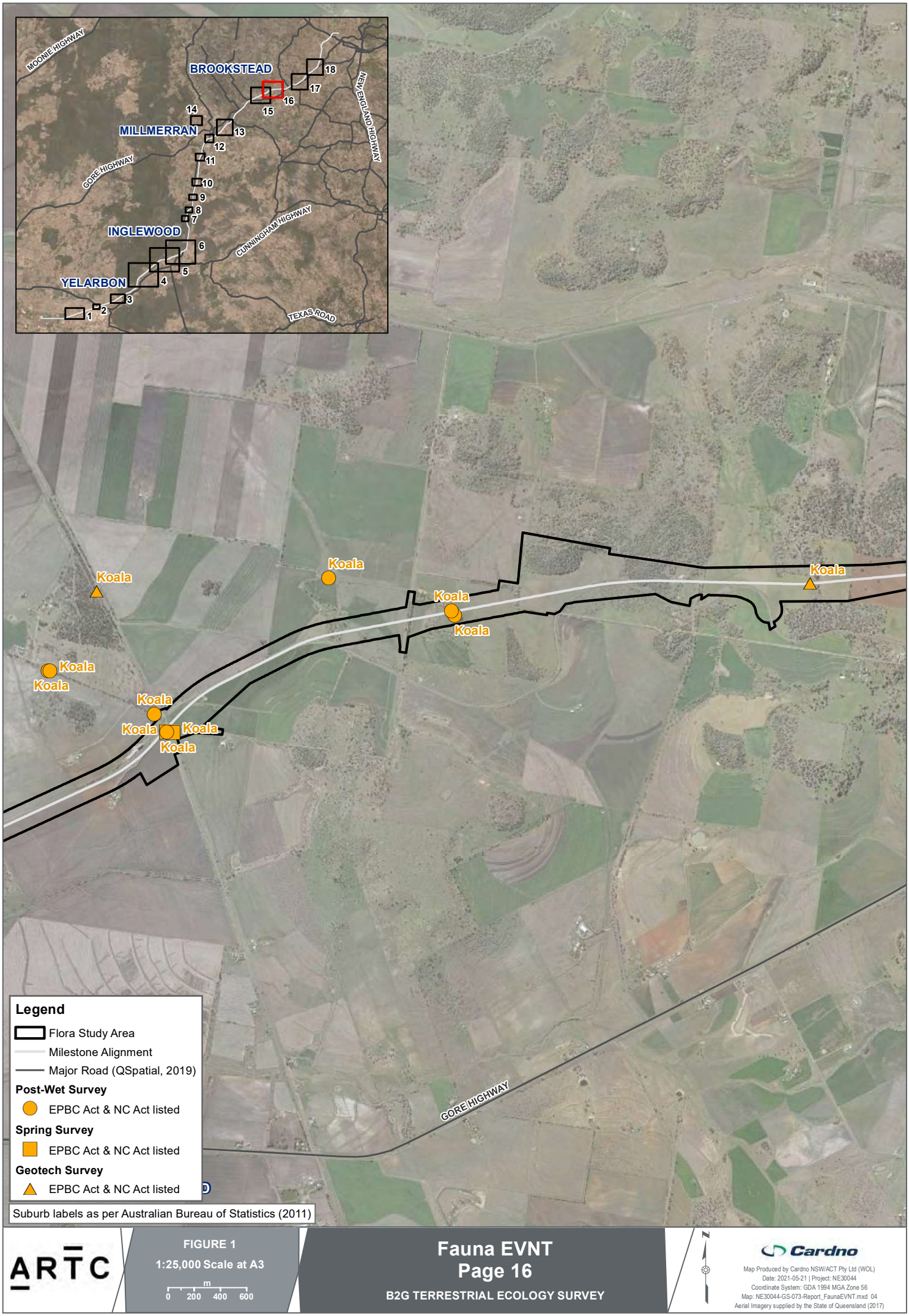
Fauna EVNT
Page 15

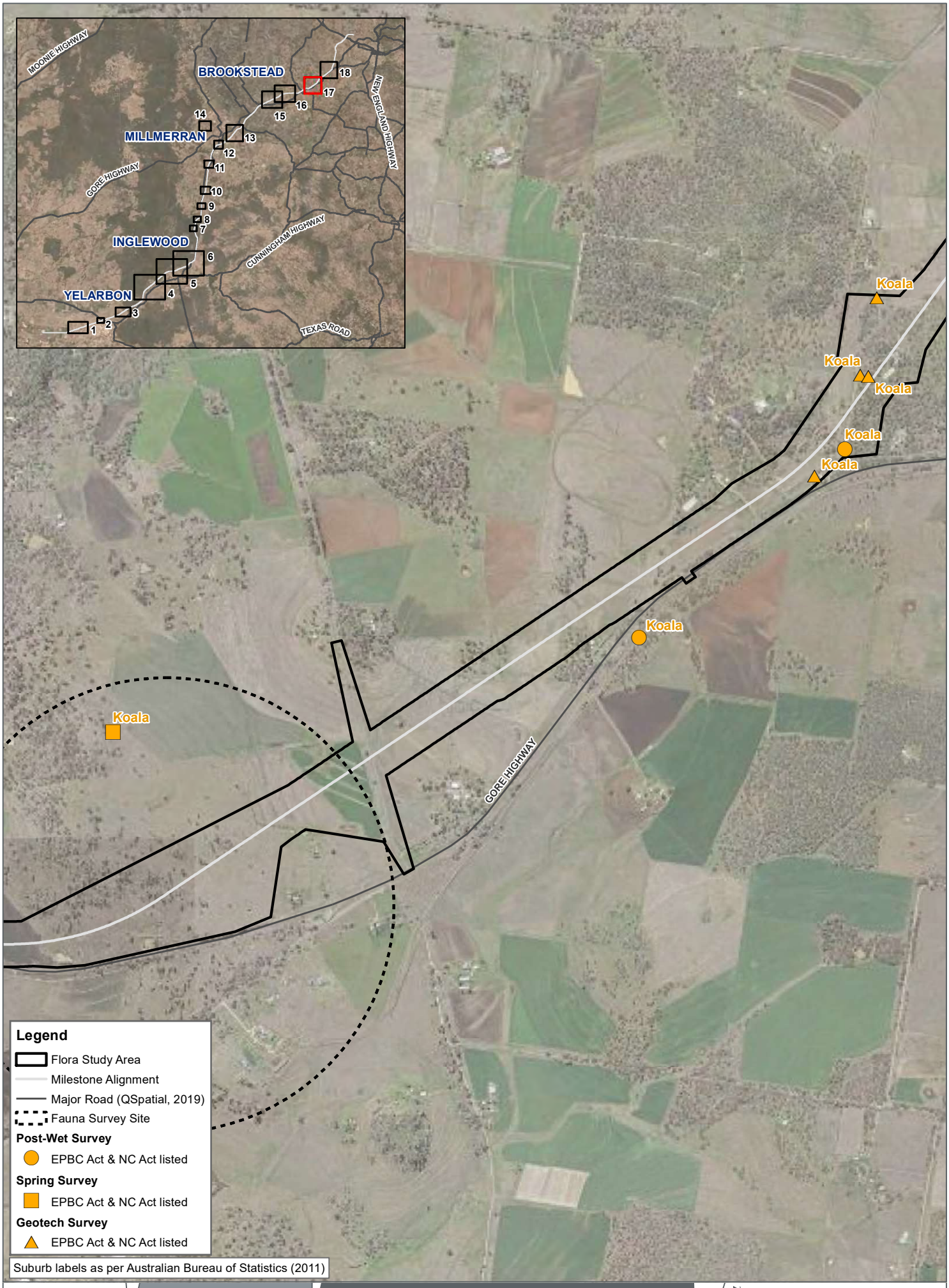
B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)


MOONIE HIGHWAY
BROOKSTEAD
MILLMERRAN
INGLEWOOD
YELARBON
GORE HIGHWAY
CUNNINGHAM HIGHWAY
NEW ENGLAND HIGHWAY
TEXAS ROAD
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Koala
Koala
Koala
Koala
Koala
Koala
Koala
Koala
Koala
Koala
Koala
GORE HIGHWAY
Legend
Flora Study Area
Milestone Alignment
Major Road (QSpatial, 2019)
Post-Wet Survey
EPBC Act & NC Act listed
Spring Survey
EPBC Act & NC Act listed
Geotech Survey
EPBC Act & NC Act listed
Suburb labels as per Australian Bureau of Statistics (2011)
ARTC
FIGURE 1
1:25,000 Scale at A3
m
0 200 400 600
Fauna EVNT
Page 16
B2G TERRESTRIAL ECOLOGY SURVEY
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:15,000 Scale at A3

m

0 100 200 300

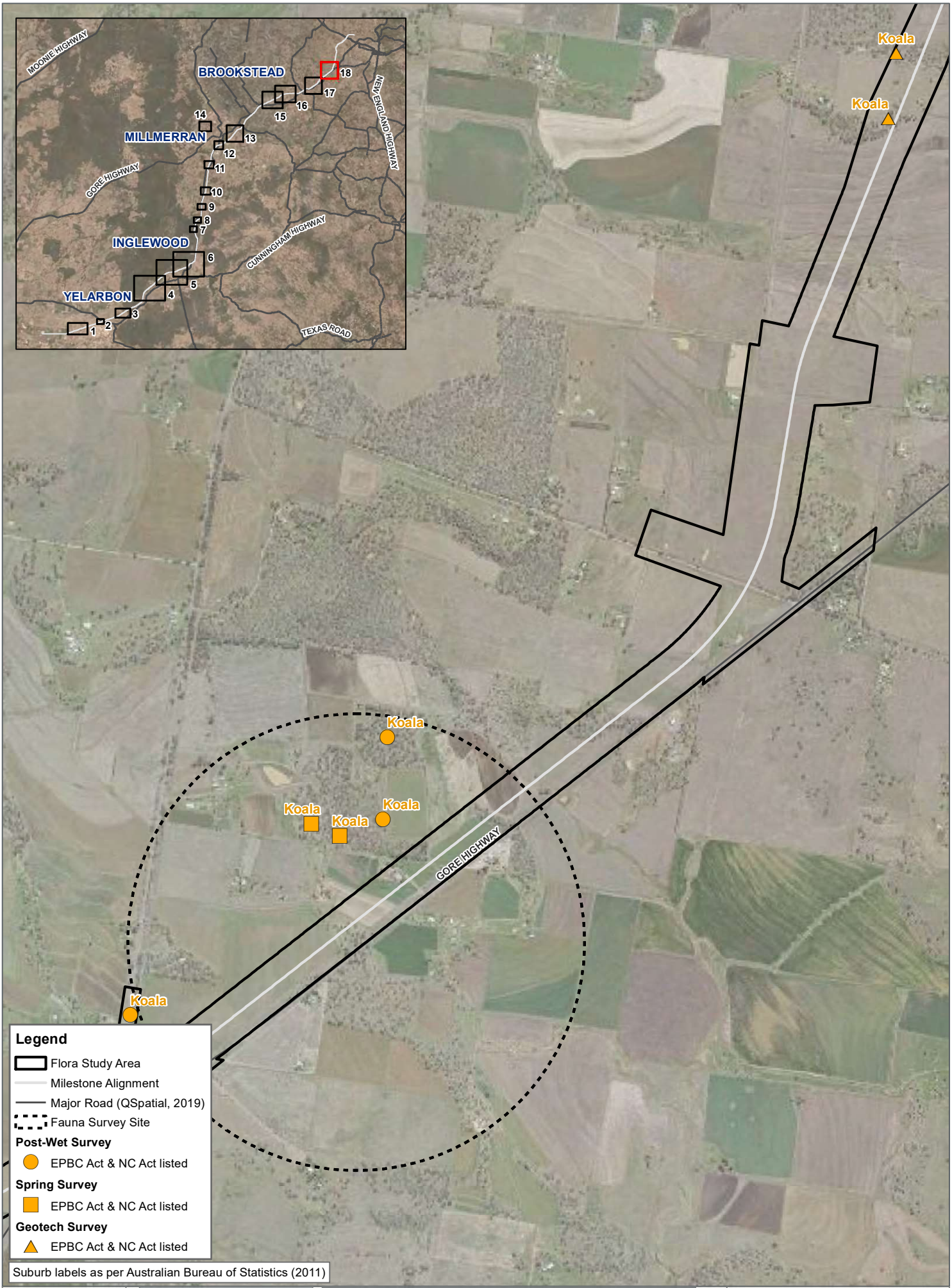
Fauna EVNT
Page 17

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

FIGURE 1

1:15,000 Scale at A3

m

0 100 200 300

Fauna EVNT
Page 18

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-073-Report_FaunaEVNT.mxd 04
Aerial Imagery supplied by the State of Queensland (2017)

APPENDIX J

FAUNA SPECIES LIST

Class	Family	Scientific Name	Common Name	Nature Conservation Act 1992 Status	Environment Protection and Biodiversity Conservation Act 1999 Status	Exotic?	Environment Protection and Biodiversity Conservation Act 1999 Marine/Migratory (Ma/Mi)	Period observed
Amphibians	Hylidae	*Cyclorana alboguttata*	Green-striped burrowing frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Cyclorana brevipes*	Short-footed frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Cyclorana novaehollandiae*	Eastern snapping frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Cyclorana verrucosa*	Rough collared frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Litoria caerulea*	Green tree frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Litoria latopalmata*	Broad-palmed rocket frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Litoria nasuta*	Striped rocket frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Litoria peronii*	Emerald-spotted tree frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Litoria rubella*	Desert tree frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Hylidae	*Litoria wilcoxii*	Eastern stony creek frog	Least concern	-	-	-	Post-Wet
Amphibians	Hylidae	*Litoria fallax*	Eastern sedgefrog	Least concern	-	-	-	Spring
Amphibians	Limnodyanstidae	*Limnodynastes tasmaniensis*	Spotted marsh frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Limnodyanstidae	*Limnodynastes terraereginae*	Northern banjo frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Limnodyanstidae	*Platyplectrum ornatum*	Ornate burrowing frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Limnodynastidae	*Limnodynastes dumerilii*	Eastern pobblebonk	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Limnodynastidae	*Limnodynastes salmini*	Salmon-striped frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Limnodynastidae	*Neobatrachus sudellae*	Sudell's frog	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Limnodynastidae	*Limnodynastes fletcheri*	Barking frog	Least concern	-	-	-	Spring
Amphibians	Limnodynastidae	*Limnodynastes peronii*	Striped marshfrog	Least concern	-	-	-	Spring
Amphibians	Myobatrachidae	*Crinia parinsignifera*	Beeping froglet	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Myobatrachidae	*Crinia signifera*	Clicking froglet	Least concern	-	-	-	Post-Wet
Amphibians	Myobatrachidae	*Uperoleia rugosa*	Chubby gungan	Least concern	-	-	-	Spring and Post-Wet
Amphibians	Myobatrachidae	*Uperoleia laevigata*	Eastern gungan	Least concern	-	-	-	Spring
Birds	Acanthizidae	*Acanthiza apicalis*	Inland thornbill	Least concern	-	-	-	Spring and Post-Wet
Birds	Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped thornbill	Least concern	-	-	-	Post-Wet
Birds	Acanthizidae	*Acanthiza nana*	Yellow thornbill	Least concern	-	-	-	Spring and Post-Wet
Birds	Acanthizidae	*Acanthiza pusilla*	Brown thornbill	Least concern	-	-	-	Spring and Post-Wet
Birds	Acanthizidae	*Acanthiza reguloides*	Buff-rumped thornbill	Least concern	-	-	-	Spring and Post-Wet
Birds	Acanthizidae	*Gerygone olivacea*	White-throated gerygone	Least concern	-	-	-	Spring and Post-Wet
Birds	Acanthizidae	*Pyrrholaemus sagittatus*	Speckled warbler	Least concern	-	-	-	Post-Wet
Birds	Acanthizidae	*Smicrornis brevirostris*	Weebill	Least concern	-	-	-	Post-Wet
Birds	Acanthizidae	*Acanthiza lineata*	Striated thornbill	Least concern	-	-	-	Spring
Birds	Acanthizidae	*Gerygone fusca*	Western gerygone	Least concern	-	-	-	Spring
Birds	Accipitridae	*Elanus axillaris*	Black-shouldered kite	Least concern	-	-	-	Spring and Post-Wet
Birds	Accipitridae	*Haliastur sphenurus*	Whistling kite	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Accipitridae	*Milvus migrans*	Black kite	Least concern	-	-	-	Spring and Post-Wet
Birds	Accipitridae	*Haliaeetus leucogaster*	White-bellied sea-eagle	Least concern	-	-	Ma	Spring
Birds	Accipitridae	*Hieraaetus morphnoides*	Little eagle	Least concern	-	-	-	Spring
Birds	Acrocephalidae	*Acrocephalus australis*	Australian reed-warbler	Least concern	-	-	-	Spring
Birds	Aegothelidae	*Aegotheles cristatus*	Australian owlet-nightjar	Least concern	-	-	-	Spring and Post-Wet
Birds	Alaudidae	*Mirafra javanica*	Horsfield's bushlark	Least concern	-	-	-	Spring
Birds	Alcedinidae	*Dacelo novaeguineae*	Laughing kookaburra	Least concern	-	-	-	Spring and Post-Wet
Birds	Alcedinidae	*Ceyx azureus*	Azure kingfisher	Least concern	-	-	-	Spring
Birds	Anatidae	*Anas gracilis*	Grey teal	Least concern	-	-	-	Spring and Post-Wet
Birds	Anatidae	*Anas superciliosa*	Pacific black duck	Least concern	-	-	-	Spring and Post-Wet
Birds	Anatidae	*Chenonetta jubata*	Australian wood duck	Least concern	-	-	-	Spring and Post-Wet
Birds	Anatidae	*Dendrocygna eytoni*	Plumed whistling-duck	Least concern	-	-	-	Spring and Post-Wet
Birds	Anatidae	*Malacorhynchus membranaceus*	Pink-eared duck	Least concern	-	-	-	Post-Wet
Birds	Anhingidae	*Anhinga novaehollandiae*	Australasian darter	Least concern	-	-	-	Post-Wet
Birds	Anseranatidae	*Anseranas semipalmata*	Magpie goose	Least concern	-	-	Ma	Spring
Birds	Apodidae	*Hirundapus caudacutus*	White-throated needletail	Vulnerable	Vulnerable	-	Ma, Mi	Spring and Post-Wet
Birds	Apodidae	*Collocalia esculenta*	Glossy swiftlet	Least concern	-	-	-	Spring
Birds	Ardeidae	*Ardea intermedia*	Intermediate egret	Least concern	-	-	Ma	Post-Wet
Birds	Ardeidae	*Ardea pacifica*	White-necked heron	Least concern	-	-	-	Spring and Post-Wet
Birds	Ardeidae	*Egretta novaehollandiae*	White-faced heron	Least concern	-	-	-	Spring and Post-Wet
Birds	Ardeidae	*Butorides striata*	Striated heron	Least concern	-	-	-	Spring
Birds	Artamidae	*Artamus leucorynchus*	White-breasted woodswallow	Least concern	-	-	-	Spring and Post-Wet
Birds	Artamidae	*Cracticus nigrogularis*	Pied butcherbird	Least concern	-	-	-	Spring and Post-Wet
Birds	Artamidae	*Cracticus torquatus*	Grey butcherbird	Least concern	-	-	-	Spring and Post-Wet
Birds	Artamidae	*Gymnorhina tibicen*	Australian magpie	Least concern	-	-	-	Spring and Post-Wet
Birds	Artamidae	*Strepera graculina graculina*	Pied currawong (eastern Australia)	Least concern	-	-	-	Spring and Post-Wet

Birds	Artamidae	*Artamus minor*	Little woodswallow	Least concern	-	-	-	Spring
Birds	Artamidae	*Artamus personatus*	Masked woodswallow	Least concern	-	-	-	Spring
Birds	Cacatuidae	*Cacatua galerita*	Sulphur-crested cockatoo	Least concern	-	-	-	Spring and Post-Wet
Birds	Cacatuidae	*Cacatua sanguinea*	Little corella	Least concern	-	-	-	Spring and Post-Wet
Birds	Cacatuidae	*Calyptorhynchus lathami lathami*	Glossy black-cockatoo	Vulnerable	-	-	-	Post-Wet
Birds	Cacatuidae	*Eolophus roseicapilla*	Galah	Least concern	-	-	-	Spring and Post-Wet
Birds	Cacatuidae	*Nymphicus hollandicus*	Cockatiel	Least concern	-	-	-	Spring and Post-Wet
Birds	Campephagidae	*Coracina novaehollandiae*	Black-faced cuckoo-shrike	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Casuariidae	*Dromaius novaehollandiae*	Emu	Least concern	-	-	-	Spring and Post-Wet
Birds	Centropodidae	*Centropus phasianinus*	Pheasant coucal	Least concern	-	-	-	Spring and Post-Wet
Birds	Charadriidae	*Elseyornis melanops*	Black-fronted dotterel	Least concern	-	-	-	Spring and Post-Wet
Birds	Charadriidae	*Vanellus miles novaehollandiae*	Masked lapwing	Least concern	-	-	-	Spring and Post-Wet
Birds	Cisticolidae	*Cisticola exilis*	Golden-headed cisticola	Least concern	-	-	-	Spring and Post-Wet
Birds	Climacteridae	*Climacteris picumnus picumnus*	Brown treecreeper	Least concern	-	-	-	Spring and Post-Wet
Birds	Climacteridae	*Cormobates leucophaea metastasis*	White-throated treecreeper	Least concern	-	-	-	Spring and Post-Wet
Birds	Columbidae	*Columba livia*	Feral pigeon	-	-	Yes	-	Spring and Post-Wet
Birds	Columbidae	*Geopelia cuneata*	Diamond dove	Least concern	-	-	-	Spring and Post-Wet
Birds	Columbidae	*Geopelia humeralis*	Bar-shouldered dove	Least concern	-	-	-	Spring and Post-Wet
Birds	Columbidae	*Geopelia striata*	Peaceful dove	Least concern	-	-	-	Spring and Post-Wet
Birds	Columbidae	*Ocyphaps lophotes*	Crested pigeon	Least concern	-	-	-	Spring and Post-Wet
Birds	Columbidae	*Phaps chalcoptera*	Common bronzewing	Least concern	-	-	-	Spring and Post-Wet
Birds	Columbidae	*Streptopelia chinensis*	Spotted dove	-	-	Yes	-	Spring and Post-Wet
Birds	Columbidae	*Phaps elegans*	Brush bronzewing	Least concern	-	-	-	Spring
Birds	Coraciidae	*Eurystomus orientalis*	Dollarbird	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Corcoracidae	*Corcorax melanorhamphos*	White-winged chough	Least concern	-	-	-	Spring and Post-Wet
Birds	Corvidae	*Corvus coronoides*	Australian raven	Least concern	-	-	-	Spring and Post-Wet
Birds	Corvidae	*Corvus orru*	Torresian crow	Least concern	-	-	-	Spring and Post-Wet
Birds	Corvidae	*Struthidea cinerea*	Apostlebird	Least concern	-	-	-	Spring and Post-Wet
Birds	Cuculidae	*Eudynamys orientalis*	Eastern koel	Least concern	-	-	-	Spring and Post-Wet
Birds	Cuculidae	*Cacomantis variolosus*	Brush cuckoo	Least concern	-	-	-	Spring
Birds	Cuculidae	*Chalcites basalis*	Horsfield's bronze-cuckoo	Least concern	-	-	-	Spring
Birds	Cuculidae	*Chalcites osculans*	Black-eared cuckoo	Least concern	-	-	-	Spring
Birds	Cuculidae	*Scythrops novaehollandiae*	Channel-billed cuckoo	Least concern	-	-	Ma	Spring
Birds	Dicruridae	*Dicrurus bracteatus bracteatus*	Spangled drongo	Least concern	-	-	-	Post-Wet
Birds	Estrildidae	*Lonchura castaneothorax*	Chestnut-breasted mannikin	Least concern	-	-	-	Post-Wet
Birds	Estrildidae	*Taeniopygia bichenovii*	Double-barred finch	Least concern	-	-	-	Spring and Post-Wet
Birds	Estrildidae	*Taeniopygia guttata*	Zebra finch	Least concern	-	-	-	Spring and Post-Wet
Birds	Eurostopodidae	*Eurostopodus mystacalis*	White-throated nightjar	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Falconidae	*Falco berigora*	Brown falcon	Least concern	-	-	-	Spring and Post-Wet
Birds	Falconidae	*Falco cenchroides*	Nankeen kestrel	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Falconidae	*Falco longipennis*	Australian hobby	Least concern	-	-	-	Post-Wet
Birds	Falconidae	*Falco peregrinus*	Peregrine falcon	Least concern	-	-	-	Post-Wet
Birds	Falconidae	*Falco subniger*	Black falcon	Least concern	-	-	-	Spring and Post-Wet
Birds	Halcyonidae	*Todiramphus sanctus*	Sacred kingfisher	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Hirundinidae	*Hirundo neoxena*	Welcome swallow	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Hirundinidae	*Petrochelidon nigricans*	Tree martin	Least concern	-	-	-	Post-Wet
Birds	Hirundinidae	*Petrochelidon ariel*	Fairy martin	Least concern	-	-	-	Spring
Birds	Maluridae	*Malurus cyaneus*	Superb fairy-wren	Least concern	-	-	-	Spring and Post-Wet
Birds	Maluridae	*Malurus lamberti*	Variegated fairy-wren	Least concern	-	-	-	Spring and Post-Wet
Birds	Maluridae	*Malurus leucopterus*	White-winged fairy-wren	Least concern	-	-	-	Post-Wet
Birds	Megaluridae	*Cincloramphus mathewsi*	Rufous songlark	Least concern	-	-	-	Post-Wet
Birds	Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked honeyeater	Least concern	-	-	-	Spring and Post-Wet
Birds	Meliphagidae	*Caligavis chrysops*	Yellow-faced honeyeater	Least concern	-	-	-	Post-Wet
Birds	Meliphagidae	*Entomyzon cyanotis*	Blue-faced honeyeater	Least concern	-	-	-	Spring and Post-Wet
Birds	Meliphagidae	*Lichmera indistincta*	Brown honeyeater	Least concern	-	-	-	Spring and Post-Wet
Birds	Meliphagidae	*Manorina melanocephala*	Noisy miner	Least concern	-	-	-	Spring and Post-Wet
Birds	Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater	Least concern	-	-	-	Spring and Post-Wet
Birds	Meliphagidae	*Melithreptus brevirostris*	Brown-headed honeyeater	Least concern	-	-	-	Post-Wet
Birds	Meliphagidae	*Myzomela sanguinolenta*	Scarlet honeyeater	Least concern	-	-	-	Post-Wet
Birds	Meliphagidae	*Nesoptilotis leucotis*	White-eared honeyeater	Least concern	-	-	-	Post-Wet
Birds	Meliphagidae	*Philemon citreogularis*	Little friarbird	Least concern	-	-	-	Spring and Post-Wet
Birds	Meliphagidae	*Philemon corniculatus*	Noisy friarbird	Least concern	-	-	-	Spring and Post-Wet
Birds	Meliphagidae	*Plectorhyncha lanceolata*	Striped honeyeater	Least concern	-	-	-	Spring and Post-Wet
Birds	Meliphagidae	*Grantiella picta*	Painted honeyeater	Vulnerable	Vulnerable	-	-	Spring
Birds	Meliphagidae	*Manorina flavigula*	Yellow-throated miner	Least concern	-	-	-	Spring

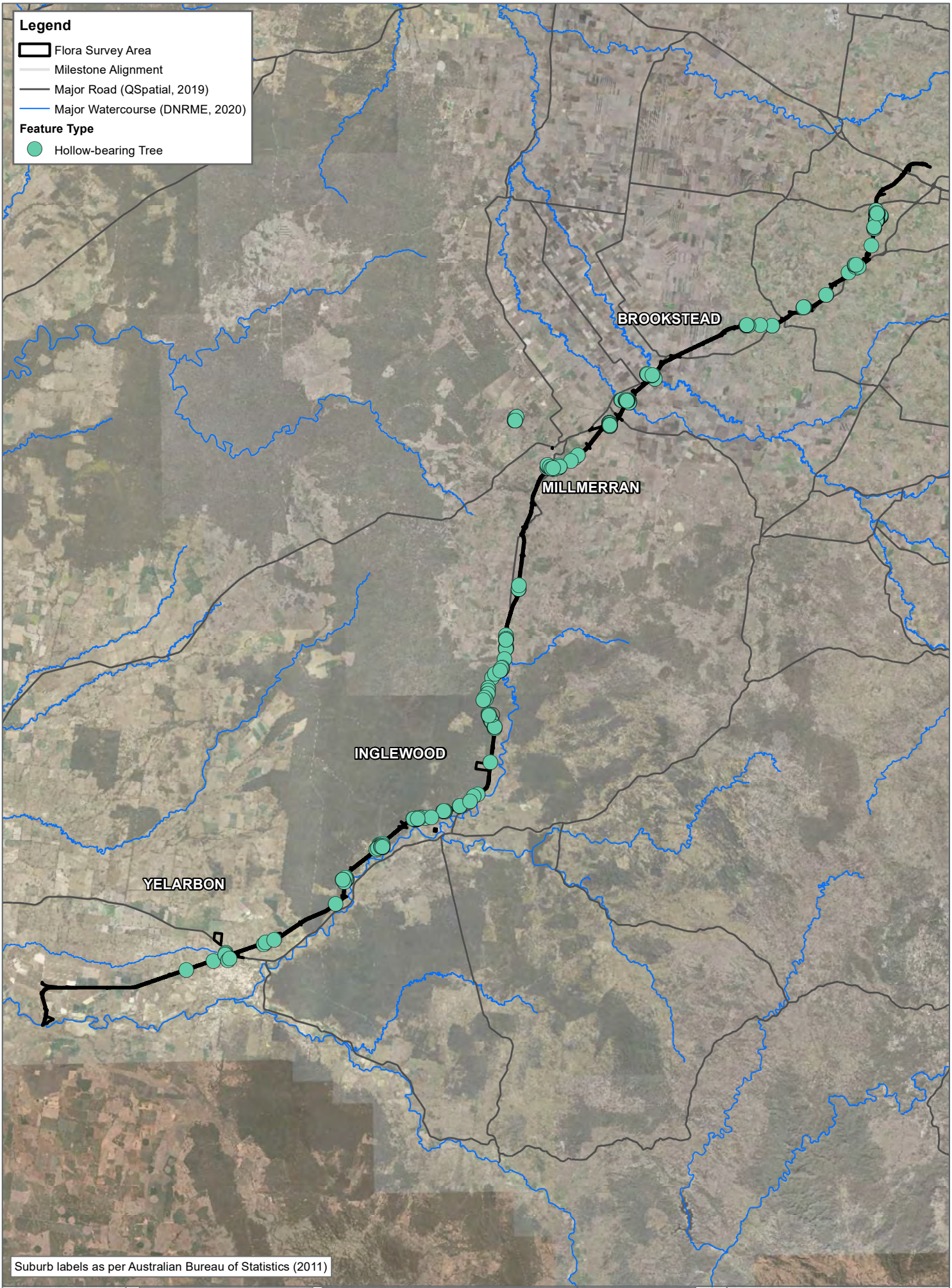
Birds	Meropidae	*Merops ornatus*	Rainbow bee-eater	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Monarchidae	*Grallina cyanoleuca*	Magpie-lark	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Monarchidae	*Myiagra cyanoleuca*	Satin flycatcher	Special least concern	-	-	Ma, Mi	Post-Wet
Birds	Monarchidae	*Myiagra rubecula*	Leaden flycatcher	Least concern	-	-	-	Spring and Post-Wet
Birds	Monarchidae	*Myiagra inquieta*	Restless flycatcher	Least concern	-	-	-	Spring
Birds	Motacillidae	*Anthus novaeseelandiae*	Australasian pipit	Least concern	-	-	Ma	Spring
Birds	Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird	Least concern	-	-	-	Spring and Post-Wet
Birds	Neosittidae	*Daphoenositta chrysoptera*	Varied sittella	Least concern	-	-	-	Post-Wet
Birds	Oriolidae	*Oriolus sagittatus*	Olive-backed oriole	Least concern	-	-	-	Post-Wet
Birds	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird	Least concern	-	-	-	Post-Wet
Birds	Pachycephalidae	*Colluricincla harmonica*	Grey shrike-thrush	Least concern	-	-	-	Spring and Post-Wet
Birds	Pachycephalidae	*Colluricincla megarhyncha*	Little shrike-thrush	Least concern	-	-	-	Post-Wet
Birds	Pachycephalidae	*Pachycephala rufiventris*	Rufous whistler	Least concern	-	-	-	Spring and Post-Wet
Birds	Pachycephalidae	*Pachycephala pectoralis youngi*	Golden whistler (south-eastern Australia)	Least concern	-	-	-	Spring
Birds	Pardalotidae	*Pardalotus striatus*	Striated pardalote	Least concern	-	-	-	Spring and Post-Wet
Birds	Pelecanidae	*Pelecanus conspicillatus*	Australian pelican	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Petroicidae	*Eopsaltria australis*	Eastern yellow robin	Least concern	-	-	-	Post-Wet
Birds	Petroicidae	*Melanodryas cucullata*	Hooded robin	Least concern	-	-	-	Post-Wet
Birds	Petroicidae	*Microeca fascinans*	Jacky winter	Least concern	-	-	-	Spring and Post-Wet
Birds	Petroicidae	*Petroica goodenovii*	Red-capped robin	Least concern	-	-	-	Post-Wet
Birds	Phalacrocoracidae	*Microcarbo melanoleucos*	Little pied cormorant	Least concern	-	-	-	Post-Wet
Birds	Phalacrocoracidae	*Phalacrocorax carbo*	Great cormorant	Least concern	-	-	-	Post-Wet
Birds	Phasianidae	*Coturnix pectoralis*	Stubble quail	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Phasianidae	*Coturnix ypsilophora*	Brown quail	Least concern	-	-	-	Post-Wet
Birds	Phipiduridae	*Rhipidura albiscapa*	Grey fantail	Least concern	-	-	-	Spring and Post-Wet
Birds	Podargidae	*Podargus strigoides*	Tawny frogmouth	Least concern	-	-	-	Spring and Post-Wet
Birds	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian grebe	Least concern	-	-	-	Spring and Post-Wet
Birds	Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned babbler	Least concern	-	-	-	Spring and Post-Wet
Birds	Psittacidae	*Aprosmictus erythropterus*	Red-winged parrot	Least concern	-	-	-	Spring and Post-Wet
Birds	Psittacidae	*Platycercus adscitus palliceps*	Pale-headed rosella	Least concern	-	-	-	Spring and Post-Wet
Birds	Psittacidae	*Psephotus haematonotus*	Red-rumped parrot	Least concern	-	-	-	Spring and Post-Wet
Birds	Psittacidae	*Trichoglossus chlorolepidotus*	Scaly-breasted lorikeet	Least concern	-	-	-	Spring and Post-Wet
Birds	Psittacidae	*Trichoglossus haematodus moluccanus*	Rainbow lorikeet	Least concern	-	-	-	Spring and Post-Wet
Birds	Psittacidae	*Alisterus scapularis*	Australian king-parrot	Least concern	-	-	-	Spring
Birds	Psittacidae	*Northiella haematogaster haematorrhoa*	Blue bonnet (red-vented)	Least concern	-	-	-	Spring
Birds	Psittacidae	*Platycercus eximius*	Eastern rosella	Least concern	-	-	-	Spring
Birds	Ptilonorhynchidae	*Ptilonorhynchus maculatus*	Spotted bowerbird	Least concern	-	-	-	Post-Wet
Birds	Rallidae	*Gallinula tenebrosa*	Dusky moorhen	Least concern	-	-	-	Spring and Post-Wet
Birds	Rallidae	*Gallirallus philippensis*	Buff-banded rail	Least concern	-	-	-	Post-Wet
Birds	Rallidae	*Porphyrio melanotus*	Purple swamphen	Least concern	-	-	-	Post-Wet
Birds	Rhipiduridae	*Rhipidura leucophrys leucophrys*	Willie wagtail	Least concern	-	-	-	Spring and Post-Wet
Birds	Rhipiduridae	*Rhipidura rufifrons*	Rufous fantail	Special least concern	-	-	Ma, Mi	Post-Wet
Birds	Strigidae	*Ninox boobook*	Southern boobook	Least concern	-	-	-	Spring and Post-Wet
Birds	Strigidae	*Ninox connivens*	Barking owl	Least concern	-	-	-	Spring
Birds	Sturnidae	*Acridotheres tristis*	Common myna	-	-	Yes	-	Spring and Post-Wet
Birds	Threskiornithidae	*Platalea flavipes*	Yellow-billed spoonbill	Least concern	-	-	-	Post-Wet
Birds	Threskiornithidae	*Platalea regia*	Royal spoonbill	Least concern	-	-	-	Post-Wet
Birds	Threskiornithidae	*Threskiornis molucca*	Australian white ibis	Least concern	-	-	Ma	Post-Wet
Birds	Threskiornithidae	*Threskiornis spinicollis*	Straw-necked ibis	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Timaliidae	*Zosterops lateralis*	Silvereye	Least concern	-	-	Ma	Spring and Post-Wet
Birds	Turnicidae	*Turnix varius*	Painted button-quail	Least concern	-	-	-	Spring and Post-Wet
Birds	Tytonidae	*Tyto delicatula*	Eastern barn owl	Least concern	-	-	-	Spring and Post-Wet
Gastropods	Camaenidae	*Ponderconcha gilberti*	Darling Downs woodland snail	-	-	-	-	Post-Wet
Gastropods	Camaenidae	*Ponderconcha ianthostoma*		-	-	-		Post-Wet
Insects	Erebidae	*Utetheisa pulchelloides*	Heliotrope moth	-	-	-	-	Post-Wet
Insects	Hesperiidae	*Trapezites eliena*	Orange ochre	-	-	-	-	Post-Wet
Insects	Mantidae	*Pseudomantis albofimbriata*	False garden mantis	-	-	-	-	Post-Wet
Insects	Noctuidae	*Comocrus behri*	Mistletoe Day Moth	-	-	-	-	Post-Wet
Insects	Nymphalidae	*Danaus petilia*	Lesser wanderer	-	-	-	-	Post-Wet
Insects	Nymphalidae	*Danaus plexippus*	Wanderer butterfly	-	-	Yes	-	Post-Wet
Insects	Nymphalidae	*Hypolimnas bolina nerina*	Varied eggfly	-	-	-	-	Spring and Post-Wet
Insects	Nymphalidae	*Junonia villida villida*	Meadow argus	-	-	-	-	Post-Wet
Insects	Nymphalidae	*Euploea corinna*	Common crow	-	-	-	-	Spring
Insects	Nymphalidae	*Tirumala hamata hamata*	Blue tiger	-	-	Yes	-	Spring

Insects	Nymphalidae	*Acraea andromacha*	Glass wing	-	-	-	-	Post-Wet
Insects	Nymphalidae	*Charaxes sempronius*	Tailed emperor	-	-	-	-	Post-Wet
Insects	Nymphalidae	*Pieris rapae*	Cabbage white	-	-	Yes	-	Post-Wet
Insects	Nymphalidae	*Eurema smilax*	Small grass-yellow	-	-	-	-	Post-Wet
Insects	Papilionidae	*Papilio aegeus*	Orchard swallowtail	-	-	-	-	Post-Wet
Insects	Papilionidae	*Papilio demoleus sthenelus*	Chequered swallowtail	-	-	-	-	Post-Wet
Insects	Pieridae	*Catopsilia pomona*	Lemon migrant	-	-	-	-	Post-Wet
Insects	Pieridae	*Belenois java teutonia*	Caper white	-	-	Yes	-	Spring
Insects	Pieridae	*Catopsilia pyranthe crokera*	White migrant	-	-	-	-	Spring
Insects	Pieridae	*Cepora perimale scyllara*	Caper gull (Australian subspecies)	-	-	-	-	Spring
Malacostracans	Parastacidae	*Cherax destructor*	Common yabbie	-	-	-	-	Post-Wet
Mammals	Bovidae	*Bos taurus*	European cattle	-	-	Yes	-	Spring and Post-Wet
Mammals	Canidae	*Canis lupus*	Dingo, domestic dog	-	-	Yes	-	Spring and Post-Wet
Mammals	Canidae	*Vulpes vulpes*	European fox	-	-	Yes	-	Spring and Post-Wet
Mammals	Cyprinidae	*Pseudomys delicatulus*	Delicate mouse	Least concern			-	Post-Wet
Mammals	Dasyuridae	*Planigale maculata*	Common planigale	Least concern	-	-	-	Post-Wet
Mammals	Dasyuridae	*Antechinus flavipes flavipes*	Yellow-footed antechinus (south-east Queensland)	Least concern	-	-	-	Spring
Mammals	Dayouroidea	*Sminthopsis murina murina*	Common dunnart	Least concern	-	-	-	Spring and Post-Wet
Mammals	Emballonuridae	*Phascolarctos cinereus*	Koala	Vulnerable	Vulnerable		-	Spring and Post-Wet
Mammals	Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied sheath-tailed bat	Least concern	-	-	-	Post-Wet
Mammals	Felidae	*Felis catus*	Cat	-	-	Yes	-	Spring and Post-Wet
Mammals	Leporidae	*Lepus europaeus*	Hare	-	-	Yes	-	Spring and Post-Wet
Mammals	Leporidae	*Oryctolagus cuniculus*	Rabbit	-	-	Yes	-	Spring and Post-Wet
Mammals	Macropodidae	*Macropus giganteus*	Eastern grey kangaroo	Least concern	-	-	-	Spring and Post-Wet
Mammals	Macropodidae	*Notamacropus parryi*	Whiptail wallaby	Least concern	-	-	-	Spring and Post-Wet
Mammals	Macropodidae	*Notamacropus rufogriseus*	Red-necked wallaby	Least concern	-	-	-	Spring and Post-Wet
Mammals	Macropodidae	*Osphranter robustus*	Common wallaroo	Least concern	-	-	-	Spring and Post-Wet
Mammals	Macropodidae	*Notamacropus dorsalis*	Black-striped wallaby	Least concern	-	-	-	Post-Wet
Mammals	Macropodidae	*Wallabia bicolor*	Swamp wallaby	Least concern	-	-	-	Spring and Post-Wet
Mammals	Muridae	*Mus musculus*	House mouse	-	-	Yes	-	Spring and Post-Wet
Mammals	Muridae	*Rattus rattus*	Black rat	-	-	Yes	-	Spring
Mammals	Petauridae	*Petaurus norfolcensis*	Squirrel glider	Least concern	-	-	-	Post-Wet
Mammals	Petauridae	*Petaurus breviceps*	Sugar glider	Least concern	-	-	-	Spring
Mammals	Phalangeridae	*Trichosurus vulpecula*	Common brushtail possum	Least concern	-	-	-	Spring and Post-Wet
Mammals	Pseudocheiridae	*Pseudocheirus peregrinus*	Common ringtail possum	Least concern	-	-	-	Spring
Mammals	Pteropodidae	*Pteropus scapulatus*	Little red flying-fox	Least concern	-	-	-	Spring and Post-Wet
Mammals	Pteropodidae	*Pteropus poliocephalus*	Grey-headed flying-fox	Least concern	Vulnerable	-	-	Post-Wet
Mammals	Pteropodidae	*Pteropus alecto*	Black flying-fox	Least concern	-	-	-	Spring
Mammals	Suidae	*Sus scrofa*	Feral pig	-	-	Yes	-	Spring and Post-Wet
Mammals	Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked echidna	Special least concern	-	-	-	Spring and Post-Wet
Mammals	Vespertilionidae	*Nyctophilus geoffroyi*	Lesser long-eared bat	Least concern	-	-	-	Spring and Post-Wet
Mammals	Vespertilionidae	*Nyctophilus gouldi*	Gould's long-eared bat	Least concern	-	-	-	Spring and Post-Wet
Mammals	Vespertilionidae	*Scotorepens sp. (* Parnaby*)*	Central-eastern broad-nosed bat	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Vespadelus baverstocki*	Inland forest bat	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Nyctophilus corbeni*	Eastern long-eared bat	Vulnerable	Vulnerable	-	-	Spring
Mammals	Vespertilionidae	*Scotorepens greyii*	Little broad-nosed bat	Least concern	-	-	-	Spring
Mammals	Vespertilionidae	*Scotorepens orion*	South-eastern broad-nosed bat	Least concern	-	-	-	Spring
Mammals	Vespertilionidae	*Chalinolobus gouldii*	Gould's wattled bat	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Chalinolobus morio*	chocolate wattled bat	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Chalinolobus picatus*	Little pied bat	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Nyctophilus* sp.	-	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Scotorepens balstoni*	Inland broad-nosed bat	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Scotorepens* sp. / *Scotorepens greyii*	-	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Vespadelus regulus*	Southern forest bat	Least concern	-	-	-	Post-Wet
Mammals	Vespertilionidae	*Vespadelus vulturnus*	Little forest bat	Least concern	-	-	-	Post-Wet
Mammals	Miniopteridae	*Miniopterus orianae*	Eastern bent-wing bat	Least concern	-	-	-	Post-Wet
Mammals	Molossidae	*Austronomus australis*	White-striped freetail bat	Least concern	-	-	-	Post-Wet
Mammals	Molossidae	*Ozimops lumsdenae*	Northern free-tailed bat	Least concern	-	-	-	Post-Wet
Mammals	Molossidae	*Ozimops ridei*	Eastern free-tailed bat	Least concern	-	-	-	Post-Wet
Reptiles	Agamidae	*Amphibolurus muricatus*	Jacky dragon	Least concern	-	-	-	Post-Wet
Reptiles	Agamidae	*Diporiphora nobbi*	Nobbi dragon	Least concern	-	-	-	Post-Wet
Reptiles	Agamidae	*Pogona barbata*	Eastern bearded dragon	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Boidae	*Morelia spilota*	Carpet python	Least concern	-	-	-	Spring
Reptiles	Chelidae	*Chelodina longicollis*	Eastern long-necked turtle	Least concern	-	-	-	Spring and Post-Wet

Reptiles	Chelidae	*Emydura macquarii macquarii*	Murray turtle	Least concern	-	-	-	Spring
Reptiles	Colubridae	*Dendrelaphis punctulatus*	Common tree snake	Least concern	-	-	-	Post-Wet
Reptiles	Diplocactylidae	*Diplodactylus vittatus*	Eastern stone gecko	Least concern	-	-	-	Post-Wet
Reptiles	Diplodactylidae	*Nebulifera robusta*	Robust velvet gecko	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Diplodactylidae	*Strophurus williamsi*	Eastern spiny-tailed gecko	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Elapidae	*Cacophis churchilli*	Northern dwarf crowned snake	Least concern	-	-	-	Post-Wet
Reptiles	Elapidae	*Pseudechis guttatus*	Spotted black snake	Least concern	-	-	-	Post-Wet
Reptiles	Elapidae	*Suta dwyeri*	Dwyer's snake	Least concern	-	-	-	Post-Wet
Reptiles	Elapidae	*Cryptophis boschmai*	Carpentaria whip snake	Least concern	-	-	-	Spring
Reptiles	Elapidae	*Demansia psammophis*	Yellow-faced whipsnake	Least concern	-	-	-	Spring
Reptiles	Elapidae	*Furina diadema*	Red-naped snake	Least concern	-	-	-	Spring
Reptiles	Elapidae	*Hemiaspis damelii*	Grey snake	Endangered	-	-	-	Spring
Reptiles	Elapidae	*Hoplocephalus bitorquatus*	Pale-headed snake	Least concern	-	-	-	Spring
Reptiles	Elapidae	*Pseudonaja textilis*	Eastern brown snake	Least concern	-	-	-	Spring
Reptiles	Elapidae	*Vermicella annulata*	Bandy-bandy	Least concern	-	-	-	Post-Wet
Reptiles	Gekkonidae	*Gehyra dubia*	Dubious dtella	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Gekkonidae	*Gehyra versicolor*	Eastern tree dtella	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Gekkonidae	*Heteronotia binoei*	Bynoe's gecko	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Gekkonidae	*Gehyra catenata*	Chain-backed dtella	Least concern	-	-	-	Spring
Reptiles	Pygopodidae	*Delma plebeia*	Leaden delma	Least concern	-	-	-	Post-Wet
Reptiles	Pygopodidae	*Lialis burtonis*	Burton's legless lizard	Least concern	-	-	-	Spring
Reptiles	Pygopodidae	*Paradelma orientalis*	Brigalow scaly-foot	Least concern	-	-	-	Spring
Reptiles	Scincidae	*Carlia pectoralis*	Open-litter rainbow-skink	Least concern	-	-	-	Post-Wet
Reptiles	Scincidae	*Carlia vivax*	Lively rainbow skink	Least concern	-	-	-	Post-Wet
Reptiles	Scincidae	*Ctenotus robustus*	Eastern striped skink	-	-	Yes	-	Post-Wet
Reptiles	Scincidae	*Egernia striolata*	Tree skink	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Scincidae	*Liopholis modesta*	Eastern ranges rock-skink	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Scincidae	*Morethia boulengeri*	South-eastern morethia skink	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Scincidae	*Eremiascincus richardsonii*	Broad-banded sand-swimmer	Least concern	-	-	-	Post-Wet
Reptiles	Scincidae	*Lampropholis delicata*	Grass skink	Least concern	-	-	-	Post-Wet
Reptiles	Scincidae	*Cryptoblepharus virgatus*	Striped snake-eyed skink	Least concern	-	-	-	Spring
Reptiles	Scincidae	*Ctenotus spaldingi*	Straight-browed ctenotus	Least concern	-	-	-	Spring
Reptiles	Scincidae	*Tiliqua scincoides*	Common blue-tongued skink	Least concern	-	-	-	Post-Wet
Reptiles	Typhlopidae	*Anilios ligatus*	Robust blind snake	Least concern	-	-	-	Spring
Reptiles	Typhlopidae	*Anilios torresianus*	North-eastern blind snake	Least concern	-	-	-	Spring
Reptiles	Varanidae	*Varanus gouldii*	Sand goanna	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Varanidae	*Varanus varius*	Lace monitor	Least concern	-	-	-	Spring and Post-Wet
Reptiles	Varanidae	*Varanus panoptes*	Yellow-spotted monitor	Least concern	-	-	-	Spring

APPENDIX K

BREEDING PLACES



ARTC

1:525,000 Scale at A3

km
0 5 10 15 20

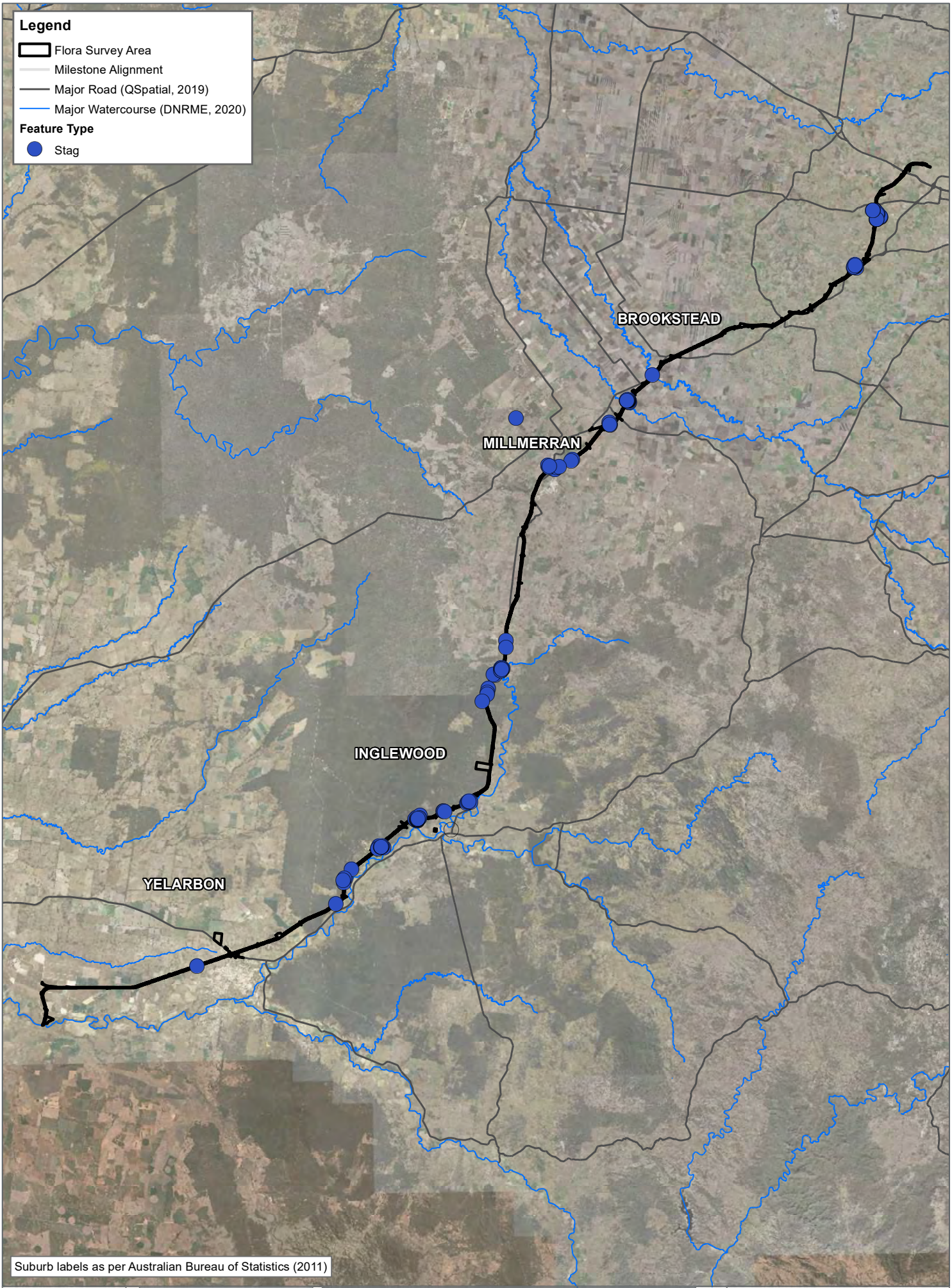
Fauna Breeding Features
Hollow-bearing Tree

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-076-Report_FaunaBreedingFull.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

1:525,000 Scale at A3

km
0 5 10 15 20

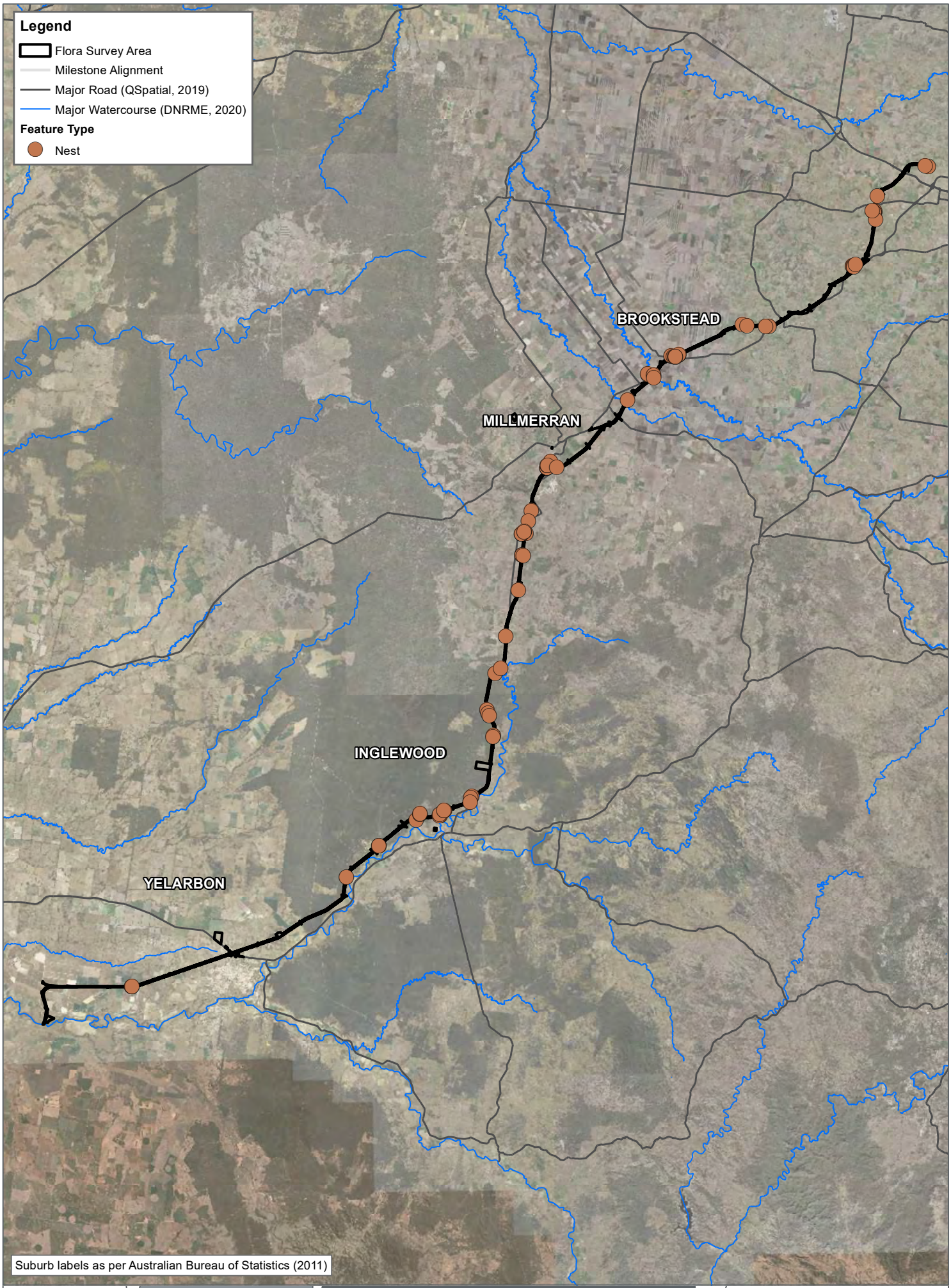
Fauna Breeding Features
Stag

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-076-Report_FaunaBreedingFull.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

1:525,000 Scale at A3

km
0 5 10 15 20

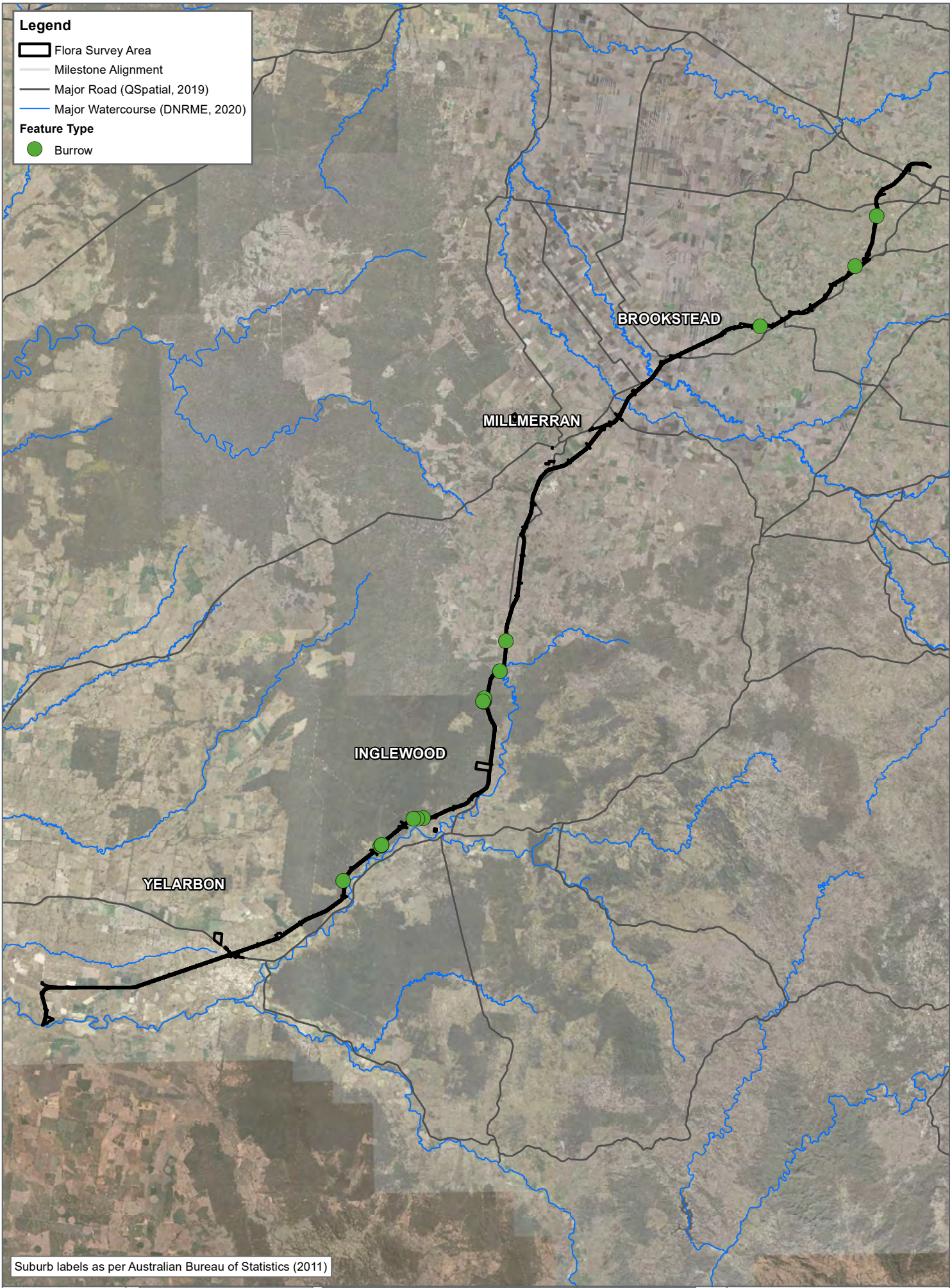
Fauna Breeding Features
Nest

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-076-Report_FaunaBreedingFull.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

1:525,000 Scale at A3

km
0 5 10 15 20

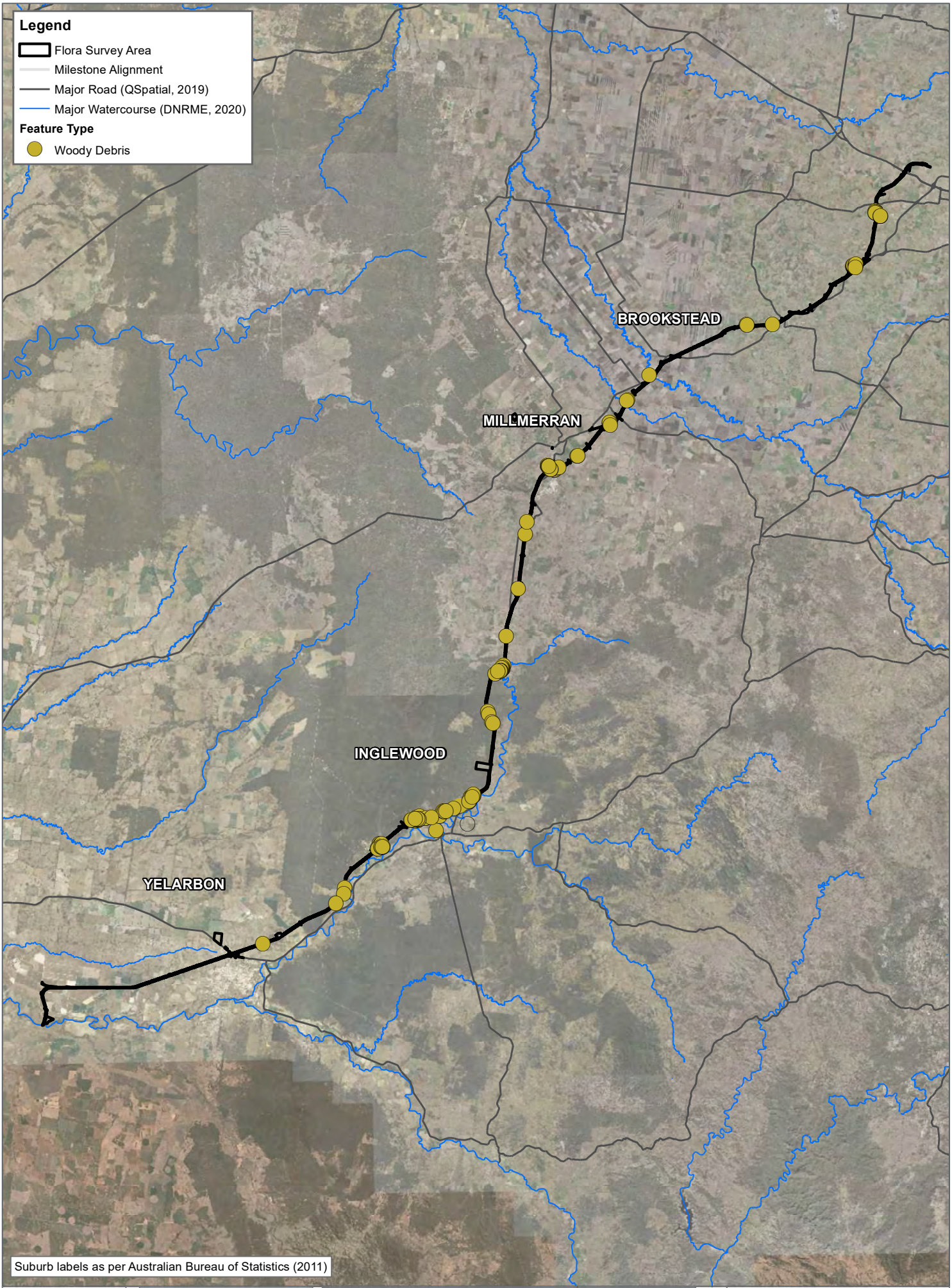
Fauna Breeding Features
Burrow

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-076-Report_FaunaBreedingFull.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

1:525,000 Scale at A3

km
0 5 10 15 20

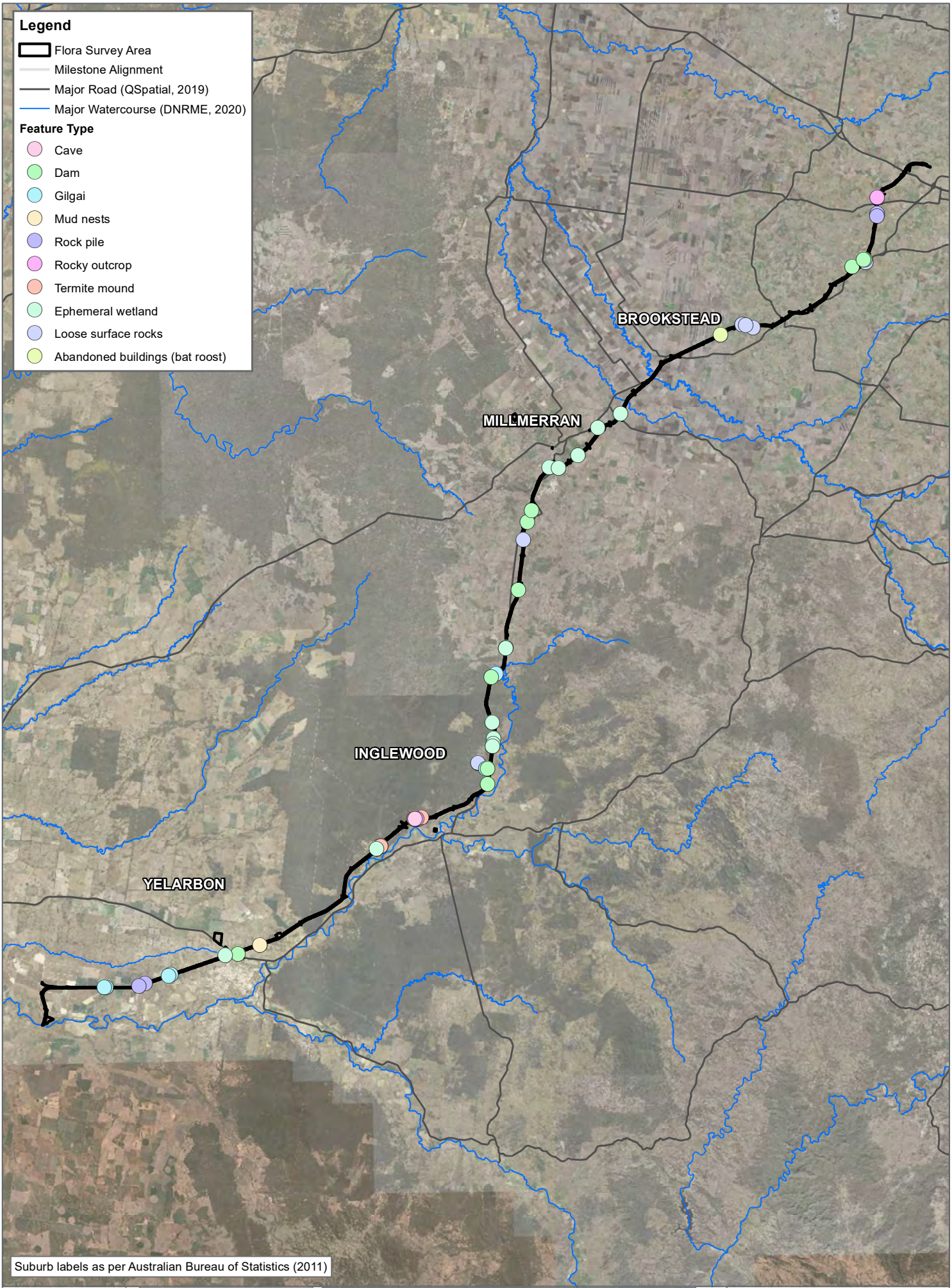
Fauna Breeding Features
Woody Debris

B2G TERRESTRIAL ECOLOGY SURVEY

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-076-Report_FaunaBreedingFull.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

1:525,000 Scale at A3

km
0 5 10 15 20

Fauna Breeding Features
Other features

B2G TERRESTRIAL ECOLOGY SURVEY

N

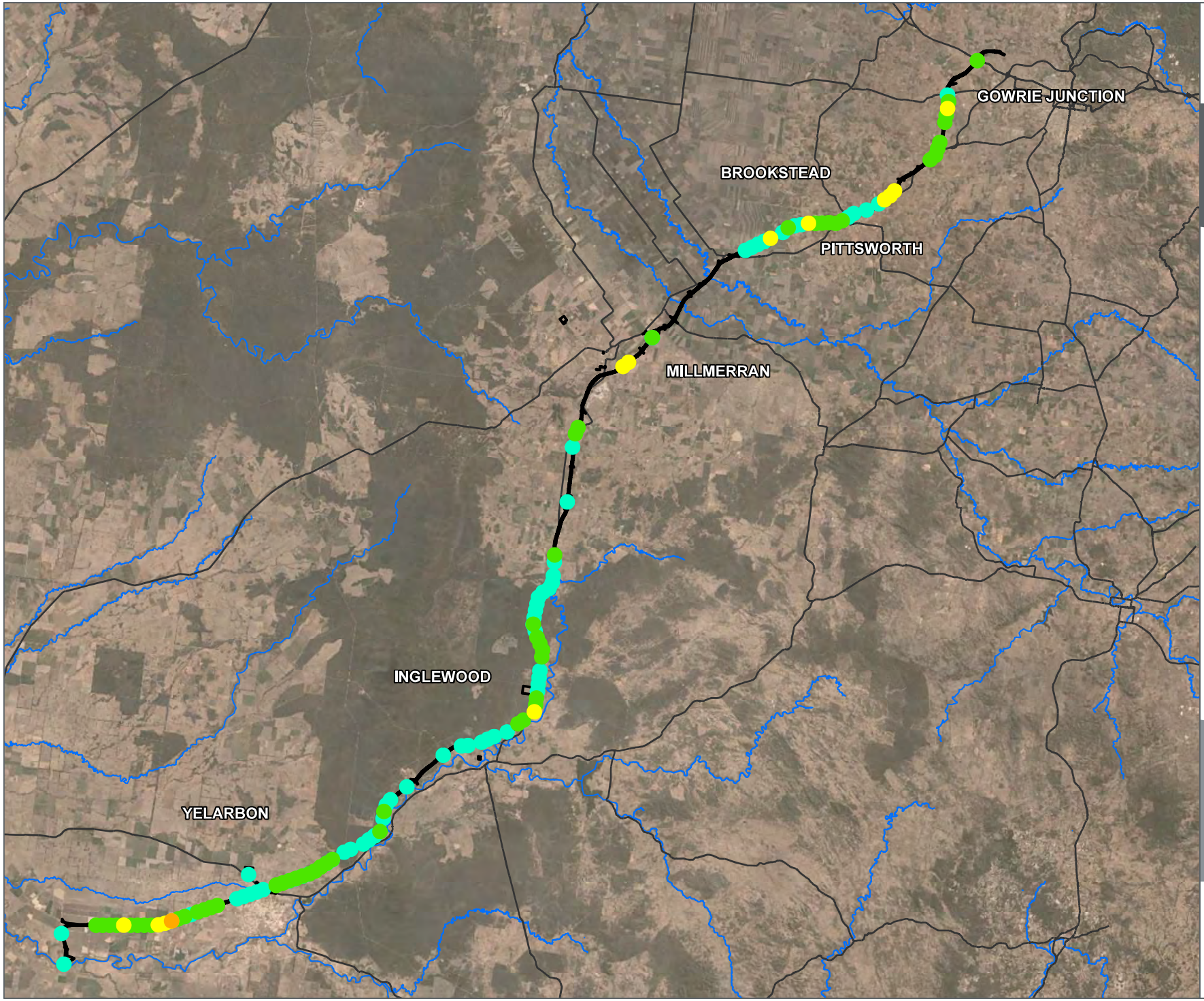
Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-05-21 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-076-Report_FaunaBreedingFull.mxd 02
Aerial Imagery supplied by the State of Queensland (2017)

APPENDIX

L

WEED ABUNDANCES



ARTC

Weed 1km Summary Points - *Opuntia tomentosa*

B2G ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Watercourse (DNRME)
- Major Road (QSpatial, 2019)

Abundance

- Present
- Scattered
- Low
- Moderate

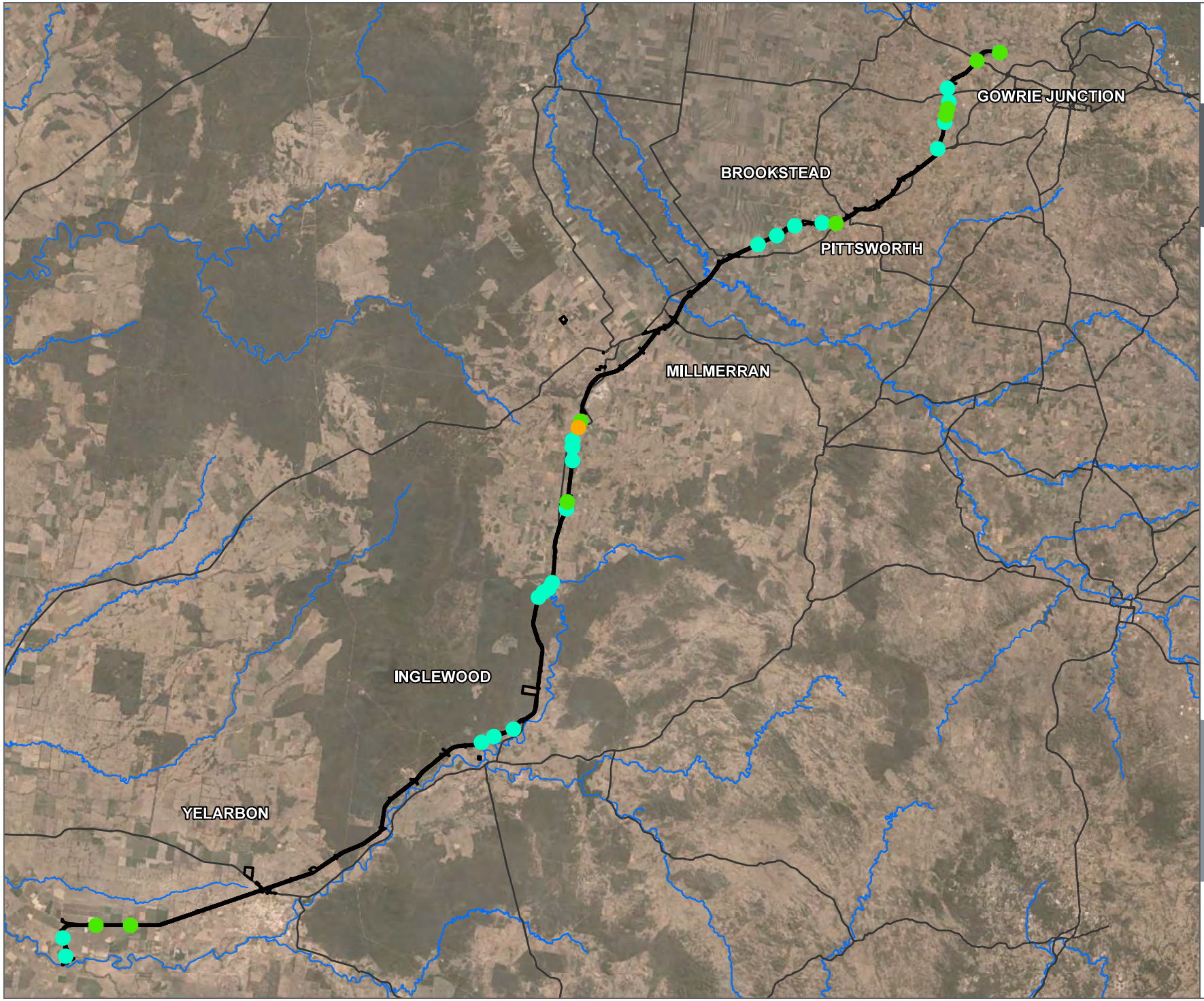
Suburb labels as per Australian Bureau of Statistics (2011)

1:525,000 Scale at A3

km
0 5 10 15 20

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-04-16 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-068-Report_Weeds.mxd 01
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Weed 1km Summary Points - *Lycium ferocissimum*

B2G ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Watercourse (DNRME)
- Major Road (QSpatial, 2019)

Abundance

- Present
- Scattered
- Moderate

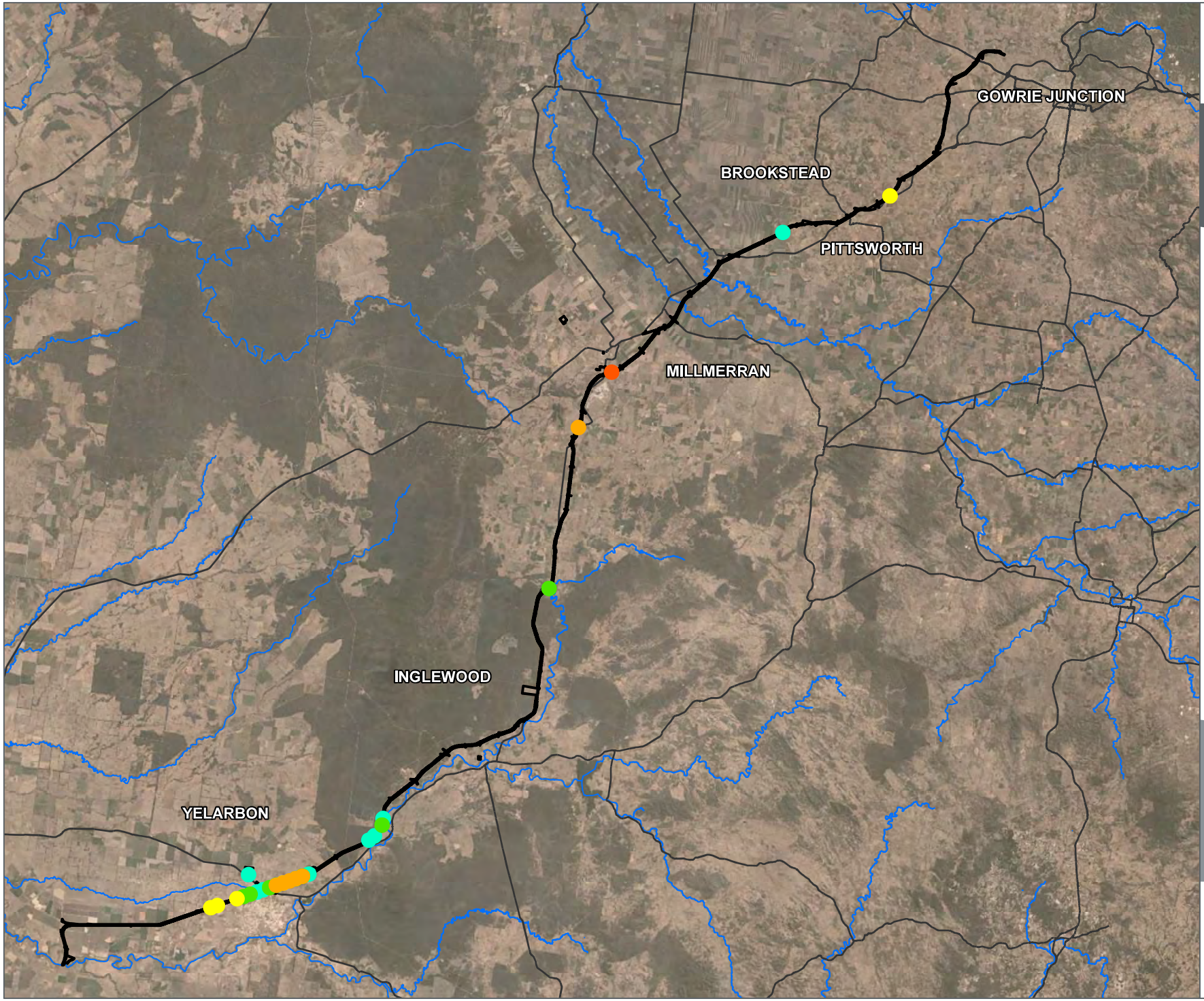
Suburb labels as per Australian Bureau of Statistics (2011)

1:525,000 Scale at A3

km
0 5 10 15 20

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-04-16 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-068-Report_Weeds.mxd 01
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Weed 1km Summary Points - *Bryophyllum delagoense*

B2G ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Watercourse (DNRME)
- Major Road (QSpatial, 2019)

Abundance

- Present
- Scattered
- Low
- Moderate
- High

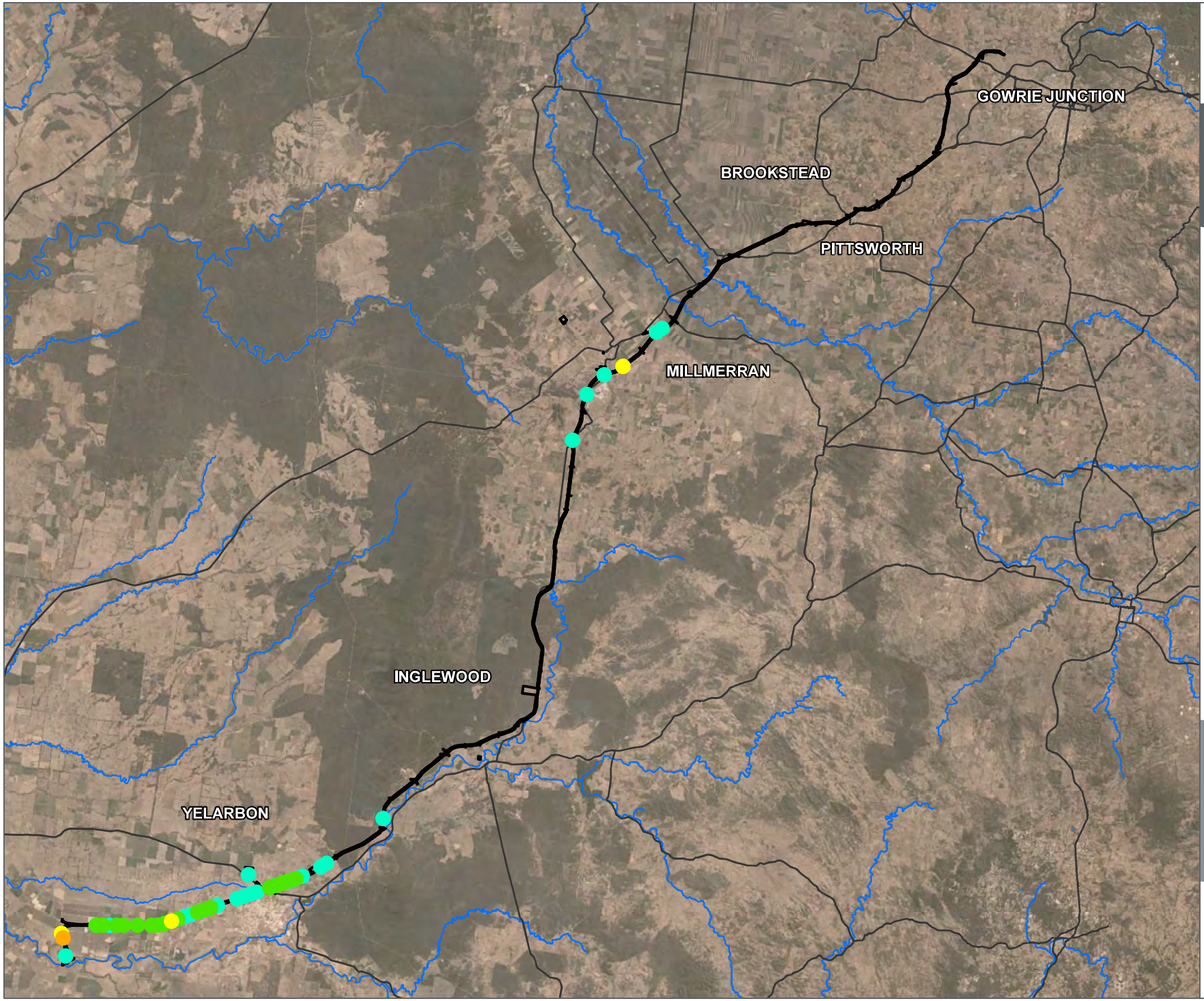
Suburb labels as per Australian Bureau of Statistics (2011)

1:525,000 Scale at A3

km
0 5 10 15 20

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-04-16 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-068-Report_Weeds.mxd 01
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Weed 1km Summary Points - *Harrisia martinii*

B2G ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Watercourse (DNRME)
- Major Road (QSpatial, 2019)

Abundance

- Present
- Scattered
- Low
- Moderate

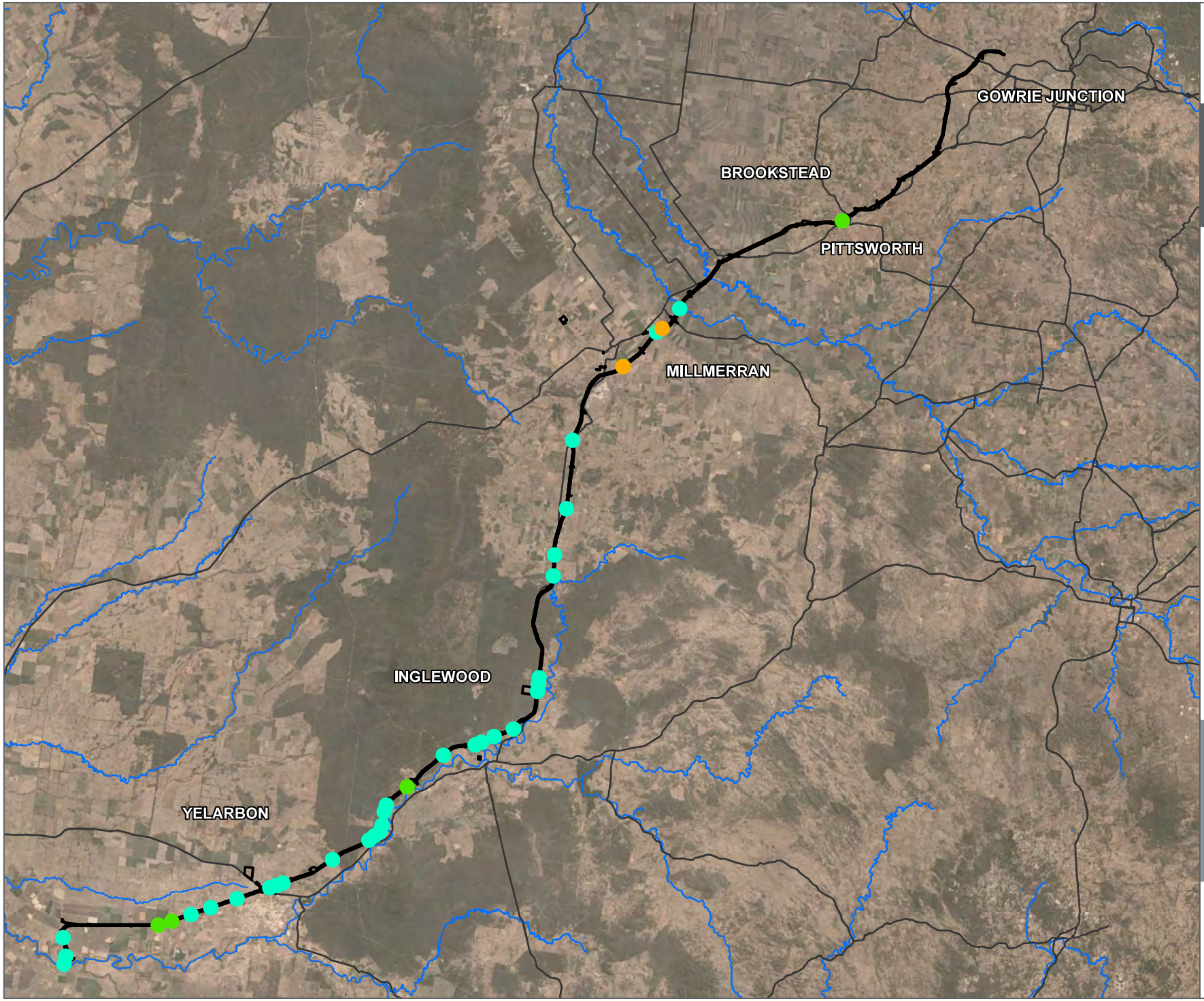
Suburb labels as per Australian Bureau of Statistics (2011)

1:525,000 Scale at A3

km
0 5 10 15 20

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-04-16 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-068-Report_Weeds.mxd 01
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Weed 1km Summary Points - *Opuntia aurantiaca*

B2G ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Watercourse (DNRME)
- Major Road (QSpatial, 2019)

Abundance

- Present
- Scattered
- Moderate

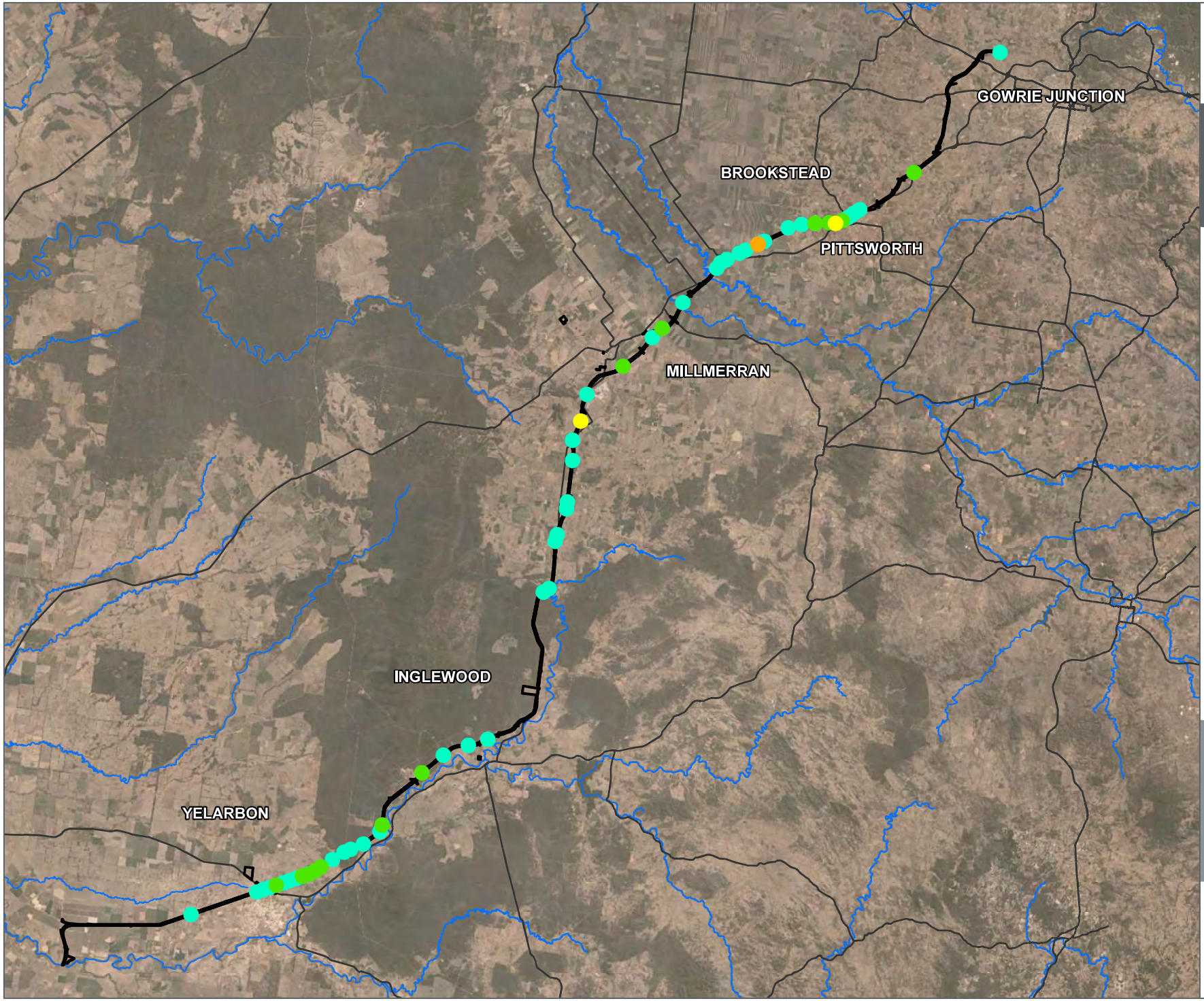
Suburb labels as per Australian Bureau of Statistics (2011)

1:525,000 Scale at A3

km
0 5 10 15 20

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-04-16 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-068-Report_Weeds.mxd 01
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Weed 1km Summary Points - *Opuntia stricta*

B2G ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Watercourse (DNRME)
- Major Road (QSpatial, 2019)

Abundance

- Present
- Scattered
- Low
- Moderate

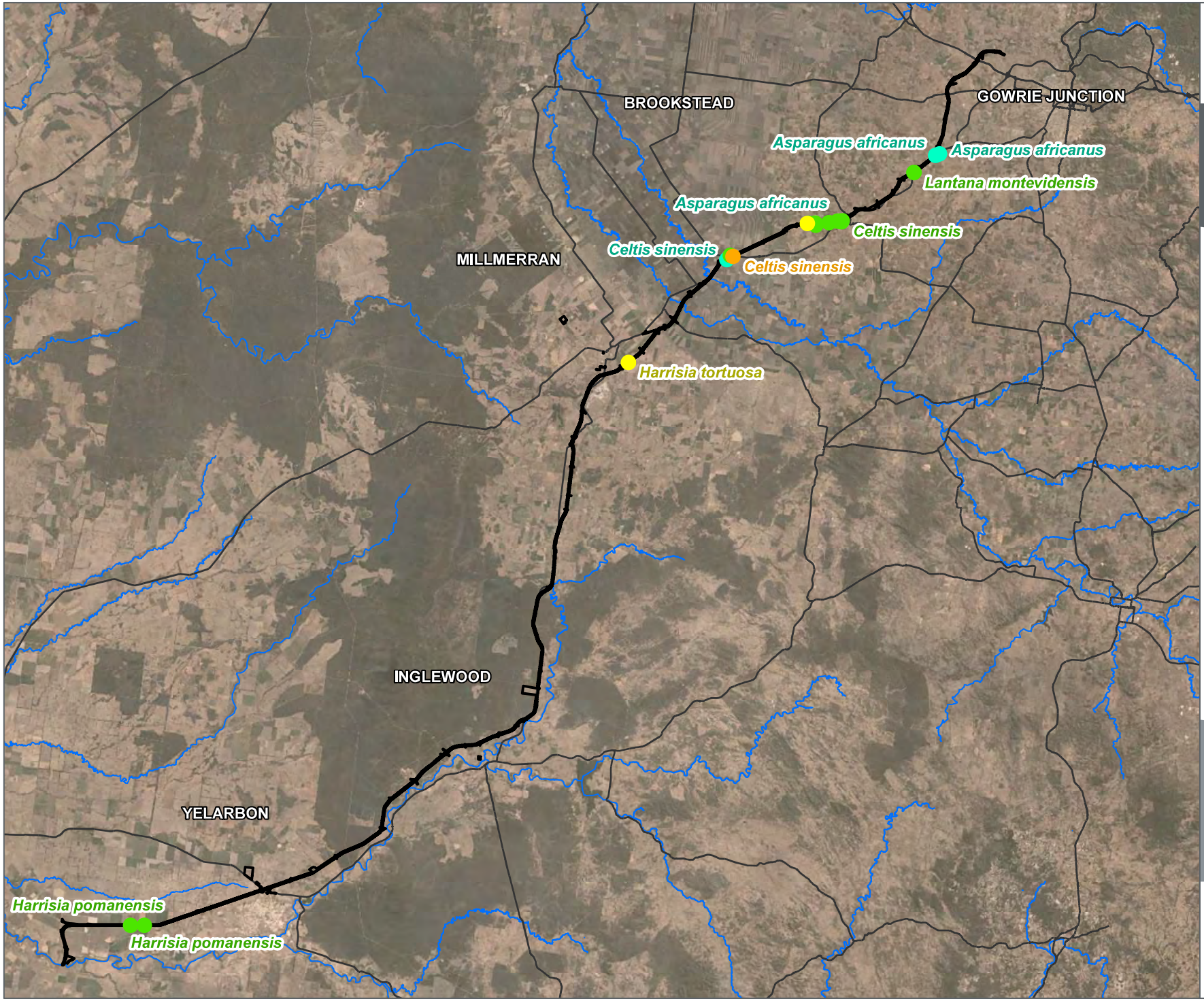
Suburb labels as per Australian Bureau of Statistics (2011)

1:525,000 Scale at A3

km
0 5 10 15 20

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-04-16 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-068-Report_Weeds.mxd 01
Aerial Imagery supplied by the State of Queensland (2017)



ARTC

Weed 1km Summary Points - Other weeds

B2G ECOLOGICAL ASSESSMENT

Legend

- Flora Study Area
- Major Watercourse (DNRME)
- Major Road (QSpatial, 2019)

Abundance

- Present
- Scattered
- Low
- Moderate

Suburb labels as per Australian Bureau of Statistics (2011)

1:525,000 Scale at A3

km
0 5 10 15 20

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2021-04-16 | Project: NE30044
Coordinate System: GDA 1994 MGA Zone 56
Map: NE30044-GS-068-Report_Weeds.mxd 01
Aerial Imagery supplied by the State of Queensland (2017)

Appendix D – BioCondition assessment photos

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	15	0	1	0	0	5	12	0	67	0	100%
	35	0	6	1	0	22	28	0	8	0	100%
	18	0	2	0	0	6	7	2	65	0	100%
	82	0	1	0	1	9	4	1	2	0	100%
	10	0	1	0	0	6	43	0	40	0	100%
Mean	32.00	0.00	2.20	0.20	0.20	9.60	18.80	0.60	36.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	5	80	15	0	0	0	100%
	2	0	10	0	0	73	15	0	0	0	100%
	5	0	10	0	0	65	20	0	0	0	100%
	5	0	5	0	0	75	15	0	0	0	100%
	10	0	10	0	10	40	30	0	0	0	100%
Mean	4.40	0.00	7.00	0.00	3.00	66.60	19.00	0.00	0.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	20	0	5	0	0	30	40	0	5	0	100%
	5	0	0	8	11	50	25	0	1	0	100%
	0	0	2	0	30	33	35	0	0	0	100%
	20	0	1	0	25	25	24	0	5	0	100%
	15	0	0	0	36	45	3	0	1	0	100%
Mean	12.00	0.00	1.60	1.60	20.40	36.60	25.40	0.00	2.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	10	0	52	0	0	0	35	0	3	0	100%
	68	0	10	0	0	2	15	0	5	0	100%
	65	0	10	0	0	0	15	0	10	0	100%
	71	0	20	0	0	0	3	0	6	0	100%
	64	0	4	1	0	1	10	0	20	0	100%
Mean	55.60	0.00	19.20	0.20	0.00	0.60	15.60	0.00	8.80	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	1	0	3	0	0	93	2	0	1	0	100%
	5	0	15	0	0	78	2	0	0	0	100%
	1	0	5	0	0	91	2	0	1	0	100%
	3	0	10	0	0	85	2	0	0	0	100%
	3	0	35	0	0	59	3	0	0	0	100%
Mean	2.60	0.00	13.60	0.00	0.00	81.20	2.20	0.00	0.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	10	0	20	0	0	0	55	0	15	0	100%
	0	0	1	0	0	0	94	0	5	0	100%
	3	0	1	0	0	0	94	0	2	0	100%
	2	0	5	0	0	0	78	0	15	0	100%
	1	0	20	0	0	0	74	0	5	0	100%
Mean	3.20	0.00	9.40	0.00	0.00	0.00	79.00	0.00	8.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	75	0	10	0	0	0	15	0	0	0	100%
	48	0	0	30	0	0	17	0	5	0	100%
	82	0	5	1	0	0	10	0	2	0	100%
	62	0	2	1	0	0	30	0	5	0	100%
	15	0	5	0	0	0	80	0	0	0	100%
Mean	56.40	0.00	4.40	6.40	0.00	0.00	30.40	0.00	2.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

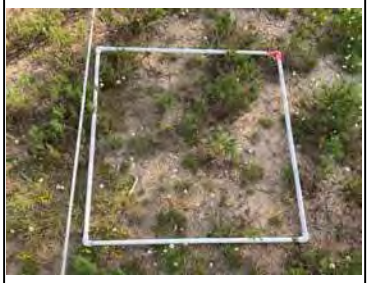
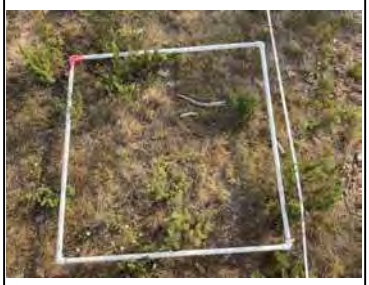
North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	55	0	35	3	0	1	5	0	1	0	100%
	3	0	40	30	0	0	0	0	27	0	100%
	3	0	67	10	0	0	10	0	10	0	100%
	2	0	65	30	0	0	0	0	3	0	100%
	3	0	72	20	0	0	0	0	5	0	100%
Mean	13.20	0.00	55.80	18.60	0.00	0.20	3.00	0.00	9.20	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	30	0	10	0	0	0	55	0	5	0	100%
	2	0	2	0	0	1	80	0	15	0	100%
	20	0	2	0	0	0	58	0	20	0	100%
	10	0	10	0	0	1	30	0	49	0	100%
	5	0	20	0	0	2	68	0	5	0	100%
Mean	13.40	0.00	8.80	0.00	0.00	0.80	58.20	0.00	18.80	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	15	0	5	1	0	0	0	0	79	0	100%
	2	0	1	52	0	40	0	0	5	0	100%
	3	0	1	61	0	0	5	0	30	0	100%
	80	0	3	2	0	0	0	0	15	0	100%
	8	0	30	25	0	0	1	0	36	0	100%
Mean	21.60	0.00	8.00	28.20	0.00	8.00	1.20	0.00	33.00	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	1	0	1	65	0	33	0	100%
	1	0	3	1	0	0	66	1	28	0	100%
	0	0	1	0	0	0	40	1	55	3	100%
	2	0	3	0	0	0	70	0	25	0	100%
	0	0	4	0	0	0	15	0	66	15	100%
Mean	0.60	0.00	2.20	0.40	0.00	0.20	51.20	0.40	41.40	3.60	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	75	0	15	0	0	0	3	0	7	0	100%
	96	0	0	1	0	0	3	0	0	0	100%
	65	0	25	5	0	0	5	0	0	0	100%
	47	0	10	15	0	0	3	0	25	0	100%
	93	0	5	2	0	0	0	0	0	0	100%
Mean	75.20	0.00	11.00	4.60	0.00	0.00	2.80	0.00	6.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	63	0	25	2	0	0	10	0	0	0	100%
	72	0	15	2	0	0	8	0	3	0	100%
	80	0	15	0	0	0	5	0	0	0	100%
	80	0	0	5	0	10	5	0	0	0	100%
	60	0	35	0	0	0	5	0	0	0	100%
Mean	71.00	0.00	18.00	1.80	0.00	2.00	6.60	0.00	0.60	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	30	0	7	0	0	2	56	0	5	0	100%
	5	0	5	25	0	0	63	0	2	0	100%
	1	0	1	0	0	0	93	0	5	0	100%
	1	0	1	0	0	0	83	0	15	0	100%
	1	0	1	0	0	0	83	0	15	0	100%
Mean	7.60	0.00	3.00	5.00	0.00	0.40	75.60	0.00	8.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	6	0	1	0	0	45	45	1	2	0	100%
	2	0	1	0	0	70	25	0	2	0	100%
	8	0	1	0	0	86	3	2	0	0	100%
	2	0	3	0	0	60	35	0	0	0	100%
	0	0	0	0	0	87	10	1	2	0	100%
Mean	3.60	0.00	1.20	0.00	0.00	69.60	23.60	0.80	1.20	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	86	0	1	0	2	3	8	0	0	0	100%
	10	0	2	0	0	86	2	0	0	0	100%
	50	0	25	0	0	21	3	0	1	0	100%
	66	0	2	0	0	30	2	0	0	0	100%
	25	0	0	0	0	70	5	0	0	0	100%
Mean	47.40	0.00	6.00	0.00	0.40	42.00	4.00	0.00	0.20	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	63	0	10	5	0	0	20	2	0	0	100%
	3	0	35	0	0	0	41	1	20	0	100%
	20	0	14	45	0	1	20	0	0	0	100%
	32	0	30	0	0	1	25	2	10	0	100%
	5	0	10	40	0	0	35	5	5	0	100%
Mean	24.60	0.00	19.80	18.00	0.00	0.40	28.20	2.00	7.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	30	0	0	0	0	65	5	0	0	0	100%
	99	0	0	0	0	1	0	0	0	0	100%
	94	0	0	0	0	1	5	0	0	0	100%
	95	0	0	0	0	0	5	0	0	0	100%
	45	0	10	0	30	15	0	0	0	0	100%
Mean	72.60	0.00	2.00	0.00	6.00	16.40	3.00	0.00	0.00	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	27	0	3	70	0	0	100%
	0	0	0	0	0	25	30	40	5	0	100%
	0	0	0	0	3	3	25	67	2	0	100%
	0	0	0	10	90	0	0	0	0	0	100%
	0	0	0	0	100	0	0	0	0	0	100%
Mean	0.00	0.00	0.00	2.00	44.00	5.60	11.60	35.40	1.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	10	0	5	0	0	1	79	0	5	0	100%
	5	0	0	0	0	0	5	0	10	80	100%
	15	0	3	0	0	0	20	0	5	57	100%
	3	0	3	0	0	0	20	0	7	67	100%
	2	0	10	0	0	0	30	0	25	33	100%
Mean	7.00	0.00	4.20	0.00	0.00	0.20	30.80	0.00	10.40	47.40	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	61	0	3	0	0	2	2	0	2	30	100%
	10	0	1	0	0	0	0	0	0	89	100%
	15	0	58	0	10	0	2	0	0	15	100%
	0	0	0	0	0	0	0	0	0	0	100%
	71	0	6	0	0	0	3	0	0	20	100%
Mean	31.40	0.00	13.60	0.00	2.00	0.40	1.40	0.00	0.40	30.80	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	86	0	1	0	0	0	3	0	10	0	100%
	88	0	2	0	0	0	5	0	5	0	100%
	92	0	0	0	0	0	3	0	5	0	100%
	90	0	0	0	0	0	5	0	5	0	100%
	90	0	0	0	0	0	5	0	5	0	100%
Mean	89.20	0.00	0.60	0.00	0.00	0.00	4.20	0.00	6.00	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	53	0	6	0	0	8	30	0	3	0	100%
	42	0	0	0	0	27	30	0	1	0	100%
	25	0	0	0	0	30	45	0	0	0	100%
	15	0	0	0	0	81	3	0	1	0	100%
	71	0	1	0	0	3	25	0	0	0	100%
Mean	41.20	0.00	1.40	0.00	0.00	29.80	26.60	0.00	1.00	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	10	0	1	0	0	44	10	0	35	0	100%
	20	0	1	0	0	41	3	0	35	0	100%
	5	0	3	0	0	36	50	0	6	0	100%
	15	0	5	0	0	30	10	0	40	0	100%
	5	0	2	8	0	35	20	0	30	0	100%
Mean	11.00	0.00	2.40	1.60	0.00	37.20	18.60	0.00	29.20	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

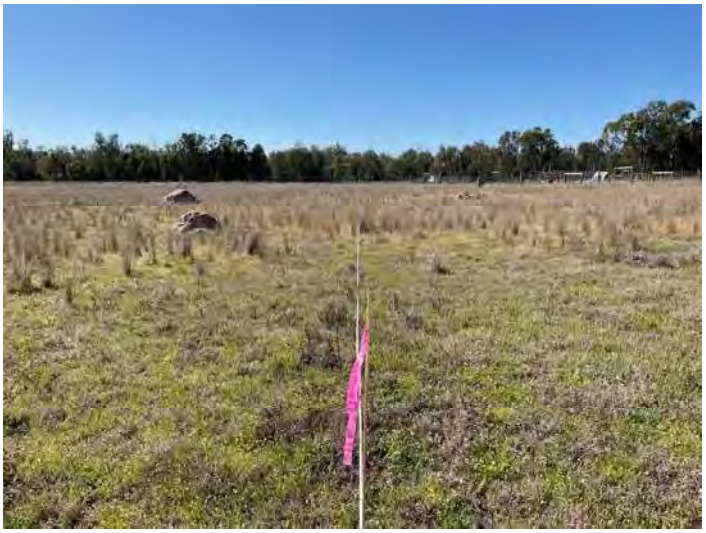
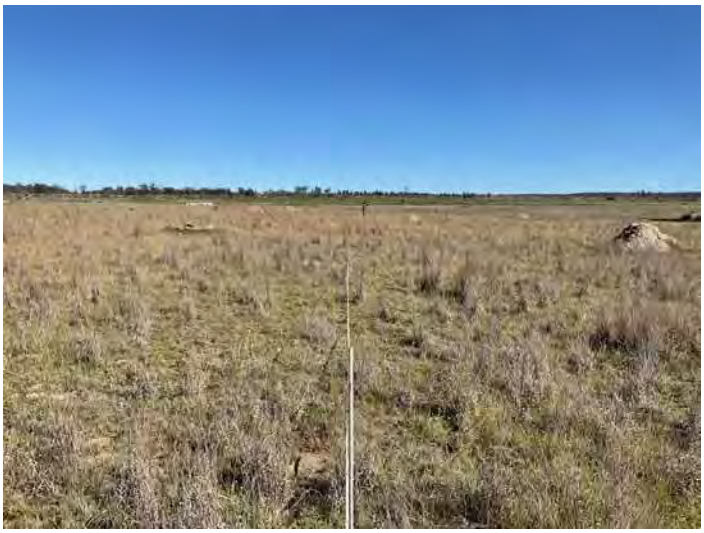
Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	70	0	25	3	0	0	1	0	1	0	100%
	62	0	35	0	0	0	2	0	1	0	100%
	89	0	5	0	0	0	0	0	1	5	100%
	84	0	10	0	0	0	1	0	5	0	100%
	73	0	25	0	0	0	1	0	1	0	100%
Mean	75.60	0.00	20.00	0.60	0.00	0.00	1.00	0.00	1.80	1.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

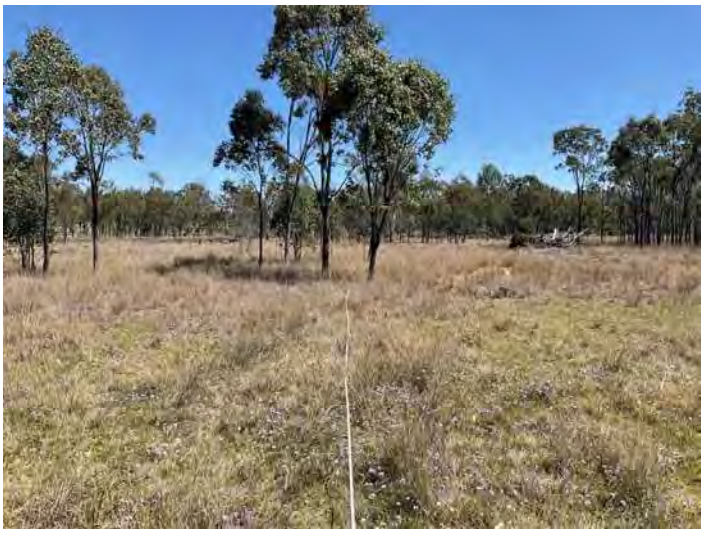
	
Transect Start	**Transect End**
	
North	**East**
South	**West**

1 m x 1 m Quadrats:

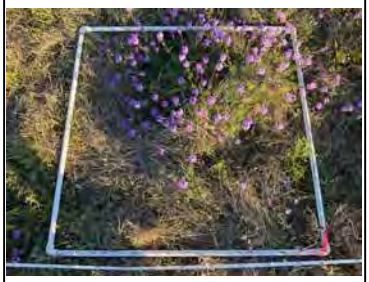
Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	85	0	3	0	0	10	2	0	0	0	100%
	73	0	2	0	0	16	8	0	1	0	100%
	54	0	2	0	0	40	4	0	0	0	100%
	56	0	1	0	0	25	12	0	5	1	100%
	40	0	0	0	0	8	36	0	15	1	100%
Mean	61.60	0.00	1.60	0.00	0.00	19.80	12.40	0.00	4.20	0.40	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

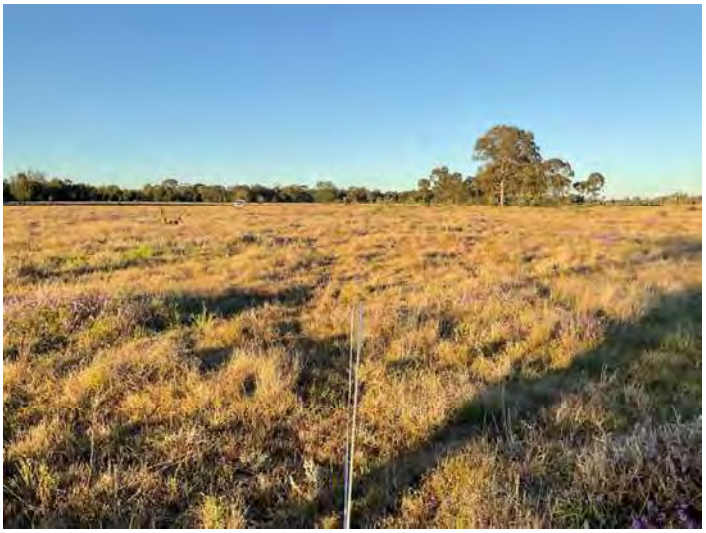
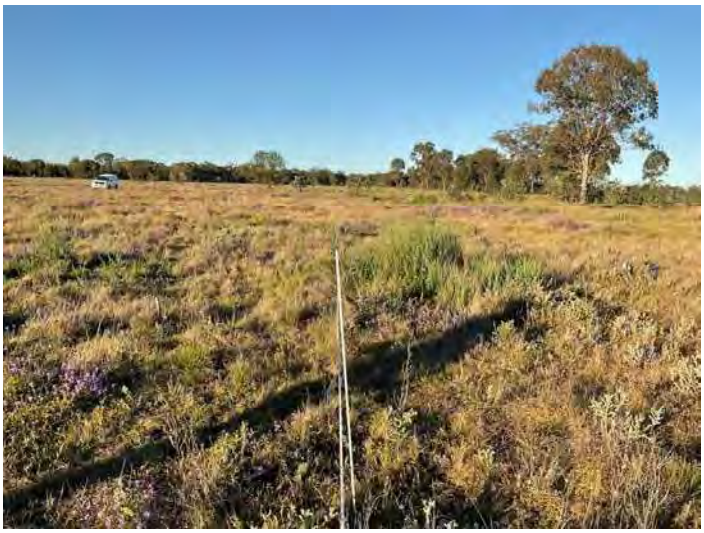
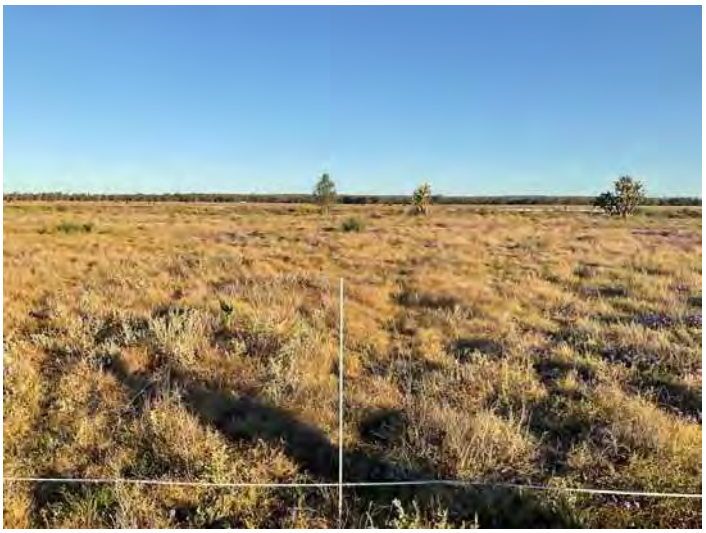
Transect Start	**Transect End**
	
North	**East**
South	**West**

1 m x 1 m Quadrats:

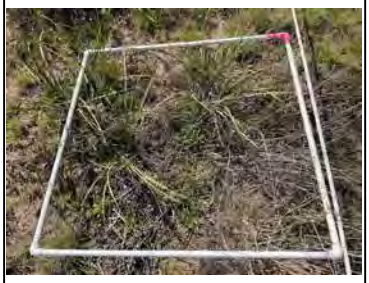
Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	48	0	7	0	0	30	15	0	0	0	100%
	70	0	25	1	0	4	0	0	0	0	100%
	27	0	3	0	0	45	25	0	0	0	100%
	60	0	20	0	0	5	15	0	0	0	100%
	42	0	25	15	0	3	15	0	0	0	100%
Mean	49.40	0.00	16.00	3.20	0.00	17.40	14.00	0.00	0.00	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

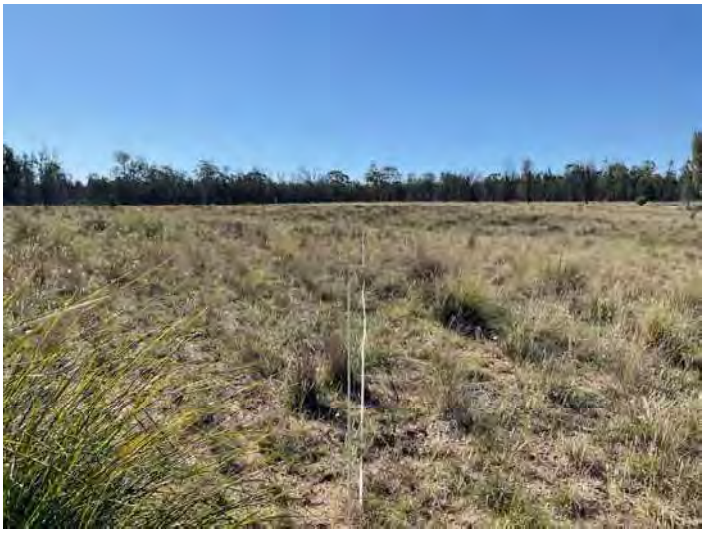
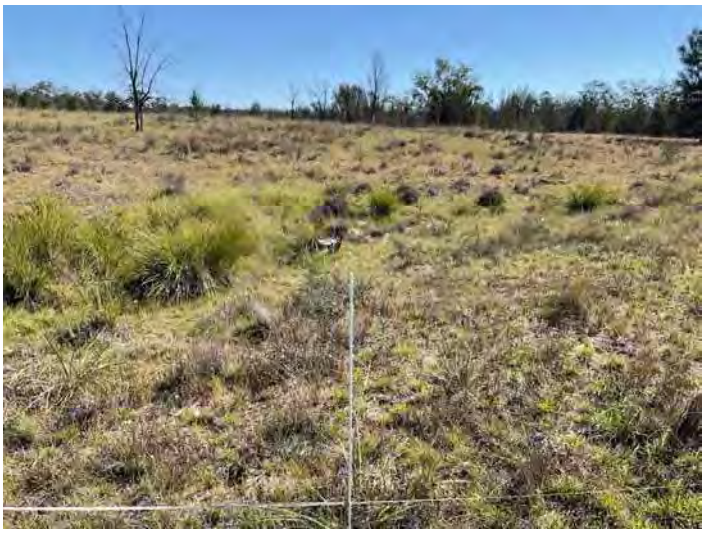
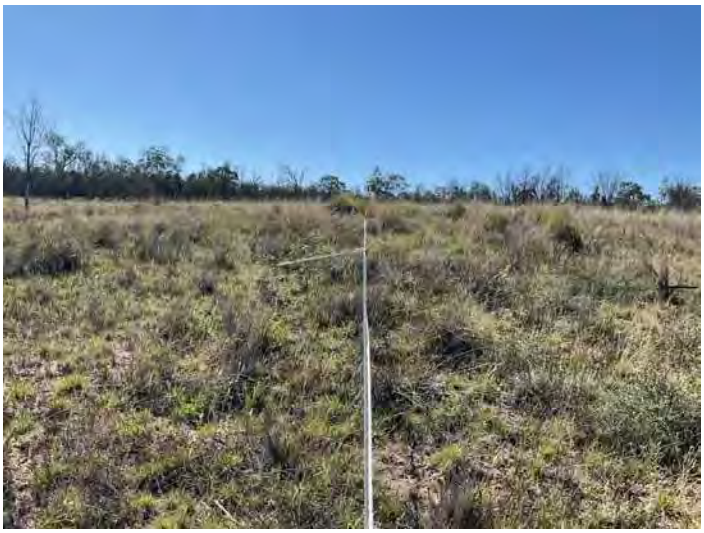
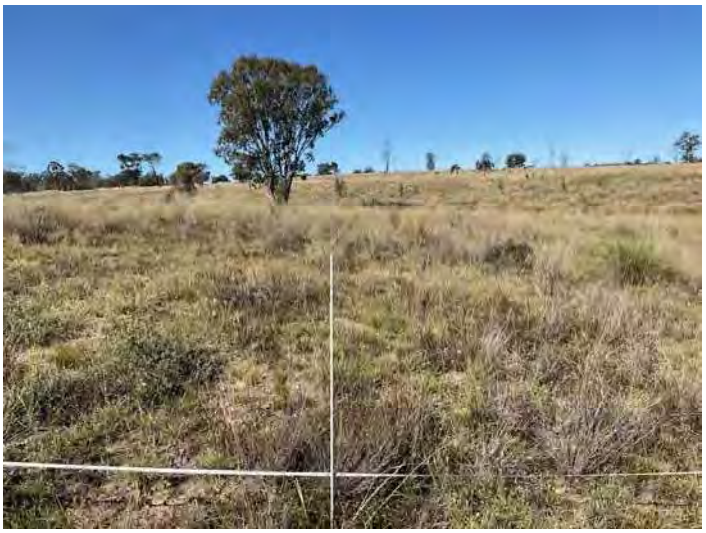
	
Transect Start	**Transect End**
North	**East**
	
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	5	0	79	0	0	1	5	0	10	0	100%
	25	0	63	0	0	2	5	0	5	0	100%
	81	0	8	0	0	1	5	0	5	0	100%
	0	0	8	0	4	48	15	0	25	0	100%
	20	0	32	0	0	0	3	0	45	0	100%
Mean	26.20	0.00	38.00	0.00	0.80	10.40	6.60	0.00	18.00	0.00	

Codes Used

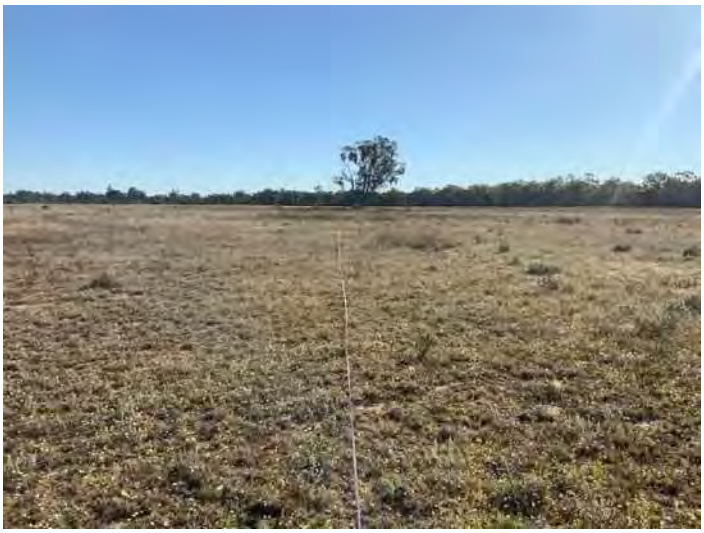
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

	
Transect Start	**Transect End**
	
North	**East**
	
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	15	0	5	20	0	0	5	0	15	40	100%
	20	0	10	10	0	0	2	0	5	53	100%
	10	0	55	5	0	0	0	0	10	20	100%
	35	0	40	0	0	0	5	0	10	10	100%
	15	0	35	20	5	0	10	0	5	10	100%
Mean	19.00	0.00	29.00	11.00	1.00	0.00	4.40	0.00	9.00	26.60	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

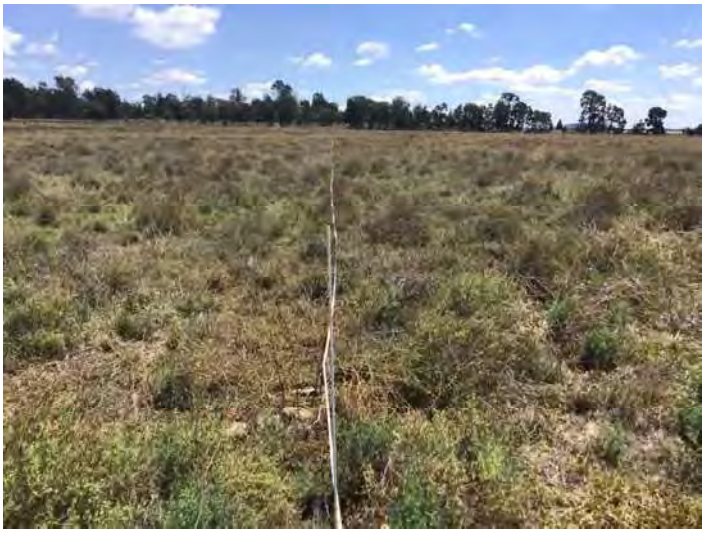
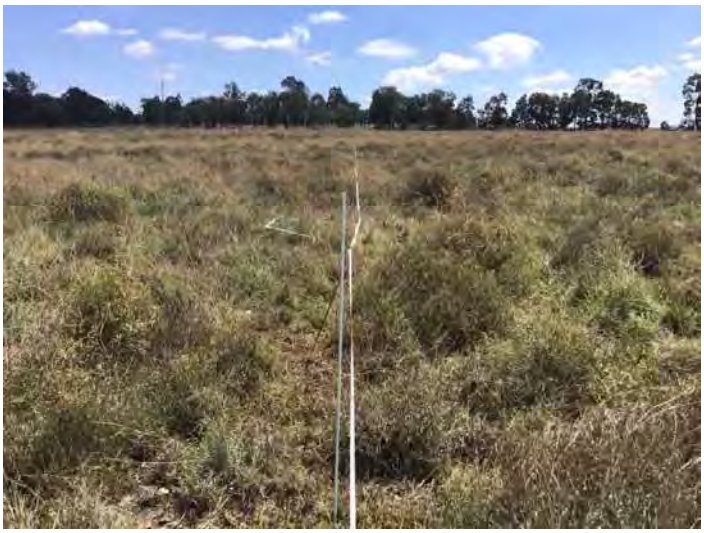
Transect Start	**Transect End**
	
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	15	0	0	25	0	45	15	0	0	0	100%
	53	0	0	5	0	10	25	1	6	0	100%
	40	0	0	52	0	5	2	1	0	0	100%
	63	0	3	2	0	8	20	3	1	0	100%
	49	0	0	35	0	10	5	1	0	0	100%
Mean	44.00	0.00	0.60	23.80	0.00	15.60	13.40	1.20	1.40	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

	
Transect Start	**Transect End**
North	**East**
	
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	0	96	3	0	1	0	100%
	0	0	0	0	0	98	2	0	0	0	100%
	0	0	1	0	0	88	10	0	1	0	100%
	0	0	0	0	0	89	10	0	1	0	100%
	0	0	0	0	5	90	5	0	0	0	100%
Mean	0.00	0.00	0.20	0.00	1.00	92.20	6.00	0.00	0.60	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	62	3	0	20	15	0	100%
	0	0	0	0	65	5	0	5	25	0	100%
	0	0	0	5	0	5	50	0	40	0	100%
	0	0	0	0	5	55	35	0	5	0	100%
	5	0	0	0	17	15	50	8	5	0	100%
Mean	1.00	0.00	0.00	1.00	29.80	16.60	27.00	6.60	18.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	0	90	10	0	0	0	100%
	0	0	1	0	0	91	0	0	8	0	100%
	0	0	0	0	5	80	15	0	0	0	100%
	0	0	0	0	0	75	15	0	10	0	100%
	0	0	1	0	0	8	0	0	91	0	100%
Mean	0.00	0.00	0.40	0.00	1.00	68.80	8.00	0.00	21.80	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	40	0	40	0	0	10	10	0	0	0	100%
	43	0	5	2	0	40	10	0	0	0	100%
	20	0	60	0	0	20	0	0	0	0	100%
	10	0	30	0	0	25	35	0	0	0	100%
	55	0	10	0	0	15	20	0	0	0	100%
Mean	33.60	0.00	29.00	0.40	0.00	22.00	15.00	0.00	0.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	20	0	0	0	0	60	20	0	0	0	100%
	0	0	0	0	0	60	40	0	0	0	100%
	20	0	25	10	0	5	40	0	0	0	100%
	10	0	15	0	0	55	20	0	0	0	100%
	0	0	20	0	0	15	65	0	0	0	100%
Mean	10.00	0.00	12.00	2.00	0.00	39.00	37.00	0.00	0.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	20	0	0	0	0	60	20	0	0	0	100%
	0	0	0	0	0	60	40	0	0	0	100%
	20	0	25	10	0	5	40	0	0	0	100%
	10	0	15	0	0	55	20	0	0	0	100%
	0	0	20	0	0	15	65	0	0	0	100%
Mean	10.00	0.00	12.00	2.00	0.00	39.00	37.00	0.00	0.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	35	40	25	0	0	0	0	100%
	0	0	0	30	40	30	0	0	0	0	100%
	0	0	5	5	70	20	0	0	0	0	100%
	0	0	10	15	60	15	0	0	0	0	100%
	0	0	0	15	55	30	0	0	0	0	100%
Mean	0.00	0.00	3.00	20.00	53.00	24.00	0.00	0.00	0.00	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	80	0	8	0	0	0	5	0	7	0	100%
	20	0	10	0	0	5	2	0	63	0	100%
	67	0	10	0	0	20	0	0	3	0	100%
	30	0	10	0	0	25	5	0	30	0	100%
	48	0	7	0	0	35	5	0	5	0	100%
Mean	49.00	0.00	9.00	0.00	0.00	17.00	3.40	0.00	21.60	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	72	0	3	20	0	0	5	0	0	0	100%
	25	0	10	0	1	2	0	0	62	0	100%
	40	0	2	52	0	1	5	0	0	0	100%
	82	0	5	3	0	2	5	0	3	0	100%
	3	0	5	0	0	1	2	0	89	0	100%
Mean	44.40	0.00	5.00	15.00	0.20	1.20	3.40	0.00	30.80	0.00	

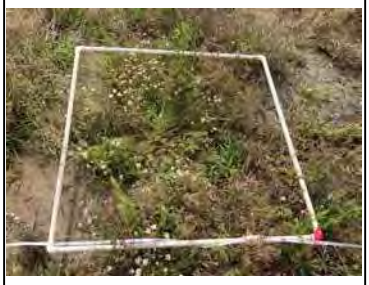
Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**

North	**East**

South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	39	0	15	10	0	1	0	0	30	5	100%
	40	0	18	1	0	1	15	0	10	15	100%
	20	0	20	25	0	5	15	0	15	0	100%
	30	0	15	20	0	0	5	0	15	15	100%
	5	0	39	32	0	2	2	0	10	10	100%
Mean	26.80	0.00	21.40	17.60	0.00	1.80	7.40	0.00	16.00	9.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	3	0	20	15	5	0	57	0	100%
	0	0	2	5	25	5	5	0	58	0	100%
	0	0	15	7	1	6	10	0	61	0	100%
	19	0	60	10	0	10	1	0	0	0	100%
	45	0	15	25	0	0	5	0	10	0	100%
Mean	12.80	0.00	19.00	9.40	9.20	7.20	5.20	0.00	37.20	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	15	0	5	0	0	52	3	0	25	0	100%
	65	0	2	5	0	20	5	0	3	0	100%
	15	0	5	0	0	40	15	0	25	0	100%
	8	0	2	0	0	75	5	0	10	0	100%
	25	0	8	0	0	56	5	0	6	0	100%
Mean	25.60	0.00	4.40	1.00	0.00	48.60	6.60	0.00	13.80	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	35	0	32	0	0	0	30	0	3	0	100%
	65	0	10	0	0	0	20	0	5	0	100%
	36	0	15	20	0	0	25	0	0	4	100%
	74	0	20	0	0	0	5	0	0	1	100%
	64	0	18	1	0	0	15	0	0	2	100%
Mean	54.80	0.00	19.00	4.20	0.00	0.00	19.00	0.00	1.60	1.40	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	2	0	0	0	68	25	5	0	0	0	100%
	1	0	0	0	7	1	3	3	85	0	100%
	0	0	1	0	28	1	2	3	65	0	100%
	1	0	1	0	63	3	0	2	30	0	100%
	0	0	2	0	10	0	0	3	85	0	100%
Mean	0.80	0.00	0.80	0.00	35.20	6.00	2.00	2.20	53.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

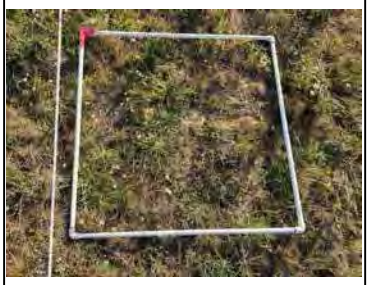
Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	15	0	44	2	0	0	35	1	3	0	100%
	7	0	28	0	0	0	5	25	35	0	100%
	4	0	31	0	0	0	12	8	45	0	100%
	25	0	0	0	0	39	30	6	0	0	100%
	10	0	28	0	0	0	2	25	35	0	100%
Mean	12.20	0.00	26.20	0.40	0.00	7.80	16.80	13.00	23.60	0.00	

Codes Used

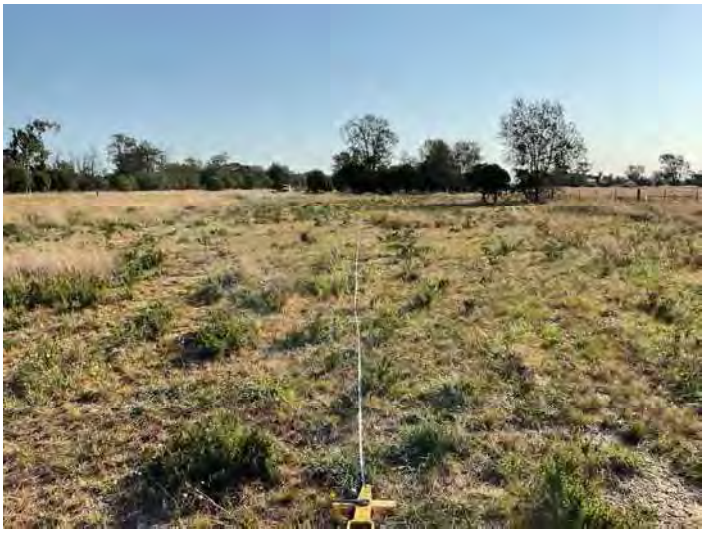
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

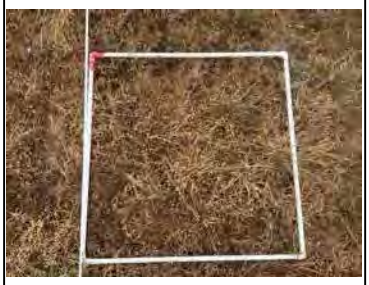
1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	74	0	15	5	0	0	3	0	3	0	100%
	51	0	2	7	0	0	20	0	20	0	100%
	72	0	1	2	0	0	0	0	25	0	100%
	62	0	10	25	0	0	0	0	3	0	100%
	68	0	30	0	0	0	0	0	1	1	100%
Mean	65.40	0.00	11.60	7.80	0.00	0.00	4.60	0.00	10.40	0.20	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

	
Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	2	0	86	1	0	1	10	0	0	0	100%
	2	0	67	1	0	0	5	0	20	5	100%
	5	0	67	0	0	0	3	0	15	10	100%
	25	0	50	0	0	0	10	0	15	0	100%
	48	0	20	0	0	2	20	0	10	0	100%
Mean	16.40	0.00	58.00	0.40	0.00	0.60	9.60	0.00	12.00	3.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	68	0	5	10	0	0	3	0	4	10	100%
	54	0	10	20	0	0	3	0	3	10	100%
	51	0	10	15	0	1	3	0	10	10	100%
	7	0	10	25	0	0	2	0	15	41	100%
	63	0	17	0	0	0	10	0	10	0	100%
Mean	48.60	0.00	10.40	14.00	0.00	0.20	4.20	0.00	8.40	14.20	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	62	0	5	0	5	3	10	0	15	0	100%
	61	0	10	1	0	0	3	0	25	0	100%
	35	0	30	0	0	0	5	30	0	0	100%
	35	0	6	1	0	0	2	0	56	0	100%
	40	0	37	0	0	0	3	0	20	0	100%
Mean	46.60	0.00	17.60	0.40	1.00	0.60	4.60	6.00	23.20	0.00	

Codes Used

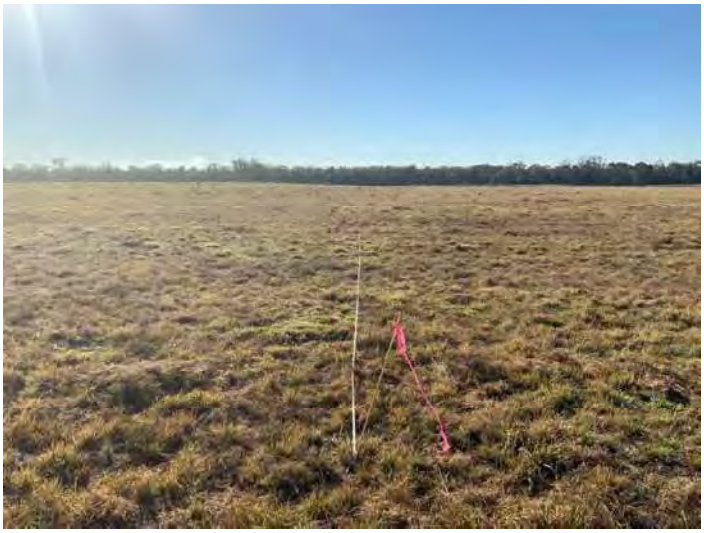
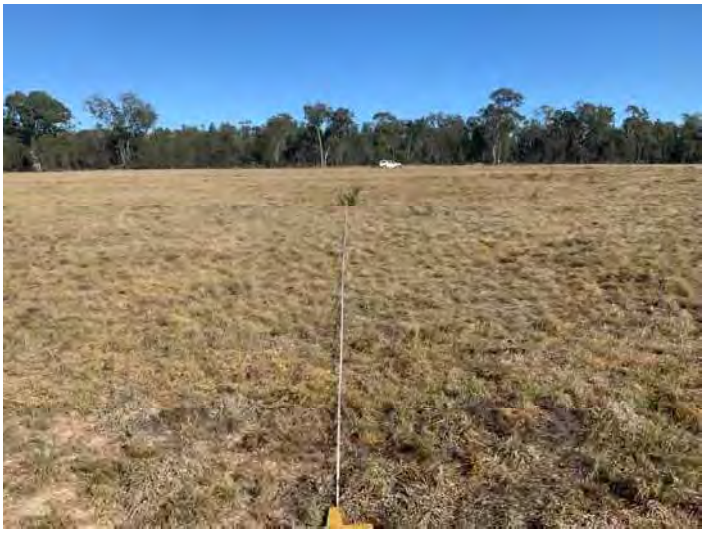
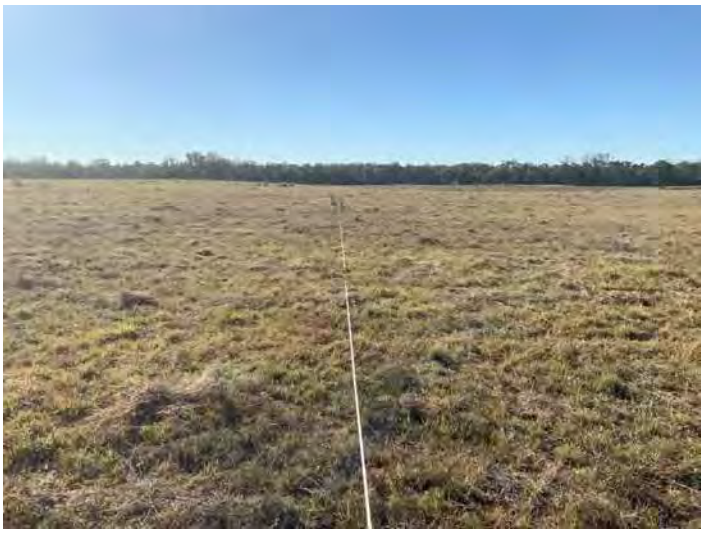
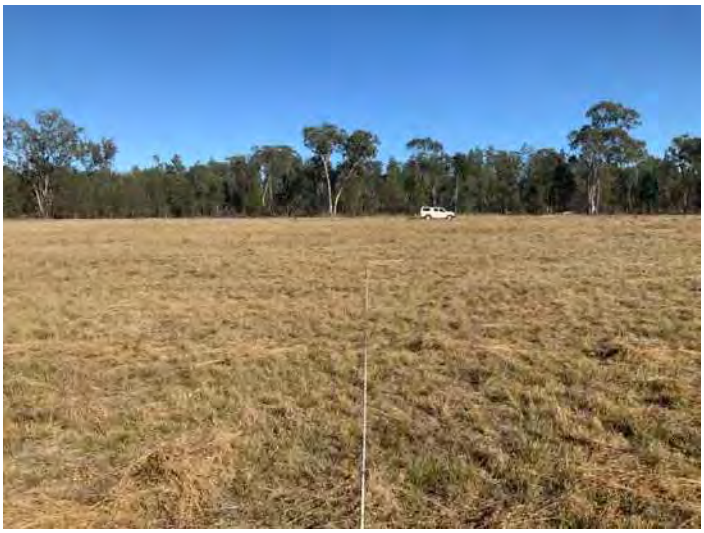
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	77	0	0	2	0	1	15	0	5	0	100%
	30	0	1	3	0	0	46	0	20	0	100%
	15	0	2	20	0	0	33	0	30	0	100%
	70	0	10	0	0	0	15	0	5	0	100%
	43	0	2	5	0	0	30	0	20	0	100%
Mean	47.00	0.00	3.00	6.00	0.00	0.20	27.80	0.00	16.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

	
Transect Start	**Transect End**
	
North	**East**
	
South	**West**

1 m x 1 m Quadrats:

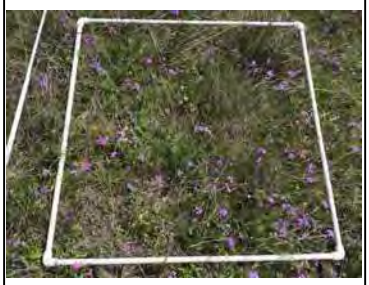
Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	3	0	60	0	0	0	0	0	37	0	100%
	2	0	30	0	0	0	1	0	67	0	100%
	2	0	55	0	0	0	0	0	43	0	100%
	30	0	30	0	0	4	2	0	34	0	100%
	8	0	40	0	0	2	2	0	48	0	100%
Mean	9.00	0.00	43.00	0.00	0.00	1.20	1.00	0.00	45.80	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

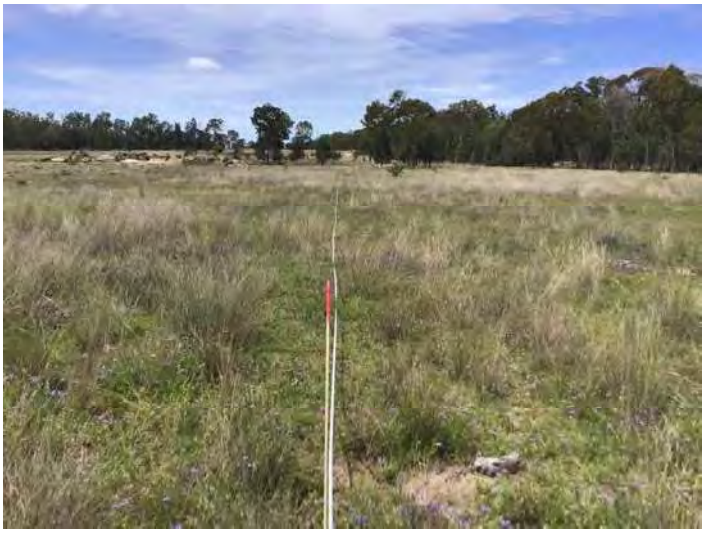
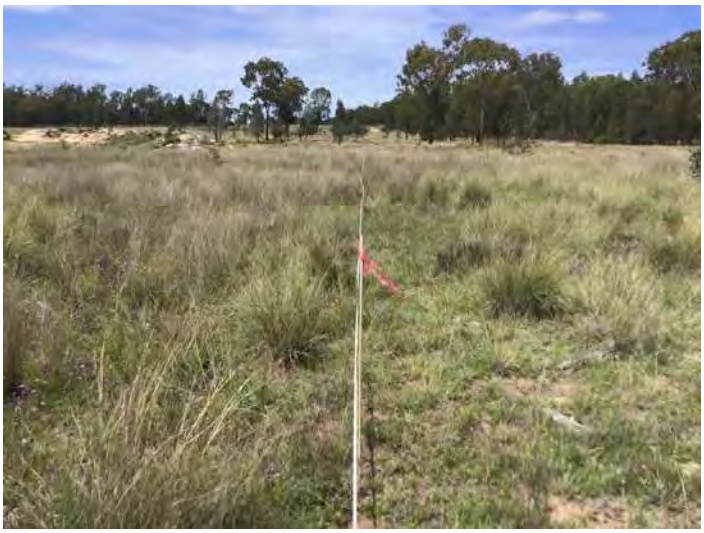
Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	5	0	35	0	10	0	50	0	100%
	0	0	8	0	45	0	35	0	12	0	100%
	20	0	2	0	25	40	8	0	5	0	100%
	10	0	10	0	15	58	5	0	2	0	100%
	61	0	25	0	0	10	3	0	1	0	100%
Mean	18.20	0.00	10.00	0.00	24.00	21.60	12.20	0.00	14.00	0.00	

Codes Used

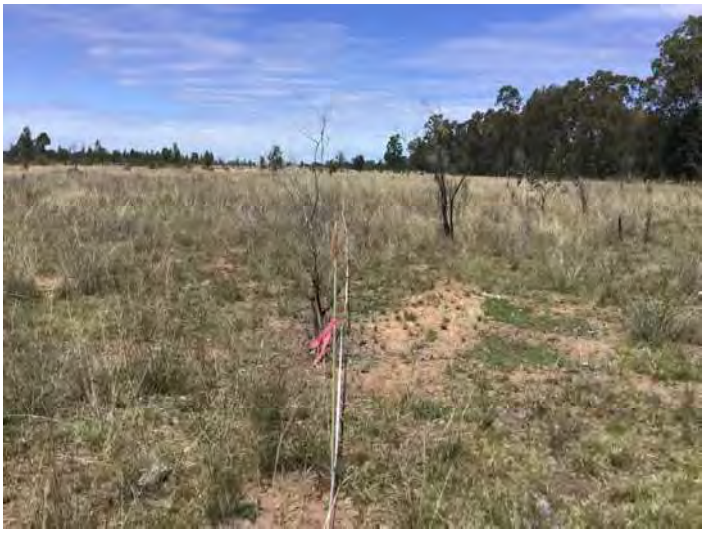
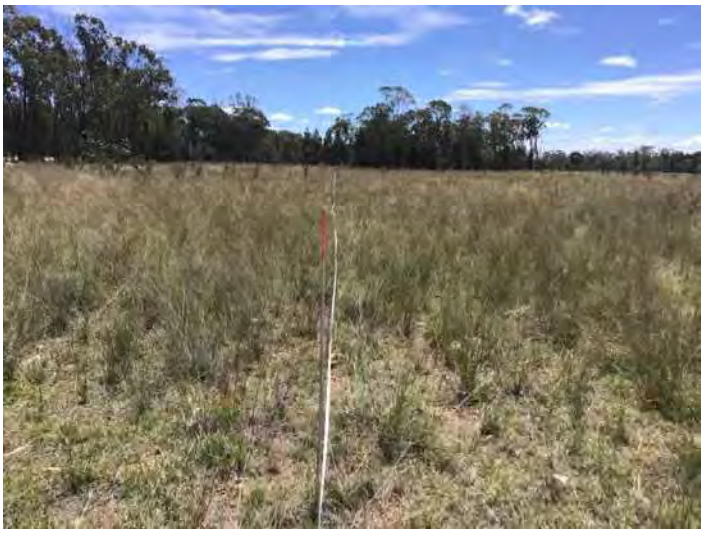
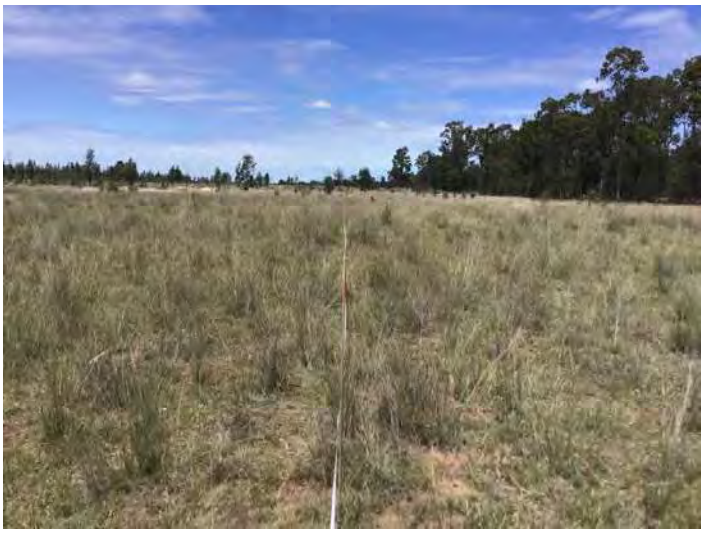
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

	
Transect Start	**Transect End**
North	**East**
	
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	10	0	5	0	53	7	10	0	15	0	100%
	10	0	3	0	75	1	10	0	1	0	100%
	0	0	10	0	50	0	10	0	30	0	100%
	5	0	20	0	25	0	15	0	35	0	100%
	0	0	1	0	53	1	5	0	40	0	100%
Mean	5.00	0.00	7.80	0.00	51.20	1.80	10.00	0.00	24.20	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

	
Transect Start	**Transect End**
	
North	**East**
	
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	15	0	5	0	0	50	5	0	25	0	100%
	10	0	6	0	0	63	5	1	15	0	100%
	0	4	35	0	0	49	2	0	10	0	100%
	3	0	15	0	0	45	7	0	30	0	100%
	10	0	20	0	0	45	10	0	15	0	100%
Mean	7.60	0.80	16.20	0.00	0.00	50.40	5.80	0.20	19.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	3	0	10	30	50	5	2	0	100%
	0	0	2	0	5	73	20	0	0	0	100%
	10	0	1	0	0	44	45	0	0	0	100%
	2	0	2	0	0	46	50	0	0	0	100%
	3	0	3	0	0	69	10	0	15	0	100%
Mean	3.00	0.00	2.20	0.00	3.00	52.40	35.00	1.00	3.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	35	0	1	0	0	49	10	0	5	0	100%
	77	0	0	0	5	15	0	0	3	0	100%
	0	0	6	0	25	35	4	0	30	0	100%
	0	0	0	0	35	63	2	0	0	0	100%
	0	0	1	0	20	29	10	0	40	0	100%
Mean	22.40	0.00	1.60	0.00	17.00	38.20	5.20	0.00	15.60	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	30	0	0	0	25	25	20	0	0	0	100%
	10	0	10	0	20	0	55	0	5	0	100%
	0	0	0	0	15	15	70	0	0	0	100%
	60	0	0	0	0	20	20	0	0	0	100%
	30	0	0	0	0	10	60	0	0	0	100%
Mean	26.00	0.00	2.00	0.00	12.00	14.00	45.00	0.00	1.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	79	0	0	0	0	10	8	0	3	0	100%
	61	0	0	0	0	35	3	0	1	0	100%
	72	0	0	0	0	0	3	0	25	0	100%
	81	0	1	0	0	3	15	0	0	0	100%
	63	0	0	0	0	5	30	0	2	0	100%
Mean	71.20	0.00	0.20	0.00	0.00	10.60	11.80	0.00	6.20	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	10	0	25	0	20	20	25	0	0	0	100%
	30	0	15	0	0	10	25	10	10	0	100%
	0	0	0	0	40	51	5	1	3	0	100%
	50	0	10	0	0	15	10	15	0	0	100%
	50	0	5	0	0	15	28	2	0	0	100%
Mean	28.00	0.00	11.00	0.00	12.00	22.20	18.60	5.60	2.60	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	65	0	1	0	5	5	3	1	20	0	100%
	64	0	1	0	0	10	5	0	20	0	100%
	50	0	0	0	0	10	0	0	40	0	100%
	30	0	0	0	0	3	0	0	67	0	100%
	20	0	1	0	0	10	0	0	69	0	100%
Mean	45.80	0.00	0.60	0.00	1.00	7.60	1.60	0.20	43.20	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	10	0	20	0	0	55	10	0	5	0	100%
	30	0	30	0	0	20	20	0	0	0	100%
	20	0	15	0	0	40	10	0	15	0	100%
	33	0	40	2	5	10	10	0	0	0	100%
	10	0	10	0	0	35	20	0	25	0	100%
Mean	20.60	0.00	23.00	0.40	1.00	32.00	14.00	0.00	9.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	95	5	0	0	0	0	100%
	0	0	0	0	75	25	0	0	0	0	100%
	0	0	0	0	87	8	2	0	3	0	100%
	0	0	0	0	64	18	3	0	15	0	100%
	0	0	0	4	77	0	12	0	7	0	100%
Mean	0.00	0.00	0.00	0.80	79.60	11.20	3.40	0.00	5.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

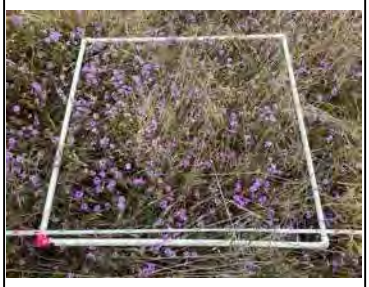
1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	3	0	74	15	0	8	0	100%
	0	0	8	0	0	30	58	0	4	0	100%
	3	0	1	0	0	20	66	0	10	0	100%
	2	0	6	0	0	25	46	1	20	0	100%
	0	0	2	0	0	53	20	0	25	0	100%
Mean	1.00	0.00	3.40	0.60	0.00	40.40	41.00	0.20	13.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	60	34	5	0	1	0	100%
	0	0	0	0	65	30	5	0	0	0	100%
	0	0	0	7	53	35	5	0	0	0	100%
	40	0	1	0	0	56	3	0	0	0	100%
	35	0	8	0	0	55	2	0	0	0	100%
Mean	15.00	0.00	1.80	1.40	35.60	42.00	4.00	0.00	0.20	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	20	0	10	5	15	0	30	0	20	0	100%
	20	0	5	25	15	0	20	0	15	0	100%
	40	0	5	0	1	0	30	0	24	0	100%
	10	0	15	0	2	5	64	0	4	0	100%
	30	0	5	0	0	0	45	0	20	0	100%
Mean	24.00	0.00	8.00	6.00	6.60	1.00	37.80	0.00	16.60	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**

North	**East**

South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	20	0	2	75	0	1	1	0	1	0	100%
	65	0	5	20	0	0	5	0	5	0	100%
	0	0	2	81	0	5	2	0	10	0	100%
	82	0	0	2	0	0	15	0	1	0	100%
	35	0	1	54	0	0	0	0	10	0	100%
Mean	40.40	0.00	2.00	46.40	0.00	1.20	4.60	0.00	5.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

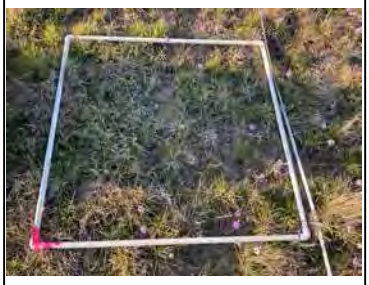
1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	44	0	50	0	0	0	1	0	5	0	100%
	25	0	65	0	0	0	0	0	10	0	100%
	50	0	50	0	0	0	0	0	0	0	100%
	35	0	55	0	0	0	0	0	10	0	100%
	35	0	35	0	0	0	0	0	30	0	100%
Mean	37.80	0.00	51.00	0.00	0.00	0.00	0.20	0.00	11.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	88	0	7	0	0	3	0	0	2	0	100%
	84	0	8	0	0	3	3	0	2	0	100%
	84	0	5	0	0	3	3	0	5	0	100%
	93	0	2	0	0	2	3	0	0	0	100%
	76	0	10	0	0	3	10	0	1	0	100%
Mean	85.00	0.00	6.40	0.00	0.00	2.80	3.80	0.00	2.00	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	20	0	0	5	75	0	0	0	100%
	6	0	30	0	0	15	47	0	2	0	100%
	70	0	2	0	0	20	8	0	0	0	100%
	12	0	25	0	0	35	28	0	0	0	100%
	10	0	2	0	0	85	3	0	0	0	100%
Mean	19.60	0.00	15.80	0.00	0.00	32.00	32.20	0.00	0.40	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	66	0	25	0	0	3	6	0	0	0	100%
	84	0	3	0	0	4	7	0	2	0	100%
	63	0	3	0	0	7	25	2	0	0	100%
	51	0	6	0	0	35	8	0	0	0	100%
	47	0	6	1	0	10	35	0	1	0	100%
Mean	62.20	0.00	8.60	0.20	0.00	11.80	16.20	0.40	0.60	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	77	0	12	0	0	3	8	0	0	0	100%
	27	0	10	60	0	0	3	0	0	0	100%
	73	0	2	3	0	7	15	0	0	0	100%
	54	0	6	0	0	30	5	0	5	0	100%
	70	0	2	0	0	25	3	0	0	0	100%
Mean	60.20	0.00	6.40	12.60	0.00	13.00	6.80	0.00	1.00	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

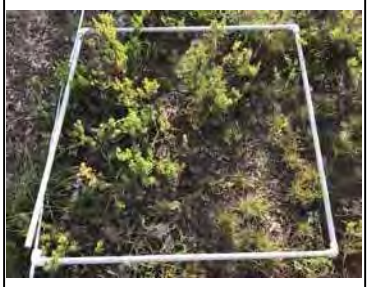
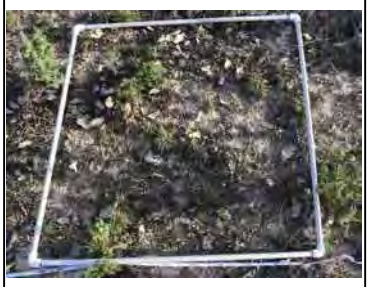
1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	7	31	30	5	0	27	0	100%
	0	0	2	3	80	10	5	0	0	0	100%
	0	0	0	15	30	53	2	0	0	0	100%
	0	0	10	0	83	4	3	0	0	0	100%
	0	0	0	0	46	4	35	0	15	0	100%
Mean	0.00	0.00	2.40	5.00	54.00	20.20	10.00	0.00	8.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	3	0	17	23	0	0	55	2	100%
	0	0	20	8	5	57	10	0	0	0	100%
	40	0	0	25	0	35	0	0	0	0	100%
	0	0	15	47	0	3	0	0	30	5	100%
	1	0	5	3	0	2	0	0	84	5	100%
Mean	8.20	0.00	8.60	16.60	4.40	24.00	2.00	0.00	33.80	2.40	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start

Transect End

North

East

South

West

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	5	0	35	0	0	0	30	0	30	0	100%
	57	0	8	0	0	0	25	0	10	0	100%
	73	0	6	0	0	0	20	0	1	0	100%
	64	0	3	27	0	0	5	0	1	0	100%
	0	0	0	100	0	0	0	0	0	0	100%
Mean	39.80	0.00	10.40	25.40	0.00	0.00	16.00	0.00	8.40	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	1	0	4	0	0	0	65	0	25	5	100%
	42	0	25	0	0	0	30	0	3	0	100%
	1	0	5	0	0	0	92	0	1	1	100%
	3	0	70	0	0	0	27	0	0	0	100%
	49	0	20	0	0	0	30	0	1	0	100%
Mean	19.20	0.00	24.80	0.00	0.00	0.00	48.80	0.00	6.00	1.20	

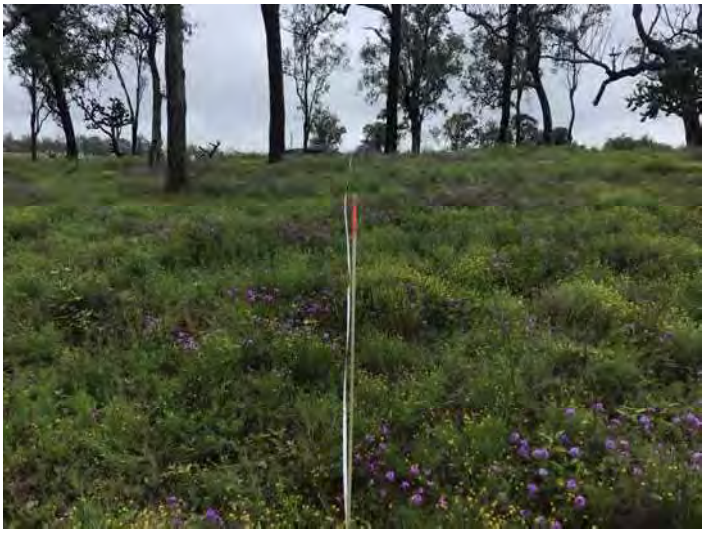
Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	40	59	1	0	0	0	100%
	0	0	0	0	5	88	5	2	0	0	100%
	0	0	5	0	1	74	5	15	0	0	100%
	0	0	15	0	3	43	3	35	1	0	100%
	0	0	60	0	5	15	8	10	2	0	100%
Mean	0.00	0.00	16.00	0.00	10.80	55.80	4.40	12.40	0.60	0.00	

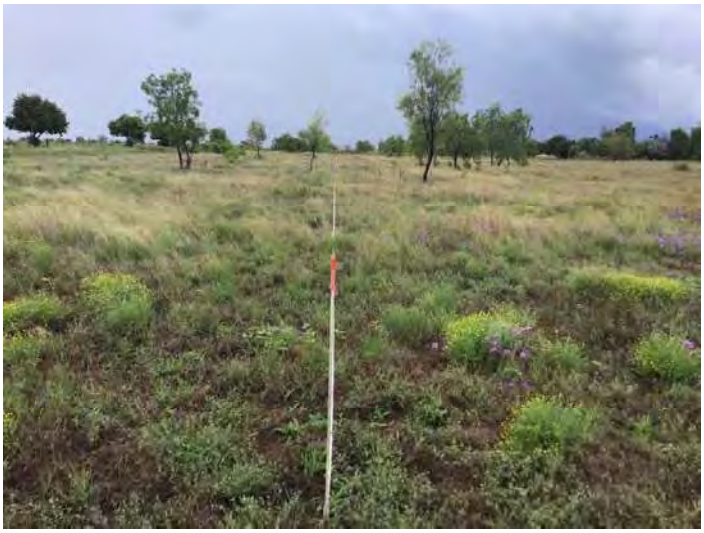
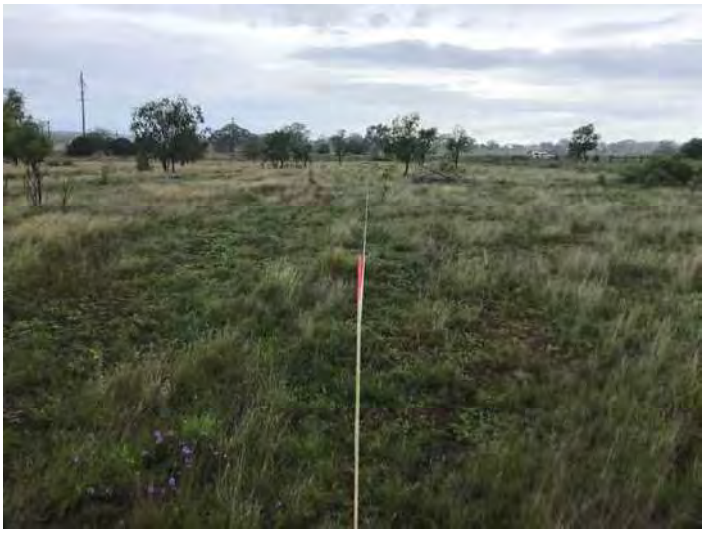
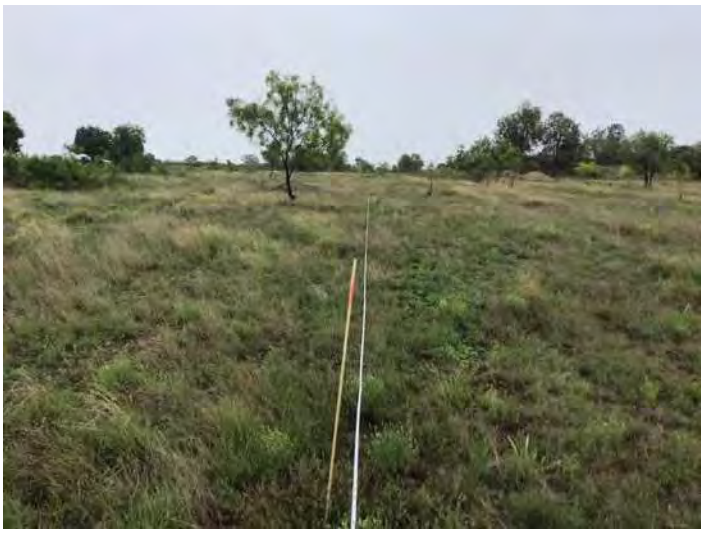
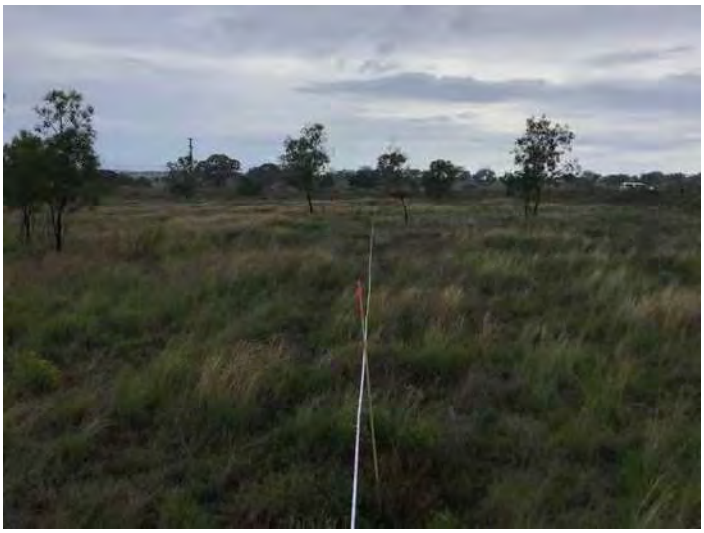
Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

	
Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	65	0	25	0	0	5	3	0	2	0	100%
	43	0	2	0	0	15	35	0	5	0	100%
	79	0	1	0	5	3	10	0	2	0	100%
	33	0	8	0	25	2	5	2	25	0	100%
	81	0	2	0	0	1	10	3	3	0	100%
Mean	60.20	0.00	7.60	0.00	6.00	5.20	12.60	1.00	7.40	0.00	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

	
Transect Start	**Transect End**
	
North	**East**
	
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	85	0	6	0	0	2	5	1	0	1	100%
	86	0	1	1	0	3	6	2	0	1	100%
	57	0	25	0	0	8	8	2	0	0	100%
	88	0	1	0	0	1	5	1	3	1	100%
	23	0	0	0	0	25	50	2	0	0	100%
Mean	67.80	0.00	6.60	0.20	0.00	7.80	14.80	1.60	0.60	0.60	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	2	0	20	0	0	46	25	2	5	0	100%
	10	0	3	4	0	78	5	0	0	0	100%
	5	0	40	0	0	3	10	0	42	0	100%
	15	0	25	0	10	41	7	1	1	0	100%
	45	0	2	0	0	50	3	0	0	0	100%
Mean	15.40	0.00	18.00	0.80	2.00	43.60	10.00	0.60	9.60	0.00	

Codes Used

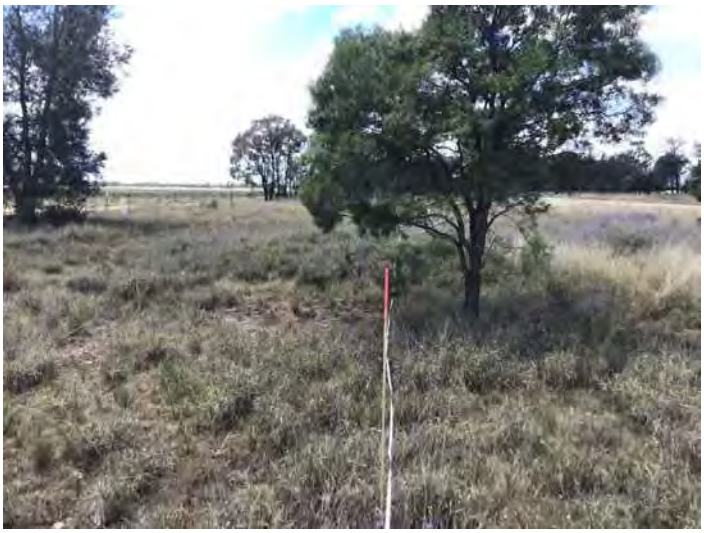
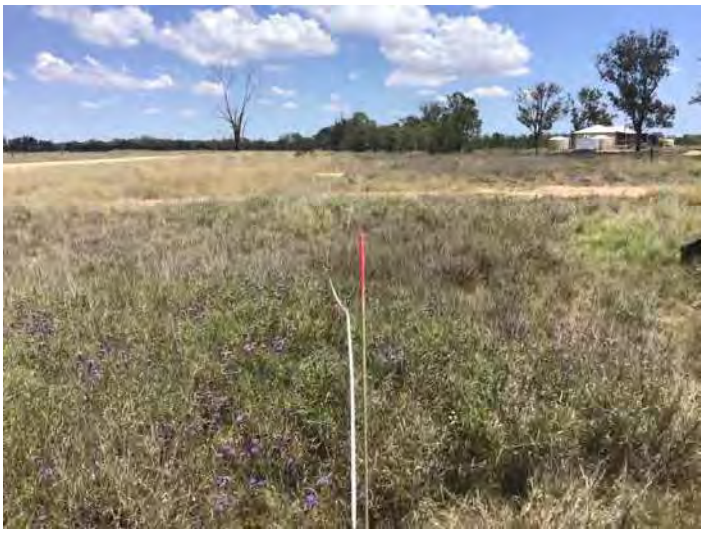
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	0	0	0	0	30	25	15	0	30	0	100%
	0	0	8	5	70	0	10	0	7	0	100%
	0	0	5	0	20	0	5	0	70	0	100%
	0	0	8	0	77	7	3	0	5	0	100%
	0	0	4	6	59	0	30	0	0	1	100%
Mean	0.00	0.00	5.00	2.20	51.20	6.40	12.60	0.00	22.40	0.20	

Codes Used
NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
	
North	**East**
	
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	35	0	0	7	0	2	30	0	26	0	100%
	1	0	4	0	0	0	95	0	0	0	100%
	43	0	0	1	0	1	30	0	25	0	100%
	61	0	3	25	0	1	10	0	0	0	100%
	3	0	2	27	0	0	6	0	62	0	100%
Mean	28.60	0.00	1.80	12.00	0.00	0.80	34.20	0.00	22.60	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	5	0	0	3	38	2	2	0	50	0	100%
	5	0	0	3	62	0	10	0	20	0	100%
	1	0	0	25	30	0	3	0	41	0	100%
	0	0	7	2	0	0	0	0	91	0	100%
	30	0	0	25	10	0	5	0	30	0	100%
Mean	8.20	0.00	1.40	11.60	28.00	0.40	4.00	0.00	46.40	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	29	0	5	30	0	35	1	0	0	0	100%
	96	0	2	0	0	1	1	0	0	0	100%
	84	0	15	0	0	0	0	0	0	1	100%
	71	0	25	0	0	0	3	0	1	0	100%
	90	0	6	0	0	2	0	0	1	1	100%
Mean	74.00	0.00	10.60	6.00	0.00	7.60	1.00	0.00	0.40	0.40	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

1 m x 1 m Quadrats:

Quadrats	NG	OG	NF	NS	NNG	NNF	L	R	BG	C	TOTAL
	20	0	0	74	0	2	2	0	2	0	100%
	49	0	30	3	0	5	3	0	10	0	100%
	60	0	24	10	0	1	5	0	0	0	100%
	65	0	30	0	0	0	5	0	0	0	100%
	25	0	60	0	0	2	10	0	3	0	100%
Mean	43.80	0.00	28.80	17.40	0.00	2.00	5.00	0.00	3.00	0.00	

Codes Used

NG - Native Perennial Grasses, OG - Other Native Grasses, NF - Native Forbs, NS - Native Shrubs, NNG - Non-Native Grasses, NNF - Non-Native Forbs, L -Litter, R - Rock, BG - Bare Ground, FL - Fallen Log, C - Cryptogams.

Transect Start	**Transect End**
North	**East**
South	**West**

APPENDIX B

Ecology assessment

BORDER TO GOWRIE REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

Inland Rail is a subsidiary of
Australian Rail Track Corporation

INLAND RAIL

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Table of Contents

1.0 Introduction 1

1.1 Study Area and Development Footprint 1

1.2 Objective and Scope 1

2.0 Legislative Context 4

3.0 Methodology 6

3.1 Desktop Assessment 6

3.2 Field Assessment 7

3.2.1 Other Ecological Assessments 7

3.2.2 Umwelt Survey 7

3.2.3 Assumptions and Limitations 9

3.2.4 Nomenclature 9

3.3 Likelihood of Occurrence Assessment 11

3.4 Impact Assessment 11

4.0 Ecological Values 12

4.1 Study Area Characteristics 12

4.2 Flora 12

4.2.1 Bioregion and Subregion 12

4.2.2 Vegetation Communities 12

4.2.3 Protected Plants 17

4.2.4 Flora Diversity 17

4.3 Fauna 17

4.3.1 Fauna Habitat Types 17

4.3.2 Fauna Diversity 25

4.3.3 Animal Breeding Places 25

4.3.4 Connectivity and Fauna Movement 25

4.3.5 Wetlands and Watercourses 26

4.4 Essential Habitat 26

4.5 Likelihood of Occurrence 28

4.6 Fauna Habitat Criteria 28

5.0 Potential Impacts 29

5.1 Direct Impacts 29

5.1.1 Vegetation Clearance and Habitat Loss 29

5.1.2 Loss or Alteration of MSES or MNES Community or Habitat 29

5.1.3 Disturbance, Injury and Mortality of Fauna 30
5.2 Indirect Impacts 30
5.2.1 Impacts to Waterways 30
5.2.2 Exacerbation of Pest Fauna and Weeds 31
5.2.3 Activity and Noise 32
5.2.4 Increased Dust 33
6.0 Matters of State Environmental Significance 34
6.1 Significant Residual Impact Assessment for MSES 36
7.0 Matters of National Environmental Significance 38
7.1 Significant Impact Assessment for MNES 38
8.0 Mitigation Measures 41
9.0 Conclusion and Recommendations 43
10.0 References 45

Figures

Figure 1.1 Study Area 3
Figure 3.1 Field Assessment Sites 10
Figure 4.1 State Mapped Regional Ecosystems 15
Figure 4.2 Ground-Truthed Vegetation Communities 16
Figure 4.3 Fauna Habitat Types 24
Figure 4.4 Biodiversity Planning Assessment Mapping 27
Figure 7.1 Potential Koala Habitat 40

Photos

Photo 4.1 *Eucalyptus moluccana* woodland on flat plains 19
Photo 4.2 Regrowth eucalypt woodland with scattered mature trees 20
Photo 4.3 Two farm dams within the Study Area. Larger and higher quality dam in the west (pictured left), smaller dam in the east (pictured right) 21
Photo 4.4 Exotic pasture 22
Photo 4.5 Wheat cropping 23

Tables

Table 2.1	Relevant Legislation Summary	4
Table 3.1	Field Assessment Methods and Effort	8
Table 3.2	Likelihood of Occurrence Categories	11
Table 4.1	State Mapped Regional Ecosystems within the Study Area	13
Table 4.2	Fauna Habitat Types	18
Table 4.3	Likelihood of Occurrence – Summary of Results	28
Table 4.4	Fauna Habitat Criteria	28
Table 5.1	Predicted Direct Impacts to Habitat Types and Vegetation Communities	29
Table 5.2	Predicted Direct Impacts to MSES and MNES Values	30
Table 6.1	Study Area MSES Values	34
Table 7.1	Study Area MNES Values	38
Table 9.1	Significant impact assessment – Poplar Box TEC	E-3

Appendices

Appendix A	PMST and WildNet Database Results
Appendix B	Flora and Fauna Species List
Appendix C	Likelihood of Occurrence Assessment
Appendix D	Significant Residual Impact Assessment for MSES
Appendix E	Significant Impact Assessment for MNES

1.0 Introduction

Umwelt (Australia) Pty Ltd has been engaged by Australian Rail Track Corporation (ARTC) to provide an approvals and environmental due diligence assessment for Stage 1 of the Temporary Material Distribution Centre (MDC) in Whetstone, Queensland (the Project). Once operational, the Project will be used to store materials and service the construction of four of the Queensland projects of Inland Rail, which are currently subject to an Environmental Impact Statement (EIS) assessment process.

To support the overarching due diligence assessment, a supplementary terrestrial ecological assessment was deemed necessary to provide additional detail regarding the flora and fauna values of the Study Area, with a particular focus on those considered Matters of State Environmental Significance (MSES) and Matters of National Environmental Significance (MNES). This report documents the terrestrial ecological assessment which has been informed by both desktop and field-based assessments.

1.1 Study Area and Development Footprint

The Project is proposed to occur within the rural locality of Whetstone, approximately 18 kilometres (km) to the south-west of Inglewood and 59 km east of Goondiwindi in Queensland. The Project will be constructed within part of Lot and plan 2/MH784, as well as parts of the South Western System Railway Line and the Cunningham Highway (the 'Study Area'). Other mapped roads connect to the Study Area including Loupals Road and Bosnjaks Road to the south and the Whetstone Access Road to the north-east. Lot 2 MH784 is freehold land located within the Goondiwindi Regional local government area.

The Study Area covers approximately 336 hectares (ha) and comprises largely flat, rural agricultural land currently used for cropping with historical evidence of use for cattle grazing. Although land use in the surrounding area is also predominantly agricultural, large intact areas of woody vegetation also occur. These areas include Whetstone State Forest to the immediate north-west of the Study Area, and Yelarbon State Forest approximately 2.5 km to the south-east.

The Study Area will be accessed from Whetstone Access Road, an existing local road that intersects with the Cunningham Highway. The Development Footprint exists along the northern boundary of the Study Area and extends south along Whetstone Access Road, covering approximately 69.3 ha.

The Study Area and the Development Footprint along with notable local landscape features are shown in **Figure 1.1**.

1.2 Objective and Scope

The objective of this assessment is to identify the presence and extent of terrestrial ecological values protected under State or Commonwealth legislation within the Study Area, discuss the potential impacts on such values and any approval implications. To achieve this, the assessment included the following tasks:

- Conduct a desktop review of available literature and previous studies in the vicinity of the Study Area and run database searches to determine known or potentially occurring threatened species or communities and migratory species.
- Undertake a field survey within the Study Area to:

- document condition, extent and value of vegetation communities, habitat types and other ecological values within the Study Area
- identify habitat resources for known and potentially occurring threatened species and migratory species.

- Undertake a likelihood of occurrence assessment to determine the potential or known presence of threatened species and communities as well as migratory species within the Development Footprint.
- Complete an impact assessment for known or potentially occurring MSES and MNES values, inclusive of recommended mitigation and management measures (as necessary)
  - Determine the significance of identified impacts on MSES in consideration of the *Significant Residual Impact Guideline* (Department of State Development Infrastructure and Planning 2014).
  - Determine the significance of identified impacts on MNES in consideration of the Commonwealth *Significant Impact Guidelines Policy Statement 1.1* (Department of the Environment 2013).

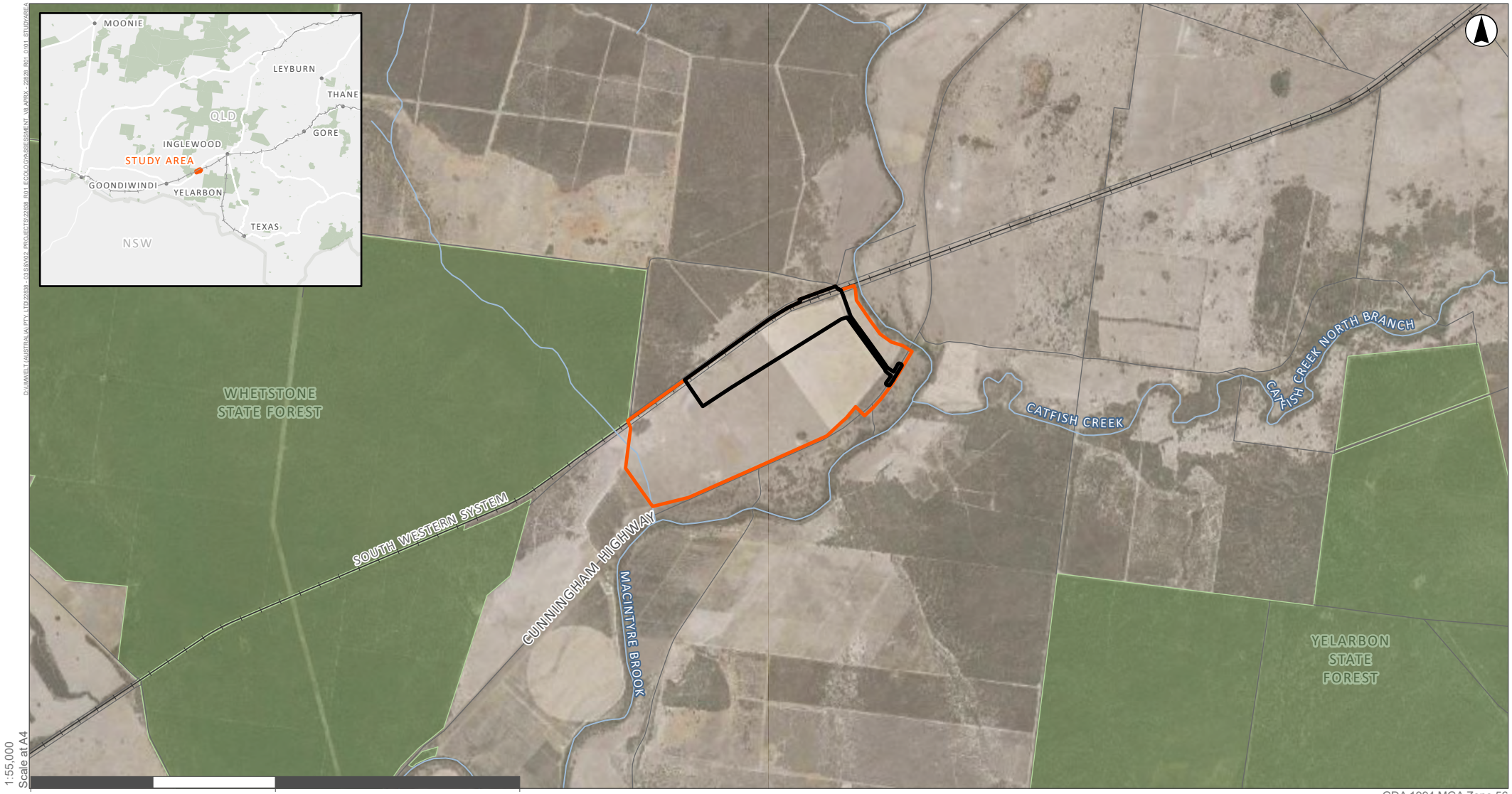


FIGURE 1.1
Study Area

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

2.0 Legislative Context

The legislation relevant to the assessment is summarised in **Table 2.1** below.

Table 2.1 Relevant Legislation Summary

Relevant Legislation	Governing Agency	Summary	Project Relevance
Commonwealth			
Environment Protection and Biodiversity Conservation Act 1999 **(EPBC Act)**	Department of Climate Change, Energy, the Environment and Water (DCCEEW)	The EPBC Act is Australia's key piece of environmental legislation. It outlines nine MNES. Actions that adversely affect MNES may be deemed to be a controlled action requiring assessment under the EPBC Act.	The presence of MNES values within the Development Footprint is discussed in **Section 7.0**. One MNES is relevant to the Project: threatened species and ecological communities.
State Legislation			
Nature Conservation Act 1992 **(NC Act)**	Department of Environment and Science (DES)	The purpose of the NC Act is to conserve biodiversity by creating and managing protected areas, managing and protecting native plants and animals, and managing the spread of non-native plants and animals.	Where a proposed development will result in such impacts to flora and/or fauna protected under the NC Act, authorisation from the Director General of the DES is required. The presence of species listed threatened or Special Least Concern under the NC Act within the Development Footprint is discussed in **Section 4.5**.
Vegetation Management Act 1999 **(VM Act)**	Department of Resources (DoR)	The VM Act establishes the vegetation management framework for Queensland that applies to all vegetation with the exception of State forests, National parks, forest reserves, and certain other tenures defined under the NC Act and the *Forestry Act 1959*.	The presence of regulated vegetation including Regional Ecosystems (REs) within the Development Footprint and broader Study Area is detailed in **Section 4.2.2**.
Biosecurity Act 2014 **(Biosecurity Act)**	Department of Agriculture and Fisheries (DAF)	The Biosecurity Act lists fauna and flora pest species as either a prohibited or restricted biosecurity matter.	The Biosecurity Act defines specific requirements for notification and management actions for all listed biosecurity matters, including specific requirements for the disposal of restricted matters. The potential presence of flora and fauna species listed as restricted matters within the Development Footprint and broader Study Area is discussed in **Section 4.2.4.1** and **Section 4.3.2.1** respectively.

Relevant Legislation	Governing Agency	Summary	Project Relevance
***Environmental Offsets Act 2014* (EO Act)**	DES	An environmental offset condition may be imposed for prescribed activities under the EO Act. Activities which have an impact on MSES may require offsetting under the EO Act.	The presence of MSES within the Development Footprint is detailed in **Section 6.0**. MSES relevant to the Project include: protected wildlife habitat.

3.0 Methodology

3.1 Desktop Assessment

A desktop assessment was undertaken to characterise and identify the ecological values that may be supported by the Study Area. The desktop assessment included a review of existing literature and online mapping, as well as searches of publicly available databases. The following information sources were reviewed:

- EPBC Act Protected Matters Search Tool (PMST) for MNES ((10 km buffer applied from the Study Area boundary) (**Appendix A**).
- Species Profile and Threats (SPRAT) database for MNES information (Department of Climate Change, Energy, the Environment and Water 2022).
- DES BioMaps/WildNet databases for species records (10 km buffer applied from the Study Area boundary) (**Appendix A**).
- DES (2021c) Protected Plants Flora Survey Trigger map to identify the locations of previously recorded threatened flora species.
- DES certified Biodiversity Planning Assessment (BPA) (2018) mapping to identify significant wildlife corridors and areas of state, regional and local biodiversity significance.
- DES (2019) Queensland Wetland areas mapping.
- DoR (2021) Vegetation Management Regional Ecosystem map (Version 12).
- DoR (2021a) Vegetation Management Watercourse and Drainage Feature map (Version 5.0).
- DoR (2021b) Vegetation Management Supporting Map, including Essential Habitat mapping.
- DAF (2016) Queensland waterways for waterway barrier works mapping.
- Qld Herbarium (2021) Regional Ecosystem Description Database (REDD) (Version 12.1).
- Atlas of Living Australia (ALA) (2022) spatial records database.
- published and unpublished ecology reports relevant to the Project, including:
    - Supplementary Ecological Assessments: Leeson's Road, Whetstone, Yelarbon (Ausecology 2022).
    - Inland Rail – Border to Gowrie Project: Geotechnical Investigations – Matters of National Environmental Significance Report (Australian Rail Track Corporation 2021).

Information collected as part of the desktop assessment was collated and used in the preparation of the field survey to determine target areas and appropriate survey techniques to employ.

3.2 Field Assessment

3.2.1 Other Ecological Assessments

Previously completed ecological assessments were reviewed where available. Two assessments were considered particularly relevant to the Project, both being undertaken within or in proximity to the Study Area. These studies were reviewed to gain an understanding of the ecological values across the area as well as the methods utilised to determine possible presence of the MNES or MSES values. The methods adopted by each study are summarised below.

Ausecology (2022). Supplementary Ecological Assessments: Leeson's Road, Whetstone, Yelarbon

In early 2022, Ausecology Pty Ltd (Ausecology) was engaged by ARTC to complete additional ecological assessments relevant to the Border to Gowrie (B2G) Project footprint. One of the three areas assessed ('Whetstone') primarily occurs over the Whetstone State Forest but also overlaps a section of the northern extent of the Study Area discussed in this report. The scope of the assessment included both a desktop and field assessment. The field assessment was completed in March 2022 and the primary focus was to verify RE occurrence and extent via quaternary assessments and identify the presence and extent of threatened ecological communities (TECs). Targeted searches for threatened flora and opportunistic searches for threatened fauna were also undertaken.

ARTC (2021). Inland Rail – Border to Gowrie Project: Geotechnical Investigations – Matters of National Environmental Significance Report

As described in **Section 1.0,** ARTC are continuing to progress the EIS assessment of the B2G section of the Inland Rail. To inform design and siting of the B2G project, geotechnical investigations were required to gain an understanding of the landform conditions. An MNES report was produced and published in April 2021 as supporting information to the referral of the geotechnical works. This report details the ecological surveys that have been completed as part of the overarching EIS assessment which includes:

- Initial constraints assessments in April, September and October of 2016, conducted by EcoLogical.
- Baseline seasonal sampling in Autumn and Spring 2018 totalling 14 days, conducted by Aurecon.
- Aquatic surveys over three survey periods: June 2018, November/December 2018 and May 2019 conducted by EcoLogical.
- Supplementary targeted surveys conducted by Cardno (2019–2020).

Across the entirety of the field program, a suite of methodologies has been employed including habitat assessments, verification of vegetation communities, protected plant surveys, aquatic surveys and an array of terrestrial fauna sampling and trapping techniques.

3.2.2 Umwelt Survey

Field assessments within the Study Area were undertaken by a suitably qualified Umwelt ecologist on 20 September 2022. The methods employed and the respective survey effort is detailed in **Table 3.1**. Field assessment sites are shown on **Figure 3.1**.

Table 3.1 Field Assessment Methods and Effort

Method	Description	Total Effort
Quaternary Assessments	Quaternary plots constitute rapid vegetation surveys which include marking the GPS location and recording the dominant species in the characteristic layers, along with soil/landform and structural data, as per Neldner *et al.* (2020).	14 sites
Opportunistic Threatened Flora	Opportunistic searches for flora species listed under the NC Act or EPBC Act were completed throughout the survey in areas of potential habitat. If threatened flora species were found during these searches, their location and spatial extent were recorded and notes regarding population size and photographs were collected.	NA
Fauna Habitat Assessments	Each habitat assessment occurred within a one hectare (100 m x 100 m, or 200 m x 50 m) site, and had the following characteristics recorded: • Vegetation structure and dominant species, including a description of canopy, shrub and ground layer structure and composition. • Soil composition and landform. • Presence and abundance of tree hollows and stags. • Presence and abundance of woody debris such as habitat logs and ground timber. • Rocky habitat such as surface rocks, boulders, crevices etc. • Proximity to water (both permanent and ephemeral). • Disturbance from invasive weeds/pests. • Other disturbances such as grazing pressure, clearing, thinning or fire. Any other significant habitat features, or values present, such as leaf litter, gilgai, decorticating bark, dense grass/shrub shelter, seeding grass cover, fruiting plants, nectar and pollen producing plants (i.e. mistletoe), and koala food trees.	13 sites
Active Searches	Active searching was completed at habitat assessment sites across the Study Area. Searches included scanning the trees and ground, searching beneath microhabitat such as rocks, fallen timber and peeling bark, digging through leaf litter and soil at tree bases and flushing birds from areas with a dense or grassy ground cover. Physical disturbance to habitat features and reptiles was kept to a minimum.	
Diurnal Bird Surveys	Diurnal birds were sampled using an area census method, supplemented by broad observational surveys throughout the Study Area.	8 person-hours
Opportunistic Fauna Sightings	All fauna observed directly or indirectly (scats and tracks) during the survey were recorded.	NA

3.2.3 Assumptions and Limitations

A flora assessment has inherent limitations associated with the variability of vegetation communities across a survey location, and changes to the detectability and presence of species over time. It is recognised that field studies undertaken over just one season cannot always account for all potential floral diversity present across a survey location. However, the seasonal condition during which the survey was undertaken (spring) is generally conducive to a high degree of detectable floral diversity.

The detection of fauna species during habitat assessments is limited, given the cryptic and nocturnal nature of many fauna. The species directly observed during the survey are opportunistic sightings only and not considered exhaustive. However, habitat assessment is an accepted method to identify the potentially occurring threatened and migratory species within the Study Area.

It should be noted that the objective of the survey was not to provide an exhaustive list of flora and fauna species relevant to a baseline survey effort. The survey did however record common and dominant flora species as well as all fauna species observed.

Field survey data collection to inform mapping was conducted using a hand-held iPad unit with aerial imagery. The accuracy of the iPad is generally <5 metres and is not intended to be relied upon for design purposes.

As the Study Area intersected a rail corridor and the survey team do not hold Rail Industry Workers Cards, no survey was conducted in these areas. Ausecology (2022) have previously surveyed this area and for the purpose of this assessment, the findings of this report have been used and considered to be correct.

3.2.4 Nomenclature

Taxonomic nomenclature used for the description of flora species is according to Census of the Queensland Flora 2021(Bostock & Holland, 2021). Exotic flora species are signified in the text by an asterisk (*).

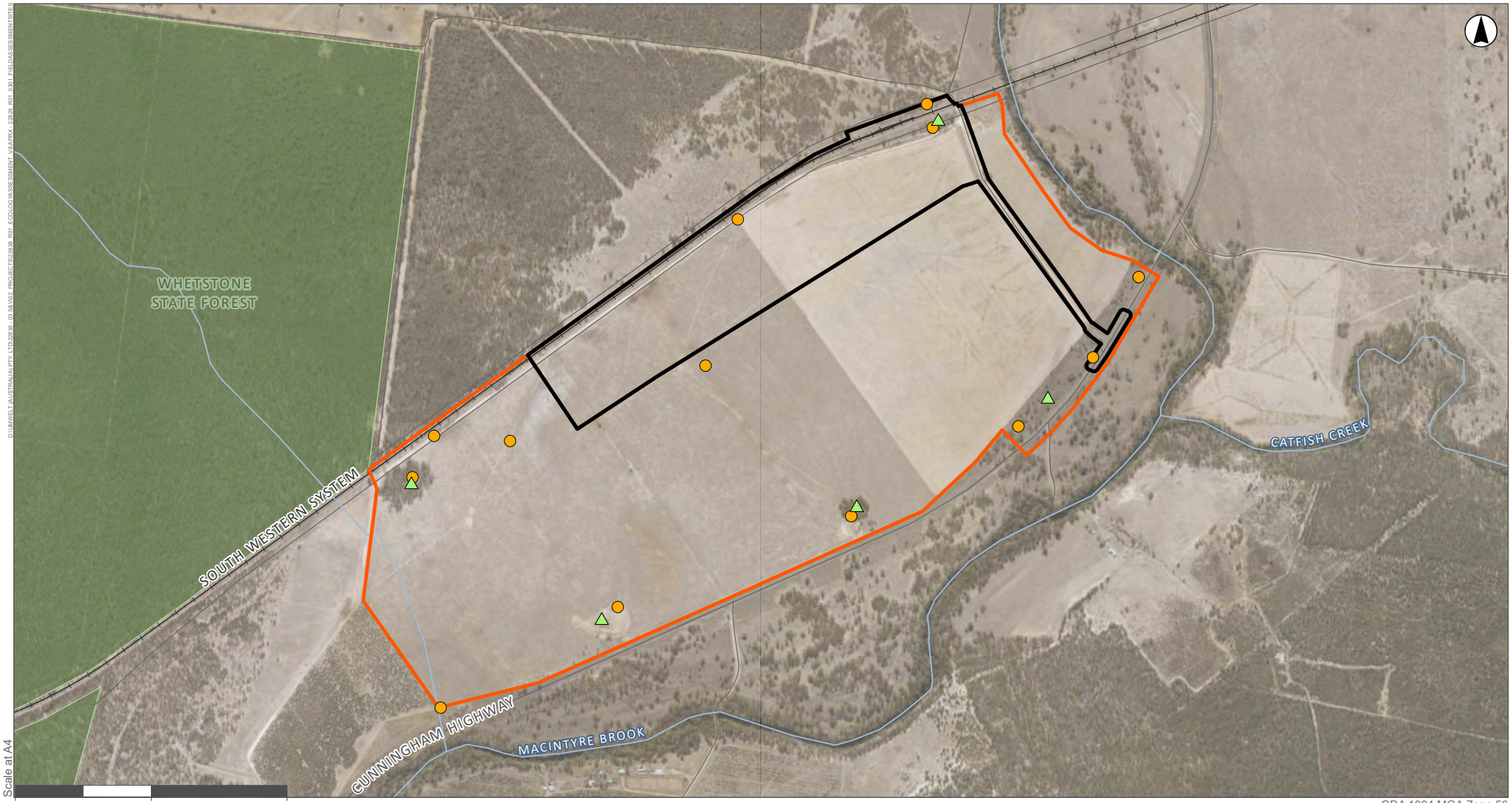


FIGURE 3.1

Field Assessment Sites

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

3.3 Likelihood of Occurrence Assessment

A likelihood of occurrence assessment was undertaken for threatened communities, flora and fauna species and migratory species identified as potentially occurring within the Development Footprint during the desktop assessment. The likelihood of occurrence assessment was based on a review of known records, habitat preferences and the broad habitat types and microhabitat features observed within the Development Footprint.

Listed species and communities were assigned to one of the categories described in **Table 3.2**.

Table 3.2 Likelihood of Occurrence Categories

Category	Description
Known	**Listed Species:** The listed species has been recently (within the last 10 years) recorded within the Development Footprint. **Listed Communities:** The listed community has been recently (within the last 10 years) recorded within the Development Footprint.
High	**Listed Species:** The listed species has been historically (not within the last 10 years) recorded within the Development Footprint or in the immediate vicinity, and the area contains preferred habitat resources which may support a population of the listed species. **Listed Communities:** The listed community has one or more corresponding Regional Ecosystems (REs) mapped within the Development Footprint, and key species have been recorded from the broader area (desktop search extent).
Moderate	**Listed Species:** This category includes species that have been recorded from the broader area (desktop search extent for all species except those considered highly mobile) and where some of the preferred habitat is present within the Development Footprint. **Listed Communities:** The listed community has one or more corresponding Regional Ecosystems (REs) mapped within the Development Footprint; however, key species have not been recorded from the broader area (desktop search extent).
Low	**Listed Species:** The Development Footprint supports some suitable habitat for the listed species, though often marginal. The listed species may disperse through the Development Footprint infrequently though is unlikely to depend on the habitat for survival. Aerial foragers and other migratory birds that may overfly the Development Footprint but will not depend on the values within this area are also included in this category. **Listed Communities:** The listed community has no corresponding REs mapped within the Development Footprint.
Unlikely	**Listed Species:** The Development Footprint offers limited to no potential habitat for the listed species, is outside its known range and/or is lacking broader habitat requirements. **Listed Communities:** The listed community has corresponding REs which are associated with a different bioregion or land zone than REs mapped within the Development Footprint.

3.4 Impact Assessment

MNES and MSES known or deemed to have a likely or moderate potential of occurrence within the Development Footprint were subjected to assessment under the Commonwealth *Significant Impact Guidelines 1.1* (DoE, 2013) or the Queensland *Significant Residual Impact Guideline* (DSDIP, 2014).

4.0 Ecological Values

4.1 Study Area Characteristics

The Study Area comprises historically cleared land dominated by exotic grasslands and wheat cropping with occasional patches of remnant or regrowth vegetation and scattered canopy trees, generally located close to the boundary or along existing tracks. Exotic grass cover in the ground layer is dense across the entire Study Area, and weeds such as velvety tree pear (*Opuntia tomentosa**) are common. North of the rail corridor and near the southern Study Area boundary, small and narrow, fragmented patches of eucalypt woodland in regrowth and remnant condition also occur. The highest quality vegetation within the Study Area occurs in the north-western extent: a single patch of grey-box (*Eucalyptus moluccana*) woodland on flat plains analogous to RE 11.5.20 (detailed further in **Section 4.2.2.2** below).

Aerial imagery indicates that vegetation communities and fauna habitats within the Study Area and portions of the local area are generally disturbed and fragmented as a result of ongoing agricultural land use practices. However, the local area also contains large intact areas of remnant vegetation associated with the State Forests and the Macintyre Brook watercourse and riparian vegetation. In the north-west and north-east, these occur directly adjacent to the Study Area.

Land within the Study Area is largely flat and level, occurring at elevations between 260 m and 270 m Australian Height Datum (AHD). Shallow depressions occur in select locations, largely associated with the overflow of the two farm dams present. A single, first order, drainage line is mapped within the south-western extent of the Study Area. Wetlands and watercourses are discussed further in **Section 4.3.5**.

4.2 Flora

4.2.1 Bioregion and Subregion

The Study Area occurs within the Brigalow Belt Bioregion, which covers the 500-759 mm rainfall area between the Queensland – New South Wales border in the south, to Townsville in the north. The Bioregion is characterised by the tree species brigalow (*Acacia harpophylla*) that forms forest and woodland on clay soils. Brigalow does not predominate across the entire region, with the bioregion including a range of ecosystems including eucalypt forest and woodland, grassland, dry rainforest, cypress pine woodland and riparian communities (Sattler & Williams 1999).

Within the Brigalow Belt Bioregion, the Study Area occurs within the Inglewood Sandstones subregion (Sattler & Williams 1999).

4.2.2 Vegetation Communities

4.2.2.1 Regulated Vegetation

As per the DoR Regulated Vegetation Management map, the Study Area almost entirely contains Category X non-remnant vegetation. One small area (0.15 ha) of Category B remnant vegetation is mapped along the north-western boundary of the Study Area, north of the rail corridor. No other regulated vegetation categories are mapped.

The field assessment found that extent of regulated vegetation within the Study Area was similar to that shown in the Regulated Vegetation Management map, with the Study Area dominated by Category X non-remnant vegetation. The primary difference noted was the presence of one patch of remnant Category B vegetation in the north-western extent of the Study Area, south of the rail corridor.

4.2.2.2 Regional Ecosystems

Review of the Vegetation Management Regional Ecosystem map (Version 12) (Department of Resources 2022) identified the potential presence of three REs within the Study Area. One RE (11.3.2) is listed as Of Concern while the other two are listed Least Concern under the VM Act. These REs along with their relevant VM Act Class is provided in **Table 4.1** while **Figure 4.1** displays their occurrence spatially.

Table 4.1 State Mapped Regional Ecosystems within the Study Area

RE	REDD Description	VM Act Class	Extent within the Study Area (ha)	Extent within the Development Footprint (ha)
11.5.1	*Eucalyptus crebra* and/or *E. populnea*, *Callitris glaucophylla*, *Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains and/or remnant surfaces	Least Concern	Not present	Not present
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	Of Concern	0.22 ha (confirmed by Ausecology)	0.22 ha (confirmed by Ausecology)
11.5.20	*Eucalyptus moluccana* and/or *E. microcarpa* and/or *E. woollsiana* +/- *E. crebra woodland* on Cainozoic sand plains	Least Concern	2.45 ha	Not present

Field assessments within the Study Area confirmed the presence of one State-mapped RE while the remaining two were not recorded. A single patch of RE 11.5.20 approximately 2.45 ha in size was recorded in the north-western corner of the Study Area, however will not be impacted by the Project. This area is likely too small to have been captured in the State Regional Ecosystem map which is generally developed using a scale of 1:100,000.

A small area of RE 11.3.2 (0.22 ha) was confirmed by Ausecology (2022) to occur in the far northern Study Area (see **Figure 4.2**[1]), which formed the edges of several larger patches. These patches were unable to be assessed during the Umwelt survey due to their location within the rail corridor but are considered present as per the findings of Ausecology (2022).

Three non-remnant vegetation communities were also confirmed by Umwelt to occur within the Study Area and Development Footprint, as described below:

- Regrowth eucalypt woodland with scattered mature canopy trees occurs as small linear patches near the north and south of the Study Area boundary and are intersected by the Development Footprint. Dominant species vary between patches but include silver-leaved ironbark (*Eucalyptus melanophloia*),

[1] The extent of Poplar Box TEC and RE 11.3.2 shown in Figure 4.2 is not accurate. Please see mapping shown in Ausecology (2022).

Queensland blue gum (*Eucalyptus tereticornis*), poplar box (*Eucalyptus populnea*), Moreton Bay ash (*Corymbia tesselaris*) up to 12 m tall. A very sparse shrub layer is present containing wilga (*Geijera parviflora*) and velvet tree pear (*Opuntia tomentosa**). The ground layer cover is variable, but dense throughout and dominated by a mixture of exotic and native grasses including slender chloris (*Chloris divaricata*), *Austrostipa sp.,* barbed-wire grass (*Cymbopogon refractus*), *Sporobolus sp.,* buffel grass (*Cenchrus ciliaris**) and grader grass (*Themeda quadrivalvis**).

- The majority of the Study Area and Development Footprint is open paddock with 95 to 100 % cover of exotic and native grasses, herbs and forbs. Very rare paddock trees occur along a small strip in the centre of the site, however elsewhere no canopy or subcanopy is present. These trees have been avoided in the Project design. The shrub layer is also very low in cover (<5 %) and height (<1 m) and consists of small-leaf bluebrush (*Maireana microhpylla*) and velvety tree pear (*Opuntia tomentosa**). Other common species in the ground layer included buffel grass (*Cenchrus ciliaris**), black speargrass (*Heteropogon contortus*), *Vittadinia sp., Einadia nutans subsp. nutans,* South American vervains (*Verbena bonariensis**), Mayne's pest (*Glandularia aristigera**), and lippia (*Phyla canescens**).

- Recently sown monoculture crops also occur within the north-eastern extent of the Study Area and Development Footprint, likely comprising wheat.

Non-remnant communities within the Study Area and Development Footprint are also shown on **Figure 4.2**.

4.2.2.3 Threatened Ecological Communities (TECs)

No TECs or analogous REs were identified within the Study Area or Development Footprint during the Umwelt survey.

The Poplar Box Grassy Woodland on Alluvial Plains TEC (Poplar Box TEC) was recorded within and directly adjacent to the Study Area and the Development Footprint, associated with remnant patches of RE 11.3.2 by Ausecology (2022), located north of the South Western System Railway Line (see **Figure 4.2**[2]). As per Ausecology (2022), four patches of RE 11.3.2 were assessed and all were found to meet the criteria of the highest condition class of the Poplar Box TEC.

As described above, areas assessed and mapped by Ausecology were unable to be assessed during the Umwelt survey due to their location within the rail corridor. Given the Ausecology assessment was completed within the last six months, it is unlikely the vegetation community condition has changed. Therefore, the Poplar Box TEC is considered present as per the findings of Ausecology (2022).

[2] The extent of Poplar Box TEC and RE 11.3.2 shown in Figure 4.2 is not accurate. Please see mapping shown in Ausecology (2022).

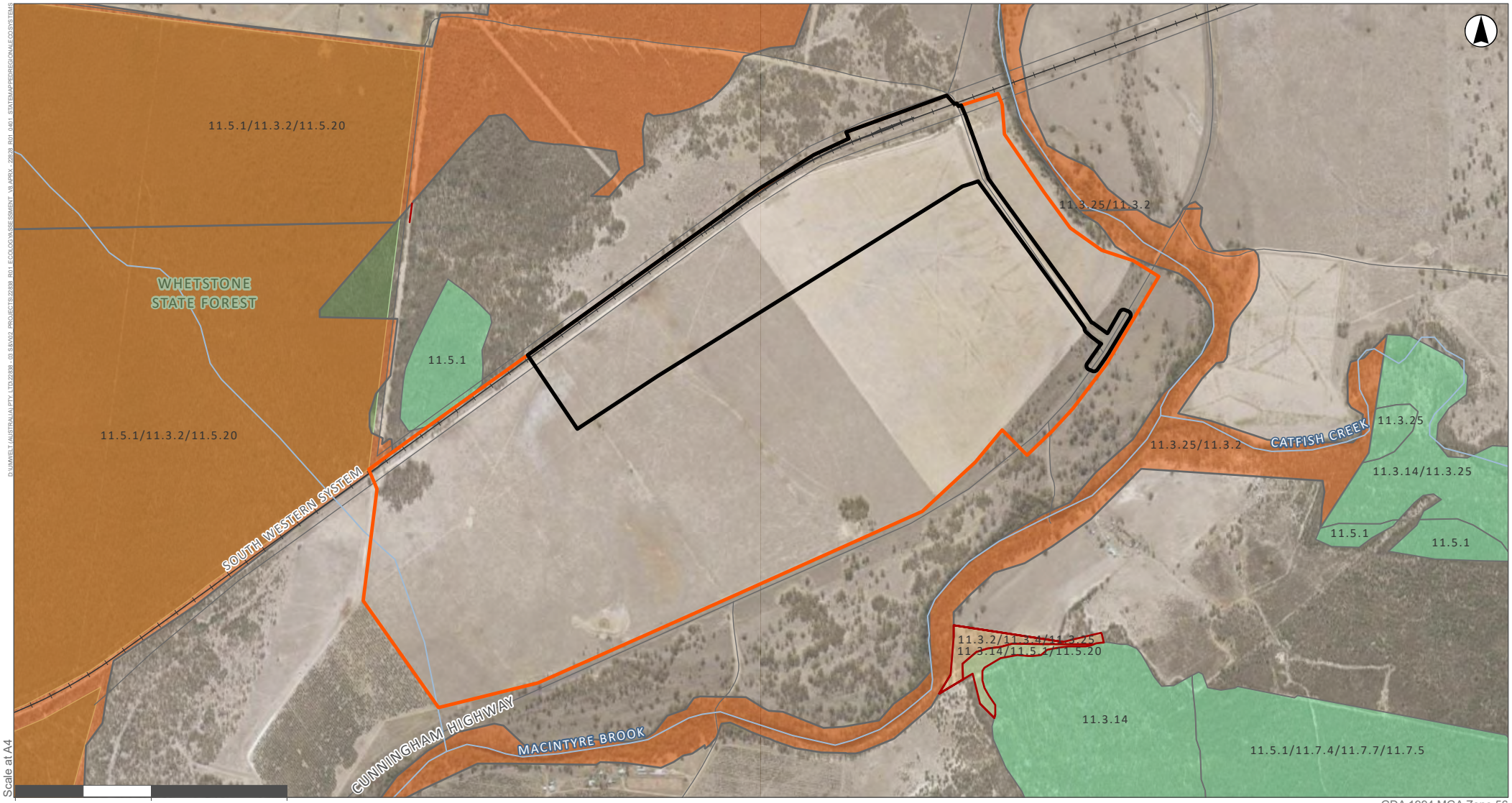


FIGURE 4.1

State Mapped Regional Ecosystems

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

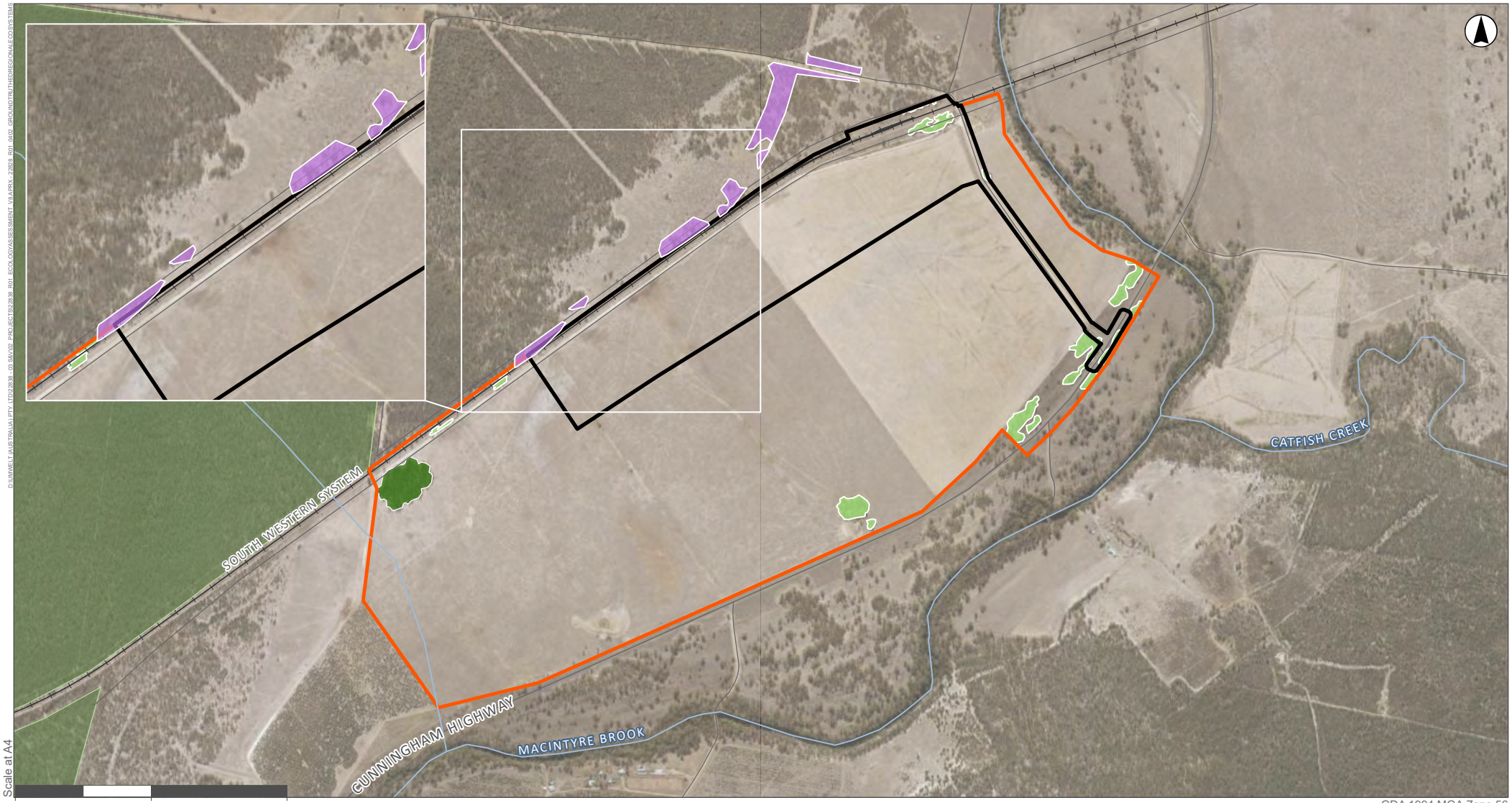


FIGURE 4.2

Ground-truthed Regional Ecosystems

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

4.2.3 Protected Plants

No high-risk areas for protected plants on the flora survey trigger map were identified within the Study Area. The closest mapped high-risk area for protected plants is approximately 1 km to the south-east of the Study Area, connected to Yelarbon State Forest.

4.2.4 Flora Diversity

The objective of the flora scope was to characterise vegetation communities and conduct searches for threatened species. Nonetheless, a total of 25 flora species were recorded within the Study Area during the Umwelt survey. These species represented the dominant species in each strata and common species in the ground layer. The dominant plant families recorded were Myrtaceae (5 taxa) and Poaceae (9 taxa). The field survey identified six introduced flora species which are discussed further in **Section 4.2.4.1** below. No flora species listed as threatened under the NC Act or EPBC Act were recorded during the field survey. The full list of flora recorded during the field survey is provided as **Appendix B**.

4.2.4.1 Introduced Flora

Six introduced flora species were recorded within the Study Area representing three families. One species, velvety tree pear (*Opuntia tomentosa**), is listed under the National Weeds Strategy as a Weed of National Significance and a Category 3 Restricted Invasive species under the Biosecurity Act.

4.3 Fauna

4.3.1 Fauna Habitat Types

The Study Area supports a total of four fauna habitat types (**Table 4.2**). Two of these fauna habitat types are also intersected by the Development Footprint. Habitat type 1 (*Eucalyptus moluccana* woodland on flat plains) and Habitat type 3 (farm dams) will not be disturbed by the Project, with the boundary of the Development Footprint a distance of approximately 500 m and 700 m from these habitat types, respectively. A description of these communities and the key fauna habitat opportunities is provided in the subsequent sections below.

It is noted that an additional RE (11.3.2) occurs within the Study Area as described in **Section 4.2.2.2**. While this RE may provide fauna habitat it was not assessed during the Umwelt survey, and as such has not been described further in this section.

Fauna habitat within the Development Footprint and broader Study Area has been subject to disturbance from clearing, agricultural practices, weeds and pests, and as a result is considered to be of reduced quality. Ongoing disturbance has led to a general lack of native understorey growth, structural complexity and microhabitat features such as fallen woody debris and leaf litter.

Table 4.2 Fauna Habitat Types

Habitat Number	Habitat Type	Extent within Study Area (ha)	Extent within Development Footprint (ha)
1	*Eucalyptus moluccana* woodland on flat plains	2.45	0
2	Regrowth eucalypt woodland with scattered mature trees	5.32	1.1
3	Farm dams	2.52	0
4A	Cleared areas – exotic pasture and tracks	222.0	42.9
4B	Cleared areas – wheat cropping	104.17	25.3

4.3.1.1 Habitat 1 – *Eucalyptus moluccana* Woodland on Flat Plains

This habitat occurs as a single patch in the north-western Study Area, flanked by barbed wire fencing to the north and west. Further north is the existing South Western System Railway Line and the Whetstone State Forest. The Development Footprint is approximately 500 m away at the closest point and no impacts area expected as a result of the Project.

Characterised as a woodland dominated by grey-box (*Eucalyptus moluccana*) with an open grassy understorey, this habitat is primarily expected to support woodland birds, small reptiles and some mammals. Mature koala food trees (grey-box (*Eucalyptus moluccana*)) are common, providing potential foraging opportunities for the koala. However, a number of existing barriers to movement (mesh fencing excluding large tracts of remnant vegetation in the adjacent Whetstone State Forest; the rail line; the Cunningham Highway) occur in close proximity and may restrict access to this habitat. Hollows in canopy trees are rare and exclusively small in size indicating suitability is limited to microbats, arboreal reptiles and some small parrot species.

When in flower, the myrtaceous canopy is likely to provide foraging opportunities for a range of common bird and flying-fox species. A single, large bull oak (*Allocasuarina luehamnni*) also occurs within the canopy. This species is known to be a key foraging resource for the threatened glossy black cockatoo (south-eastern) (*Calyptorhynchus lathami lathami*); however, no evidence of foraging was recorded. Although several recruiting individuals were observed, the rarity of this species indicates the habitat provides negligible habitat opportunities for the species. No mistletoe or fruiting shrub species were recorded.

The grassy ground layer also contains occasional ground-timber, which may be used by small ground-dwelling mammals and reptiles. Occasional decorticating bark on trees may also provide opportunities for common geckos and skinks. Macropods are also likely to utilise the habitat for foraging and shelter as evident by the presence of scats in the ground layer.

Photo 4.1 *Eucalyptus moluccana* woodland on flat plains

4.3.1.2 Habitat 2 – Regrowth Eucalypt Woodland with Scattered Mature Trees

This habitat occurs as disconnected, scattered patches close to the Study Area and Development Footprint boundary, generally in proximity to the Cunningham Highway and South Western System Railway Line. In the south-eastern corner of the Study Area, this habitat is connected to the riparian vegetation of the Macintyre Brook to the east of Whetstone Access Road. Habitat exhibits a high level of disturbance, with weeds common and evidence of selective thinning.

Variable in composition and structure, this habitat is broadly characterised as regrowth woodland dominated by *Eucalyptus spp.* with an open grassy understorey. Young and mature koala food trees including Queensland blue gum (*Eucalyptus tereticornis*), poplar box (*Eucalyptus populnea*), narrow-leaved ironbark (*Eucalyptus crebra*) and Morten Bay ash (*Corymbia tesselaris*) are generally common, providing potential foraging opportunities for the koala. Hollows in canopy trees are rare; and all but one medium sized hollow recorded were small. Based on the small size and low density of hollows and the existing fragmentation impacts, habitat is not suitable for the greater glider (central and southern) (*Petauroides volans*).

As per habitat type 1, the myrtaceous canopy is likely to provide foraging opportunities for a range of common bird and flying-fox species when in flower. Rare white cypress pine (*Callitris glaucophylla*) trees were recorded in the south-eastern corner of the Study Area where the patch connects to the Macintyre Brook. However, no other key foraging resources such as mistletoe or fruiting species were recorded. Habitat opportunities for reptiles and small mammals are limited to the grassy ground layer and occasional ground-timber which consisted of occasional fallen logs.

Photo 4.2 Regrowth eucalypt woodland with scattered mature trees

4.3.1.3 Habitat 3 – Farm Dams

Two farm dams were identified within the southern Study Area approximately 700m from the Development Footprint at its closest point during the field survey. The farm dams differed in quality, however both had modified banks which had been raised primarily along the southern boundary and were dominated by common weed species.

The southern-most farm dam is the largest (approximately 2.2 ha) and highest quality (**Photo 4.3, left**). Relative to the extent observable on aerial imagery, this dam was found to be considerably larger during the field survey likely as a result of recent rainfall and the extended wet season in 2022. Margins up to 6 m wide of wetland vegetation including *Juncus sp.* and macrophytes occur on the low-lying fringes in the northern, shallow overflow areas. These areas may provide refuge and foraging opportunities for a diversity of waterbirds including some migratory shorebirds. The second farm dam located to the east is smaller in size (approximately 0.3 ha) and has more defined banks (**Photo 4.3, right**). Fringing wetland vegetation is largely absent. However, a small area of regrowth eucalypt woodland occurs directly adjacent and may provide shade to aquatic species in the dam such as turtles, as well as perching opportunities for foraging predatory birds.

Species observed utilising the farm dams during the field survey include the Australasian grebe (*Tachybaptus novaehollandiae*), Australian wood duck (*Chenonetta jubata*), sulphur crested cockatoo (*Cacatua galerita*), pied cormorant (*Phalacrocorax varius*), white-necked heron (*Ardea pacifica*), black-fronted dotterel (*Elseyornis melanops*), straw-necked ibis (*Threskionris spinicollis*) and intermediate egret (*Ardea intermedia*). The larger farm dam within the Study Area is conservatively considered to provide some foraging and dispersal opportunities for wetland birds while on passage to higher quality habitat, however the depth and lack of fringing vegetation at the smaller farm dam were not suitable for the ecological requirements for these species.

Photo 4.3 Two farm dams within the Study Area. Larger and higher quality dam in the west (pictured left), smaller dam in the east (pictured right)

4.3.1.4 Habitat 4A – Cleared Areas – Exotic Pasture and Tracks

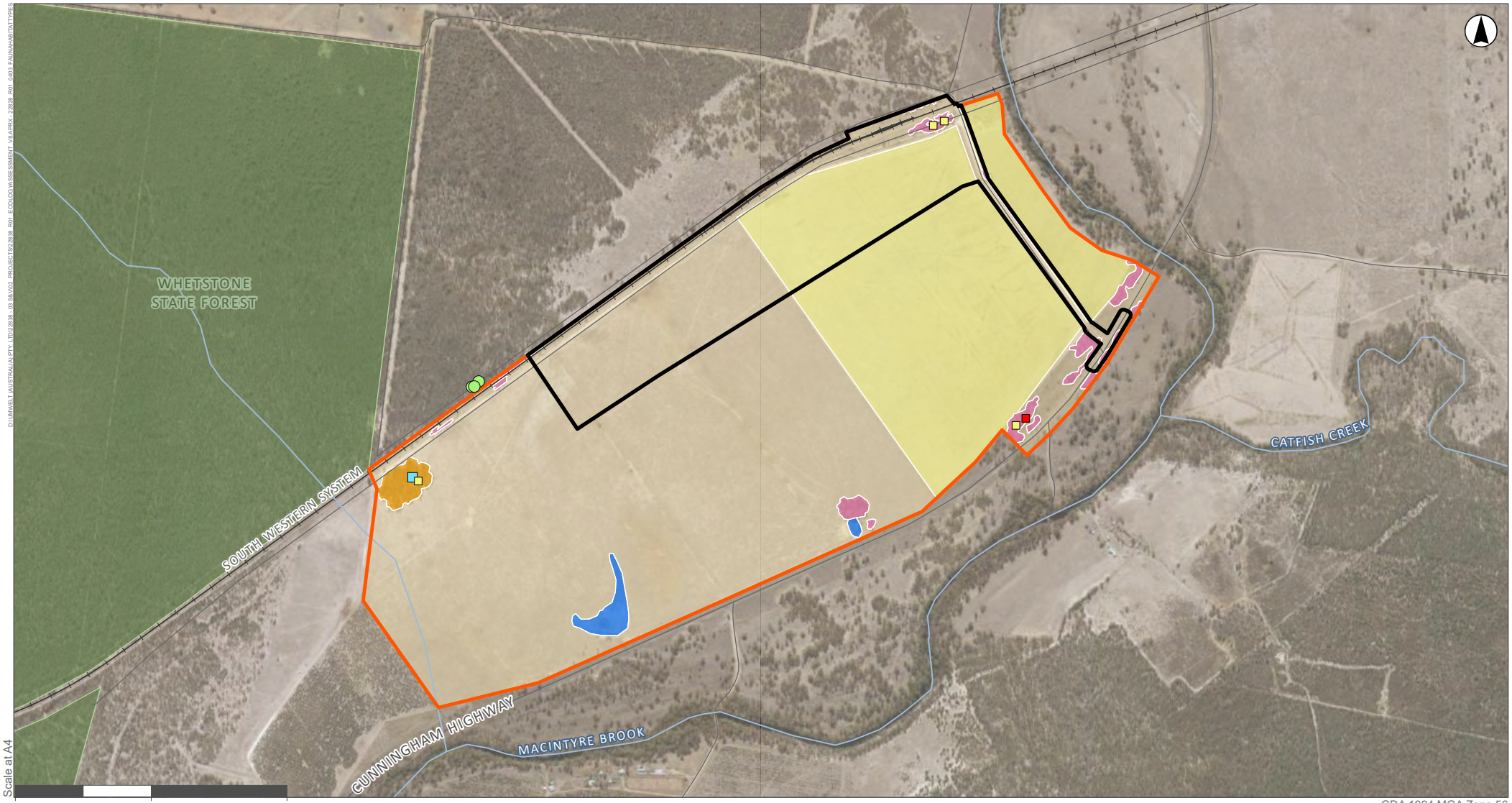
Cleared areas comprising exotic pasture and tracks occur over the majority of the Study Area and the Development Footprint. Habitat is highly disturbed, and values are limited but include rare individual paddock trees (generally adjacent to tracks, on fence lines or near farm dams) and an abundance of exotic grass in the ground layer where grazing had been restricted. Rare areas of bare ground are also present as a result of recent clearing works (**Photo 4.4**). Where grass cover is high, dispersal opportunities for small reptiles and mammals occur. Common raptors, granivorous birds and common mammal species such as the eastern grey kangaroo may forage in this habitat and emu (*Dromaius novaehollandiae*) and red-backed fairy wren (*Malurus melanocephalus*) were regularly recorded. Given the species' very broad habitat requirements, habitat may also be suitable for the short-beaked echidna (*Tachyglossus aculeatus*). Habitat is not considered to provide dispersal opportunities for koala given the large expanses of area devoid of suitable trees. No potential shelter trees were recorded within this habitat.

Photo 4.4 Exotic pasture

4.3.1.5 Habitat 4B – Cleared Areas – Wheat Cropping

Cleared areas comprising cropping occur in the eastern extent of the Study Area and the Development Footprint. Similar to the exotic pasture, habitat is highly disturbed and provides very limited habitat opportunities. The crop observed during the field survey was very short, likely only recently planted, however did provide ground-cover for dispersing small-bodied ground-dwelling fauna (**Photo 4.5**). Birds are the fauna group most likely to utilise this habitat for foraging and dispersal purposes. Habitat is not considered suitable for any species listed under the NC Act or EPBC Act.

Photo 4.5 Wheat cropping



Legend

- Roads
- Watercourse
- Railways
- Study Area
- Development Footprint
- State Forest

Potential Animal Breeding Places

- Small Hollows (Umwelt 2022)
- Medium Hollows (Umwelt 2022)
- Active Animal Breeding Place (Noisy Miner Nest) (Umwelt 2022)
- Potential Animal Breeding Place (Cardno 2021)

Fauna Habitats

- Cleared areas - exotic pasture and tracks
- Cleared areas - wheat cropping
- Eucalyptus moluccana woodland on flat plains
- Regrowth eucalypt woodland with scattered mature trees
- Farm dams

FIGURE 4.3
Fauna Habitat Types

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

4.3.2 Fauna Diversity

Fauna species were recorded opportunistically throughout the duration of the field survey as ecologists traversed the Study Area on foot. A total of 40 fauna species were recorded including one reptile, one amphibian, one mammal and 37 birds.

The full fauna species list is provided in Appendix B.

4.3.2.1 Introduced Fauna

A number of introduced fauna species are recognised as threats to native flora and fauna under the EPBC Act. No introduced fauna species were recorded during the field assessment; however, introduced species likely to occur (and listed as restricted matters under the Biosecurity Act) include cane toad (*Rhinella marina**), black rat (*Rattus rattus**), house mouse (*Mus musculus**), red fox (*Vulpes vulpes**) and feral cat (*Felis catus**).

4.3.3 Animal Breeding Places

Findings of the Umwelt survey confirmed the presence of one active animal breeding place within the *Eucalyptus moluccana* woodland on flat plains habitat type (habitat 1), in the western Study Area outside of the Development Footprint. A noisy miner (*Manorina melanocephala*) nest with two chicks was recorded in a low branch of the single mature bull oak (*Allocasuarina leuhamanii*) present. The noisy miner is not listed threatened or migratory under the NC Act or EPBC Act, however, the 'Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*)' is a Key Threatened Process under the EPBC Act. Additionally, small hollows which may be utilised by microchiropteran bats or small parrot species were present in regrowth eucalypt woodlands. One medium hollow was also present in this habitat type.

Ecology surveys completed by Cardno to support the B2G EIS also identified three potential animal breeding places immediately north of the Study Area, as described below:

- Large stag with 5 large hollows and 5 medium hollows
- Stag with 2 medium hollows
- Large hollow log.

4.3.4 Connectivity and Fauna Movement

Although occurring in an area used largely for agriculture, a number of protected areas including State Forests occur in the immediate vicinity of the Study Area. The Macintyre Brook also occurs directly east and south-east which has a well-developed, remnant riparian zone and was flowing heavily at the time of the Umwelt survey.

As discussed in **Section 4.3.1**, the Study Area is dominated by non-remnant cleared areas with only relatively small, scattered areas of remnant and regrowth woodland habitat. While these woodland habitats may provide increased habitat resources relative to the surrounding grasslands, a number of barriers to movement exist that may limit access to these areas. Movement within the Study Area is restricted by the large areas of cleared land and tracks. Although areas outside of the Study Area are

functionally connected for more mobile species, the South Western System Railway Line in the north and the Cunningham Highway in the south may be a barrier to movement for smaller species and also present a risk of vehicle strike for dispersing fauna.

Nonetheless, woodland patches within the Study Area are expected to provide some 'stepping-stone' opportunities and potentially facilitate the movement of threatened fauna such as the koala by limiting the distance required to travel in cleared exposed landscapes. In the south-eastern Study Area especially, regrowth woodland connects to the riparian vegetation of the Macintyre Brook. In the far northern and north-western corner of the Study Area, regrowth and remnant vegetation occurs in close proximity to the rail corridor and existing vegetation, potentially allowing the crossing of this barrier to be simplified.

The Study Area is not located within a Biodiversity Planning Assessment (BPA) Statewide Biodiversity Corridor; however, adjacent areas to the north and south are considered to be of State significance.

4.3.5 Wetlands and Watercourses

The DES Queensland Wetland mapping, MSES High Ecological Significance (HES) wetland mapping and Vegetation management wetland mapping were reviewed as part of the desktop assessment. State mapped watercourse values such as VM Act watercourses and DAF waterways for waterway barrier works were also reviewed.

The Study Area is located within the Macintyre Brook sub-basin of the Murry Darling Basin. Macintyre Brook, a stream order 8 watercourse, flows north to south around the eastern and southern boundary of the Study Area. Feeding into Macintyre Brook, Catfish Creek, a stream order 5 watercourse, flows east to west to the south-east of the Study Area. Both Macintyre Brook and Catfish Creek occur on the VM Act Watercourses map. One unnamed, stream order 1 drainage feature, flows north to south through the western portion of the Study Area and into Macintyre Brook. However, this watercourse could not be identified during the field survey possibly due to severe exotic grass incursion. This drainage feature does not fall within the Development Footprint. Macintyre Brook and Catfish Creek are classified as Major waterways for waterway barrier works. Both of these systems are located outside of the Study Area.

The Study Area contains two mapped artificial waterbodies represented as agricultural dams. No HES wetlands occur within the Study Area.

Field surveys confirmed the presence of the two agricultural dams on the southern boundary of the Study Area (**Section 4.3.1.3**) which support aquatic flora species and may provide habitat for fauna species such as turtles, reptiles, frogs, freshwater fish and birds. Migratory birds such as EPBC Act listed snipes may utilise these habitats for foraging and roosting during migration. Although within the Study Area, farm dams are approximately 700m from the Development Footprint at the closest point. Outside of the Study Area, the Macintyre Brook is likely to support a greater diversity of aquatic fauna including the Murray cod (*Maccullochella peelii*), which was confirmed during field surveys completed for the B2G EIS (ARTC, 2021).

4.4 Essential Habitat

No areas of Essential Habitat for threatened flora or fauna species occur within the Development Footprint as per the DES Essential Habitat mapping. The nearest area of mapped Essential Habitat occurs >10 km to the south-east, within Yelarbon State Forest.

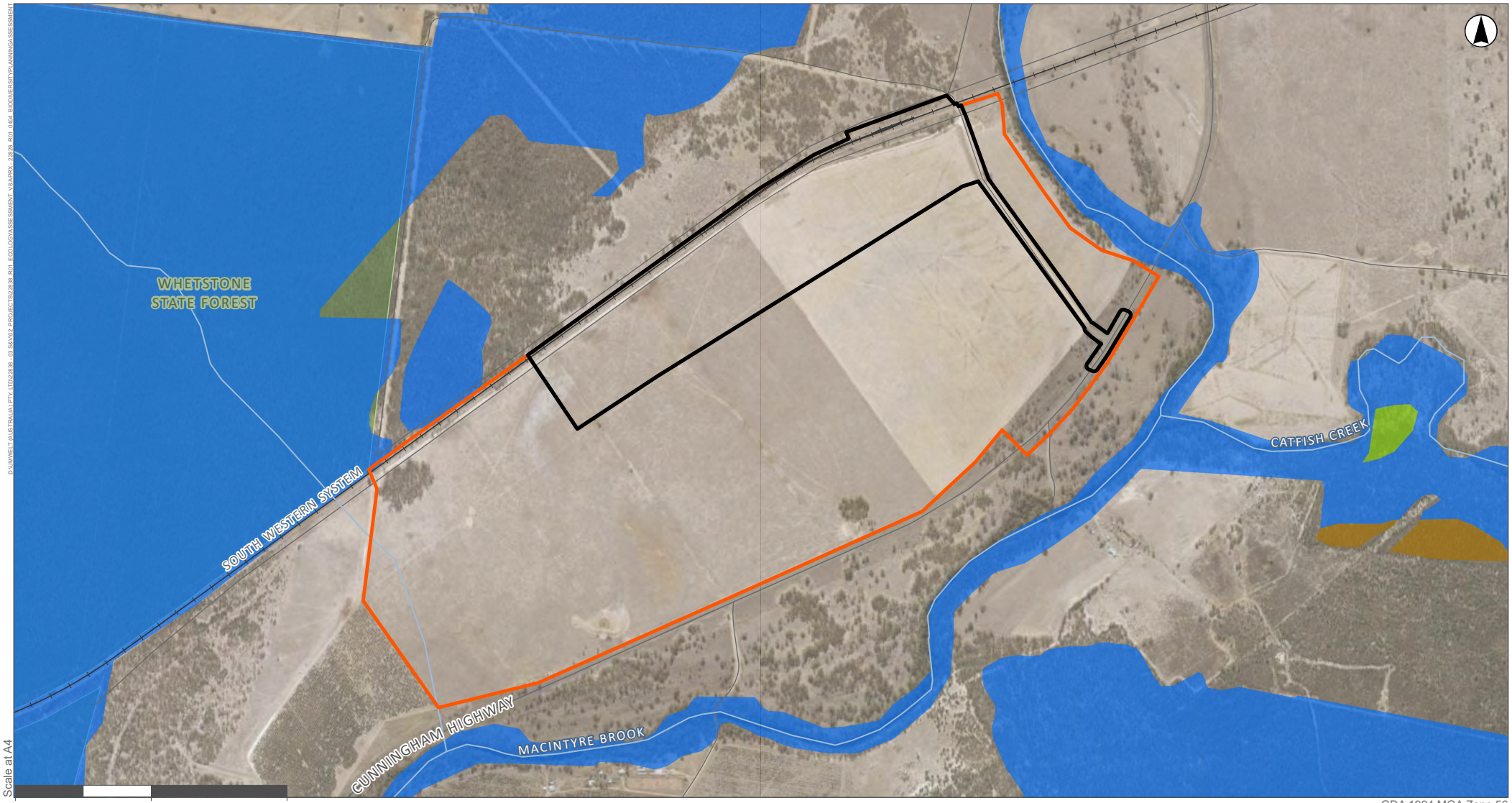


FIGURE 4.4

Biodiversity Planning Assessment Mapping

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

4.5 Likelihood of Occurrence

The desktop assessment identified the potential occurrence of 30 fauna and 10 flora species listed under the NC Act or EPBC Act, as well as five TECs listed under the EPBC Act within the Development Footprint (**Appendix A**). As described in **Section 3.3**, the potential presence of these values was interrogated further through the likelihood of occurrence assessment, which is detailed in full in **Appendix C**.

Findings of the assessment determined three fauna species listed under the NC Act or EPBC Act have a Moderate or High likelihood of occurrence within the Development Footprint. One TEC is Known to occur within the Development Footprint as per Ausecology (2022), however the remaining four TECs and all threatened flora species were determined to have a likelihood of Unlikely or Low.

A summary of the likelihood of occurrence results is provided in **Table 4.3** below.

Table 4.3 Likelihood of Occurrence – Summary of Results

Common Name	Scientific Name	EPBC Act Status	NC Act Status
Known			
Poplar Box Grassy Woodland on Alluvial Plains TEC		Endangered	-
Moderate			
koala	*Phascolarctos cinereus*	Endangered	Endangered
grey-headed flying-fox	*Pteropus poliocephalus*	Vulnerable	-
short-beaked echidna	*Tachyglossus aculeatus*	-	Special Least Concern

4.6 Fauna Habitat Criteria

Fauna habitat criteria have been developed for listed fauna species which have a high or moderate likelihood of occurring. This criterion is based on mapped fauna habitat types presented in this report (**Section 4.3.1**) to determine the extent of suitable habitat for each species. Fauna habitat for each species is provided in **Table 4.4**.

Table 4.4 Fauna Habitat Criteria

Common Name	Scientific Name	Associated Fauna Habitat	Extent within Development Footprint (ha)
Threatened and Species Least Concern Species			
koala	*Phascolarctos cinereus*	Regrowth eucalypt woodland with scattered mature trees.	1.1
grey-headed flying-fox	*Pteropus poliocephalus*		
short-beaked echidna	*Tachyglossus aculeatus*	All fauna habitat types.	69.3

5.0 Potential Impacts

The primary impacts on ecological values as a result of the Project will occur during disturbance of vegetation and microhabitat features during construction. Further information on the potential direct and indirect impacts associated with the Project is outlined below. The impacts discussed below are based on the Development Footprint which covers a total of 69.3 ha.

5.1 Direct Impacts

5.1.1 Vegetation Clearance and Habitat Loss

The Project has been designed and sited within the Study Area to avoid and minimise vegetation clearing wherever feasible; however, removal of native vegetation cannot be completely avoided. Predicted direct impacts (i.e. vegetation removal and associated habitat loss) based on the Development Footprint are quantified in **Table 5.1** below. Further reduction in direct impacts to regrowth eucalypt woodland with scattered mature trees, which provides habitat for koala (*Phascolarctos cinereus*) and grey-headed flying-fox (*Pteropus poliocephalus*) may be avoided during the detailed design phase.

Table 5.1 Predicted Direct Impacts to Habitat Types and Vegetation Communities

Habitat Type / Vegetation Community	RE	VM Act Status	Extent (ha) within Study Area	Extent (ha) within Development Footprint
Eucalyptus moluccana woodland on flat plains	11.5.20	Least Concern	2.4	0
Regrowth eucalypt woodland with scattered mature trees	-	-	5.3	1.1
Farm dams	-	-	2.5	0
Cleared areas – exotic pasture and tracks	-	-	221.9	42.9
Cleared areas – wheat cropping	-	-	104.2	25.3
		Total	**336.4**	**69.3**

5.1.2 Loss or Alteration of MSES or MNES Community or Habitat

The maximum required clearing will impact on approximately 1.1 ha of habitat for species and communities considered MSES or MNES. How this loss of habitat may impact each individual species through the direct loss of foraging and breeding resources varies depending on the current utilisation of the area by the species and the species-specific habitat requirements. Predicted direct impacts for species and communities with a Moderate likelihood or higher are provided in **Table 5.2** below.

Table 5.2 Predicted Direct Impacts to MSES and MNES Values

Species / Community	EPBC Act Status^	NC Act Status^	Habitat Utilisation	Extent (ha) within Development Footprint
Poplar Box TEC	E	-	-	0.22
Koala (*Phascolarctos cinereus*)	E	E	Foraging and dispersal	1.1
grey-headed flying-fox (*Pteropus poliocephalus*)	V	-	Marginal foraging and dispersal	1.1
short-beaked echidna (*Tachyglossus aculeatus*)	-	SLC	Breeding, foraging and dispersal	69.3
Total Impact to MNES/MSES Fauna Habitat				**69.3**

[1] V = Vulnerable; E = Endangered; SLC = Special Least Concern

5.1.3 Disturbance, Injury and Mortality of Fauna

Clearing of vegetation can result in injury or mortality of fauna, particularly ground dwelling fauna, that may be crushed by machinery or struck by vehicles. Arboreal mammals and reptiles may be trapped in trees as they are felled. Additionally, nesting birds may be disturbed and displaced. Whilst a local impact on fauna may occur, the impact on fauna populations within the broader landscape is considered minimal.

5.2 Indirect Impacts

5.2.1 Impacts to Waterways

A single first order drainage feature exists in the western portion of the Study Area and flows north to south, connecting with the Macintyre Brook outside of the Study Area. This watercourse represents a small runoff drainage feature, heavily impacted by exotic grass that was indiscernible during the Umwelt survey. During periods of flood, it may flow into Macintyre Brook but under normal circumstances, it is unlikely to flow or hold water. This drainage feature is approximately 850 m from the Development Footprint at its closest point. No direct impacts are anticipated as a result of the Project.

Downstream impacts to Macintyre Brook from watercourses and drainage features within the Study Area are considered unlikely given the minor holding capacity and intermittent flow associated with these systems. Although the MNES species Murray cod (*Maccullochell peelii*) is known to occur in Macintyre Brook, any potential impacts to this species would be negligible as no direct works will be conducted in the waterway, no barriers to movement will be constructed and habitat complexity and flow regime would not be impacted to any material extent.

In consideration to the above, potential indirect impacts to waterways during high-rainfall periods and construction may include:

- Erosion and sedimentation.
- Reduced water quality from point and non-point sources.

- Material stockpiles may cause a direct influx of sediment in the surface water runoff from the work sites, particularly from areas of cleared vegetation.
- Increased nutrient input which may have flow on effects to vegetation and algal growth.
- Contamination of hydrocarbons and other chemicals due to spills.
- Sediment and suspended solids as a run-off from tracks and other exposed areas.
- Changes to soil chemistry due to:
    - Importation of foreign soils
    - Exposure of subsoils.
- Facilitation of the establishment of terrestrial and aquatic weed species, which may further degrade habitat value in fringing vegetation.

5.2.2 Exacerbation of Pest Fauna and Weeds

As described in **Section 4.3.2.1**, although no introduced fauna were recorded within the Study Area during the survey, some species are anticipated to occur given the area's highly disturbed nature. Introduced fauna populations, left unchecked, may flourish in newly disturbed areas, disperse into higher quality habitat areas and further contribute toward the degradation of fauna habitat within the Study Area. Newly cleared linear areas may also act as conduits for pest fauna movement.

Given the extent of historical clearing within the Study Area and the likely prevalence of these species within the existing landscape, it is unlikely that the proposed works will result in further introductions of feral vertebrate species. However, further habitat modification may facilitate larger populations of certain introduced species such as European rabbit (*Oryctolagus cuniculus**) and house mouse (*Mus musculus**) where some native species will not be able to persist. Some potential impacts of these pest fauna to native species include that they may:

- Prey on native species and compete for food.
- Carry diseases that may affect native animals.
- Act as the primary prey for other exotic predators such as feral cats or foxes which then threaten native species.

The introduction and/or spread of weeds is an indirect impact that can impact the integrity of remaining vegetation, increase the intensity and/or frequency of fires, as well as threaten the long-term survival of threatened fauna species. The weed species that pose the biggest threat to fauna and associated habitat values are the Category 3 'restricted' species listed under the *Biosecurity Act 2014*, Weeds of National Significance, as well as high-biomass grass species. High-biomass grass species can out-compete native vegetation as well as reduce the germination of native species. The high biomass of these species also increases the intensity and/or frequency of fires posing a further risk to fauna habitat.

Project activities that may increase the risk of establishment of new infestations and exacerbation of existing infestations include the following:

- Soil disturbance through vegetation clearance and construction activities.
- Areas of ground remaining bare for extended periods will establish weed species where there is little competition from other species.
- Increased vehicular traffic through the area.
- Importation of construction materials to the site which may harbour introduced species.

However, as described in **Section 4.2.2.2** weed species are common within the Development Footprint and the broader Study Area, including a high biomass of exotic grasses and ground cover species. Given the prevalence of these species, it is considered unlikely Project works will further exacerbate weed populations.

5.2.3 Activity and Noise

During the construction and operation phase, there will be an increase in noise and activity in the Study Area as machinery undertakes clearing and other activities. When activity and noise is occurring in areas adjoining retained habitat, potential impacts may include:

- Reduced foraging ability by auditory predators due to increased background noise.
- Increased risk of predation by visual predators due to increased background noise.
- Increased potential for collisions with vehicles and plant.
- Human visitation causing disturbance to foraging or breeding behaviours.

Current research indicates that there are no government policies or other widely-accepted guidelines in respect to the noise levels which may be acceptable to wildlife. The levels or character of noise that may "startle" or otherwise affect the feeding or breeding pattern of birds or other wild animals are also not firmly established in the technical literature.

Sudden loud, impulsive or impact noises are capable of causing birds and other fauna to become startled, which if occurring over the longer term, may affect feeding and breeding behaviour in some species. These impacts are expected to occur to the fauna using the habitats both within and immediately adjacent to the Study Area.

It is expected that excavation, construction and earthmoving associated with the Project will potentially cause disturbance to all groups of fauna, especially birds and hollow-dwelling fauna. This may result in the temporary avoidance of the area for the duration of these activities. The construction works will be conducted during daylight hours only and no temporary or permanent lighting will be instated as part of the Project. Impacts from noise will be limited to temporary construction noise, most of which will be of similar noise level to passing heavy vehicles.

Existing noise and lighting conditions in the Study Area are typical of land adjacent to a high-speed motorway environment and are restricted to that created by passing vehicles. The operation phase of the Project is not expected to result in increased traffic or light, therefore the impacts during the operational phases of the Project will reflect current levels.

5.2.4 Increased Dust

Deposition of dust, sand and soil resulting from construction may have potential impacts on vegetation if excessive levels are sustained over extended periods. When dust settles on plant foliage it can reduce the amount of light penetration on the leaf surface, block and damage stomata, and slow rates of gas exchange and water loss (Farmer 1993). Reduction in the ability to photosynthesise due to physical effects may result in reduced growth rates of vegetation and decreases in floral vigour and overall community health.

6.0 Matters of State Environmental Significance

MSES include certain environmental values that are protected under Queensland legislation including:

- NC Act
- *Marine Parks Act 2004*
- *Fisheries Act 1994*
- EP Act
- *Regional Interests Planning Act 2014*
- VM Act
- EO Act.

MSES that could be relevant to the Project include those listed in Schedule 2 of the Queensland Environmental Offset Regulations. Most of these MSES include flora and fauna values that have been previously discussed in **Section 4.0** and **Section 4.5**. These values within the Development Footprint, along with others that are considered MSES have been summarised in **Table 6.1** below.

Table 6.1 MSES Values

Prescribed MSES	Definition	Present in the Development Footprint
Regulated vegetation	Prescribed regional ecosystems that are 'endangered' or 'of concern' regional ecosystems, as defined under the VM Act.	**No** Although an Of Concern regional ecosystem is present within the Development Footprint, it does not occur within a category B area on the Regulated Vegetation Management map, as such it does not constitute a 'prescribed matter'.
	Prescribed regional ecosystem that intersects with an area shown on the vegetation management wetlands map.	
	Prescribed regional ecosystem that is located within the defined distance from the defining banks of a watercourse identified on the vegetation management watercourse map Act.	
	Prescribed regional ecosystem that is an area of essential habitat on the essential habitat map for an animal that is critically endangered wildlife, endangered wildlife or vulnerable wildlife or a plant that is critically endangered wildlife, endangered wildlife or vulnerable wildlife.	

Prescribed MSES	Definition	Present in the Development Footprint
Marine plants	Marine plants are part of the mosaic of fish habitats and are an integral and usually highly visible feature of the coastline. Fish habitat is defined under the *Fisheries Act 1994* and includes land, waters and plants associated with the life cycle of fish, and includes land and waters not presently occupied by fisheries resources. Marine plants are defined under the Fisheries Act and include the following: a. a plant (a tidal plant) that usually grows on, or adjacent to, tidal land, whether it is living, dead, standing or fallen; b. material of a tidal plant, or other plant material on tidal land; c. a plant, or material of a plant, prescribed under regulation or management plan to be a marine plant.	**No** The Development Footprint does not contain a tidal watercourse.
Connectivity	Prescribed regional ecosystem that: • is of sufficient size or configured in a way that maintains ecosystem functioning; and • will remain despite a threatening process within the meaning of the NC Act.	**No** The Development Footprint does not contain a prescribed regional ecosystem that meets the definition.
Wetlands and watercourses	Wetland in a wetland protection area as shown on the map of referrable wetlands.	**No** No mapped wetlands or watercourses occur within the Development Footprint.
	Wetlands of high ecological significance as shown on the map of referrable wetlands.	
	Wetland or watercourse in a high ecological value waters as identified under the Environmental Protection (Water) Policy 2019.	
Protected areas	Protected areas are declared under the NC Act for the conservation of Queensland's natural and cultural resources. They include: • national parks • national parks (Aboriginal land / Torres Strait Islander land / Cape York Peninsula Aboriginal land) • regional parks • nature refuges.	**No** The Development Footprint does not contain protected areas.
Fish habitat areas and highly protected zones of State Marine Parks	Fish Habitat Areas are declared under the *Fisheries Act 1994.* Marine parks are declared under the *Marine Parks Act 2004.*	**No** The Development Footprint does not contain a watercourse or marine environment.

Prescribed MSES	Definition	Present in the Development Footprint
Waterways providing for fish passage	Any part of a waterway that provides for passage of fish regulated under the *Fisheries Act 1994* for the natural movement patterns of fish species required to maintain the biological integrity of the species.	**No** No waterways that may provide for fish passage are found within the Development Footprint.
Legally secured offset areas	Legally secured offset areas are any areas declared as an environmental offset protection area, high nature conservation value under the VM Act or another area prescribed under a regulation.	**No** The Development Footprint does not contain legally secured offset areas.
Protected wildlife habitat	• an area that is shown as a high risk area on the flora survey trigger map that contains plants that are endangered wildlife or vulnerable wildlife • an area that is not shown as a high risk area on the flora survey trigger map, to the extent the area contains plants that are endangered wildlife or vulnerable wildlife • a koala habitat area as defined by the Nature Conservation (Koala) Conservation Plan 2017 • an area of habitat (e.g. foraging, roosting, nesting or breeding habitat) for an animal that is Endangered, Vulnerable or a Special Least Concern animal.	**Yes** Ground-truthed potential habitat for threatened and special least concern fauna species occurs within the Development Footprint.
Designated precinct in a strategic environmental area	An area identified on the Strategic Environmental Area map. Designated precincts include the Channel Country, Fraser Island, Gulf Rivers and Hinchinbrook Island.	**No** There are no Strategic Environmental Areas mapped within or adjacent to the Development Footprint.

6.1 Significant Residual Impact Assessment for MSES

As described in **Section 4.5**, findings of the likelihood of occurrence assessment determined that two species listed under the NC Act have a Moderate or higher likelihood of occurring within the Development Footprint. These species and their associated potential habitat are considered to comprise the Protected wildlife habitat MSES based on the definitions in **Table 6.1**. These are:

- koala (*Phascolarctos cinereus*)
- short-beaked echidna (*Tachyglossus aculeatus*).

Of the above species, one (the short-beaked echidna (*Tachyglossus aculeatus*)) is not also listed under the EPBC Act and therefore not an MNES. Protection under the EPBC Act is the highest level of protection within Australia and the impact assessment under such is therefore considered to be the most stringent. Further, the questions to be addressed in determining a significant impact to MNES and MSES are substantially the same and therefore a similar conclusion is most likely. As such, potential impacts on the remaining species (koala) has been assessed under the EPBC Act guidelines (as detailed in **Section 7.1**) and further assessment against the MSES significant residual impact guidelines has not been conducted. No other MSES values are considered relevant to the Project.

An assessment of the significance of potential Project impacts in accordance with *Significant Residual Impact Guideline* (Department of State Development Infrastructure and Planning 2014) was conducted for the short-beaked echidna (*Tachyglossus aculeatus*) (see **Appendix D**). The findings of the assessment determined that a significant residual impact on the species was unlikely given small area of proposed disturbance, the generally degraded nature of this habitat, the species' ability to disperse between habitat patches and the large areas of higher value habitat available directly adjacent the Disturbance Footprint.

7.0 Matters of National Environmental Significance

The MNES values relevant to the Development Footprint and Project are outlined below in **Table 7.1.**

Table 7.1 MNES Values

MNES Value	Location Relative to the Study Area
World heritage properties	**No –** There are no World heritage places within proximity to the Development Footprint.
National heritage places	**No –** There are no National heritage places within proximity to the Development Footprint.
Wetlands of international importance (listed under the Ramsar convention)	**No –** There are no Wetlands of International Importance within proximity to the Development Footprint.
Listed threatened species and ecological communities	**Yes –** No threatened species or communities were recorded during the Umwelt survey. However, one TEC is considered known to occur within the Development Footprint as per Ausecology (2022), and two fauna species are potential occurrences based on the available habitat and the presence of records. No listed flora species have the potential to occur within the Study Area.
Migratory species	**No** – No listed migratory species were recorded during the Umwelt survey and none are considered to occur within or above the Development Footprint, given the absence of farm dams and wetland habitat.
Commonwealth marine areas	**No –** The Development Footprint is located >250 km inland.
Great Barrier Reef Marine Park	**No –** The Development Footprint is located >250 km inland, and considerably south of the Great Barrier Reef Marine Park.
Nuclear actions (including uranium mines)	**No –** The Project is not and does not involve a nuclear action.
A water resource, in relation to coal seam gas development and large coal mining development	**No –** The Project is not a coal seam gas development or a large coal mining development.

7.1 Significant Impact Assessment for MNES

As described in **Section 4.5**, findings of the likelihood of occurrence assessment determined that one TEC and two species listed under the EPBC Act have a Moderate or higher likelihood of occurring within the Development Footprint.

The precautionary principle has been applied when deciding whether or not the Project is likely to have a significant impact on a value. Despite the small scale of direct impacts, significant impact assessments in accordance *Significant Impact Guidelines Policy Statement 1.1* (Department of the Environment 2013) were completed for the following values:

- Koala (*Phascolarctos cinereus*)
- Grey-headed flying-fox (*Pteropus poliocephalus*)
- Poplar Box TEC.

Poplar Box TEC is shown on **Figure 4.2**, and potential koala and grey-headed flying-fox habitat within the Development Footprint (and Study Area) is shown on **Figure 7.1.**

The full assessments are detailed in **Appendix E**. The findings of these assessments determined that the Project is unlikely to result in a significant impact on the koala, grey-headed flying-fox or Poplar Box TEC.

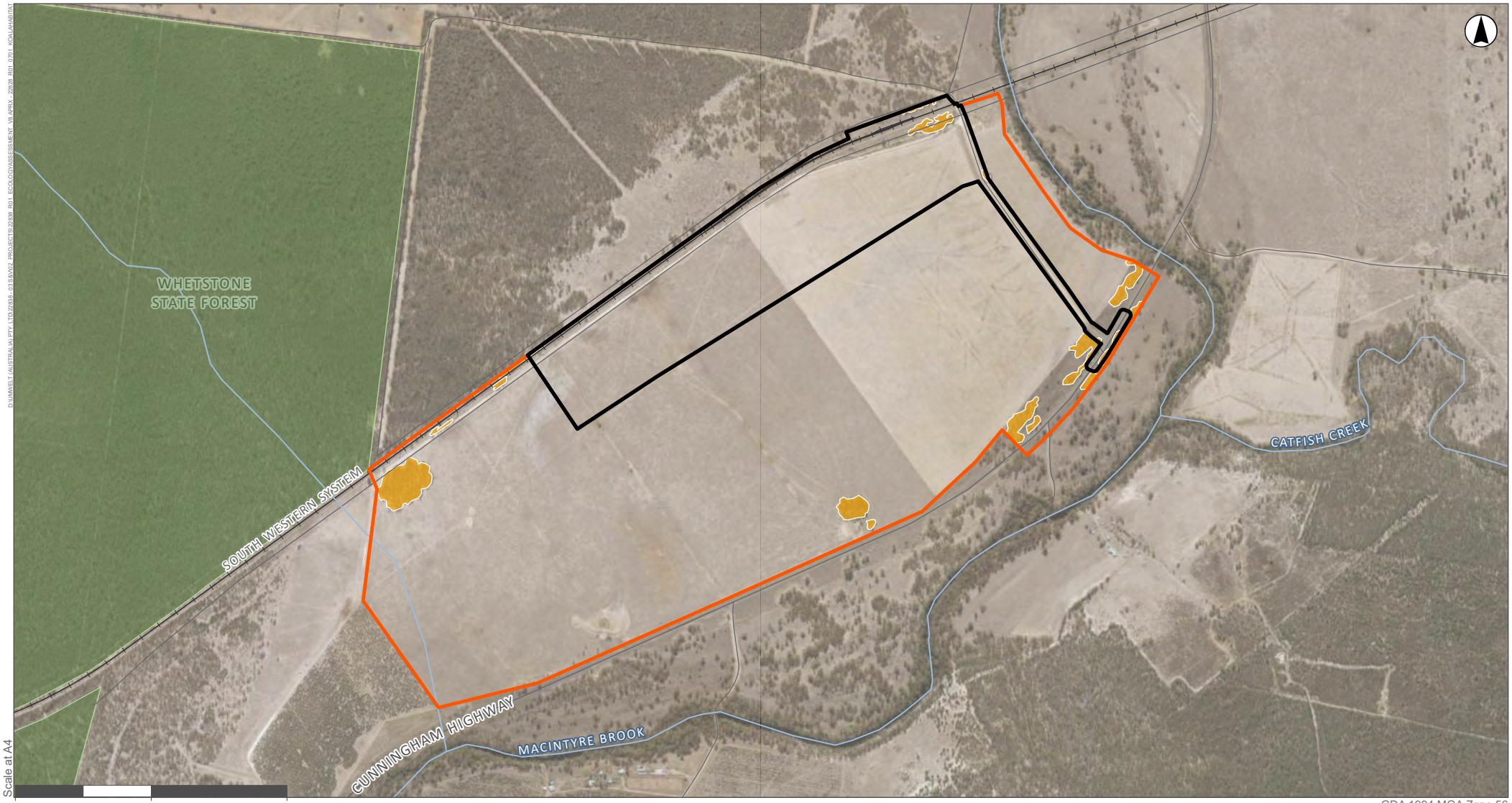


FIGURE 7.1

Potential Koala and Grey-headed Flying Fox Habitat

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

8.0 Mitigation Measures

Mitigation measures relevant to the planning and design, construction and construction and operation phases of the Project are summarised below.

Planning and Design

- During detailed design, areas of suitable habitat for koala and grey-headed flying-fox should be avoided wherever feasible (**Figure 7.1**).
- Vehicle washdown facilities should be utilised during construction activities to minimise biosecurity risk.
- Habitat trees and mature vegetation within the Development Footprint are to be maintained to the greatest extent possible (**Figure 4.3**).
- As potential animal breeding places have been identified within the Development Footprint, it is recommended that a Low-Risk Species Management Program (SMP) be developed and implemented for the Project. The pre-emptive preparation of a Low-Risk SMP will mitigate time risks associated with preparing a SMP for impacts to breeding places (e.g. nests and hollow bearing trees) that are present or that may be established prior to construction.
- Breeding places for colonial breeding species exists within the north-eastern section of the Development Footprint (see small hollows and vegetation identified on **Figure 4.3**). Impacts to these areas should be avoided through planning and design activities and a no-go zone should be established around this vegetation. Where impacts are necessary to this portion of the Development Footprint a High Risk SMP will be required prior to the commencement of works.

Construction

- Where clearing is required, it should be limited to the approved 'Development Footprint'. Any unauthorised clearing beyond the Development Footprint should be reported to the site manager and ARTC immediately.
- Remnant vegetation adjoining areas subject to disturbance should be clearly identified as no-go zones.
- A qualified fauna spotter catcher is to be engaged to undertake pre-clearance surveys for fauna and fauna breeding places.
- Clearing and construction activities are to be undertaken in daylight hours where possible to reduce impacts from lighting and construction noise on nocturnal species, including the koala.
- All staff and contractors should receive environmental awareness and mitigation training to ensure they are aware of their environmental responsibilities.
- If a koala is located during pre-clearance surveys or during clearing activities:
    - the individual must not be forcibly relocated
    - any tree which houses a koala as well as any tree with a crown that overlaps that tree will not be cleared until the koala vacates the tree on its own volition

- allow a clearing buffer surrounding the tree, equal to the height of the tree or deemed suitable by the spotter catcher
- any injured koala (and fauna in general) should be transported to a vet or recognised wildlife carer as soon as practicable.

- The Study Area should not be used for cattle grazing during construction activities to disturbance from noise. It is noted that no cattle are currently utilising the Study Area, however there is historical evidence of cattle grazing.

Construction and Operation

- All site personnel should be educated about ecological values within and adjoining the Development Footprint. Personnel should be educated about the risk of fauna injury and death and be made aware of on-site speed limits.
- Weed control and pest management measures are to be developed in accordance with the Biosecurity Queensland guidelines for invasive plants and animals and incorporated into a Construction Environment Management Plant (CEMP) and Operational and Environment Management Plant (OEMP).
- Reducing speed limits on Project roads and access tracks and limiting traffic movements during dawn and dusk.
- The presence of pest and weed species should be monitored by ARTC environmental officers and where necessary, control measures should be implemented to limit abundance and distribution on the site.

9.0 Conclusion and Recommendations

Ecological values validated within the Development Footprint include regrowth and non-remnant vegetation in degraded condition. Nonetheless, these communities support some habitat values and resources for a diversity of flora and fauna species, conservatively including listed threatened and migratory species. This includes potential animal breeding places for least concern, threatened and colonial breeding fauna. One first order drainage line is mapped along the western extent of the Development Footprint, however will not be directly impacted by the Project.

The field survey did not confirm the presence of any conservation significant fauna or flora species. However, field surveys were observational only and were not intended to provide an exhaustive list of species diversity. In the absence of baseline fauna and flora surveys, desktop assessment in combination with habitat assessment was conducted to determine the potential for listed threatened and migratory species to occur. The result of this assessment was that two threatened fauna and one special least concern fauna species listed under the NC Act or EPBC Act were considered as having the potential to occur in the Development Footprint. Additionally, one TEC was confirmed to be present within the Development Footprint by Ausecology (2021). This could not be confirmed during the field surveys as work was not permitted in the rail corridor, however the overstorey vegetation was present and it is assumed that the Ausecology assessment and mapping is correct.

These species and the TEC were subject to a significant impact assessment against the State or Commonwealth significant impact assessment criteria:

- Koala
- Grey-headed flying-fox
- Short-beaked echidna
- Poplar box TEC.

Further detailed assessment determined that significant impacts to all four values were unlikely to occur. This is primarily based on the small amount of clearing required in suitable habitat as well as the low connectivity value, degraded nature of the vegetation and the wide availability of higher quality habitat in adjacent areas.

However, to minimise any potential impacts to these species or communities it is recommended that disturbance to the following areas be minimised or avoided wherever possible:

- All areas of Poplar Box TEC as mapped by Ausecology (**Figure 4.2**).
- Areas of potential koala and grey-headed flying-fox habitat (**Figure 7.1**).

The Project has the potential to impact on a range of biodiversity values including least concern flora and fauna and habitat for these species. The proposed mitigation measures should be implemented throughout construction and operation to ensure impacts to ecological values are limited to the greatest extent possible.

As potential animal breeding places have been identified within the Development Footprint, it is recommended that a Low-Risk Species Management Program (SMP) be obtained for the Project to protect against any breeding places (e.g. nests and hollow bearing trees) that are present or that may be established prior to construction. As potential breeding places for colonial breeding species (i.e. microchiropteran bat species which may utilise hollows) were identified during the field survey, a High Risk SMP will also be required. The SMPs must effectively demonstrate the management intent of the species within the site and evidence regarding how avoidance of adverse impacts to the species will be implemented.

10.0 References

Atlas of Living Australia 2022, 'Spatial Portal', accessed from <https://spatial.ala.org.au/>.

Ausecology 2022, Supplementary Ecological Assessments Leeson's Road, Whetstone, Yelarbon, Brisbane QLD, accessed from <www.ausecology.com>.

Australian Rail Track Corporation 2021, Inland Rail – Border to Gowrie Project (part 1),.

Department of Agriculture and Fisheries 2016, 'Queensland waterways for waterway barrier works', accessed from <https://qldspatial.information.qld.gov.au/catalogue/>.

Department of Agriculture Water and the Environment 2022, Conservation Advice for Phascolarctos cinereus (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory,.

Department of Climate Change, Energy, the Environment and Water 2022, 'Species Profile and Threats Database',.

Department of Climate Change Energy the Environment and Water 2022, 'Protected Matters Search Tool', *Australian Government*, accessed from <http://www.environment.gov.au/epbc/pmst/>.

Department of Environment and Science 2018, 'Biodiversity planning assessment - Brigalow Belt', accessed from <https://qldspatial.information.qld.gov.au/catalogue/>.

Department of Environment and Science 2019, 'Wetland data - version 5 - wetland areas - Queensland', accessed from <https://qldspatial.information.qld.gov.au/catalogue/>.

Department of Environment and Science 2021, 'Flora Survey Trigger Map for Clearing Protected Plants in Queensland - Version 8.0', accessed from <https://qldspatial.information.qld.gov.au/catalogue/>.

Department of Resources 2021a, 'Vegetation management watercourse and drainage feature map (1:100000 and 1:250000) – Queensland except South East Queensland Version 5.0', accessed from <https://qldspatial.information.qld.gov.au/catalogue/>.

Department of Resources 2021b, *Vegetation Management Supporting Map*, accessed from <https://www.qld.gov.au/environment/land/management/vegetation/maps/map-request>.

Department of Resources 2022, 'Vegetation management regional ecosystem map - version 12.0', accessed from <https://qldspatial.information.qld.gov.au/catalogue/>.

Department of State Development Infrastructure and Planning 2014, Significant Residual Impact Guideline - For matters of state environmental significance and prescribed activities assessable under the Sustainable Planning Act 2009, Brisbane, accessed from <https://dsdmipprd.blob.core.windows.net/general/dsdip-significant-residual-impact-guideline.pdf>.

Department of the Environment 2013, Significant Impact Guildelines 1.1: Matters of National Environmental Significance, Canberra.

Department of the Environment 2014, EPBC Act referral guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory), Commonwealth of Australia, Canberra ACT, accessed from <https://www.awe.gov.au/sites/default/files/documents/koala-referral-guidelines.pdf>.

Department of the Environment 2021, 'Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) — Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)', accessed June 9, 2021, from <https://www.environment.gov.au/sprat>.

Farmer, AM 1993, 'The effects of dust on vegetation - a review', *Environmental Pollution*, vol. 79, pp. 63–75.

Melzer, A, Carrick, F, Menkhorst, P, Lunney, D & John, B ST. 2000, 'Overview, Critical Assessment, and Conservation Implications of Koala Distribution and Abundance', *Conservation Biology*, vol. 14, no. 3, pp. 619–628.

of Natural Resources, D & Mines 2016, 'Vegetation management - regulated vegetation management map - version 1.28', accessed from <http://qldspatial.information.qld.gov.au/catalogue/>.

Queensland Herbarium 2021, *Regional Ecosystem Description Database (REDD) (Version 12)*, Department of Environment and Science, Brisbane QLD.

Sattler, P & Williams, R 1999, *The conservation status of Queensland's bioregional ecosystems*, Environmental Protection Agency, Brisbane.

APPENDIX B

Ecology assessment

Appendix A Protected Matters Search Tool and Wildnet Database results

Inland Rail is a subsidiary of
Australian Rail Track Corporation

INLAND RAIL

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 25-Sep-2022

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	3
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	31
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	5
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	1
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands)		[Resource Information]
Ramsar Site Name	Proximity	Buffer Status
Banrock station wetland complex	1100 - 1200km upstream from Ramsar site	In feature area
Riverland	1100 - 1200km upstream from Ramsar site	In feature area
The coorong, and lakes alexandrina and albert wetland	1300 - 1400km upstream from Ramsar site	In feature area

Listed Threatened Ecological Communities			[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area	In buffer area only
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area	In feature area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area	In feature area
Weeping Myall Woodlands	Endangered	Community likely to occur within area	In feature area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community may occur within area	In feature area

Listed Threatened Species			[Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Anthochaera phrygia			
Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calyptorhynchus lathami lathami			
South-eastern Glossy Black-Cockatoo [67036]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Erythrotriorchis radiatus			
Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area	In feature area
Falco hypoleucos			
Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Geophaps scripta scripta			
Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area	In feature area
Grantiella picta			
Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus			
White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area	In feature area
Rostratula australis			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
FISH			
Maccullochella peelii			
Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area	In feature area
MAMMAL			
Chalinolobus dwyeri			
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Dasyurus maculatus maculatus (SE mainland population)			
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area	In feature area
Nyctophilus corbeni			
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Petauroides volans			
Greater Glider (southern and central) [254]	Endangered	Species or species habitat likely to occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)			
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat likely to occur within area	In feature area
Pteropus poliocephalus			
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area	In feature area
PLANT			
Acacia lauta			
Tara Wattle [4165]	Vulnerable	Species or species habitat may occur within area	In feature area
Androcalva procumbens			
[87153]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Cadellia pentastylis			
Ooline [9828]	Vulnerable	Species or species habitat may occur within area	In feature area
Dichanthium setosum			
bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Homopholis belsonii			
Belson's Panic [2406]	Vulnerable	Species or species habitat may occur within area	In feature area
Lepidium monoplocoides			
Winged Pepper-cress [9190]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Thesium australe			
Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area	In feature area
Vincetoxicum forsteri listed as Tylophora linearis			
[92384]	Endangered	Species or species habitat may occur within area	In feature area
Westringia parvifolia			
[4822]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Xerothamnella herbacea			
[4146]	Endangered	Species or species habitat likely to occur within area	In buffer area only
REPTILE			
Anomalopus mackayi			
Five-clawed Worm-skink, Long-legged Worm-skink [25934]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Delma torquata			
Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area	In feature area
Egernia rugosa			
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Furina dunmalli			
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area	In feature area
Uvidicolus sphyrurus			
Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko [84578]	Vulnerable	Species or species habitat may occur within area	In buffer area only

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Hirundapus caudacutus			
White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area	In feature area
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat likely to occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Gallinago hardwickii			
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
[Bubulcus ibis as Ardea ibis](#) Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
[Chalcites osculans as Chrysococcyx osculans](#) Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area overfly marine area	In feature area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
[Hirundapus caudacutus](#) White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In feature area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area overfly marine area	In feature area
Neophema chrysostoma Blue-winged Parrot [726]		Species or species habitat may occur within area overfly marine area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
ARG Border Rail Project Moree to Toowoomba QLD	2013/7061	Controlled Action	Further Information Request	In feature area
Inland Rail Border to Gowrie Project, QLD	2018/8165	Controlled Action	Assessment Approach	In feature area
Not controlled action				
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
Inland Rail Border to Gowrie Geotechnical Investigations	2021/8911	Not Controlled Action	Completed	In feature area
Not controlled action (particular manner)				
132kV transmission line	2003/1024	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Bioregional Assessments

SubRegion	BioRegion	Website	Buffer Status
Maranoa-Balonne-Condamine	Northern Inland Catchments	BA website	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

© Commonwealth of Australia

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

WildNet Records
Species List

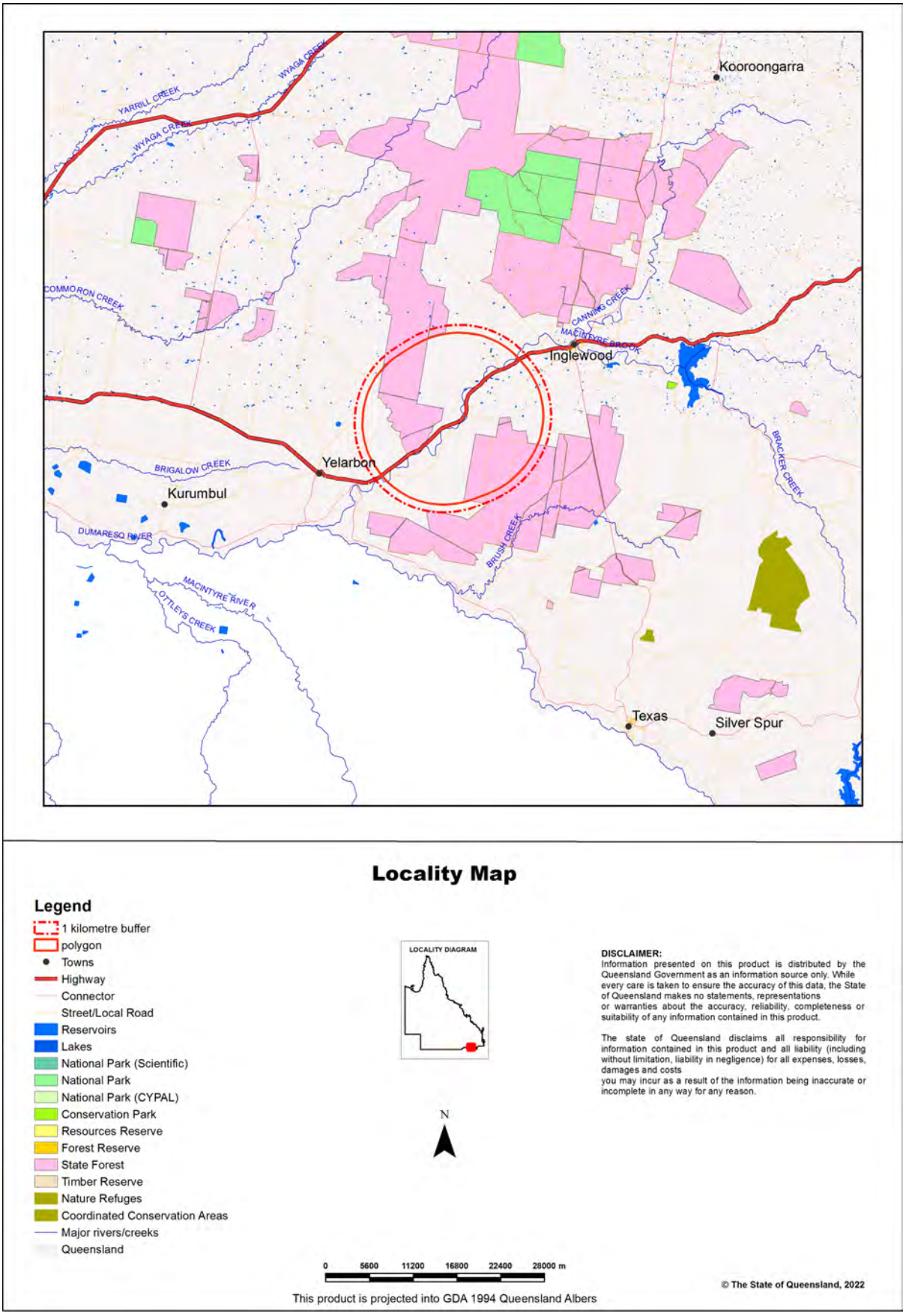
For the selected area of interest 39512.95ha Custom Geometry

Current as at 25/09/2022

Whetstone-AllSpecies10kmBuffer

Queensland Government

Map 1. Locality Map



Summary Information

The following table provides an overview of the area of interest Custom Geometry.

Table 1. Area of interest details

Size (ha)	39,512.95
Local Government(s)	Goondiwindi Regional
Bioregion(s)	Brigalow Belt
Subregion(s)	Inglewood Sandstones, Moonie R. - Commoron Creek Floodout
Catchment(s)	Border Rivers

Protected Area(s)

The following estates and/or reserves are located in the area of interest:

Whetstone State Forest

Yelarbon State Forest

World Heritage Area(s)

No World Heritage Areas are located within the area of interest.

Ramsar Area(s)

No Ramsar Areas are located within the area of interest.

Species List

Introduction

This report is derived from a spatial layer generated from the WildNet database managed by the Department of Environment and Science. The layer which is generated weekly contains the WildNet wildlife records that are not classed as erroneous or duplicate, that have a location precision equal to or less than 10000 metres and do not have a count of zero.

The WildNet dataset is constantly being enhanced and the taxonomic and status information revised. If a species is not listed in this report, it does not mean it doesn't occur there and listed species may also no longer inhabit the area. It is recommended that you also access other internal and external data sources for species information in your area of interest (Refer Links and Support).

Table 2 lists the animals recorded within the area of interest and its one kilometre buffer.

Table 3 lists the plants recorded within the area of interest and its one kilometre buffer.

Table 4 lists the fungi recorded within the area of interest and its one kilometre buffer.

Table 5 lists the other species recorded within the area of interest and its one kilometre buffer.

Table 2. Animals recorded within the area of interest and its one kilometre buffer

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
624	Amphibia	Hylidae	*Cyclorana alboguttata*	greenstripe frog	C	None	0	1	07/01/2005
614	Amphibia	Hylidae	*Litoria latopalmata*	broad palmed rocketfrog	C	None	2	6	07/01/2005
596	Amphibia	Hylidae	*Litoria peronii*	emerald spotted treefrog	C	None	1	4	03/09/1996
600	Amphibia	Hylidae	*Litoria rubella*	ruddy treefrog	C	None	1	3	07/01/2005
679	Amphibia	Limnodynastidae	*Limnodynastes fletcheri*	barking frog	C	None	0	1	07/01/2005

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
684	Amphibia	Limnodynastidae	*Limnodynastes tasmaniensis*	spotted grassfrog	C	None	0	1	07/01/2005
680	Amphibia	Limnodynastidae	*Platyplectrum ornatum*	ornate burrowing frog	C	None	0	2	07/01/2005
696	Amphibia	Myobatrachidae	*Crinia parinsignifera*	beeping froglet	C	None	0	1	03/09/1996
1419	Aves	Acanthizidae	*Acanthiza chrysorrhoa*	yellow-rumped thornbill	C	None	0	5	28/09/2001
1422	Aves	Acanthizidae	*Acanthiza nana*	yellow thornbill	C	None	0	5	09/08/2009
1423	Aves	Acanthizidae	*Acanthiza pusilla*	brown thornbill	C	None	0	1	04/07/1999
1425	Aves	Acanthizidae	*Acanthiza reguloides*	buff-rumped thornbill	C	None	0	1	20/12/1994
1396	Aves	Acanthizidae	*Gerygone olivacea*	white-throated gerygone	C	None	0	5	28/09/2001
1403	Aves	Acanthizidae	*Pyrrholaemus sagittatus*	speckled warbler	C	None	0	3	09/08/2009
1371	Aves	Acanthizidae	*Smicrornis brevirostris*	weebill	C	None	0	9	09/08/2009
1742	Aves	Accipitridae	*Accipiter cirrocephalus*	collared sparrowhawk	C	None	0	3	22/06/1999
1729	Aves	Accipitridae	*Accipiter fasciatus*	brown goshawk	C	None	0	2	29/09/1999
1732	Aves	Accipitridae	*Aquila audax*	wedge-tailed eagle	C	None	0	1	24/08/1999
1721	Aves	Accipitridae	*Aviceda subcristata*	Pacific baza	C	None	0	2	27/01/2001
1707	Aves	Accipitridae	*Haliastur sphenurus*	whistling kite	C	None	0	2	29/09/1999
1712	Aves	Accipitridae	*Lophoictinia isura*	square-tailed kite	C	None	0	1	18/08/2017
1714	Aves	Accipitridae	*Milvus migrans*	black kite	C	None	0	5	24/08/1999
1776	Aves	Alcedinidae	*Ceyx azureus*	azure kingfisher	C	None	0	19	27/01/2001
1993	Aves	Anatidae	*Anas gracilis*	grey teal	C	None	0	1	27/06/2000
1998	Aves	Anatidae	*Anas superciliosa*	Pacific black duck	C	None	0	18	09/08/2009
2003	Aves	Anatidae	*Chenonetta jubata*	Australian wood duck	C	None	0	15	07/01/2001
1977	Aves	Anatidae	*Dendrocygna arcuata*	wandering whistling-duck	C	None	0	1	27/06/2000
1279	Aves	Anhingidae	*Anhinga novaehollandiae*	Australasian darter	C	None	0	8	01/06/2000
1829	Aves	Ardeidae	*Ardea alba modesta*	eastern great egret	C	None	0	2	30/05/1999
1832	Aves	Ardeidae	*Ardea pacifica*	white-necked heron	C	None	0	13	24/01/2000
1830	Aves	Ardeidae	*Bubulcus ibis*	cattle egret	C	None	0	11	01/11/2000
1826	Aves	Ardeidae	*Egretta novaehollandiae*	white-faced heron	C	None	0	7	26/09/2000
1659	Aves	Artamidae	*Artamus cyanopterus*	dusky woodswallow	C	None	0	2	09/08/2009

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
1660	Aves	Artamidae	*Artamus leucorynchus*	white-breasted woodswallow	C	None	0	2	24/01/2000
1654	Aves	Artamidae	*Cracticus nigrogularis*	pied butcherbird	C	None	0	5	28/09/2001
1656	Aves	Artamidae	*Cracticus torquatus*	grey butcherbird	C	None	0	12	05/07/2020
1644	Aves	Artamidae	*Gymnorhina tibicen*	Australian magpie	C	None	0	22	28/09/2001
1645	Aves	Artamidae	*Strepera graculina*	pied currawong	C	None	0	21	05/07/2020
1191	Aves	Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo	C	None	0	31	09/08/2009
1194	Aves	Cacatuidae	*Cacatua sanguinea*	little corella	C	None	0	13	14/11/2017
1185	Aves	Cacatuidae	*Calyptorhynchus funereus*	yellow-tailed black-cockatoo	C	None	0	1	17/02/1993
22494	Aves	Cacatuidae	*Calyptorhynchus lathami lathami*	glossy black-cockatoo (eastern)	V	V	0	1	17/02/1993
1193	Aves	Cacatuidae	*Eolophus roseicapilla*	galah	C	None	0	33	09/08/2009
1173	Aves	Cacatuidae	*Nymphicus hollandicus*	cockatiel	C	None	0	16	02/08/2001
1636	Aves	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike	C	None	0	7	27/06/2000
1637	Aves	Campephagidae	*Coracina papuensis*	white-bellied cuckoo-shrike	C	None	0	3	09/08/2009
1639	Aves	Campephagidae	*Edolisoma tenuirostre*	common cicadabird	C	None	0	1	20/12/1994
1089	Aves	Casuariidae	*Dromaius novaehollandiae*	emu	C	None	0	6	08/09/2021
1933	Aves	Charadriidae	*Vanellus miles novaehollandiae*	masked lapwing (southern subspecies)	C	None	0	1	24/01/2000
1628	Aves	Climacteridae	*Climacteris picumnus*	brown treecreeper	C	None	0	23	02/08/2001
18293	Aves	Climacteridae	*Cormobates leucophaea metastasis*	white-throated treecreeper (southern)	C	None	0	4	12/01/1998
1809	Aves	Columbidae	*Geopelia cuneata*	diamond dove	C	None	0	1	31/07/2000
1810	Aves	Columbidae	*Geopelia humeralis*	bar-shouldered dove	C	None	0	21	09/08/2009
18323	Aves	Columbidae	*Geopelia placida*	peaceful dove	C	None	0	27	28/09/2001
1793	Aves	Columbidae	*Ocyphaps lophotes*	crested pigeon	C	None	0	30	23/11/2001
1795	Aves	Columbidae	*Phaps chalcoptera*	common bronzewing	C	None	0	3	12/01/1998
1774	Aves	Columbidae	*Streptopelia chinensis*	spotted dove	None	None	0	1	30/04/1999
1779	Aves	Coraciidae	*Eurystomus orientalis*	dollarbird	C	None	0	21	28/03/2001

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
1603	Aves	Corcoracidae	*Corcorax melanorhamphos*	white-winged chough	C	None	0	5	05/07/2020
1605	Aves	Corcoracidae	*Struthidea cinerea*	apostlebird	C	None	0	15	23/11/2001
1607	Aves	Corvidae	*Corvus bennetti*	little crow	C	None	0	1	22/12/1998
1608	Aves	Corvidae	*Corvus coronoides*	Australian raven	C	None	0	4	27/06/2000
1609	Aves	Corvidae	*Corvus orru*	Torresian crow	C	None	0	7	09/08/2009
1610	Aves	Corvidae	*Corvus sp.*	None	C	None	0	1	28/03/2001
1754	Aves	Cuculidae	*Cacomantis flabelliformis*	fan-tailed cuckoo	C	None	0	1	03/09/1996
1751	Aves	Cuculidae	*Centropus phasianinus*	pheasant coucal	C	None	0	1	07/01/2001
1738	Aves	Cuculidae	*Eudynamys orientalis*	eastern koel	C	None	0	2	24/01/2000
1369	Aves	Estrildidae	*Neochmia modesta*	plum-headed finch	C	None	0	17	02/08/2001
1342	Aves	Estrildidae	*Taeniopygia bichenovii*	double-barred finch	C	None	0	29	28/09/2001
1343	Aves	Estrildidae	*Taeniopygia guttata*	zebra finch	C	None	0	10	02/08/2001
1704	Aves	Falconidae	*Falco cenchroides*	nankeen kestrel	C	None	0	3	28/09/2001
1691	Aves	Falconidae	*Falco longipennis*	Australian hobby	C	None	0	1	12/05/2000
1692	Aves	Falconidae	*Falco peregrinus*	peregrine falcon	C	None	0	4	28/03/2000
1767	Aves	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra	C	None	0	30	05/07/2020
1760	Aves	Halcyonidae	*Todiramphus macleayii*	forest kingfisher	C	None	0	1	22/12/1998
1762	Aves	Halcyonidae	*Todiramphus sanctus*	sacred kingfisher	C	None	0	3	23/11/2001
1572	Aves	Hirundinidae	*Hirundo neoxena*	welcome swallow	C	None	0	27	05/07/2006
1570	Aves	Maluridae	*Malurus cyaneus*	superb fairy-wren	C	None	0	35	05/07/2020
1556	Aves	Maluridae	*Malurus lamberti sensu lato*	variegated fairy-wren	C	None	0	3	05/07/2006
1291	Aves	Megaluridae	*Cincloramphus cruralis*	brown songlark	C	None	0	1	08/09/2021
1292	Aves	Megaluridae	*Cincloramphus mathewsi*	rufous songlark	C	None	0	1	28/09/2001
1552	Aves	Meliphagidae	*Acanthagenys rufogularis*	spiny-cheeked honeyeater	C	None	0	3	27/01/2001
1542	Aves	Meliphagidae	*Anthochaera chrysoptera*	little wattlebird	C	None	0	1	30/05/1999
1523	Aves	Meliphagidae	*Caligavis chrysops*	yellow-faced honeyeater	C	None	0	4	09/08/2009

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
1539	Aves	Meliphagidae	*Entomyzon cyanotis*	blue-faced honeyeater	C	None	0	9	07/01/2001
1497	Aves	Meliphagidae	*Lichmera indistincta*	brown honeyeater	C	None	0	1	12/01/1998
1499	Aves	Meliphagidae	*Manorina flavigula*	yellow-throated miner	C	None	0	2	05/07/2006
1500	Aves	Meliphagidae	*Manorina melanocephala*	noisy miner	C	None	0	6	09/08/2009
1504	Aves	Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater	C	None	0	1	04/07/1999
1507	Aves	Meliphagidae	*Melithreptus albogularis*	white-throated honeyeater	C	None	0	1	03/09/1996
1508	Aves	Meliphagidae	*Melithreptus brevirostris*	brown-headed honeyeater	C	None	0	4	03/09/1996
1489	Aves	Meliphagidae	*Myzomela sanguinolenta*	scarlet honeyeater	C	None	0	1	17/02/1993
1516	Aves	Meliphagidae	*Nesoptilotis leucotis*	white-eared honeyeater	C	None	0	17	05/07/2020
1493	Aves	Meliphagidae	*Philemon citreogularis*	little friarbird	C	None	0	4	11/11/2000
1494	Aves	Meliphagidae	*Philemon corniculatus*	noisy friarbird	C	None	0	16	09/08/2009
1471	Aves	Meliphagidae	*Plectorhyncha lanceolata*	striped honeyeater	C	None	0	6	14/11/2017
1513	Aves	Meliphagidae	*Ptilotula fusca*	fuscous honeyeater	C	None	0	2	20/12/1994
1518	Aves	Meliphagidae	*Ptilotula penicillata*	white-plumed honeyeater	C	None	0	16	09/08/2009
1589	Aves	Monarchidae	*Grallina cyanoleuca*	magpie-lark	C	None	0	34	09/08/2009
1600	Aves	Monarchidae	*Myiagra inquieta*	restless flycatcher	C	None	0	8	14/11/2017
1586	Aves	Monarchidae	*Myiagra rubecula*	leaden flycatcher	C	None	0	2	14/11/2017
1611	Aves	Nectariniidae	*Dicaeum hirundinaceum*	mistletoebird	C	None	0	6	12/05/2000
1453	Aves	Neosittidae	*Daphoenositta chrysoptera*	varied sittella	C	None	0	4	12/01/1998
1442	Aves	Oriolidae	*Oriolus sagittatus*	olive-backed oriole	C	None	0	4	24/02/2000
1444	Aves	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird	C	None	0	4	27/01/2001
1449	Aves	Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush	C	None	0	30	23/11/2001
1436	Aves	Pachycephalidae	*Pachycephala pectoralis*	golden whistler	C	None	0	2	04/07/1999
1437	Aves	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler	C	None	0	10	09/08/2009
1389	Aves	Pardalotidae	*Pardalotus punctatus*	spotted pardalote	C	None	0	4	03/09/1996
1392	Aves	Pardalotidae	*Pardalotus striatus*	striated pardalote	C	None	0	19	09/08/2009

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
1284	Aves	Pelecanidae	*Pelecanus conspicillatus*	Australian pelican	C	None	0	14	02/08/2001
1347	Aves	Petroicidae	*Eopsaltria australis*	eastern yellow robin	C	None	0	9	05/07/2020
1337	Aves	Petroicidae	*Melanodryas cucullata*	hooded robin	C	None	0	1	20/12/1994
1339	Aves	Petroicidae	*Microeca fascinans*	jacky winter	C	None	0	3	28/09/2001
1261	Aves	Phalacrocoracidae	*Microcarbo melanoleucos*	little pied cormorant	C	None	0	2	29/09/1999
1263	Aves	Phalacrocoracidae	*Phalacrocorax sulcirostris*	little black cormorant	C	None	0	5	04/01/2000
1687	Aves	Phasianidae	*Synoicus ypsilophorus*	brown quail	C	None	0	1	28/03/2000
1955	Aves	Podargidae	*Podargus strigoides*	tawny frogmouth	C	None	0	7	29/09/1999
1249	Aves	Podicipedidae	*Tachybaptus no vaehollandiae*	Australasian grebe	C	None	0	1	09/08/2009
1317	Aves	Pomatostomidae	*Pomatostomus superciliosus*	white-browed babbler	C	None	0	2	14/01/1998
1318	Aves	Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler	C	None	0	5	09/08/2009
1180	Aves	Psittacidae	*Alisterus scapularis*	Australian king-parrot	C	None	0	4	04/12/2000
1182	Aves	Psittacidae	*Aprosmictus erythropterus*	red-winged parrot	C	None	0	26	02/08/2001
1154	Aves	Psittacidae	*Neophema pulchella*	turquoise parrot	C	None	0	1	09/09/2021
1147	Aves	Psittacidae	*Parvipsitta pusilla*	little lorikeet	C	None	0	8	23/11/1999
1136	Aves	Psittacidae	*Platycercus adscitus*	pale-headed rosella	C	None	0	17	09/08/2009
1139	Aves	Psittacidae	*Platycercus eximius*	eastern rosella	C	None	0	1	27/06/2000
1118	Aves	Psittacidae	*Psephotus haematonotus*	red-rumped parrot	C	None	0	10	28/09/2001
1124	Aves	Psittacidae	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet	C	None	0	1	28/09/2001
1125	Aves	Psittacidae	*Trichoglossus moluccanus*	rainbow lorikeet	C	None	0	3	03/09/1996
1160	Aves	Ptilonorhynchidae	*Chlamydera maculata*	spotted bowerbird	C	None	0	6	07/01/2001
1662	Aves	Rallidae	*Porphyrio melanotus*	purple swamphen	C	None	0	1	24/02/2000
1575	Aves	Rhipiduridae	*Rhipidura albiscapa*	grey fantail	C	None	0	8	05/07/2020
1576	Aves	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail	C	None	0	32	05/07/2020
1853	Aves	Scolopacidae	*Tringa nebularia*	common greenshank	SL	None	0	1	22/12/1998
1102	Aves	Strigidae	*Ninox boobook*	southern boobook	C	None	0	1	24/01/2000

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
1314	Aves	Sturnidae	*Acridotheres tristis*	common myna	None	None	0	1	21/08/2011
1303	Aves	Sturnidae	*Sturnus vulgaris*	common starling	None	None	0	3	28/09/2001
1822	Aves	Threskiornithidae	*Platalea flavipes*	yellow-billed spoonbill	C	None	0	5	23/11/1999
1823	Aves	Threskiornithidae	*Platalea regia*	royal spoonbill	C	None	0	1	14/01/1998
1812	Aves	Threskiornithidae	*Threskiornis molucca*	Australian white ibis	C	None	0	3	24/01/2000
1800	Aves	Threskiornithidae	*Threskiornis spinicollis*	straw-necked ibis	C	None	0	18	28/09/2001
1276	Aves	Timaliidae	*Zosterops lateralis*	silvereye	C	None	0	7	04/12/2000
1081	Aves	Turnicidae	*Turnix varius*	painted button-quail	C	None	0	1	03/09/1996
1108	Aves	Tytonidae	*Tyto javanica*	eastern barn owl	C	None	0	5	29/09/1999
35081	Insecta	Aeshnidae	*Anax papuensis*	Australian Emperor	None	None	0	1	08/09/2021
35176	Insecta	Lestidae	*Austrolestes aridus*	inland ringtail	None	None	0	1	08/09/2021
35199	Insecta	Libellulidae	*Diplacodes bipunctata*	wandering percher	None	None	0	1	08/09/2021
1071	Mammalia	Canidae	*Vulpes vulpes*	red fox	None	None	0	5	05/07/2020
22485	Mammalia	Dasyuridae	*Antechinus flavipes flavipes*	yellow-footed antechinus (south-east Queensland)	C	None	0	1	31/12/1997
793	Mammalia	Dasyuridae	*Sminthopsis murina*	common dunnart	C	None	0	1	31/12/1997
1056	Mammalia	Felidae	*Felis catus*	cat	None	None	0	4	05/07/2020
901	Mammalia	Macropodidae	*Macropus giganteus*	eastern grey kangaroo	C	None	0	3	05/07/2020
885	Mammalia	Macropodidae	*Wallabia bicolor*	swamp wallaby	C	None	0	1	03/09/1996
764	Mammalia	Muridae	*Mus musculus*	house mouse	None	None	0	1	31/12/1997
747	Mammalia	Muridae	*Pseudomys delicatulus*	delicate mouse	C	None	1	1	31/12/1997
1080	Mammalia	Suidae	*Sus scrofa*	pig	None	None	0	3	05/07/2020
838	Mammalia	Tachyglossidae	*Tachyglossus aculeatus*	short-beaked echidna	SL	None	0	4	05/07/2020
561	Reptilia	Agamidae	*Diporiphora nobbi*	nobbi	C	None	0	1	16/02/1993
512	Reptilia	Colubridae	*Dendrelaphis punctulatus*	green tree snake	C	None	0	1	10/03/2006
482	Reptilia	Elapidae	*Denisonia devisi*	De Vis' banded snake	C	None	1	1	31/12/1996
420	Reptilia	Gekkonidae	*Gehyra dubia*	dubious dtella	C	None	0	2	03/09/1996
413	Reptilia	Gekkonidae	*Heteronotia binoei*	Bynoe's gecko	C	None	0	1	03/09/1996
304	Reptilia	Scincidae	*Anomalopus leuckartii*	two-clawed worm-skink	C	None	0	2	03/09/1996
226	Reptilia	Scincidae	*Liopholis modesta*	eastern ranges rock-skink	C	None	5	5	01/12/1948
127	Reptilia	Scincidae	*Menetia greyii*	common dwarf skink	C	None	0	1	03/09/1996

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
134	Reptilia	Scincidae	*Morethia boulengeri*	south-eastern morethia skink	C	None	0	3	03/09/1996
103	Reptilia	Scincidae	*Tiliqua rugosa*	shingle-back	C	None	0	1	09/09/2021
78	Reptilia	Varanidae	*Varanus gouldii*	sand monitor	C	None	0	1	03/09/1996
61	Reptilia	Varanidae	*Varanus varius*	lace monitor	C	None	0	1	31/01/1999

Table 3. Plants recorded within the area of interest and its one kilometre buffer

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
9086	Equisetopsida	Aizoaceae	*Zaleya galericulata subsp. galericulata*	None	C	None	1	1	24/03/1969
35564	Equisetopsida	Asteraceae	*Brachyscome casstiana*	None	C	None	1	1	07/10/1993
35554	Equisetopsida	Asteraceae	*Brachyscome whitei subsp. whitei*	None	C	None	2	2	10/05/1994
10061	Equisetopsida	Asteraceae	*Calocephalus sonderi*	palebeauty heads	C	None	1	1	07/10/2007
14738	Equisetopsida	Asteraceae	*Cassinia laevis*	None	C	None	0	1	14/09/2000
26775	Equisetopsida	Asteraceae	*Leiocarpa panaetioides*	None	C	None	1	1	11/10/2020
10465	Equisetopsida	Asteraceae	*Olearia ramosissima*	None	C	None	1	1	08/07/1997
36235	Equisetopsida	Asteraceae	*Verbesina encelioides var. encelioides*	None	None	None	1	1	28/03/2010
11201	Equisetopsida	Boraginaceae	*Heliotropium europaeum*	common heliotrope	None	None	1	1	31/01/1999
18389	Equisetopsida	Cactaceae	*Cereus uruguayanus*	None	None	None	0	1	14/11/2017
26344	Equisetopsida	Cactaceae	*Harrisia martinii*	None	None	None	0	3	07/10/2015
16549	Equisetopsida	Cactaceae	*Opuntia aurantiaca*	tiger pear	None	None	0	5	07/10/2015
9011	Equisetopsida	Cactaceae	*Opuntia ficus-indica*	Indian fig	None	None	1	2	14/11/2017
9535	Equisetopsida	Cactaceae	*Opuntia tomentosa*	velvety tree pear	None	None	0	1	22/02/2016
18011	Equisetopsida	Casuarinaceae	*Allocasuarina inophloia*	None	C	None	1	2	14/09/2000
18013	Equisetopsida	Casuarinaceae	*Allocasuarina luehmannii*	bull oak	C	None	0	3	31/01/2002
17707	Equisetopsida	Casuarinaceae	*Casuarina cristata*	belah	C	None	0	1	01/04/1990
14431	Equisetopsida	Chenopodiaceae	*Maireana microphylla*	None	C	None	1	1	29/09/1986
10937	Equisetopsida	Chenopodiaceae	*Sclerolaena tetracuspis*	brigalow burr	C	None	1	1	24/10/1994
7047	Equisetopsida	Convolvulaceae	*Dichondra sp. (Inglewood J.M.Dalby 86/93)*	None	C	None	1	1	20/09/1986
17757	Equisetopsida	Cupressaceae	*Callitris endlicheri*	black cypress pine	C	None	1	1	22/06/1994
8221	Equisetopsida	Cupressaceae	*Callitris glaucophylla*	white cypress pine	C	None	1	4	31/01/2002
13965	Equisetopsida	Cyperaceae	*Cyperus bowmanni*	None	C	None	1	1	28/03/2010

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
17078	Equisetopsida	Cyperaceae	*Gahnia aspera*	None	C	None	0	1	14/09/2000
13593	Equisetopsida	Ericaceae	*Melichrus adpressus*	None	C	None	1	1	08/07/1997
16844	Equisetopsida	Juncaceae	*Juncus continuus*	None	C	None	1	1	06/10/1994
16776	Equisetopsida	Laxmanniaceae	*Lomandra longifolia*	None	C	None	1	1	06/10/1994
15827	Equisetopsida	Leguminosae	*Acacia aulacocarpa*	None	C	None	0	1	31/01/2002
15780	Equisetopsida	Leguminosae	*Acacia burrowii*	None	C	None	1	1	22/06/1994
14932	Equisetopsida	Leguminosae	*Acacia conferta*	None	C	None	1	2	14/09/2000
15792	Equisetopsida	Leguminosae	*Acacia crassa subsp. crassa*	None	C	None	1	1	21/09/1993
11842	Equisetopsida	Leguminosae	*Acacia cultriformis*	None	C	None	1	1	30/11/1984
15752	Equisetopsida	Leguminosae	*Acacia harpophylla*	brigalow	C	None	0	1	01/04/1990
14864	Equisetopsida	Leguminosae	*Acacia lineata*	streaked wattle	C	None	1	1	09/07/1975
15727	Equisetopsida	Leguminosae	*Acacia neriifolia*	pechey wattle	C	None	0	1	14/09/2000
14872	Equisetopsida	Leguminosae	*Acacia polybotrya*	western silver wattle	C	None	2	2	06/10/1994
14891	Equisetopsida	Leguminosae	*Acacia spectabilis*	pilliga wattle	C	None	1	1	30/11/1984
14085	Equisetopsida	Leguminosae	*Acacia striatifolia*	None	C	None	0	1	14/09/2000
13705	Equisetopsida	Leguminosae	*Aotus subglauca var. filiformis*	None	C	None	1	1	06/10/1994
15260	Equisetopsida	Leguminosae	*Jacksonia scoparia*	None	C	None	0	1	31/01/2002
15014	Equisetopsida	Leguminosae	*Swainsona galegifolia*	smooth Darling pea	C	None	1	1	02/10/1964
8254	Equisetopsida	Leguminosae	*Swainsona queenslandica*	None	C	None	1	1	02/10/1964
34114	Equisetopsida	Leguminosae	*Vachellia farnesiana*	None	None	None	0	2	07/10/2015
14847	Equisetopsida	Loranthaceae	*Amyema cambagei*	None	C	None	1	1	24/10/1994
16727	Equisetopsida	Macarthuriaceae	*Macarthuria neocambrica*	None	C	None	1	1	07/10/1993
13307	Equisetopsida	Menyanthaceae	*Nymphoides crenata*	wavy marshwort	SL	None	1	1	17/09/1968
17999	Equisetopsida	Myrtaceae	*Angophora leiocarpa*	rusty gum	C	None	0	2	31/01/2002
17766	Equisetopsida	Myrtaceae	*Calytrix tetragona*	fringe myrtle	C	None	2	2	06/10/1994
6443	Equisetopsida	Myrtaceae	*Corymbia trachyphloia subsp. trachyphloia*	None	C	None	0	2	31/01/2002
13610	Equisetopsida	Myrtaceae	*Eucalyptus bakeri*	Baker's mallee	C	None	1	1	16/02/1969
17249	Equisetopsida	Myrtaceae	*Eucalyptus chloroclada*	Baradine red gum	C	None	1	3	31/01/2002
17252	Equisetopsida	Myrtaceae	*Eucalyptus crebra*	narrow-leaved red ironbark	C	None	0	2	13/07/1999
30502	Equisetopsida	Myrtaceae	*Eucalyptus elegans*	None	C	None	1	1	22/06/1994
17188	Equisetopsida	Myrtaceae	*Eucalyptus populnea*	poplar box	C	None	1	1	06/10/1994
26471	Equisetopsida	Myrtaceae	*Eucalyptus tereticornis subsp. tereticornis*	None	C	None	1	1	06/10/1994
13609	Equisetopsida	Myrtaceae	*Eucalyptus viridis*	None	C	None	2	2	22/06/1994

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
31943	Equisetopsida	Myrtaceae	*Eucalyptus woollsiana*	None	C	None	1	2	06/10/1994
18863	Equisetopsida	Myrtaceae	*Kunzea opposita var. opposita*	None	C	None	2	2	06/10/1994
13465	Equisetopsida	Myrtaceae	*Leptospermum brevipes*	None	C	None	1	1	22/06/1994
16685	Equisetopsida	Myrtaceae	*Melaleuca densispicata*	None	C	None	1	1	11/07/1994
29765	Equisetopsida	Nymphaeaceae	*Nymphaea gigantea*	None	SL	None	2	2	01/04/2005
26012	Equisetopsida	Pittosporaceae	*Pittosporum angustifolium*	None	C	None	1	1	29/09/1986
5965	Equisetopsida	Poaceae	*Austrostipa verticillata*	slender bamboo grass	C	None	1	1	02/05/1976
33785	Equisetopsida	Poaceae	*Cenchrus spinifex*	None	None	None	1	1	28/03/2010
15490	Equisetopsida	Poaceae	*Dactyloctenium radulans*	button grass	C	None	1	1	28/03/2010
18913	Equisetopsida	Poaceae	*Digitaria eriantha*	None	None	None	1	1	28/03/2010
15391	Equisetopsida	Poaceae	*Eragrostis cilianensis*	None	None	None	1	1	21/03/2006
32007	Equisetopsida	Poaceae	*Eragrostis trichophora*	None	None	None	1	1	21/03/2006
18061	Equisetopsida	Poaceae	*Poaceae*	None	None	None	0	1	14/09/2000
14978	Equisetopsida	Poaceae	*Thyridolepis xerophila*	None	C	None	1	1	14/11/1994
17012	Equisetopsida	Proteaceae	*Hakea purpurea*	None	C	None	3	3	10/05/1994
9070	Equisetopsida	Proteaceae	*Persoonia terminalis subsp. recurva*	None	C	None	1	1	13/12/1990
18819	Equisetopsida	Rutaceae	*Citrus glauca*	None	C	None	0	1	01/04/1990
17085	Equisetopsida	Rutaceae	*Geijera parviflora*	wilga	C	None	0	1	01/04/1990
11943	Equisetopsida	Rutaceae	*Philotheca ciliata*	None	C	None	1	1	22/06/1994
17640	Equisetopsida	Santalaceae	*Choretrum candollei*	white sour bush	C	None	1	2	14/09/2003
16237	Equisetopsida	Santalaceae	*Santalum lanceolatum*	None	SL	None	0	1	01/04/1990
18054	Equisetopsida	Sapindaceae	*Alectryon diversifolius*	scrub boonaree	C	None	0	1	01/04/1990
13655	Equisetopsida	Sapindaceae	*Dodonaea macrossanii*	None	C	None	2	2	11/07/1994
17391	Equisetopsida	Sapindaceae	*Dodonaea viscosa*	None	C	None	0	1	01/04/1990
17278	Equisetopsida	Scrophulariaceae	*Eremophila mitchellii*	None	C	None	2	3	23/07/2007
16736	Equisetopsida	Solanaceae	*Lycium ferocissimum*	African boxthorn	None	None	0	7	07/10/2015
12654	Equisetopsida	Ulmaceae	*Celtis sinensis*	Chinese elm	None	None	0	5	07/10/2015
34284	Equisetopsida	Verbenaceae	*Glandularia aristigera*	None	None	None	1	2	14/09/2003

Table 4. Fungi recorded within the area of interest and its one kilometre buffer

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
29414	Eurotiomycetes	Verrucariaceae	*Endocarpon simplicatum*	None	C	None	1	1	23/09/2004
34915	Lecanoromycetes	Caliciaceae	*Buellia epigaella*	None	C	None	1	1	23/09/2004
23239	Lecanoromycetes	Lecideaceae	*Lecidea ochroleuca*	None	C	None	1	1	23/09/2004

Table 5. Other species recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

NCA: Queensland conservation status of the taxon under the *Nature Conservation Act 1992* (Least Concern (C), Critically Endangered (CR), Endangered (E), Extinct (EX), Near Threatened (NT), Extinct in the Wild (PE), Special Least Concern (SL), and Vulnerable (V)).

EPBC: Australian conservation status of the taxon under the *Environment Protection and Biodiversity Conservation Act 1999* (Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Vulnerable (V), and Extinct in the Wild (XW)).

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Links and Support

Other sites that deliver species information from the WildNet database include:

- Species profile search - access species information approved for publication including species names, statuses, notes, images, distribution maps and records
- Species lists - generate species lists for Queensland protected areas, forestry areas, local governments and areas defined using coordinates
- Biomaps - view biodiversity information, including WildNet records approved for publication, and generate reports
- Queensland Globe - view spatial information, including WildNet records approved for publication
- Qld wildlife data API - access WildNet species information approved for publication such as notes, images and records etc.
- Wetland*Maps* - view species records, survey locations etc. approved for publication
- Wetland*Summary* - view wildlife statistics, species lists for a range of area types, and access WildNet species profiles
- WildNet wildlife records - published - Queensland - spatial layer of WildNet records approved for publication generated weekly
- Generalised distribution and densities of Queensland wildlife - Queensland species distributions and densities generalised to a 10 km grid resolution
- Conservation status of Queensland wildlife - access current lists of priority species for Queensland including nomenclature and status information
- Queensland Confidential Species - the list of species flagged as confidential in the WildNet database.

Please direct queries about this report to the WildNet Team.

Other useful sites for accessing Queensland biodiversity data include:

- Useful wildlife resources
- Queensland Government Data
- Atlas of Living Australia (ALA)
- Online Zoological Collections of Australian Museums (OZCAM)
- Australia's Virtual Herbarium (AVH)
- Protected Matters Search Tool

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government, to the maximum extent permitted by law, makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.

APPENDIX B

Ecology assessment

Appendix B Flora and fauna species list

Inland Rail is a subsidiary of
Australian Rail Track Corporation

INLAND RAIL

B.1 Flora Species List

Scientific Name	Family	NC Act Status	EPBC Act Status	Biosecurity Act Status
Tetragonia tetragonoides	Aizoaceae	Least Concern	Not Listed	-
Vittadinia sp.	Asteraceae	Least Concern	Not Listed	-
*Opuntia tomentosa**	Cactaceae	-	Not Listed	Category 3 Restricted Matter
Allocasuarina leuhmanii	Casuarinaceae	Least Concern	Not Listed	-
Einadia nutans ssp. nutans	Chenopodiaceae	Least Concern	Not Listed	-
Maireana microphylla	Chenopodiaceae	Least Concern	Not Listed	-
Cyperus sp.	Cyperaceae	Least Concern	Not Listed	-
Juncus continuus	Juncaceae	Least Concern	Not Listed	-
Corymbia tessellaris	Myrtaceae	Least Concern	Not Listed	-
Eucalyptus melanophloia	Myrtaceae	Least Concern	Not Listed	-
Eucalyptus moluccana	Myrtaceae	Least Concern	Not Listed	-
Eucalyptus populnea	Myrtaceae	Least Concern	Not Listed	-
Eucalyptus tereticornis	Myrtaceae	Least Concern	Not Listed	-
Austrostipa sp.	Poaceae	Least concern	Not Listed	-
*Cenchrus ciliaris**	Poaceae	-	Not Listed	-
Chloris divaricata	Poaceae	Least concern	Not Listed	-
Cynodon dactylon	Poaceae	Least Concern	Not Listed	-
Cympogon refractus	Poaceae	Least Concern	Not Listed	-
Heteropogon contortus	Poaceae	Least Concern	Not Listed	-
Sporobolus sp.	Poaceae	Least Concern	Not Listed	-
*Themeda quadrivalvis**	Poaceae	-	Not Listed	-
Geijera parviflora	Rutaceae	Least Concern	Not Listed	-
*Glandularia aristigera**	Verbenaceae	-	Not Listed	-
*Phyla canescens**	Verbenaceae	-	Not Listed	-
*Verbena bonariensis**	Verbenaceae	-	Not Listed	-

B.2 Fauna Species List

Common Name	Scientific Name	Type	NC Act Status	EPBC Act Status
northern laughing treefrog	*Litoria rothii*	Amphibian	Least Concern	Not Listed
red-necked wallaby	Macropus rufogriseus	Mammal	Least Concern	Not Listed
spotted black snake	Pseudechis guttatus	Reptile	Least Concern	Not Listed
black-fronted dotterel	*Elseyornis melanops*	Bird	Least Concern	Not Listed
straw-necked ibis	*Threskiornis spinicollis*	Bird	Least Concern	Not Listed
grey teal	*Anas gracilis*	Bird	Least Concern	Not Listed
Pacific black duck	*Anas superciliosa*	Bird	Least Concern	Not Listed
white-faced heron	*Egretta novaehollandiae*	Bird	Least Concern	Not Listed
willie wagtail	*Rhipidura leucophrys*	Bird	Least Concern	Not Listed

Common Name	Scientific Name	Type	NC Act Status	EPBC Act Status
welcome swallow	*Hirundo neoxena*	Bird	Least Concern	Not Listed
masked lapwing	*Vanellus miles*	Bird	Least Concern	Not Listed
pied cormorant	*Phalacrocorax varius*	Bird	Least Concern	Not Listed
dollarbird	*Eurystomus orientalis*	Bird	Least Concern	Not Listed
crested pigeon	*Ocyphaps lophotes*	Bird	Least Concern	Not Listed
noisy miner	*Manorina melanocephala*	Bird	Least Concern	Not Listed
sulphur-crested cockatoo	*Cacatua galerita*	Bird	Least Concern	Not Listed
emu	*Dromaius novaehollandiae*	Bird	Least Concern	Not Listed
intermediate egret	*Ardea intermedia*	Bird	Least Concern	Not Listed
magpie-lark	*Grallina cyanoleuca*	Bird	Least Concern	Not Listed
Australasian grebe	*Tachybaptus novaehollandiae*	Bird	Least Concern	Not Listed
Australian wood duck	*Chenonetta jubata*	Bird	Least Concern	Not Listed
mistletoebird	*Dicaeum hirundinaceum*	Bird	Least Concern	Not Listed
eastern koel	*Eudynamys orientalis*	Bird	Least Concern	Not Listed
black-faced cuckoo-shrike	*Coracina novaehollandiae*	Bird	Least Concern	Not Listed
black-shouldered kite	*Elanus axillaris*	Bird	Least Concern	Not Listed
superb fairy-wren	*Malurus cyaneus*	Bird	Least Concern	Not Listed
little corella	*Cacatua sanguinea*	Bird	Least Concern	Not Listed
white-breasted woodswallow	*Artamus leucorynchus*	Bird	Least Concern	Not Listed
red-winged parrot	*Aprosmictus erythropterus*	Bird	Least Concern	Not Listed
Australian magpie	*Gymnorhina tibicen*	Bird	Least Concern	Not Listed
galah	*Eolophus roseicapilla*	Bird	Least Concern	Not Listed
red-backed fairy-wren	*Malurus melanocephalus*	Bird	Least Concern	Not Listed
nankeen kestrel	*Falco cenchroides*	Bird	Least Concern	Not Listed
apostlebird	*Struthidea cinerea*	Bird	Least Concern	Not Listed
noisy friarbird	*Philemon corniculatus*	Bird	Least Concern	Not Listed
white-throated gerygone	*Gerygone olivacea*	Bird	Least Concern	Not Listed
pied currawong	*Strepera graculina*	Bird	Least Concern	Not Listed
Torresian crow	*Corvus orru*	Bird	Least Concern	Not Listed
red-rumped parrot	*Psephotus haematonotus*	Bird	Least Concern	Not Listed
pied butcherbird	*Cracticus nigrogularis*	Bird	Least Concern	Not Listed

APPENDIX B

Ecology assessment

Appendix C Likelihood of occurrence assessment

Inland Rail is a subsidiary of
Australian Rail Track Corporation

INLAND RAIL

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
Threatened Species					
Birds					
regent honeyeater	*Anthochaera phrygia*	CE	CE	The regent honeyeater is endemic to mainland south-eastern Australia. It has a patchy distribution which extends from south-east Queensland, through New South Wales (NSW) and the Australian Capital Territory (ACT), to central Victoria. Records are widely distributed across its range, but it is only found regularly at a few localities in NSW and Victoria. The species' movement patterns are thought to be governed by the flowering of select eucalypt species. It is nomadic and partly migratory, with some predictable seasonal movements observed. The species is most commonly associated with box-ironbark eucalypt woodland and dry sclerophyll forest, but also inhabits riparian vegetation such as sheoak (*Casuarina* spp.) where it feeds on needle-leaved mistletoe and sometimes breeds. It sometimes utilises lowland coastal forest, which may act as a refuge when its usual habitat is affected by drought. It also uses a range of other habitats including remnant patches in farmland and urban areas, roadside reserves and travelling stock routes. Key tree and mistletoe species are outlined in the species' National Recovery Plan. Mature, large individual trees tend to be more important as they are more productive, particularly on highly fertile sites and in riparian areas	**Low –** Mistletoe is not present in the Study Area of the Development Footprint. Although eucalypt woodlands in regrowth condition were present within the Development Footprint however, these scattered trees are unlikely to support the ecological requirements of the species. Further, the abundance of noisy miners observed may exclude this species from utilising these trees. The species has not been recorded from the desktop search extent (ALA 2022). The nearest record occurs approximately 45 km north in Whetstone State Forest and is dated 2020. Due to the rarity of the species, a 10 km spatial uncertainty has been applied to the record.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
curlew sandpiper	*Calidris ferruginea*	CE, M	CE	In Australia, curlew sandpipers occur around the coasts and are also widespread inland, though erratic in their appearance. In Queensland, scattered records occur in the Gulf of Carpentaria, with widespread records along the coast south of Cairns. There are sparsely scattered records inland. The species mainly occurs on intertidal mudflats in sheltered coastal areas such as estuaries, bays, inlets and lagoons, and around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded less often inland, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand, occurring in both fresh and brackish waters.	**Low –** Farm dams within the Study Area, although dominated by exotic grass on the fringes, may provide temporary marginal foraging and roosting opportunities during periods of high water availability. However, the Development Footprint is approximately 700m from the nearest farm dam and will not be impacted by the Project. The species has not been recorded from the desktop search extent (ALA 2022). The closest records occur at Lake Coolmunda approximately 30 km to the north-east.
glossy-black cockatoo (south-eastern)	*Calyptorhynchus lathami lathami*	V	V	South-eastern glossy black cockatoos are uncommon but widespread. They can be found from Mitchell, Queensland, through eastern New South Wales to East Gippsland, Victoria. The sub-species prefers she-oak (*Allocasuarina* spp.) dominated woodlands, or open sclerophyll forests where Allocasuarina is present amongst Eucalyptus, Corymbia or Angophora. The species is also known to inhabit brigalow woodlands with vegetation assemblages including Allocasuarina, Casuarina, cypress (*Callitris* spp.) and *Acacia harpophylla*. This sub-species feed almost exclusively on the seeds of nine Allocasuarina and Casuarina species and has strong site fidelity for feeding trees.	**Low –** Only one individual suitable foraging tree was recorded and no large hollows suitable for nest sties were present. As such, no suitable habitat is considered to occur within the Study Area or Development Footprint. Records from the 1990s from Yelarbon and Whetstone State Forests occur within the desktop search extent (ALA 2022). Several additional ALA records including from 2018 and 2020 occur in the wider local area, although have not been identified to a sub-species level. The WildNet report also identifies a 1993 record within 10 km.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
red goshawk	*Erythrotriorchis radiatus*	V	E	The red goshawk is endemic to Australia. It is very sparsely dispersed across approximately 15% of coastal and sub-coastal Australia, from western Kimberley Division (north of 19°S) to northeastern NSW (north of 33°). There appears to have been a recent coastal contraction of the range in parts of eastern Australia, and a northward contraction of about 500km in NSW where it is now virtually extinct. The species occurs in coastal and sub-coastal tall open forests and woodlands, preferring areas with a mosaic of vegetation types, permanent water, and abundant small birds. Associated with gorge and escarpment country in partially cleared country in eastern Queensland. In eastern Australia, populations seem to move from inland nest sites to coastal plains in winter, thus occupying home ranges of 50–220 km^2.	**Unlikely –** The Development Footprint does not contain a suitable mosaic of vegetation types, or tall vegetation in proximity to permanent water. The species has not been recorded from the desktop search extent (ALA 2022), and the nearest record occurs approximately 65 km south near Kwiambal State Forest. Due to the rarity of this species, the record location has been generalised by 10 km.
grey falcon	*Falco hypoleucos*	V	V	The species occurs in arid and semi-arid Australia, including the Murray-Darling Basin, Eyre Basin, central Australia and Western Australia. It is mainly found where annual rainfall is less than 500 mm. The species frequents timbered lowland plains, particularly Acacia shrublands that are crossed by tree-lined water courses. It has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter.	**Low –** The climate of the local area is considered to have a temperate climate as per BoM and the areas of regrowth woodland do not meet the preferred habitat type for the species. The species has not been recorded from the desktop search extent or wider region (i.e. within 100 km) (ALA 2022).

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
squatter pigeon (southern)	*Geophaps scripta scripta*	V	V	The known distribution of the squatter pigeon (southern) extends south from the Burdekin-Lynd divide in the southern region of Cape York Peninsula to the Border Rivers region of northern NSW, and from the east coast to Hughenden, Longreach and Charleville, Queensland. Overall, the subspecies' known distribution is estimated to occur within the latitudes, 17° to 30° S, and the longitudes, 141° to 153° 30' E. The sub-species occurs in open, dry woodland with a grassy understorey in proximity to permanent water. It prefers areas of sandy soil with sparser cover of low grasses; and is less common on heavier soils with dense grass cover. Habitat is generally defined as open-forests to sparse, open-woodlands and scrub that are: (1) mostly dominated in the overstorey by Eucalyptus, Corymbia, Acacia or Callitris species (2) remnant, regrowth or partly modified vegetation communities, and (3) within 3 km of water bodies or courses. In Queensland, squatter pigeon (southern) foraging and breeding habitat is known to occur on well-draining, sandy or loamy soils on low, gently sloping, flat to undulating plains and foothills (i.e. Queensland Regional Ecosystem Land Zone 5), and lateritic (duplex) soils on low 'jump-ups' and escarpments (i.e. Queensland Regional Ecosystem Land Zone 7).	**Low –** Although the Development Footprint contain eucalypt woodlands in regrowth condition, these areas had a very dense ground layer dominated by exotic grasses. Furthermore, habitats within the Development Footprint are highly modified and are less likely to be utilised over adjacent higher-quality areas. Farm dams have the potential to be used as watering points, however these will not be impacted by the Project, with the nearest point to the Development Footprint being approximately 700m away. The species has been historically (1995, 1996) recorded from Yelarbon State Forest within the desktop search extent (ALA 2022).

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
painted honeyeater	*Grantiella picta*	V	V	The painted honeyeater is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. The greatest concentrations and almost all records of breeding come from south of 26ºS, on inland slopes of the Great Dividing Range between the Grampians, Victoria and Roma, Queensland The species inhabits mistletoes in eucalypt forests/woodlands, riparian woodlands of *Eucalyptus largiflorens* and *E. camaldulensis*, box-ironbark-yellow gum woodlands, *Acacia*-dominated woodlands, *Melaleuca, Casuarina* or *Callitris* woodlands, and trees on farmland or in gardens. The species prefers woodlands which contain a higher number of mature trees, as these host more mistletoes.	**Low –** The species has been historically (1996) recorded from Whetstone State Forest within the desktop search extent (ALA 2022) and was also confirmed approximately 5 km to the south-west during field surveys for B2G EIS in 2021. However, habitat within the Development Footprint is not suitable due to the absence of mistletoe resources.
white-throated needletail	*Hirundapus caudacutus*	V, M	V	The white-throated needletail is widespread in eastern and south-eastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. The species is found across a range of habitats, more often over wooded areas, where it is almost exclusively aerial, though it roosts in tree hollows and the foliage canopy. It forages for insects aerially, flying anywhere between “cloud level” and “ground level”, often forming mixed feeding flocks with other species. The species roosts in tall trees at night, mainly in forests.	**Low –** Three recent records occur within the desktop search extent, including one at the edge of the Development Footprint (ALA 2022). Due to its aerial nature, the species may forage over the entire Development Footprint, however no suitable roosting habitat was observed and the species is unlikely to rely on the resources within the Development Footprint for its ecological requirements.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
Australian painted snipe	*Rostratula australis*	E	E	The Australian painted snipe has been recorded at wetlands in all states of Australia. It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia. The species occurs in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland/saltmarsh, dams, rice crops, sewage farms and bore drains, generally with a good cover of grasses, rushes and reeds, low scrub, lignum (*Muehlenbeckia* spp.), open timber or samphire.	**Low –** Under ideal conditions, the farm dams within the Study Area may provide marginal foraging and roosting habitat for migrating individuals. However, farm dams will not be impacted by the Project, with the closest point approximately 700m away. Further, the species has not been recorded from the desktop search extent (ALA 2022), and the closest record is located 80 km east near Sundown Resources Reserve (32 km spatial uncertainty).
Fish					
Murray cod	*Maccullochella peelii*	V	-	The species is known to live in a wide range of warm water habitats that range from clear, rocky streams to slow flowing turbid rivers and billabongs. The upper reaches of the Murray and Murrumbidgee Rivers are considered too cold to sustain the species. Murray Cod have a presence of micro habitat features including rocks, in-stream snags and other timbered structures, stream bank vegetation and structures that generally provide cover from fast-flowing currents.	**Unlikely –** No watercourses suitable for this species occur within the Development Footprint. The Macintyre Brook occurs immediately adjacent and is known to contain Murray Cod as per ARTC (2021).

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
Mammals					
large-eared pied bat	*Chalinolobus dwyeri*	V	V	Both the former and current distribution of the large-eared pied bat is poorly known. In Queensland, records are known from sandstone escarpments in the Carnarvon, Expedition Ranges and Blackdown Tablelands. It is likely that these areas support a high proportion of the Queensland populations of the species, although local population estimates have not been established. Additional records exist in the Scenic Rim near the NSW/Queensland border. The populations in this area appear to be reliant on the presence of roosts in volcanic rock types. The species requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors which are used for foraging. No maternity roost sites are known in Queensland. The species has been recorded foraging in a range of vegetation types, including dry and wet sclerophyll forest, grassy woodland, Callitris dominated forest, tall open eucalypt forest with a rainforest sub-canopy, subtropical rainforest and small clearings adjacent to rainforest, sub-alpine woodland and sandstone outcrop country.	**Low –** Contour mapping indicates that the wider area does not contain cliffs or escarpments. Given the species only forages within proximity to roosting habitat, no areas of foraging and dispersal habitat are considered present within the Development Footprint. The species has not been recorded from the desktop search extent, with the nearest record occurring approximately 80 km north near Western Creek State Forest.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
spot-tailed quoll (SE mainland population)	*Dasyurus maculatus maculatus*	E	LC	The spot-tailed quoll was previously widely distributed from south-east Queensland, eastern NSW, Victoria, south-east South Australia and Tasmania, but it's range is estimated to have reduced significantly. The species occurs in south-east Queensland: coastally from Bundaberg to the border and inland to Monto and Stanthorpe. The subspecies has a preference for mature wet forest habitat, especially in areas with rainfall 600 mm/year. It has been recorded from a wide range of habitats, including: temperate and subtropical rainforests in mountain areas; wet schlerophyll forest; lowland forests; open and closed eucalypt woodlands; inland riparian and river red gum (*Eucalyptus camaldulensis*) forests; dry 'rainshadow' woodland; sub-alpine woodlands; coastal heathlands; occasional sightings from open country, grazing lands, rocky outcrops and other treeless areas.	**Low –** The species was recorded from near Inglewood in 2019 within the desktop search extent (ALA 2022). However, habitat within the Development Footprint is considered unsuitable due to the high levels of disturbance and fragmentation, lack of suitable microhabitat and only small wooded vegetation communities present.
south-eastern long-eared bat	*Nyctophilus corbeni*	V	V	The south-eastern long-eared bat has a scattered distribution mostly within the Murray-Darling Basin, but with some records outside of this area. The species inhabits a range of inland dry forest habitats including *Eucalyptus camaldulensis*, mallee, brigalow (*Acacia harpophylla*) and other arid and semi-arid habitats; in southern Queensland it is more common in box/ironbark and Callitris forests on sandy soils. The species is most abundant in vegetation with a distinct canopy and a dense, cluttered shrub layer, and in large, continuous remnants. It roosts solitarily in tree hollows, crevices, and under loose bark (particularly on dead *Allocasuarina luehmannii* or *Casuarina cristata*).	**Low –** Regrowth woodland habitat within the Development Footprint is highly fragmented and does not provide the cluttered understorey utilised by this species. The species has been historically (1990s) recorded from Yelarbon and Whetstone State Forests within the desktop search extent (ALA 2022). Field surveys completed for the B2G EIA recorded the species approximately 20 km north of Inglewood.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
koala (combined populations of Qld, NSW and the ACT)	*Phascolarctos cinereus*	E	E	The listed population of the koala has a wide but patchy distribution that spans the coastal and inland areas of Queensland north to the Herberton area, extending westwards into hotter and dryer semi-arid climates of central Queensland, NSW and the ACT. The species inhabits a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by eucalypt species. Biophysical habitat attributes for the koala include places that contain the resources necessary for individual foraging, survival (including predator avoidance), growth, reproduction and movement. This includes forests or woodlands, road-side and rail vegetation and paddock trees, safe intervening ground matrix for travelling between trees and patches to forage and shelter and reproduce and access to vegetated corridors or paddock trees to facilitate movement between patches.	**Moderate –** Regrowth eucalypt woodland habitat within the Development Footprint is considered suitable for the species. The species has been historically (1965, 1987) recorded from the desktop search extent (ALA 2022) and was also recorded approximately 5 km east of the Study Area during field surveys completed for the B2G EIS (ARTC, 2021).
grey-headed flying-fox	*Pteropus poliocephalus*	V	LC	The grey-headed flying-fox is Australia's only endemic flying-fox and occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria. The species is widespread throughout their range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. The species is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, Melaleuca swamps and Banksia woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas. The primary food source is blossom from Eucalyptus and related genera but in some areas it also utilises a wide range of rainforest fruits.	**Moderate –** Regrowth eucalypt woodland habitat within the Development Footprint may provide foraging and dispersal opportunities. The species has been historically (1960) recorded from the desktop search extent (ALA 2022) and was also recorded at a camp located near Inglewood approximately 16 km to the north-east as per ARTC (2021).

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
short-beaked echidna	*Tachyglossus aculeatus*	-	SLC	The short-beaked echidna is found throughout Australia, including Tasmania. It inhabits a variety of habitats including forests and woodlands, heath, grasslands and arid environments. When resting, find shelter in burrows, in tree hollows at the base of trees, in clumps of grasses, in piles of leaves and bark, under rocks, or in caves.	**Moderate** – All habitat within the Development Footprint is considered suitable given the broad requirements of the species. As per the WildNet report, four records occur within 10 km of the Development Footprint including one from 2020. One 1996 record occurs within the desktop search extent (ALA, 2022) to the south east in Yelarbon State Forest.
Plants					
Tara wattle	*Acacia lauta*	V	V	This species is restricted to a small region of the Darling Downs in south-eastern Qld, from Tara to Inglewood with a distributional range of approx. 140 km. The species grows in a subhumid subtropical climate, at localities characterised by a gently undulating to flat landforms. Soils are moderately deep and hardsetting with a weakly acidic to neutral sandy loam surface grading into neutral to alkaline sandy clay subsoil. Vegetation varies from open forest to low woodland with a dense or moderately dense shrub layer. Tree species present at all sites include white cypress pine (*Callitris glaucophylla*) and buloke (*Allocasuarina luehmannii*), while the understorey is diverse.	**Low –** As the Development Footprint is located at the limit of the species' potential distribution. Habitat within the Development Footprint is not considered suitable due to the high levels of modification and lack of shrub layer. The species was not recorded during field surveys has not been recorded from the desktop search extent (ALA 2022) and the closest record (1989) occurs 25 km to the east near Lake Coolmunda.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
-	*Androcalva procumbens*	V	LC	This species occurs primarily in NSW and limited parts of southern Queensland. Biodiversity surveys of Brigalow Belt South in 2002 recorded A. procumbens at only one of 32 previously known locations. The species is often found in communities of *Eucalyptus dealbata –E. sideroxylon* woodland, *Melaleuca uncinata* shrubland, and mallee eucalypt with *Calytrix tetragona* understorey. Associated species include *Acacia triptera*, *Callitris endlicheri*, *Eucalyptus melliodora*, *Allocasuarina diminuta*, *Philotheca salsolifolia*, *Xanthorrhoea* spp., *Exocarpos cupressiformis*, *Leptospermum parvifolium*, and *Kunzea parvifolia*. It occurs in sandy soils, often in disturbed habitats such as road verges, quarry boundaries, gravel stockpiles, and power line easements.	**Unlikely –** Although the Development Footprint occurs within the mapped distribution of the species, more recent data suggests the species occurs almost exclusively in NSW. Although regrowth eucalypt woodlands may be marginally suitable, the species has not been recorded from the region (within 100 km from the Study Area) (ALA 2022). The communities observed within the Development Footprint are not typical habitat for the species.
ooline	*Cadellia pentastylis*	V	V	Ooline occurs on the north-west slopes of NSW and in central and southern Queensland. In Queensland, ooline occurs from Balcomba (west of Rockhampton) south to the NSW border and west to near Blackall. Ooline grows in semi-evergreen vine thickets and sclerophyll vegetation on undulating terrain of various geology, including sandstone, conglomerate and claystone. Soils generally have low to medium nutrient content and are normally associated with upper and mid-slopes in the landscape. The altitude is generally 300-460 m above sea level, with some stands known to occur at 600 m above sea level.	**Low –** Habitat within the Development Footprint is considered marginal due to its low elevation (less than 300 m) and flat topography. Further, the species has not been recorded from the desktop search extent (ALA 2022) and the nearest record occurs approximately 45 km to the north west near Bendidee State Forest. Ooline is easily detectable and was not observed during field surveys.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
bluegrass	*Dichanthium setosum*	V	LC	*Dichanthium setosum* has been reported from inland NSW and Queensland. In Queensland the species has been reported from the Leichhardt, Morton, North Kennedy and Port Curtis regions. The species occurs on heavy soils (predominantly heavy basaltic black soils and red-brown loams with clay subsoil) in woodland or open woodland usually dominated by Acacia and/or Eucalyptus species. Associated climate is tropical to subtropical and seasonal, with the habitat drying out for part of the year. *Dichanthium setosum* is often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture.	**Low –** As the species is known to occur in highly disturbed pasture, habitat within the Development Footprint may be suitable. However, the species has not been recorded from the desktop search extent (ALA 2022), with the closest record occurring approximately 55 km south-west in NSW.
Belson's panic	*Homopholis belsonii*	V	E	The distributional range of Belson's Panic lies within the southern Brigalow Belt Queensland, namely the Darling Downs area west of Toowoomba, near Oakey, Jondaryan, Bowenville, Dalby, Acland, Sabine, Quinalow, Goombungee, Gurulmundi and Millmerran, and further west between Miles and Roma. The species occurs at elevations ranging from 200 m to 520 m asl. It is known to occur in dry woodland habitats on poor soils, such as those derived from basalt. It occurs on rocky hills supporting white box (*Eucalyptus albens*) and in wilga (*Geijera parviflora*) woodland; flat to gently undulating alluvial areas supporting belah (*Casuarina cristata*) forest; and soils and plant communities of poplar box (*Eucalyptus populnea*) woodlands. It may also be associated with shadier areas of brigalow (*Acacia harpophylla*), myall (*A. melvillei*), and weeping myall (*A. pendula*) communities; in mountain coolibah (*Eucalyptus orgadophila*) communities; and on roadsides.	**Low –** Development Footprint may contain marginal habitat associated with the eucalypt woodlands in regrowth condition. However, the species has not been recorded from the desktop search extent (ALA 2022) and the closest record occurs approximately 45 km north-west near Bendidee National Park.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
winged pepper-cress	*Lepidium monoplocoides*	E	LC	As per the species' SPRAT profile and National recovery plan (2010), this species occurs primarily in NSW and Victoria. The winged peppercress occurs in open, sparsely vegetated sites in a range of habitats on heavy clay or clay-loam soils, usually on sites that are seasonally flooded or prone to waterlogging, in arid to semi-arid areas with an average rainfall range of 200–450mm per year. Vegetation communities in which the species occurs include grasslands, wetlands and floodplain woodlands dominated by *Eucalyptus coolabah* and *Eucalyptus largiflorens*, and chenopod shrublands dominated by *Atriplex*, *Maireana* and/or *Nitraria* species. The winged peppercress has apparently suffered a widespread decline in both range and abundance since European settlement. The species is subject to a number of major threats including altered hydrology, increasing salinity, weed invasion, grazing, physical damage, drought and climate change.	**Low –** The species occurrence within Queensland is not well known. Two ALA records occur within the desktop search extent (ALA 2022) near the township of Yelarbon to the south-west of the Development Footprint: one from 2005 with 100 m spatial uncertainty, described as occurring in "gilgaed areas on clay soils, salt scalded", and the other from 2011 with a 10 km spatial uncertainty. Habitat within the Development Footprint is considered unsuitable as it is highly disturbed and not 'sparsely vegetated'. Exotic grass and forbs present are also likely to out-compete this species for resources.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
Austral toadflax	*Thesium australe*	V	V	Austral toadflax occurs in New South Wales, the Australian Capital Territory, Queensland and Victoria. The species was considered extinct in Queensland prior to the mid-1980s. Collections since the 1990s have been made from Kumbia, Glen Rock Regional Park, Carnarvon National Park, Crows Nest, Clifton, Warwick, Greenmount, Cambooya, Dalby, the Bunya Mountains, Blackbutt and Imbil. The species occurs in shrubland, grassland or woodland, often on damp sites. Vegetation types include open grassy heath dominated by swamp myrtle (*Leptospermum myrtifolium*), small-fruit hakea (*Hakea microcarpa*), alpine bottlebrush (*Callistemon sieberi*), woolly grevillea (*Grevillea lanigera*), coral heath (*Epacris microphylla*) and *Poa* spp., kangaroo grass (*Themeda triandra*) grassland surrounded by Eucalyptus woodland; and grassland dominated by barbed-wire grass (*Cymbopogon refractus*). It occurs on soils derived from sedimentary, igneous and metamorphic geology on a range of soils including black clay loams to yellow podzolics and peaty loams.	**Unlikely –** Woodland and grassland habitat within the Development Footprint is considered unsuitable due to the low abundance of native grass species and significant disturbance. The species has not been recorded from the desktop search extent (ALA 2022), and the closest record is approximately 45 km south-west near Yetman (10 km spatial uncertainty).
-	*Vincetoxicum forsteri*	E	E	The species has rarely been collected and is known from eight localities in the Dubbo area and Mt Crow near Barraba in NSW, and “Myall Park” near Glenmorgan in Queensland. This species is conserved within Goobang National Park, Eura State Forest, Goonoo SF, Pilliga West SF and Coolbaggie Nature Reserve. It grows in dry scrub, open forest and woodlands associated with *Melaleuca uncinata*, *Eucalyptus fibrosa*, *E. sideroxylon*, *E.albens*, *Callitris endlicheri*, *C. glaucophylla*, *Allocasuarina luehmannii*, *Acacia hakeoides*, *A. lineata*, *Myoporum* spp., and *Casuarina* spp.	**Unlikely –** The species occurrence within Queensland is not well known, and the Development Footprint does not occur near a known location. The species has not been recorded from the desktop search extent (ALA 2022), and habitat within the Development Footprint is unlikely to be suitable due to the lack of associated species and the overall high level of disturbance.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
-	*Westringia parvifolia*	V	V	*Westringia parvifolia* is known from four collections near Yelarbon, Inglewood and Goondiwindi in south-east Queensland and from near Yetman in northern New South Wales. The species grows with Baker's mallee (*Eucalyptus bakeri*) and green mallee (*E. viridis*) and between clumps of spinifex (*Triodia* sp.) on sandy and stony soils.	**Unlikely –** The species has been historically (1974 or earlier) recorded from the desktop search extent (ALA 2022); however, habitat within the Development Footprint is unsuitable due to the soil type and lack of associated species.
-	*Xerothamnella herbacea*	E	E	*Xerothamnella herbacea* is known from two sites north-east of Chinchilla, a single record from near Theodore and a record near Yelarbon east of Goondiwindi, Queensland. The species occurs in brigalow dominated communities in shade situations, often growing in leaf litter and associated with gilgai on heavy clay soil. Three of the four known populations occur in cleared areas of non-remnant vegetation.	**Unlikely –** No suitable habitat occurs within the Development Footprint as brigalow is not present nor are gilgai formations and leaf litter is largely absent. The species has been (2006) recorded from the desktop search extent (ALA 2022).
Reptiles					
common death adder	*Acanthophis antarcticus*	-	V	Found in eastern Australia (excluding far north and south) and southern Southern Australia and Western Australia. The species is found in a wide variety of well-drained habitats, including rainforests and wet sclerophyll forests, woodland, shrublands, grasslands and coastal heathlands, preferring sites with deep fixed leaf litter. Individuals burrow into sand or leaf litter, or hide under overhanging foliage.	**Unlikely –** The species has been (1990s) recorded from Yelarbon and Whetstone State Forests within the desktop search extent (ALA 2022), however habitat within the Development Footprint is not considered suitable due to the dense ground-layer cover and lack of leaf litter.
five-clawed worm-skink	*Anomalopus mackayi*	V	E	The long-legged worm-skink is found on the western slopes of the Great Dividing Range in south-eastern Queensland and north-eastern New South Wales. Its range has contracted eastward. In the past 20 years it has only been recorded from the Oakey and Dalby region of Queensland and the Wallangra, Mungindi and Wee Waa regions of New South Wales.	**Low –** The species has been recorded from the desktop search extent (WildNet 2022) however suitable habitat is unlikely to occur in the Development Footprint given the absence of black cracking clay soils, and the limited fallen timber. Further, the Development Footprint

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
				The species occurs on the lower slopes of slight rises in grassy White Box (*Eucalyptus albens*) woodland, open woodland and River Red Gum – Coolibah – poplar box (*Eucalyptus populnea*) woodland. This type of woodland is generally supported by red – black to black clay-loam soils. The species lives in permanent deep tunnel-like burrows and deep soil cracks, using fallen logs and timber as sheltering sites on the surface.	falls outside of the mapped distribution for this species (SPRAT).
collared delma	*Delma torquata*	V	V	The collared delma is endemic to Queensland, and known from the Bunya Mountains, Blackdown tablelands National Park, Expedition National Pak, Western Creek, near Millmerran and the Toowoomba Range. The species normally inhabits eucalypt-dominated woodlands and open-forests in Queensland RE Land Zones 3, 9, and 10. The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30–100 mm thick) appears to be an essential characteristic of microhabitat and is always present where the species occurs.	**Low –** Essential microhabitat features were in low abundance or absent within the Development Footprint. The microhabitat available is considered unlikely to be sufficient to support this species. The species has not been recorded from the desktop search extent (ALA 2022) and the closest record occurs approximately 47 km north near Bulli State Forest.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
yakka skink	*Egernia rugosa*	V	V	The known distribution of the yakka skink extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. This vast area covers portions of the Brigalow Belt (North and South), Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet Tropics and Cape York Peninsula Biogeographical Regions. As per SPRAT, there is at least 26 known locations of the species in Queensland. The species occurs in a variety of drier forests and woodlands, usually on well-drained, gritty soils, including *Eucalyptus populnea* on alluvial soils, *Callitris glaucophylla* on sands, *Allocasuarina luehmannii*, *Acacia harpophylla*, *A. catenulata* and *A. aneura*. The species inhabits burrows, abandoned rabbit warrens, and hollow logs or in deep rock crevices.	**Low –** Microhabitat within the Development Footprint was largely unsuitable for this species with dense ground cover, limited fallen timber, no deep crevices or hollow logs and compact clay/loam soil which is not amenable to excavating burrows. The species has not been recorded from the region (within 100 km from the Development Footprint) (ALA 2022) and the Development Footprint does not occur near a known location as per SPRAT.
Dunmall's snake	*Furina dunmalli*	V	V	The distribution of Dunmall's snake extends from near the Queensland border throughout the Brigalow Belt South and Nandewar bioregions, as far south as Ashford in New South Wales. The species has been found in a broad range of habitats, including forests and woodlands on black alluvial cracking clay/ clay loams dominated by *Acacia harpophylla* and other *Acacia* spp., *Callitris* spp. or *Allocasuarina luehmannii*, and various *Corymbia citriodora*, *Eucalyptus crebra*, *E. melanophloia* and *Callitris glaucophylla* open forest and woodland associations on sandstone derived soils.	**Low –** Due to the lack of associated species and high levels of disturbance and lack of complex microhabitat, regrowth woodlands within the Development Footprint do not provide suitable habitat for the species. The species has not been recorded from the desktop search extent (ALA 2022) and the closest record (undated) is approximately 21 km to the south-east near Yelarbon State Forest.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
border thick-tailed gecko	*Uvidicolus sphyrurus*	V	LC	The border thick-tailed gecko occurs in the New England Tableland, Nandewar and Brigalow Belt South Bioregions in northern New South Wales (NSW) and in south-east Queensland in an area bounded by Durikai State Forest (SF) (Queensland) to the north, the Great Dividing Range (NSW) to the east, the Liverpool Range (NSW) to the south and Moree/Mt Kaputar National Park (NP) to the west. The species is most commonly found in undisturbed habitat remnants on rocky outcrops and stony hills within eucalypt and cypress-pine open forest or woodland between 500-1100 m elevation. It is nocturnal and shelters by day. Sheltering occurs in well-shaded micro-sites amongst boulders, rock slabs, fallen timber (logs or debris), bark on standing trees and deep leaf litter.	**Unlikely –** The Development Footprint occurs at elevations <300 m, lacks rocky features and contains low-levels of woody microhabitat. As such, no suitable habitat is present. The species has not been recorded from the desktop search extent (ALA 2022) and the closest record occurs approximately 55 km south-east near Arcot State Forest.
Migratory Species					
Marine Birds					
fork-tailed swift	*Apus pacificus*	M	SLC	The species is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher. This species mostly occurs over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes.	**Low –**. Due to its aerial nature, the species may forage over the entire Development Footprint, however no suitable roosting habitat was observed and the species is unlikely to rely on the resources within the Development Footprint for its ecological requirements. Two records (one from 2018, the other undated) occur approximately 16 km to the south west near Yelarbon.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
Terrestrial Species					
yellow wagtail	*Motacilla flava*	M	SLC	The yellow wagtail is a regular wet season visitor to northern Australia. Increasing records in NSW suggest this species is an occasional but regular summer visitor to the Hunter River region. Habitat requirements for the species are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	**Unlikely –**Suitable habitat may occur in the Development Footprint; however, the species has not been recorded from the region (within 100 km from the Study Area) (ALA 2022). As per the SPRAT distribution map, the Development Footprint occurs within the 'potential' extent, and not close to a known location.
satin flycatcher	*Myiagra cyanoleuca*	M	SLC	Satin flycatchers are found extensively along the Great Dividing Range along the eastern and south-east seaboard of Australia – from Cape York to eastern South Australia. The species is also widespread within Tasmania. The species inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	**Low –** Regrowth and remnant woodland habitats within the Development Footprint may provide marginal habitat for the species while on migration, however no preferred habitat is available. However, the species has not been recorded from the desktop search extent (ALA 2022) and the closest record occurs approximately 29 km south near Dthinna Dthinnawan National Park.
Wetlands Species					
common sandpiper	*Actitis hypoleucos*	M	SLC	The species utilises a wide range of coastal wetlands and some inland wetlands with varying levels of salinity. The species is mostly found around muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, as well as on banks further upstream; around	**Low** – This species is known to utilise 'dams' and therefore farm dams within the Study Area may provide marginal habitat for vagrant individuals while on migration. However, farm dams were will not be impacted by the Project, with the closest point to the Development

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
				lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties.	Footprint being approximately 700m. The species has not been recorded from the region (within 100 km from the Development Footprint) (ALA 2022).
sharp-tailed sandpiper	*Calidris acuminata*	M	SLC	The sharp-tailed sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. In Queensland, they are recorded in most regions, being widespread along much of the coast and are very sparsely scattered inland, particularly in central and south-western regions. The species prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh, or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans, and hypersaline salt lakes inland. They also occur in salt works and sewage farms.	**Low** – This species is known to utilise 'dams' and therefore farm dams within the Study Area may provide marginal habitat for vagrant individuals while on migration. However, farm dams were will not be impacted by the Project, with the closest point to the Development Footprint being approximately 700m. ALA records occur within 30 km at three locations in the region including Yelarbon, Yelarbon State Forest and Lake Coolmunda.
pectoral sandpiper	*Calidris melanotos*	M	SLC	The pectoral sandpiper has been recorded in all states and territories of Australia. In Queensland, most records for the Pectoral Sandpiper occur around Cairns. There are scattered records elsewhere, mainly from east of the Great Divide between Townsville and Yeppoon. Records also exist in the south-east of the state as well as a few inland records at Mount Isa, Longreach and Oakley. The species prefers shallow fresh to saline wetlands. It is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains, and artificial wetlands.	**Unlikely –** The species has not been recorded from the region (within 100 km from the Development Footprint) (ALA 2022), and as this species does not utilise dams no suitable habitat is considered present within the Study Area. Regardless, farm dams will not be impacted by the Project.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
common greenshank	*Tringa nebularia*	M	SLC	The common greenshank is a non-breeding migrant to Australia. The species is widespread in the Gulf country and eastern Gulf of Carpentaria. It has been recorded in most coastal regions, possibly with a gap between north Cape York Peninsula and Cooktown. Inland, there have been a few records south of a line from near Dalby to Mt Guide, and sparsely scattered records elsewhere. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. It will also use artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. The edges of the wetlands used are generally of mud or clay, occasionally of sand, and may be bare or with emergent or fringing vegetation, including short sedges and saltmarsh, mangroves, thickets of rushes, and dead or live trees.	**Low** – This species is known to utilise 'dams' and therefore farm dams within the Study Area may provide marginal habitat for vagrant individuals while on migration. However, farm dams were will not be impacted by the Project, with the closest point to the Development Footprint being approximately 700m. As per the WildNet report, one record from 1998 occurs within 10 km of the Development Footprint. An ALA record also dated 1998 (and likely the same WildNet record) occurs approximately 5 km to the south-west. Other records occur approximately 30 km to the north-east at Lake Coolmunda.
Latham's snipe	*Gallinago hardwickii*	M	SLC	Latham's snipe is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia. The range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales. The species is occasionally recorded at sites located to the west of the core range (e.g. in north-western and south-western Queensland, north-western New South Wales, mid-northern South Australia, the Northern Territory and Western Australia).	**Low –** The species has been recently (2015, 2017) recorded from Yelarbon within the desktop search extent (ALA 2022). As this species is known to inhabit modified habitats, farm dams within the Study Area are considered potentially suitable. However, farm dams were will not be impacted by the Project, with the closest point to the Development Footprint being approximately 700m.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
				In Australia, the species occurs in permanent and ephemeral wetlands up to 2,000 m asl. They usually inhabit open, freshwater wetlands with low, dense vegetation such as swamps, flooded grasslands or heathlands, around bogs and other water bodies. However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity.	
Threatened Ecological Communities					
Brigalow (*Acacia harpophylla* dominant and co-dominant)		E	-	The TEC is characterised by the presence of *Acacia harpophylla* either dominant in the tree layer, or co-dominant with other species – notably *Casuarina cristata*, other *Acacia* spp. or *Eucalyptus* spp. Occasionally these other species may be more common than A*. harpophylla*. The TEC has a considerable range of vegetation structure and composition united by a suite of species that tend to occur on acidic and salty clay soils. Corresponding REs in the Brigalow Belt Bioregion: 11.3.1, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21.	**Unlikely –** The majority of the Study Area is non-remnant. A small patch of vegetation mapped as non-remnant has been ground-truthed as remnant RE 11.5.20, which does not correspond to the TEC.
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions		E	-	The TEC occurs as a semi-arid to humid subtropical woodland where *Eucalyptus coolabah* subsp. *coolabah* and/or *E. largiflorens* are the dominant canopy species and where the understorey tends to be grassy. It is found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees. Corresponding REs in the Brigalow Belt Bioregion: 11.3.3, 11.3.15, 11.3.16, 11.3.28, 11.3.37.	**Unlikely –** No remnant vegetation is present within the Development Footprint and vegetation communities in regrowth condition do not correspond to any analogous REs.

Common Name	Scientific Name	EPBC Act Status^	NC Act Status^	Distribution and Habitat (SPRAT 2022, DES 2022)	Likelihood of Occurrence
Poplar Box Grassy Woodland on Alluvial Plains		E	-	The TEC is typically a grassy woodland with a canopy dominated by *Eucalyptus populnea* and understorey mostly of grasses and other herbs. It mostly occurs in gently undulating to flat landscapes and occasionally on gentle slopes on a wide range of soil types of alluvial and depositional origin. Corresponding REs in the Brigalow Belt Bioregion: 11.3.2, 11.3.17, 11.4.7, 11.4.12.	**Known –** The majority of the Development Footprint is non-remnant. However, as per Ausecology (2022) areas of this TEC and analogous RE 11.3.2 occur in the Development Footprint north of the South Western System Railway Line (0.22 ha).
Weeping Myall Woodlands		E	-	The TEC occurs as open woodlands to woodlands, generally 4-12 m high, in which *Acacia pendula* is the sole or dominant overstorey species. Other species including *Alectryon oleifolius* subsp. *elongatus*, *Eucalyptus populnea* or *E. largiflorens* may also occur, though not as dominant species. Corresponding REs: 11.3.2, 11.3.28.	**Unlikely –** No remnant vegetation is present within the Development Footprint and vegetation communities in regrowth condition do not correspond to any analogous REs
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		CE	-	The TEC is characterised by a species-rich understorey of native tussock grasses, herbs and scattered shrubs, and the dominance, or prior dominance, of white box (*Eucalyptus albens*), yellow box (*E. melliodora*) or Blakely's red gum (*Eucalyptus blakelyi*) trees. It occurs in areas where rainfall is 400 - 1200 mm per annum, on moderate to highly fertile soils at altitudes of 170 - 1200 metres. Corresponding REs in the Brigalow Belt Bioregion: 11.8.2a, 11.8.8, 11.9.9a. It can also be a smaller component of the RE 11.3.23.	**Unlikely –** No remnant vegetation is present within the Development Footprint and vegetation communities in regrowth condition do not correspond to any analogous REs

^ LC = Least Concern, SLC = Special Least Concern, V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory.

APPENDIX B

Ecology assessment

Appendix D Significant residual impact assessment for matters of state environmental significance

Inland Rail is a subsidiary of
Australian Rail Track Corporation

INLAND RAIL

D.1Short-beaked Echidna (*Tachyglossus aculeatus*)

The short-beaked echidna is found in almost all terrestrial habitats in Australia. This species relies on a substrate of leaf litter and course woody debris for foraging. It shelters in fallen logs, rock crevices, dense leaf litter and abandoned burrows.

This species was not recorded within the Study Area during field surveys, however, given its occurrence within the desktop search extent and broad habitat requirements, it has been assessed as having a Moderate likelihood of occurrence.

As this species is a known habitat generalist, modelled habitat includes all fauna habitat types mapped within the Development Footprint and the broader Study Area. The extent of modelled habitat within the Study Area and the Development Footprint is provided below.

Fauna Habitat Type	Extent within Study Area (ha)	Development Footprint (ha)
Eucalyptus moluccana woodland on flat plains	2.5	0
Regrowth eucalypt woodland with scattered mature trees	5.3	1.1
Farm dams	2.5	0
Cleared areas - exotic pasture and tracks	221.9	42.9
Cleared areas - wheat cropping	104.2	25.4
Total	**336.4**	**69.3**

The SRI assessment for the species is presented below. In summary, a significant residual impact was not triggered for this species.

Evaluation Criteria	Response
Lead to a long-term decrease in the size of a local population	**No**. This species has not been recorded within the Development Footprint. Due to the broad habitat requirements of the species, there are large areas of potential habitat for the species in the Development Footprint and the wider region.
Reduce the extent of occurrence of the species	**No.** Given the small area of proposed disturbance to this species habitat, the generally degraded nature of this habitat, the ability of the species to disperse between habitat patches and the area of habitat disturbance comparative to habitat in the broader region, a long-term decrease in the size of a local population of this species is unlikely to result from the Project. Further, spotter-catchers will be present during all clearing works to relocate any individuals found during earthworks.
Fragment an existing population	**No**. Due to the broad habitat requirements of the species, the unimpacted portions of the Study Area and the adjacent State Forests provide substantial habitat for this species. The small area of impact relative to the surrounding region and the ability for the species to disperse between habitat patches means the Project is unlikely to reduce the species' extent of occurrence.

Evaluation Criteria	Response
Reduce gene flow among populations	**No**. Given the small area of proposed disturbance and the ability for the species to disperse between vegetated patches, the potential habitat loss associated with the Project is unlikely to present significant barriers to any existing population to the extent where it would become fragmented.
Disrupt ecologically significant locations (breeding, feeding or nesting sites)	**No**. Given the small area of proposed disturbance and the ability for the species to disperse between habitat patches, the potential habitat loss associated with the Project is unlikely to isolate habitat to the extent where genetically distinct populations would form.

APPENDIX B

Ecology assessment

Appendix E Significant impact assessment for matters of national environmental significance

Inland Rail is a subsidiary of
Australian Rail Track Corporation

INLAND RAIL

Poplar Box Grassy Woodland on Alluvial Plains Threatened Ecological Community

The Poplar Box TEC is listed Endangered under the EPBC Act. It is described as typically comprising a grassy woodland with a canopy dominated by poplar box (*Eucalyptus populnea*) and understorey mostly of grasses and other herbs. The Poplar Box TEC occurs west of the Great Dividing Range from Charters Towers, south to Leeton in New South Wales (Department of the Environment and Energy, 2019a). In Queensland, it is found in a number of bioregions including Brigalow Belt North, Brigalow Belt South, Southeast Queensland and the Darling Riverine Plains. It mostly occurs in gently undulating to flat landscapes and occasionally on gentle slopes on a wide range of soil types of alluvial and depositional origin (Webb et al. 1980).

In Queensland, the Poplar Box TEC is defined using the RE framework, where a number of REs are considered analogous with the TEC, provided that other key diagnostic criteria and condition thresholds are met.

A total of 0.22 ha of Poplar Box TEC was identified as occurring within the Development Footprint (see **Figure 4.2**). As per Ausecology (2022), the community was analogous to RE 11.3.2 in both high-value regrowth (HVR) and remnant condition. The TEC was identified to meet the Class A1 – High Quality condition thresholds. As described by Ausecology (2022), "*although several discrete patches of poplar box TEC were recorded at the site, in accordance with the poplar box TEC criteria, a patch may include small-scale (<30 m) variations, gaps, and disturbances, such as tracks, paths or breaks, or localised variations in vegetation that do not significantly alter the overall functionality of the ecological community. These breaks were included in the patch size calculations of the site. Small discrete patches of 11.3.2 (i.e. <1 ha) that were located >30m from a known compliant poplar box TEC patch were excluded*."

Threats

A number of key threats are identified for the Poplar Box TEC, which may lead to further reduction in the extent or cause a decline in condition:

- clearance and fragmentation;
- weed invasion;
- inappropriate fire and grazing;
- dieback due to herbivory, water stress, salinity and pathogens;
- chemical impact and spray drift;
- hydrological changes;
- salinisation;
- nutrient enrichment;
- invasive fauna;
- climate change.

Habitat Critical to the Survival of the Ecological Community

As per this community's Conservation Advice (Department of the Environment and Energy 2019), the areas most critical to the survival of the ecological community are the best quality, most intact patches of the ecological community (i.e. Class A). Additional areas such as buffer zones around patches, adjoining native vegetation, and areas that meet the description of the ecological community but not the condition thresholds are also important to the survival of the ecological community. They should still be taken into consideration as part of the surrounding environment and landscape context.

The small area of Poplar Box TEC within the Development Footprint meets the definition of habitat critical to the survival of the ecological community.

Significance Assessment

An assessment of the significance of impacts to this TEC under the (Department of the Environment, 2013b) is provided in Table 9.1. The assessment identified that it is unlikely that the Project will have a significant impact on Poplar Box TEC.

Table 9.1 Significant impact assessment – Poplar Box TEC

EPBC Act criteria – is there a real chance or possibility that the Project will:	Assessment of significance
Reduce the extent of an ecological community?	**No.** The Poplar Box TEC is estimated to occupy a total area of approximately 1.27 million ha across a distribution from Central Queensland to southern New South Wales. The Project involves the proposed clearing of a narrow linear strip of 0.22 ha of TEC, limited to the southern edge of a patch 2.3 ha in size. Approximately 2.1 ha of the TEC will remain and is very likely to still meet the condition thresholds for the TEC. Indirect impacts including edge effects, weed incursion, erosion and sedimentation and dust are expected to remain similar to current conditions on site given the successful implementation of mitigation measures. A large portion of this patch will be retained, with the patch occurring in the middle of the community's regional distribution. Therefore, it is unlikely that the Project will reduce the extent of the ecological community.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines?	**No.** The Project involves the proposed clearing of a narrow linear strip of 0.22 ha of the TEC on the southern edge of the 2.3 ha patch. A large portion of this patch will be retained following construction of the Project. The patch is located in close proximity to the South Western Railway Line, and part of a large contiguous area of vegetation close to the Whetstone State Forest. Clearing will be restricted to the edge of the patch, which is already subject to edge effects and disturbance. Direct impacts as a result of the Project will not impact connectivity to the north. Therefore, the Project will not further fragment the ecological community.

EPBC Act criteria – is there a real chance or possibility that the Project will:	Assessment of significance
Adversely affect habitat critical to the survival of an ecological community?	**No.** All Poplar Box TEC within the Development Footprint is considered habitat critical to the survival of the community. The Project will result in direct impacts to 0.22 ha of TEC of a patch 2.3 ha in total size. This amount of clearing is considered minor and unlikely to adversely affect habitat critical to the survival of the community given the amount that will be retained. Indirect impacts are expected to remain similar to current conditions on site. This will continue to support the Poplar Box TEC in the area following the development of the Project. Where possible, micro-siting of Project infrastructure should be employed to avoid TEC areas and poplar box (*Eucalyptus populnea*) canopy trees.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns?	**No.** During the construction and operation of the Project, the extent of exposed ground within the Development Footprint may be increased. However, given the very flat terrain, no changes to the surface flows are anticipated. The Development Footprint does not impact on any mapped water features including farm dams or mapped drainage features. Furthermore, areas that are likely to contain potential contaminants will be bunded as appropriate. Based on this, it is considered unlikely that the Project will result in a notable change to the availability of resources such as water, nutrients or soil within areas of Poplar Box TEC. Other ways in which the Project could modify or destroy abiotic factors relevant to the Poplar Box TEC include potential erosion and sedimentation, which could impact on the soil and nutrients, as well as dust deposition, which could impact on the ability of the plants to photosynthesise. Standard mitigation and management measures will be implemented to effectively reduce the risk of these potential indirect impacts.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting?	**No.** The proliferation of buffel grass in Queensland has contributed to the endangered status of the Poplar Box TEC as this species invades the understorey, outcompetes native flora species, leading to a decline in diversity and regenerative capacity of native vegetation. The presence and/or dominance of buffel grass in areas of mapped Poplar Box TEC are not known as the Umwelt survey was unable to assess these areas given their occurrence within the rail corridor. However, it is considered likely that buffel grass as well as other exotic grasses already occur within the community given the prevalence of these species across the Study Area. A total of 0.22 ha of the TEC along the southern edge of the patch will be directly impacted as a result of the Project. During the construction of the Project there is a chance of increased weed incursion and introduction of new weed species, however this risk will be actively managed through the implementation of standard environmental management protocols. During operation, the risk of weed incursion into the TEC is anticipated to remain similar to existing levels. This is based on the proximity of the South Western System Railway Line. As the Development Footprint is primarily occurring within areas historically cleared, no alteration of fire regimes is expected as a result of the Project. As such, it is considered unlikely to cause a substantial change in the species composition of the Poplar Box TEC.

EPBC Act criteria – is there a real chance or possibility that the Project will:	Assessment of significance
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established; or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community?	**No.** As above, the main risk to causing a substantial reduction in the quality or integrity of the ecological community is weed incursion. Due to the configuration and extent of the proposed clearing, it is expected there will be a similar risk of weed incursion into the TEC, as currently exists during the operational phase of the Project. As described above, this risk is considered low. Construction may cause an increased risk of invasive species becoming established in the TEC, however this will be effectively managed through the provisions of the site's standard environmental protocols The Project will not cause regular mobilisation of fertilisers, herbicides, chemicals or other pollutants into the ecological community and it is expected that the current risk at the site will remain following Project development. Therefore, the Project is considered unlikely to cause a substantial reduction in the quality or integrity of the ecological community.
Interfere with the recovery of an ecological community?	**No.** Minor direct impacts involve the proposed clearing of a narrow linear strip of 0.22 ha of TEC on the southern edge of a patch 2.3 ha in total size. Indirect impacts are expected to remain similar to current conditions on site. The Project has avoided two of the three Poplar Box TEC patches mapped in the local area. Areas to be impacted are likely to be already impacted by edge effects and occur adjacent to the rail corridor. Opportunities to further minimise the clearing of Poplar Box TEC will be explored where possible. Therefore, the Project will not interfere with priority recovery and threat abatement actions as stipulated in the conservation advice (Department of the Environment, 2013a). Habitat critical to the survival of Poplar Box TEC will remain and will continue to support the Poplar Box TEC in the area following the development of the Project.

Koala (Phascolarctos cinereus)

The koala is an arboreal mammal that occurs within Queensland, New South Wales, the Australian Capital Territory, Victoria and South Australia. Koalas are reported to be widespread across Queensland, occurring in patchy and often low-density populations across the different bioregions (DoE 2021).

The koala inhabits a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities supporting *Eucalyptus* species. Koalas in Queensland inhabit the moist coastal forests, southern and central western subhumid woodlands, and a number of eucalypt woodlands adjacent to waterbodies in the semi-arid western parts of the state (Melzer et al. 2000). They are also known to occur in modified or regenerating native vegetation communities.

Field surveys undertaken within the Study Area targeted eucalypt woodlands to assess habitat suitability for koala and actively search for signs of their presence. No koalas were recorded in the Study Area, however, habitat suitable to support foraging and dispersal was recorded. Mapped within the Study Area based on ground-truthed regional ecosystem mapping, a total of 7.7 ha of koala foraging and dispersal habitat is present. Of this habitat a total of 1.1 ha of this habitat will be impacted by the Project.

Potential habitat for the koala within the Development Footprint comprises regrowth eucalypt woodland with scattered mature trees. All potential habitat is considered suitable for foraging and dispersal.

Although the extent of koala habitat within the Study Area is minimal, large patches of suitable habitat is present to the north in the Whetstone State Forest and south in association to Macintyre Brook and Yelarbon State Forest. The proximity of these large patches of koala habitat may increase the likelihood of this species utilising the Study Area for dispersal.

Based on the availability of suitable habitat within the Study Area and the occurrence of historical records within the desktop search extent, the likelihood that this species occurs within the Study Area is Moderate.

The extent of koala habitat within the Study Area and Development Footprint is provided below.

Fauna Habitat Type	Extent within Study Area (ha)	Development Footprint (ha)
Eucalyptus moluccana woodland on flat plains	2.4	0
Regrowth eucalypt woodland with scattered mature trees	5.3	1.1
Total	7.7	1.1

Important Populations

While not generally applicable to species listed Endangered under the EPBC Act, the Conservation Advice for Phascolarctos cinereus (Koala) (Department of Agriculture Water and the Environment, 2022), defines important populations of the species. These have been identified as those which are valuable for cultural, social and economic reasons as well as for the species conservation. Important populations for the conservation of the species are those that:

- have the potential to act as source populations to adjacent areas of suitable, or potentially suitable, habitat
- exist in areas of climatically suitable refugia during periods of environmental stress including droughts, heatwaves, and long-term climate change
- are genetically diverse
- are disease free and/or exhibit low rates of infection with important pathogens
- contain genes which may confer adaptation to current and future environmental stressors
- are geographical or environmental outliers within the species range.

Populations which are considered to be important for social, cultural or economic reasons include:

- cultural and spiritual importance to Indigenous people
- the social value and enjoyment of having koalas close to residential areas
- the economic value brought to local business and tourism
- the iconic species value at the national and international political and community level.

Habitat Critical to the Survival of the Species

On 22 February 2022, the koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) status of Vulnerable was upgraded to Endangered under the EPBC Act.

Potential significant impacts on koala may occur if habitat that is considered to be critical to the survival of the species is adversely impacted. The Conservation Advice for Phascolarctos cinereus (Koala) (Department of Agriculture Water and the Environment, 2022) defines habitat critical to the survival of the species as "the areas that the species relies on to avoid or halt decline and promote the recovery of the species".

While the Study Area is not known to support a population of the species, the Conservation Advice includes currently 'unoccupied' areas in the definition of habitat critical to the survival of the species. Furthermore, the Conservation Advice also regards foraging habitat as a factor in determining habitat critical to the survival of the species. Given that foraging habitat is mapped within the Study Area, habitat critical to the survival of the species is present.

Significance Assessment

The significant impact assessment for this species is presented below. This assessment considers the information presented in the updated Conservation Advice for *Phascolarctos cinereus* (Koala) (Department of Agriculture Water and the Environment 2022), SPRAT, as well as the Referral Guidelines for the Vulnerable Koala (Department of the Environment 2014). Whilst the EPBC Act Referral Guidelines for the Vulnerable Koala have been redacted, the current Conservation Advice still references these guidelines as the source on how to "navigate the complexity of koala habitat to identify significant impacts".

The SIA for this species is presented below. In summary, a significant impact was not triggered for this species.

Evaluation Criteria	Response
Lead to a long-term decrease in the size of a population of the species	**No**. The Disturbance Footprint may be used occasionally for foraging or dispersal, however this habitat is not sufficient to support a population of koala. Based on the criteria identified in the species Conservation Advice, any individuals which may utilise this habitat would not constitute an 'important population'. A maximum of 1.1 ha of potential koala habitat will be directly impacted as a result of the Project. This habitat is characterised as regrowth eucalypt woodland with scattered mature trees. As this habitat exists in a regrowth state, it is not considered highly unique or important for refuge and habitat with much greater resource potential, quality and condition occurs directly north and south of the Study Area in State forests. Given the potential absence or infrequent use of the Development Footprint and the availability of more suitable habitat adjacent to the Study Area, a long-term decrease in the size of a population is unlikely to result from the Project.
Reduce the area of occupancy the species	**No**. As stated in the species Conservation Advice, the estimated extent of occurrence for koala is 1,665,850 km^2. Koala is also widespread across Queensland, and the Development Footprint is not located near the limit of the species distribution. The Project will result in the removal of up to 1.1 ha of potential habitat, this habitat is not known to support a local population and habitat of much higher quality is widely available directly north, and south of the Study Area. Based on this, Project works are considered unlikely to materially reduce the availability or quality of habitat for the species to the point where the species' extent of occupancy would be reduced.
Fragment an existing population into two or more populations	**No**. The species is considered highly mobile and known to disperse large distances. Patches of potential habitat occurring within the Development Footprint are already highly fragmented as a result of historical clearing and agricultural practices. Given the minor extent of proposed impact to proposed koala habitat and the ability for this species to readily disperse across non-remnant areas, vegetation clearance associated with the Project is unlikely to present a barrier to this species local movement, to the extent that it fragments any population of this species within the area.
Adversely affect habitat critical to the survival of a species	**No**. The Project proposes to remove 1.1 ha of potential koala habitat which is characterised as regrowth eucalypt woodland with scattered mature trees. The remaining area of impact exists within non-remnant agricultural land used primarily for wheat cropping. While the Development Footprint is not known to support a population of the species, the Conservation Advice includes currently 'unoccupied' areas in the definition of habitat critical to the survival of the species. The quality of this habitat is such that its removal is unlikely to result in an adverse impact to habitat critical to the survival of this species given the small scale of the disturbance and the presence of existing pressure from threatening processes such as weed incursion, agricultural impacts and previous clearing events.
Disrupt the breeding cycle of a population	**No**. No population of this species are known to occur within the Development Footprint, and if present individuals are expected to occur in low densities. Male koala's are known to disperse large distances during the breeding season in search of a mate, and dispersal will not be hindered by the Project. As the species does not have specific breeding requirements, all potential habitat may be suitable for breeding. Given the potential absence or infrequent use of the Development

Evaluation Criteria	Response
	Footprint by this species, the Project is unlikely to disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**No**. Koala has very broad habitat requirements and can inhabit vegetation in varying condition, including non-remnant. Although the small area of 1.1 ha of potential habitat will be removed via vegetation clearing, areas of suitable habitat will remain within the Study Area. Given potential absence or infrequent use of the Development Footprint by this species as well as the minimal proposed clearing of potential habitat, large tracts of higher value habitat directly adjacent and the mobility of the species, it is unlikely that the Project will alter habitat to the extent where the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	**No**. A number of exotic fauna species were identified within the Study Area during the field survey program. Although wild dog/dingo was not recorded during field surveys, the species is expected to occur surrounding region. The Project will employ best practice control methods for weeds and pests and is unlikely to introduce or exacerbate weeds or pests beyond existing levels.
Introduce disease that may cause the species to decline	**No**. Chlamydia and Koala Retrovirus (KoRV) are known threats to the species. The Project follows best practice construction and operational methods; therefore, introduction of a disease is unlikely.
Interfere with the recovery of the species	**No**. A National Recovery Plan for the Koala was published in 2022. Four main objectives are detailed: • Stabilise and then increase the area of occupancy and size of populations that are declining. • Maintain or increase the area of occupancy and size of populations that are stable. • Metapopulation processes are maintained or improved. • Partners, communities and individuals have a greater role and capability in Koala monitoring, conservation and management. As specified by the Conservation Advice, populations of koala in Queensland are generally of low density, widespread and fragmented. Although total population numbers of the species are known to have been significantly impacted following the 2020 bushfires, it is unclear how or if the local population/s within the region were affected and if they are declining. Given only a small subset of a local population may utilise the Development Footprint, the Project is unlikely to alter overall population numbers, dynamics or occupancy areas. Recognised threats to the species are also unlikely to be increased or exacerbated by the Project. Based on this, the Project is unlikely to interfere with the recovery of the species.

Grey-headed Flying Fox (*Pteropus melanocephalus*) - Vulnerable

The grey-headed flying-fox is highly mobile and considered 'highly adaptable' given its proclivity to occupy urbanised environments. Only a small proportion of its' wide range is used at any one time as the species selectively forages where food is available. Patterns of occurrence and relative abundance within its range vary widely between seasons and between years. At a local scale, the species is generally present intermittently and irregularly.

Important Population

An 'important population' of this species is not defined in the National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* (DAWE 2021), however, Nationally Important Camps have been identified on the DCCEEW interactive flying fox web viewer. Nationally Important Camps are flying fox camps that have contained ≥ 10,000 grey-headed flying-foxes in more than one year in the last 10 years or have been occupied by more than 2,500 grey-headed flying-foxes permanently or seasonally every year for the last 10 years (DAWE 2021).

As per ARTC (2021), the species was recorded at a camp located near the township of Inglewood, approximately 18 km north-east of the Study Area, however this camp does not meet the definition of a Nationally Important Camp. No Nationally Important Camps have been identified within 100 km of the Study Area.

Habitat Critical to the Survival of the Species

Habitat critical to the survival of this species, as described in the National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* (DAWE 2021) includes:

- Important winter and spring vegetation communities that contain the following species:
    - *Eucalyptus tereticornis, E. albens, E. crebra, E. fibrosa, E. melliodora, E. paniculata, E. pilularis, E. robusta, E. seeana, E. sideroxylon, E. siderophloia, Banksia integrifolia, Castanospermum australe, Corymbia citriodora citriodora, C. eximia, C. maculata, Grevillea robusta, Melaleuca quinquenervia* or *Syncarpia glomulifera*
- Vegetation communities that contain native species that are known to be productive as foraging habitat during the final weeks of gestation, and during the weeks of birth, lactation and conception (August to May)
- contain native species used for foraging and occur within 20 km of a nationally important camp as identified on the Department's interactive flying-fox web viewer
- contain native and or exotic species used for roosting at the site of a nationally important Grey-Headed Flying-Fox camp as identified on the Department's interactive flying-fox web viewer.

Given the persistence of several Queensland blue gum (*Eucalyptus tereticornis*) trees, an important flowering species, the habitat to be removed broadly represents this definition.

Modelled habitat for this species within the Study Area includes vegetation communities containing suitable food resources such as fruits and blossoms. The extent of grey-headed flying fox habitat within the Study Area and Development Footprint is provided below.

Fauna Habitat Type	Extent within Study Area (ha)	Development Footprint (ha)
Eucalyptus moluccana woodland on flat plains	2.4	0
Regrowth eucalypt woodland with scattered mature trees	5.3	1.1
Total	7.7	1.1

Significance Assessment

The significant impact assessment for this species is presented below. This assessment considers the information presented in the updated National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* (DAWE 2021) and the relevant SPRAT profile for this species.

The SIA for this species is presented below. In summary, a significant impact is considered unlikely to occur as a result of the Project for this species.

Evaluation Criteria	Response
lead to a long-term decrease in the size of an important population of a species	**No**, This species was not recorded within the Study Area. As per ARTC (2021), the species was recorded at a camp located near the township of Inglewood, approximately 18 km northeast of the Study Area, however this camp does not meet the definition of a Nationally Important Camp. An important population that is necessary for the long-term survival and recovery of this species is not known from the Study Area based on the absence of a known population (as camps or individual) of this species. A total of 1.1 ha of potential habitat occurs within the Development Footprint, associated with regrowth and remnant eucalypt woodlands. Potential habitat is likely to only be utilised occasionally by a small number of individuals, under ideal conditions when canopy trees are in flower. However, it is noted that adjacent woodlands associated with the state forests and Macintyre Brook are likely to be preferred given the significantly greater availability of resources. This species is highly mobile, travelling large distances at night in search of suitable foraging habitat. Foraging habitat for this species is highly seasonal and generally occurs in sparce distribution throughout the landscape. Given this species mobility, it is likely to avoid the area while works occur. Given that no important population is known from the Study Area and this species is not expected to rely on the Development Footprint as a foraging resource, it is unlikely that the Project will lead to a long-term decrease in the size of an important population of this species as a result of habitat clearing.
Reduce the area of occupancy of an important population	**No**. Habitat within the Development Footprint is marginally suitable foraging habitat and is not expected to be depended upon by this species. If this species uses the habitat within the Development Footprint, it is likely to be irregular given the large tracts of remnant, continuous habitat to the north and south of the Study Area contained in State Forests. Further, despite the species being recorded at a camp located near the township of Inglewood, approximately 18 km northeast of the Study Area, this camp does not meet the definition of a Nationally Important Camp. An important population that is necessary for the long-term survival and recovery of this species is not known from the Study Area given an absence of a known population (as camps or individual) of this species. Given the above, the Project is unlikely to reduce the area of occupancy of an important population.

Evaluation Criteria	Response
Fragment an existing important population into two or more populations	**No**. This species is highly mobile, travelling large distances, across cleared and developed landscapes at night in search of suitable foraging habitat. The removal of habitat within the Development Footprint would not limit this species capacity to travel between foraging habitat as this removal would not present significant barriers to the species movements. Given this, the proposed impact is unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of a species	**No.** The occurrence of key tree species including Queensland blue gum (*Eucalyptus tereticornis*) broadly defines habitat within the Development Footprint as habitat critical to the survival of the species. As only several individuals in regrowth condition would be removed, the impact to this habitat is considered to be negligible. Overall, the loss of 1.1 ha of already highly fragmented, low-quality habitat is considered to have a negligible effect on the species, should it be present. Further, the region offers large tracts of remnant, continuous habitat suitable for this species to the north and south of the Study Area. Given this, the proposed impact is unlikely to adversely affect habitat critical to the survival of a species
Disrupt the breeding cycle of an important population	**No**. This species breeds annually in camps with births occurring from October to December. As per ARTC (2021), the species was recorded at a camp located near the township of Inglewood, approximately 18 km northeast of the Study Area.. Despite the occurrence of a camp within 18 km of the Study Area, the Project is highly unlikely to impact it especially given the small scale of disturbance proposed within the Development Footprint. Further, as the species has not been recorded at the Inglewood roost historically, it is considered likely to only be used on a temporary basis by a small subset of the population. The Project is therefore unlikely to disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**No**. The proposed impact to marginal grey-headed flying fox habitat is negligible given the landscape context which offers large, continuous patches of remnant vegetation to the north and south of the Study Area. This species is unlikely to rely on the habitat contained within the Development Footprint for foraging given its small area and poor quality. Further, this species is highly mobile, travelling large distances at night in search of suitable foraging habitat. Foraging habitat for this species is highly seasonal and generally occurs in sparce distribution throughout the landscape. The removal of habitat contained within the Development footprint is therefore unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**No**. Invasive species, particularly weeds, were recorded throughout the Study Area. However, there are no particular weed or pest species identified as relevant to grey-headed flying-fox. The Project employs best practice control methods for weeds and pests and is unlikely to introduce or exacerbate weeds or pests beyond existing levels.
Introduce disease that may cause the species to decline	**No**. There are no known diseases affecting the species. The Project follows best practice construction and operational methods; therefore, introduction of a disease is unlikely.
Interfere substantially with the recovery of the species	**No**. As defined in the National Recovery Plan for Grey-headed Flying Fox *Pteropus poliocephalus* (DAWE 2021), recovery objectives for this species include: • development of robust estimate of an increasing population trend

Evaluation Criteria	Response
	• an improved understanding of habitat critical to the survival of the species • an increase in protection of habitat critical to the survival of the species and • nationally important camp sites • implementation of effective habitat restoration projects • a reduction of conflict between people and flying-foxes in residential areas through • investment in household mitigation measures • greater uptake of crop netting under subsidy schemes • decrease in the number of licences issued to harm the species • an improved understanding of threats with as yet unquantified impacts on flying foxes, such as electrocution, entanglements and climate change. The greatest threat to this species, being habitat loss and degradation is likely to occur resultant of Project impacts. However, the scale of impact, being 1.1 ha of marginally suitable habitat is unlikely to be substantial given the scale of undisturbed foraging habitat within region comparative to that proposed to be removed significant. This species is unlikely to rely on habitat within the Development Footprint and as such, it's removal will have a negligible impact on the recovery of the species.

Unit 1, 53 Southgate Avenue Cannon Hill
Brisbane, QLD 4170
Phone: +61 407 332 063
E-mail: info@ausecology.com
Web: www.ausecology.com

B2G Borrow Pit Ecological Surveys

Prepared for:
ARTC

Report issued:
September 2024

Table of contents

1 Introduction 1

1.1 Background 1
1.2 Project Scope 1

2 Methodology 1

2.1 Survey Methodology 1
2.2 Review of databases, literature and previous studies 1
2.3 Ground-truthing Regional Ecosystems 2
2.4 BioCondition assessments 2
2.5 Targeted flora surveys 2
2.6 Incidental fauna surveys 2

3 Results 3

3.1 Site ID 1 - 2SP229051 – Mooroobie Lane 3
3.2 Site ID 2 - 53MH233 – Taits Red Ridge 4
3.3 Site ID 3 - 116BNT467 – Mosquito Creek Road 5
3.4 Site ID 4 - Road Parcel Against Millmerran-Inglewood Rd 6
3.5 Site ID 5 - 33MA3499 – Kooroongarra-Andersons Road 7
3.6 Site ID 6A - 98DY182 – Heckendorfs Road 8
3.7 Site ID 6B - 111DY182 – Heckendorfs Road 9

4 References 10

Appendix A – Mapping 11

Tables

Table 3-1 Monitoring results for 2SP229051 3
Table 3-2 Monitoring results for 53MH233 4
Table 3-3 Monitoring results for 116BNT467 5
Table 3-4 Monitoring results for Road Parcel 6
Table 3-5 Monitoring results for 33MA3499 7
Table 3-6 Monitoring results for 98DY182 8
Table 3-7 Monitoring results for 111DY182 9

Glossary of Terms

Acronym	Description
ARTC	Australian Rail and Track Corporation
B2G	Border to Gowrie
cm	Centimetres
EDL	Ecologically Dominant Layer
Ha	Hectare
m	Metres
MNES	Matters of National Environmental Significance
MSES	Matters of State National Environmental Significance
NC Act	*Nature Conservation Act 1992 (Qld)*
RE	Regional Ecosystem
sp.	Species (singular)
spp.	Species (plural)
sub sp.	Sub species

1 Introduction

1.1 Background

The Inland Rail Program (Inland Rail) involves the design and construction of a new inland rail connection between Melbourne and Brisbane approximately 1,700 kilometres (km) in length. The Australian Rail Track Corporation (ARTC) is the proponent for Inland Rail. The Inland Rail has been divided into 13 separate projects, five of which are located in Queensland (QLD):

- Border to Gowrie (B2G)
- Gowrie to Helidon (G2H)
- Helidon to Calvert (H2C)
- Calvert to Kagaru (C2K)
- Kagaru to Acacia Ridge and Bromelton (K2ARB)

The Border to Gowrie (B2G) section comprises approximately 176 km of new dual gauge track and 78 km of upgraded track from the New South Wales/Queensland border to Gowrie - northwest of Toowoomba.

Formation of the track requires construction materials, which will be extracted from areas outside of the proposed rail corridor, referred to as borrow pits.

1.2 Project Scope

Ausecology was engaged by ARTC to conduct ecological surveys of the proposed borrow pits associated with the B2G alignment to assess potential ecological impacts to Matters of National Environmental Significance (MNES) and Matters of State National Environmental Significance (MSES).

2 Methodology

2.1 Survey Methodology

Field surveys were conducted at ten proposed borrow pit sites between the 5th and 6th of September 2023. Appendix A provides a mapped overview of the sites. Following initial surveys, three of the sites were removed by ARTC to avoid potential impacts and are therefore not included in this report, leaving seven pits in consideration. At each proposed borrow pit site, a general vegetation assessment was conducted, along with brief searches for threatened flora and fauna.

2.2 Review of databases, literature and previous studies

Desktop searches and a review of existing information was undertaken as part of the initial ecological assessment. These searches were undertaken to help inform and identify the presence of potential threatened species, habitat and vegetation communities prescribed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Nature Conservation Act 1992* (NC Act).

2.3 Ground-truthing Regional Ecosystems

For select sites where general observation was not sufficient to inform on the potential impacts of the proposed pit, quaternary surveys using the methodology outlined *within Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Neldner et al., 2022) were undertaken. The location of the quaternary sites is indicated in the individual site maps presented in the results.

2.4 BioCondition assessments

BioCondition assessments were only conducted if additional REs were identified that had not been previously assessed as part of Ausecology B2G survey efforts (Ausecology, 2022). No additional REs were identified and therefore no BioCondition assessments were undertaken as part of this supplementary assessment.

2.5 Targeted flora surveys

Formal protected plant surveys in accordance with the *Qld Protected Plants – Flora Survey Guidelines* (DES, 2020) were not undertaken for the present report. However, random meander transects were undertaken across the site targeting likely threatened flora species habitat.

2.6 Incidental fauna surveys

Targeted threatened fauna surveys were outside the scope of this supplementary assessment. However, incidental sightings of threatened fauna were logged, and opportunistic habitat searches were conducted at locations deemed to have an increased likelihood of occurrence for particular threatened species.

3 Results

The results of the borrow pit ecological surveys are presented for each site by Lot Plan in the section below.

3.1 Site ID 1 - 2SP229051 – Mooroobie Lane

Table 3-1 Monitoring results for 2SP229051

SITE SUMMARY 2SP229051	
KEY OBSERVATIONS AND FIELD NOTES	
The site comprises a cropped field. Scattered mature trees are present along the access track but can easily pick a path without clearing. No MNES or MSES were recorded. See Appendix 1B for mapping of this site.	
RECOMMENDATIONS	
▪ Use existing gate and track to enter access pit site. ▪ Suitable borrow pit with no impact to MSES or MNES.	

3.2 Site ID 2 - 53MH233 – Taits Red Ridge

Table 3-2 Monitoring results for 53MH233

SITE SUMMARY 53MH223
KEY OBSERVATIONS AND FIELD NOTES
The site is a cleared non-remnant (Category X) paddock dominated by exotic grass such as *Eragrostis curvulua* (African lovegrass) and forbs including *Sclerolaena* spp*., Calotis* spp. along with scattered *Eucalyptus populnea.* Restricted invasive species *Opuntia tomentosa* (velvety tree pear) and *Harissia martinii* (harissia cactus) were also recorded at the site. No MNES or MSES were recorded. See Appendix 1C for mapping of this site.
RECOMMENDATIONS
▪ No impacts to MSES or MSES noting that scattered mature paddock trees that may provide dispersal function for Koala will be avoided.

3.3 Site ID 3 - 116BNT467 – Mosquito Creek Road

Table 3-3 Monitoring results for 116BNT467

SITE SUMMARY 116BNT467	
KEY OBSERVATIONS AND FIELD NOTES	
The site contains shrubby non-remnant RE 11.9.13 (Category X), dominated by *Allocasuarina leuhmanii, Acacia polybotrya, Daviesia ulicifolia,* and *Leptospermum* sp. The ground layer consists predominantly of the native grass *Aristida caput-medusae*, with some cover of exotic forb species *Gladularia aristigera.* The section between the road and the proposed borrow pit contains RE 11.9.9a dominated by mature *Eucalyptus tereticornis, Eucalyptus crebra, Angophora leiocarpa,* and *Eucalyptus woollsiana*. This may also qualify as White Box TEC under the EPBC Act. Avoiding this area should be a priority. This has been avoided by using the existing access track from the entrance gate to access the borrow pit and avoid all impacts to potential MSES and MNES. This track is sufficiently wide the no additional clearing will be required. See Appendix 1D for mapping of this site.	
RECOMMENDATIONS	
▪ Nil – suitable borrow pit using existing access and no impact to MSES or MNES	

3.4 Site ID 4 - Road Parcel Against Millmerran-Inglewood Rd

Table 3-4 Monitoring results for Road Parcel

SITE SUMMARY Road Parcel
KEY OBSERVATIONS AND FIELD NOTES
The site is mostly cleared, with scattered mature *Eucalyptus crebra* and *Eucalyptus woollsiana*, and sparse shrubs including *Acacia shirleyi*, and *Acacia decora*. The track to the proposed pit site (bottom right image) contains non-remnant RE 11.5.20 (Category X) dominated by *Callitris glaucophylla, Eucalyptus microcarpa,* and *Eucalyptus crebra*. The track is ~4m wide and likely requires widening to access the proposed borrow pit. See Appendix 1E for mapping of this site.
RECOMMENDATIONS
▪ Clear and widen track along a 15m section to enable access to the proposed pit site. ▪ No impacts to MSES or MSES noting that scattered mature paddock trees that may provide dispersal function for Koala will be avoided.

3.5 Site ID 5 - 33MA3499 – Kooroongarra-Andersons Road

Table 3-5 Monitoring results for 33MA3499

SITE SUMMARY 33MA3499
KEY OBSERVATIONS AND FIELD NOTES
The site is a cleared paddock pilled mainly with *Chloris gayana.* A mix of native forbs such as *Sclerolaena muricata* and *Wahlenbergia gracilis* were also recorded. No MNES or MSES were recorded. See Appendix 1F for mapping of this site.
RECOMMENDATIONS
N/A

3.6 Site ID 6A - 98DY182 – Heckendorfs Road

Table 3-6 Monitoring results for 98DY182

SITE SUMMARY 98DY182
KEY OBSERVATIONS AND FIELD NOTES
The site is a grazed non-remnant (Category X) cleared paddock comprising of mainly exotic pasture grasses including *Chloris gayana* with a mix of native forbs such as *Sclerolaena muricata* and *Wahlenbergia gracilis*. No MNES or MSES were recorded. One specimen of *Santalum lanceolatum,* listed as Special Least Concern under the *Nature Conservation Act 1992* (NC Act) was recorded at the site. See Appendix 1G for mapping of this site.
RECOMMENDATIONS
▪ Nil – suitable borrow pit with existing access and no impacts to MSES or MNES

3.7 Site ID 6B - 111DY182 – Heckendorfs Road

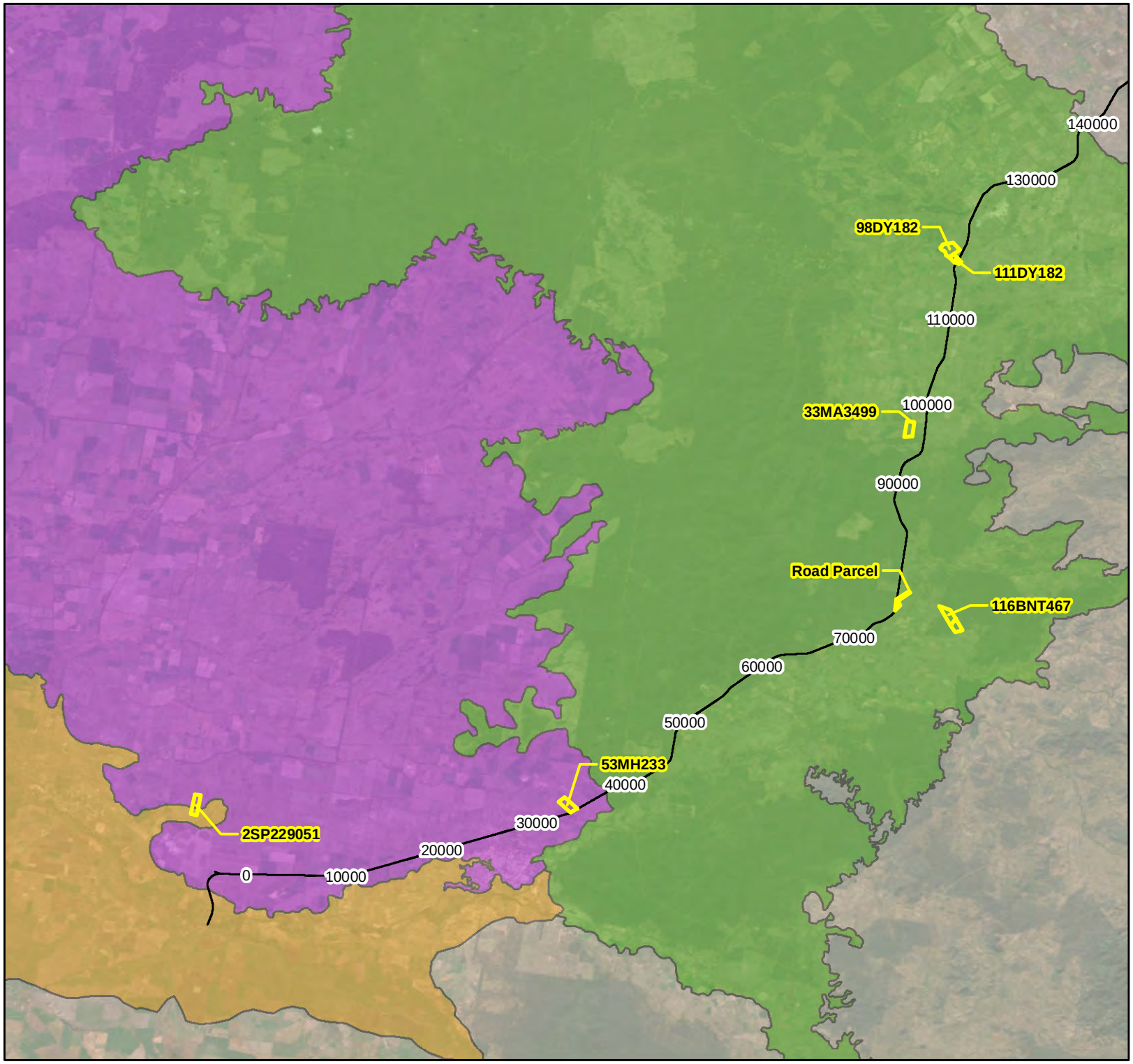
Table 3-7 Monitoring results for 111DY182

SITE SUMMARY 111DY182
KEY OBSERVATIONS AND FIELD NOTES
The site is a heavily grazed non-remnant (Category X) paddock of *Chloris gayana*. Scattered exotic shrubs include the restricted invasive species *Lycium ferocissimum* (African boxthorn) and *Gomphocarpus physocarpus* (balloon cotton bush). The site is located on the property adjacent to the previous site 98DY192. No MNES or MSES were recorded. See Appendix 1H for mapping of this site.
RECOMMENDATIONS
▪ Nil – suitable borrow pit with existing access and no impacts to MSES or MNES

4 References

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Richter, D., Addicott, E.P. and Appelman, C.N. (2022) Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 6.0. Updated April 2022. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

Appendix A – Mapping



Ausecology

Appendix 1A:

Overview Map B2G
Borrow Pits

N 0 10 20
Kilometers

Scale: 1:600,000

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Legend

- B2G
- Property

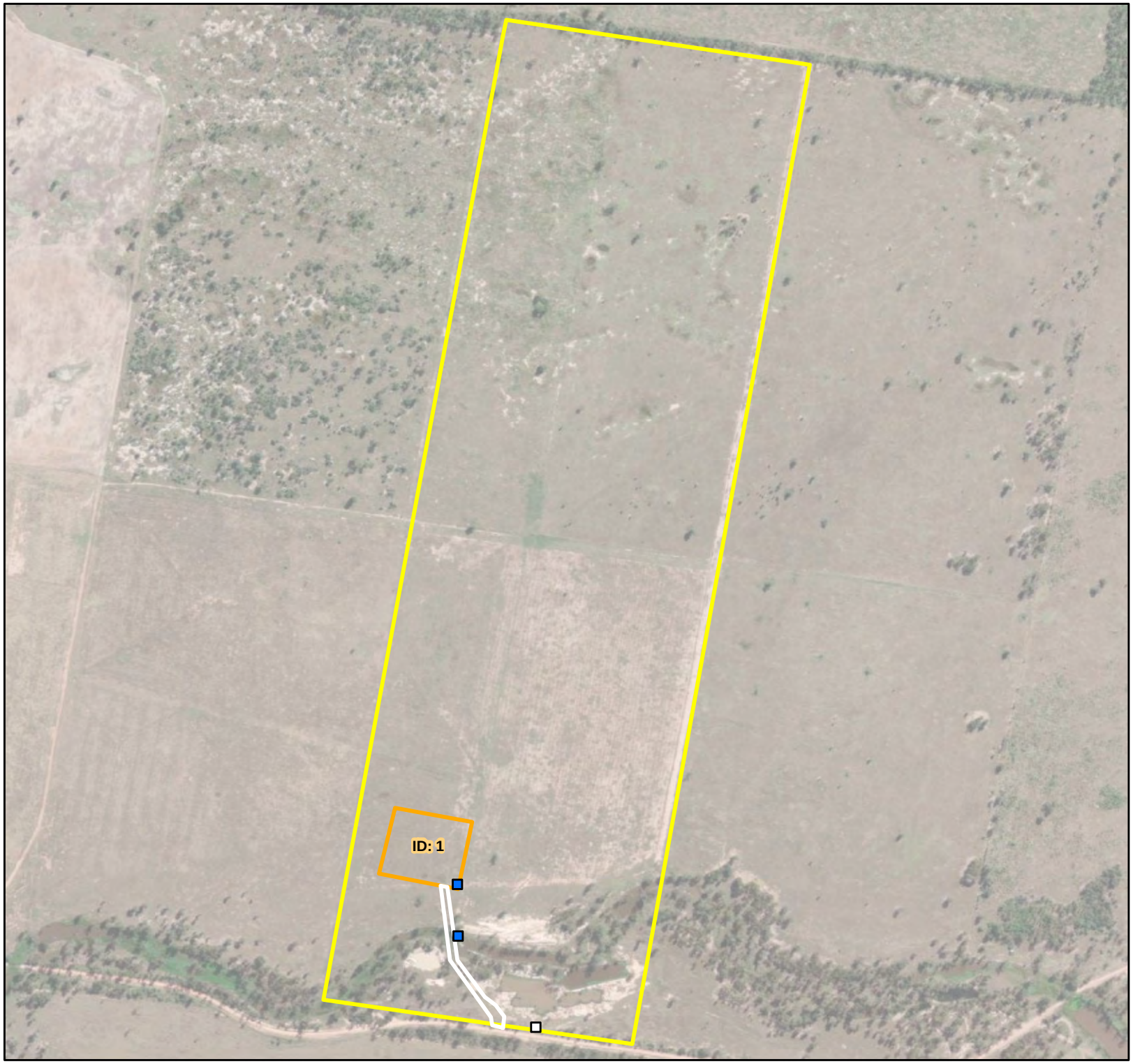
IBRA -

- Castlereagh-
- Inglewood
- Moonie-Commoron

Document History:

Rev	Reason for Issue	Author	Approver	Date
0	Issued for Information	NC	LG	13/09/2023

Document Path: C:\Users\User\Ausecology Dropbox\Nathan Cockerill\GIS\001_PROJECTS\ARTC\1284 - B2G Borrow Pits EA\03_Mapping\Figure x-x_Overview Map.mxd



Ausecology

Appendix 1B:

SITE ID 1 - 2SP229051
Mooroobie Lane
B2G Proposed Borrow Pits

N

0 125 250 500

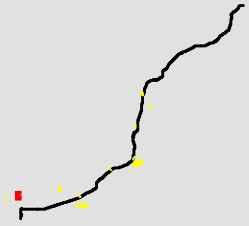
Meters

Scale: 1:12,000

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Legend

- Photo point
- Existing gate
- Access Tracks
- Borrow Pit Extent
- Property boundary



Document History:

Rev	Reason for Issue	Author	Approver	Date
1	Issued for Information	JS	LG	01/02/2024
2	Issued for Information	NC	LG	05/02/2024

Document Path: C:\Users\User\Ausecology Dropbox\Nathan Cockerill\GIS\001_PROJECTS\ARTC\1284 - B2G Borrow Pits EA\03_Mapping\Figure x-x_Updated Borrow Pits Mapping.mxd

Ausecology

Appendix 1C:

Site ID 2 - 53MH233
Taits Red Ridge
B2G Proposed Borrow Pits

N

0 125 250

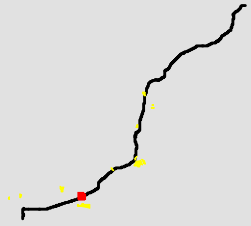
Meters

Scale: 1:10,000

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Legend

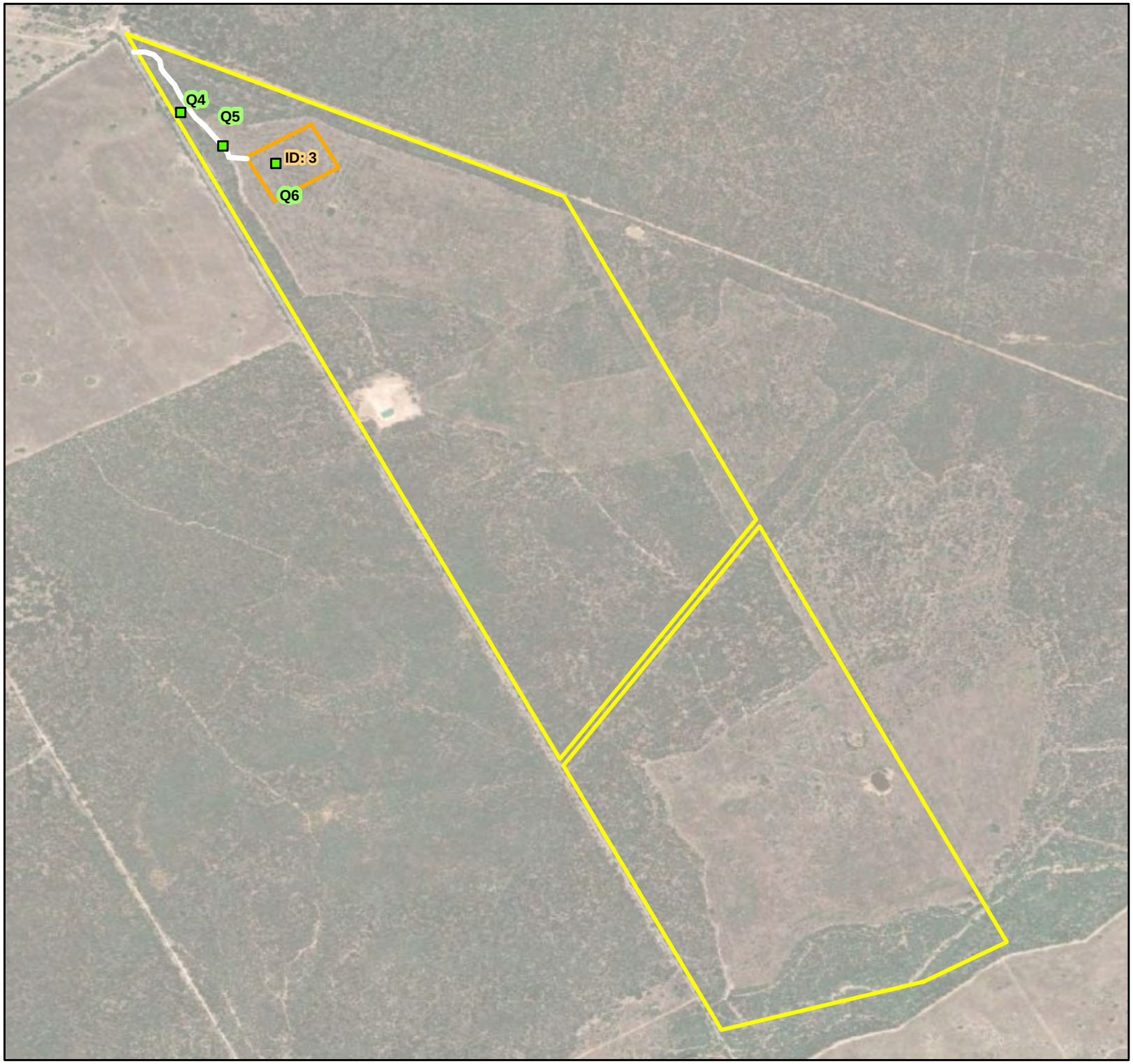
- Photo point
- Quaternary point
- Access Tracks
- Borrow Pit Extent
- Property boundary



Document History:

Rev	Reason for Issue	Author	Approver	Date
1	Issued for Information	JS	LG	01/02/2024
2	Issued for Information	NC	LG	05/02/2024

Document Path: C:\Users\User\Ausecology Dropbox\Nathan Cockerill\GIS\001_PROJECTS\ARTC\1284 - B2G Borrow Pits EA\03_Mapping\Figure x-x_Updated Borrow Pits Mapping.mxd



Ausecology

Appendix 1D:

Site ID 3 - 116BNT467
Mosquito Creek Road
B2G Proposed Borrow Pits

N

0 125 250 500

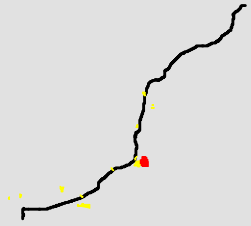
Meters

Scale: 1:16,000

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Legend

- Quaternary point
- Existing Track (Current Track)
- Borrow Pit Extent
- Property boundary



Document History:

Rev	Reason for Issue	Author	Approver	Date
1	Issued for Information	JS	LG	01/02/2024
2	Issued for Information	NC	LG	05/02/2024

Document Path: C:\Users\User\Ausecology Dropbox\Nathan Cockerill\GIS\001_PROJECTS\ARTC\1284 - B2G Borrow Pits EA\03_Mapping\Figure x-x_Updated Borrow Pits Mapping.mxd

Ausecology

Appendix 1E:

Site ID 4 - Road Parcel Against Millmerran-Inglewood Road B2G Proposed Borrow Pits

N

0 125 250 500

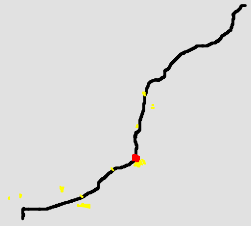
Meters

Scale: 1:12,000

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Legend

- Quaternary point
- Photo point
- Quaternary point
- Access Tracks
- Borrow Pit Extent
- Property boundary



Document History:

Rev	Reason for Issue	Author	Approver	Date
1	Issued for Information	JS	LG	01/02/2024
2	Issued for Information	NC	LG	05/02/2024

Document Path: C:\Users\User\Ausecology Dropbox\Nathan Cockerill\GIS\001_PROJECTS\ARTC\1284 - B2G Borrow Pits EA\03_Mapping\Figure x-x_Updated Borrow Pits Mapping.mxd

Ausecology

Appendix 1F:

Site ID 5 - 33MA3499
Kooroongarra Road
B2G Proposed Borrow Pits

N

0 125 250

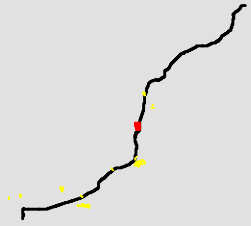
Meters

Scale: 1:10,000

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Legend

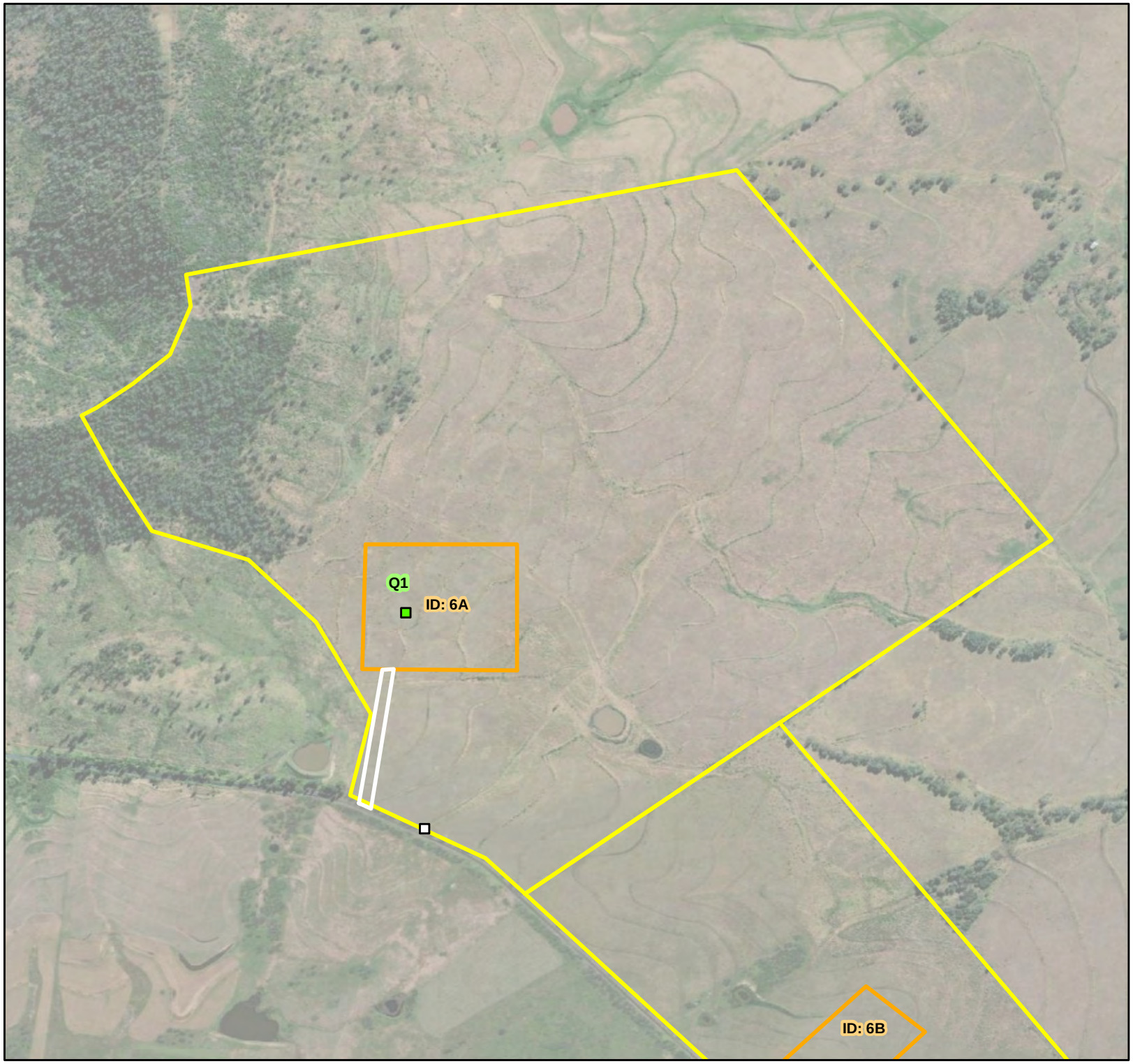
- Photo point
- Access Tracks
- Borrow Pit Extent
- Property boundary



Document History:

Rev	Reason for Issue	Author	Approver	Date
1	Issued for Information	JS	LG	01/02/2024
2	Issued for Information	NC	LG	05/02/2024

Document Path: C:\Users\User\Ausecology Dropbox\Nathan Cockerill\GIS\001_PROJECTS\ARTC\1284 - B2G Borrow Pits EA\03_Mapping\Figure x-x_Updated Borrow Pits Mapping.mxd



Ausecology

Appendix 1G:

Site ID 6A - 98DY182
Heckendorfs Road
B2G Proposed Borrow Pits

N

0 125 250 500

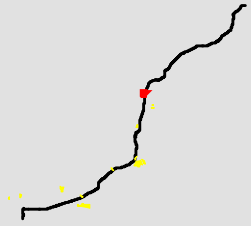
Meters

Scale: 1:12,000

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Legend

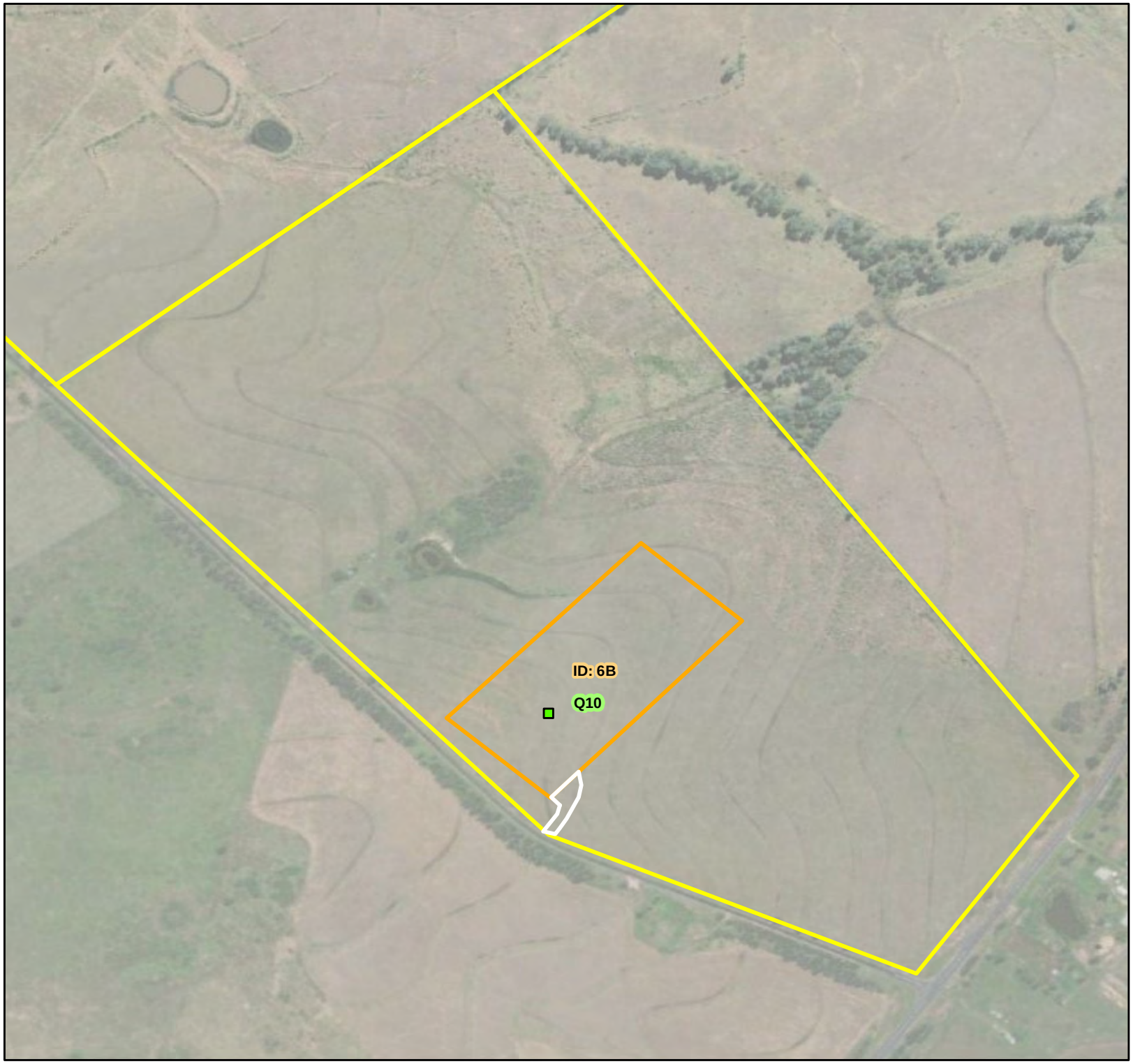
- Quaternary point
- Existing gate
- Access Tracks
- Borrow Pit Extent
- Property boundary



Document History:

Rev	Reason for Issue	Author	Approver	Date
1	Issued for Information	JS	LG	01/02/2024
2	Issued for Information	NC	LG	05/02/2024

Document Path: C:\Users\User\Ausecology Dropbox\Nathan Cockerill\GIS\001_PROJECTS\ARTC\1284 - B2G Borrow Pits EA\03_Mapping\Figure x-x_Updated Borrow Pits Mapping.mxd



Ausecology

Appenidx 1H:

Site ID 6B - 111DY182
Heckendorfs Road
B2G Proposed Borrow Pits

N

0 125 250

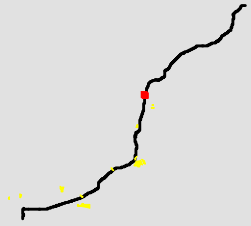
Meters

Scale: 1:7,000

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Legend

- Quaternary point
- Access Tracks
- Borrow Pit Extent
- Property boundary



Document History:

Rev	Reason for Issue	Author	Approver	Date
1	Issued for Information	JS	LG	01/02/2024
2	Issued for Information	NC	LG	05/02/2024

Document Path: C:\Users\User\Ausecology Dropbox\Nathan Cockerill\GIS\001_PROJECTS\ARTC\1284 - B2G Borrow Pits EA\03_Mapping\Figure x-x_Updated Borrow Pits Mapping.mxd

Inland Rail (Border to Gowrie Project)

Aquatic Ecology Technical Report

Prepared for

Future Freight Joint Venture

2-0001-310-EAP-10-RP-0209

23 June 2020

Contents

Executive Summary **10**

1 Introduction **12**
1.1 Background 12
1.2 Objectives and scope of works 12
1.3 Terms of reference 13
1.4 Overview of the Project 14

2 Legislation and guidelines **17**
2.1 Commonwealth legislation 17
2.1.1 Environment Protection and Biodiversity Conservation Act 1999 17
2.1.2 Water Act 2007 17
2.2 Queensland legislation 18
2.2.1 Planning Act 2016 18
2.2.2 Environmental Protection Act 1994 18
2.2.3 Water Act 2000 18
2.2.4 Vegetation Management Act 1999 18
2.2.5 Nature Conservation Act 1992 19
2.2.6 Biosecurity Act 2014 19
2.2.7 Fisheries Act 1994 19
2.3 Relevant guidelines, strategies and plans 20
2.3.1 ANZECC Guidelines (2000, 2018) 20
2.3.2 Queensland Water Quality Guidelines 20
2.3.3 DES Water Monitoring and Sampling Manual 20
2.3.4 Queensland AusRivAS Sampling and Processing Manual 20
2.3.5 AusRivAS habitat assessment protocol 20
2.3.6 Local water quality guidelines 20
2.3.7 Other guidelines 20

3 Methods **22**
3.1 Overview of the impact assessment area 22
3.2 Desktop assessment 22
3.3 Likelihood of occurrence assessment 22
3.4 Field surveys 25
3.4.1 General approach and timing of survey 25
3.4.2 Selection of sampling sites 25
3.4.3 Aquatic ecology habitat assessment and sampling 36
3.4.4 Macroinvertebrate surveys 37

© ECO LOGICAL AUSTRALIA PTY LTD

3.4.5 Fish surveys 37
3.4.6 Macro-crustaceans 38
3.4.7 Freshwater turtles 38
3.4.8 Surface water quality sampling 38
3.5 Weather conditions and site access 40
3.6 Survey limitations 44
3.7 Data collation and analysis 44
3.7.1 Aquatic ecology physical habitat 44
3.7.2 Aquatic ecology macroinvertebrate communities 44
3.7.3 Surface water quality 46
3.8 Approach to impact assessment 47
3.9 Assessment of cumulative impacts 50

4 Existing aquatic and surface water values 56
4.1 Environmental values and water quality objectives 56
4.2 Results of desktop assessment 60
4.2.1 EVNT aquatic flora 60
4.2.2 Introduced aquatic flora 60
4.2.3 EVNT aquatic fauna 61
4.2.4 Introduced fishes 62
4.2.5 MSES wetlands, watercourses and groundwater dependent ecosystems 62
4.2.6 AquaBAMM / Aquatic Conservation Assessments 64
4.2.7 Endangered ecological community (NSW) 68
4.3 Results of surface water field surveys 68
4.3.1 Macintyre Barwon Floodplain (Queensland Border Rivers Basin; sites 1 to 2) 68
4.3.2 Lower Macintyre Brook (Queensland Border Rivers Basin; sites 3 to 8) 72
4.3.3 Canning Creek (Queensland Border Rivers Basin; sites 9 to 20) 72
4.3.4 Southern Condamine (Condamine River Basin; sites 21 to 26) 72
4.3.5 Central Condamine (Condamine River Basin; sites 27 to 33) 81
4.3.6 Oakey Creek (Condamine River Basin; sites 34 to 43) 81
4.3.7 Quality assurance results 88
4.4 Results of aquatic ecology surveys 88
4.4.1 Aquatic flora 88
4.4.2 Physical habitat 89
4.4.3 Macroinvertebrates and stream health 90
4.4.4 Macro-crustaceans 92
4.4.5 Fish 92
4.4.6 Freshwater turtles 94
4.5 Synthesis of existing aquatic ecology and surface water values 94

5 Impact assessment 104

© ECO LOGICAL AUSTRALIA PTY LTD

5.1 Potential impacts of the Project 104
5.2 Mitigation measures 112
5.2.1 Mitigation through the reference design phase 112
5.2.2 Proposed mitigation measures 113
5.3 Impact assessment 125
5.4 Cumulative impacts on aquatic and surface water values 130

6 Conclusions and Recommendations 135

7 References 136

Appendix A: Site Descriptions for Aquatic Ecology Sites 140

Appendix B: Likelihood of Occurrence 167

Appendix C: Records of Calibration for Water Quality Meter 171

Appendix D: Laboratory Certificates of Analysis, Chain of Custody and Quality Control 172

Appendix E: Significant Impact Assessment – Murray Cod 173

Appendix F: Maps showing the location of waterways that provide fish passage 178

List of Figures

Figure 1 Border to Gowrie rail corridor and impact assessment area 16

Figure 2 Map showing the location of the proposed Border to Gowrie rail alignment in relation to major water courses 24

Figure 3 Location of aquatic ecology and surface water sampling sites in the impact assessment area 28

Figure 4a-g Location of aquatic ecology and surface water sampling sites 29

Figure 5 Rainfall data from Leyburn weather station from 1 April 2018 to 1 April 2019 41

Figure 6 Location of Groundwater Dependent Ecosystems in relation to the Project rail alignment 66

Figure 7 Location of high ecological significance wetlands in relation to the Project rail alignment 67

Figure 8 Macintyre Barwon Floodplain representative sites November 2018 (left: Site 1, right: Site 2) .. 95

Figure 9 Lower Macintyre Brook representative sites, November 2018 (top left: Site 3, top right: Site 4, middle left: Site 5, middle right: Site 6, bottom left: Site 7, bottom right: Site 8) 96

Figure 10 Canning Creek representative sites, November 2018 (top left: Site 10, top right: Site 12, middle left: Site 16, middle right: Site 18, bottom left: Site 19, bottom right: Site 11) 98

© ECO LOGICAL AUSTRALIA PTY LTD

Figure 11 Southern Condamine representative sites, November 2018 (top left: Site 24, top right: Site 24, bottom left: Site 23, bottom right: Site 24) 99

Figure 12 Central Condamine representative sites, taken November 2018 (top: Site 33, bottom left: Site 29, bottom right: Site 29) 101

Figure 13 Oakey Creek representative survey sites, taken November 2018 (top: looking west from Site 43, middle left: Site 43, middle right: Site 43, bottom left: Site 42, bottom right: Site 42) 103

List of Tables

Table 1 Summary of ToR relevant to aquatic ecology and surface water (Coordinator General, 2018) . 13

Table 2 Sampling sites targeted during the field surveys and associated water quality zone as specified in relevant basin plan (see Section 4.1 for a description of water quality zones) 26

Table 3 Sampling sites assessed during the four primary rounds of field surveys (- indicates not assessed) 42

Table 4 AusRivAS habitat predictor model variables for QLD Regional Western November 2018 sampling 45

Table 5 AusRivAS habitat predictor model variables for QLD Regional Western May 2019 sampling ... 46

Table 6 Sensitivity criteria 48

Table 7 Magnitude criteria 49

Table 8 Significance matrix 49

Table 9 Significance classifications 50

Table 10 Projects identified for consideration in the cumulative impact assessment for aquatic ecology 52

Table 11 Assessment matrix for assessment of cumulative impacts 55

Table 12 Impact significance criteria for cumulative impacts 55

Table 13 Environmental values for surface waters intersected by the Project (DES 2019a, b) 58

Table 14 Water quality objectives (annual median) for moderately disturbed surface water ecosystems intersected by the Project (DES 2019a, b) 59

Table 15 Introduced wetland indicator plants known to occur in the Balonne-Condamine drainage basin, and potential to occur in the impact assessment area 60

Table 16 AquaBAMM / ACA score for survey sites 65

Table 17 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – physico-chemical 69

© ECO LOGICAL AUSTRALIA PTY LTD

Table 18 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – nutrients..70

Table 19 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – dissolved metals 71

Table 20 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – physico-chemical... 73

Table 21 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – nutrients 74

Table 22 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – dissolved metals.... 75

Table 23 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – physico-chemical 76

Table 24 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – nutrients 77

Table 25 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – dissolved metals 78

Table 26 Water quality results for Site 23 and 24 in the Southern Condamine – physico-chemical 79

Table 27 Water quality results for Site 23 and 24 in the Southern Condamine – nutrients 80

Table 28 Water quality results for Site 23 and 24 in the Southern Condamine – dissolved metals 80

Table 29 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine – physico-chemical 82

Table 30 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine – nutrients 83

Table 31 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine –dissolved metals 84

Table 32 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – physico-chemical 85

Table 33 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – nutrients 86

Table 34 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – dissolved metals 87

Table 35 Aquatic flora detected within the Project aquatic survey sites June and November 2018 88

Table 36 AusRivAS physical habitat assessment scores for the Project aquatic survey sites, June and November 2018 89

Table 37 AusRivAS model outputs for sites sampled within the impact assessment area, November 2018 92

Table 38 Summary of fish caught during November 2018 field surveys..... 93

Table 39 Summary of potential impacts to aquatic ecology values 108

Table 40 Initial mitigations of relevance to aquatic ecology..... 112

Table 41 Aquatic ecology and surface water quality mitigation measures 115

© ECO LOGICAL AUSTRALIA PTY LTD

Table 42 Impact mitigation measures specific to aquatic MNES and MSES that occur in the Project footprint 124

Table 43 Results of significance assessment for impacts on aquatic ecology 127

Table 44 Residual significance assessment 130

Table 45 Projects considered for the cumulative impact assessment 131

Table 46 Summary of the results of a cumulative impact significance assessment for other relevant projects 133

© ECO LOGICAL AUSTRALIA PTY LTD

Abbreviations

Abbreviation	Description
ACA	Aquatic Conservation Assessment
ANZECC	Australian and New Zealand Environment and Conservation Council
ARTC	Australian Rail Track Corporation
AquaBAMM	Aquatic Biodiversity Assessment and Mapping Method
AusRivAS	Australian River Assessment System
CEMP	Construction Environmental Management Plan
DAF	Department of Agriculture and Fisheries
DEHP	Department of Environment and Heritage Protection
DES	Department of Environment and Science
DO	Dissolved Oxygen
EC	Electrical Conductivity
EIS	Environmental Impact Statement
ELA	Eco Logical Australia
EMP	Environmental Management Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPP	*Environmental Protection (Water and Wetland Biodiversity) Policy 2019*
EVNT	Endangered, Vulnerable or Near Threatened species
FFJV	Future Freight Joint Venture
GDE	Groundwater Dependent Ecosystem
MNES	Matter of National Environmental Significance
MSES	Matter of State Environmental Significance
NC Act	*Nature Conservation Act 1992* (Queensland)
PAH	Polycyclic Aromatic Hydrocarbons
PMST	EPBC Act Protected Matters Search Tool
SLC	Special Least Concern
TOR	Terms of Reference
TSS	Total Suspended Solids
WoNS	Weeds of National Significance

© ECO LOGICAL AUSTRALIA PTY LTD

Definitions

Term	Description
Construction footprint	The area that would be directly affected by construction. It includes the location of proposal infrastructure, the area that would be directly disturbed by the movement of construction plant and machinery, and the location of the storage areas/compounds sites etc, that would be used to construct that infrastructure.
Impact assessment area	A 2 km wide corridor around the preliminary alignment, which encloses project infrastructure and the construction footprint. The Impact assessment area is the focus of the impact assessment for the aquatic ecology and surface water disciplines. This comprises the areas where the rail corridor intersects with waterways or other locations with aquatic ecology or surface water values, and adjacent areas which may be affected by the Project, including those located downstream of the rail alignment.
Rail alignment	The exact positioning of the track, accurately defined both horizontally and vertically, along which the rail vehicles operate.
Rail corridor	The corridor within which the rail tracks and associated infrastructure are located.
Watercourse	A watercourse is defined in the *Water Act 2000* as a river, creek or other stream which includes a stream in the form of an anabranch or a tributary where water flows either permanently or intermittently, regardless of flow frequency. In this report, reference to a 'watercourse' is generally made in relation to the management of water resources, consistent with the purpose of the *Water Act 2000.*
Waterway	A waterway is defined in the *Fisheries Act 1994* as a river, creek, stream, watercourse or inlet of the sea, including both permanent and ephemeral waterways, and drainage features. Waterways providing for fish passage are a Matter of State Environmental Significance, and works within a waterway may require a development application or must achieve compliance with accepted development requirements. Waterways are generally more widespread than defined watercourses, and are more relevant to the assessment of aquatic ecology values. Therefore, in addition to its statutory meaning under the *Fisheries Act 1994*, 'waterway' has been adopted in this report as the primary term when referring to aquatic ecology habitats (e.g. rivers, creeks and streams) of the impact assessment area.

© ECO LOGICAL AUSTRALIA PTY LTD

Executive Summary

This technical report has been prepared to document aquatic ecology and surface water quality investigations for the Border to Gowrie section of Inland Rail (the Project).

The assessment involved a desktop review of existing information, three aquatic ecology field surveys in June 2018, November 2018 and May 2019, and four surface water field surveys in June 2018, November 2018, February 2019 and April 2019. Additional water quality data were collected at five sites in May 2019, to assist with the interpretation of macroinvertebrate data.

Between 31 and 35 sampling sites were assessed on each field trip, depending on land access arrangements. Many of the ephemeral waterways in the region were dry at the time of sampling, including at times following recent rainfall. In such instances, a habitat assessment was completed, and sampling of water quality and aquatic values occurred at larger waterways nearby. Between 14 and 18 sites had sufficient water during each field trip to collect samples for the analysis of water quality.

Field studies involved the assessment of surface water quality (physico-chemical, nutrients, chlorophyll *a* and dissolved metals), a physical habitat assessment, macroinvertebrate sampling per Queensland AusRivAS protocols and targeted fish surveys. Potential impacts of the Project were assessed by implementing a qualitative significance assessment, based on the sensitivity of environmental receptors to Project impacts and the expected magnitude of environmental impacts.

A number of protected species are known or have the potential to occur in the impact assessment area. This includes the sedge *Fimbristylis vagans* (potential to occur), and the Platypus (known to occur), which are listed as Vulnerable and Special Least Concern respectively under the *Nature Conservation Act 1992* (Qld). The Murray Cod, which is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), was confirmed to be present during the field assessments within both the Macintyre River and Macintyre Brook. The Agassiz's Glassfish was also confirmed to be present in the Macintyre River, with the western (i.e. Murray-Darling Basin) populations of this species listed as endangered under the NSW *Fisheries Management Act 1994*. Other listed flora and fauna species have been determined as unlikely to occur in the impact assessment area, including Silver Perch and Bell's Turtle for which there is no suitable habitat present within the impact assessment area.

Some mapped wetlands and groundwater dependent ecosystems occur throughout the impact assessment area, adjacent to the proposed rail alignment. Waterways to be intersected by the rail alignment are mostly ephemeral and were assessed to be in fair condition overall. Other land uses in the region, particularly agriculture, are likely to have resulted in some degradation of surface water quality and aquatic ecology values in local waterways.

The impact assessment identified that the sensitivity of aquatic ecology and surface water quality values to impacts from the Project ranged from negligible to moderate in scale, following the application of mitigation measures. The highest sensitivities (moderate) were associated with:

- Invasion of aquatic habitats by weed and pest species during the construction phase
- Declines in water and sediment quality from bank erosion, and the runoff of sediments and contaminants into waterways during the construction phase.

However, these risks can be effectively managed through a range of design features (e.g. bridges spanning waterways in preference to culverts) and through the development and implementation of

© ECO LOGICAL AUSTRALIA PTY LTD

detailed environmental management plans during detail design, pre-construction, construction and operation phases of the Project.

There is limited potential for cumulative impacts from other projects in the region that either currently exist or are planned in the future. Cumulative impacts were assessed to be limited to construction and operation phase activities that may influence water quality and aquatic ecology values downstream of the Project.

© ECO LOGICAL AUSTRALIA PTY LTD

1 Introduction

1.1 Background

The Australian Rail Track Corporation (ARTC) proposes to transform the way freight is moved around the country through construction of the Inland Rail project. The Inland Rail project will augment the existing national freight network between Melbourne and Brisbane via regional Victoria, New South Wales (NSW) and Queensland (QLD). The new rail line will be the largest freight rail infrastructure project in Australia, with a proposed corridor length of 1,700 km.

The Project is 216.2 km in length and extends from the NSW/QLD border at Kurumbul, approximately 18 km south east of Goondiwindi, to Gowrie, west of Toowoomba, in Queensland.

For a full project description, reference should be made to Chapter 5: Project description in the Border to Gowrie Project draft Environmental Impact Statement (EIS).

1.2 Objectives and scope of works

The objectives of the aquatic ecology and surface water study were to contribute to the draft EIS by:

- Conducting an assessment of the existing environmental values of the impact assessment area in relation to aquatic ecology and surface water quality values
- Assessing the potential impacts of the Project on these values
- Detailing mitigation measures to avoid or reduce impacts
- Outlining monitoring requirements that are relevant to the management of aquatic ecology and surface water quality values.

Eco Logical Australia (ELA) was engaged by Future Freight Joint Venture (FFJV) to conduct the following scope of works to achieve the objectives of the study:

- Conduct three surveys of aquatic ecology values at selected sites along the rail corridor. Surveys were to include physical habitat assessment for the first field trip, with subsequent aquatic ecology surveys to include assessment of macroinvertebrates and fish
- Conduct four surveys of surface water values at selected sites along the rail corridor, with two surveys occurring at the same time as aquatic ecology surveys. Water quality assessments were to include assessment of a dissolved metals suite (eight metals), pH, total suspended solids, turbidity, speciated nitrogens (ammonia, nitrate, nitrite, organic nitrogen, oxidised nitrogen, total kjeldahl nitrogen, total nitrogen), total phosphorus, chlorophyll *a*, reactive phosphorus, polycyclic aromatic hydrocarbons (PAHs), electrical conductivity and salinity.
- Conduct an impact assessment to address the Terms of reference for an environmental impact statement: Inland Rail – Border to Gowrie project (ToR, November 2018; DSDMIP 2018).

Environmental studies of aquatic ecology and surface water and the associated impact assessments were conducted in accordance with the following:

- The ToR for the Project
- The AusRivAS Physical Assessment Protocol for the Assessment of Freshwater Streams (Parsons *et al*. 2002)
- ANZECC (2000) Water Quality Guidelines, which were updated during the assessment (ANZECC 2018)

© ECO LOGICAL AUSTRALIA PTY LTD

- Queensland Water Quality Guidelines (DEHP 2013)
- Water Quality Monitoring and Sampling Manual (DES 2018a)
- Survey Guidelines for Australia's threatened fish (SEWPAC 2011).

1.3 Terms of reference

Sections of the ToR relevant to the assessment of aquatic ecology and surface water values are summarised in **Table 1**, along with notes on where these requirements are addressed in this report.

Table 1 Summary of ToR relevant to aquatic ecology and surface water (Coordinator General, 2018)

ToR Section	Summary of requirement	Where addressed in this report
11.26	Addresses listed threatened species and communities	Section 2.1, 2.2 and 4.4
11.29	List of potential listed threatened species and their status	Section 4.4, Appendix B
11.45	Describes potential impacts of in stream works on hydrology and water quality	Section 5.1
11.47	Addresses how water quality would be monitored and how impacts on water quality are to be avoided/minimised	Section 5.2
11.48	Describes appropriate management and mitigation strategies which include discharge of contaminants and sediments during construction	Section 5.2
11.50	Propose suitable measures to avoid or mitigate impacts of stream works on water quality and the stabilisation/rehabilitation of any works.	Section 5.2
11.54	Addresses local impacts to alterations of riparian vegetation, bank and channel morphology and groundwater dependent ecosystems	Section 5.1 and 5.2
11.94	Identifies and describes matters of state environmental significance, state, ecological areas, regionally significant biodiversity and natural environmental values or terrestrial and aquatic ecology likely to be impacted	Section 4.2, 4.3, 4.4 and 4.5
11.95	Describes likely impacts on biodiversity and natural environmental values of affected areas arising from construction and operation of project	Section 5.1
11.96	Describes any proposed measures to avoid, minimise or mitigate potential impacts on natural values, and enhance these values	Section 5.2
11.97	Addresses requirement for construction of fauna movement corridors with regard particularly to waterway barriers to fish movement	Section 5.2 and 5.3
11.100	Addresses the need and suitability to provide fauna passage between habitat fragmented by rail.	Section 5.2 and 5.3
11.102	Identifies current distribution of animal pests and weeds on the proposed alignment.	Section 4.4
11.103	Surveys of animal pests and weeds should be undertaken in those areas identified during the desktop assessment as containing listed flora, fauna or ecological communities of national or state environmental significance	Section 4.2

© ECO LOGICAL AUSTRALIA PTY LTD

ToR Section	Summary of requirement	Where addressed in this report
11.104	Addresses the impact that the Project's construction and operation will have on the spread of pest animals, weed species and disease along the proposed alignment and surrounding lands	Section 4.2; 5.1
11.105	Addresses proposed measures to control and limit spread to pests, weeds and disease	Section 5.2 and 5.3
11.117	Describe the existing noise and vibration environment that may be affected by the Project in the context of the environmental values.	Section 5.1
11.120	Describes noise and vibration emissions (including fugitive sources) that may occur during construction, commissioning and operation.	Section 5.1
11.122	Discusses the Project components likely to present an impact on noise and vibration for the construction and operation phases of the Project	Section 5.1
11.124.	Describe how the proposed project would be managed to be consistent with best practice environmental management for the activity	Section 5.2 and 5.3
11.153	Describe strategies and methods to be used to prevent, manage or remediate any land contamination resulting from the Project, including but not limited to the management of any acid generation or management of chemicals and fuels to prevent spills or leaks.	Section 5.2

1.4 Overview of the Project

The Project includes the establishment of 216.2 km of new single track railway, consisting of 7.0 km of standard gauge rail (1,435 mm) and 209.2 km of dual gauge rail (standard (1,435 mm) and narrow (1,067 mm) gauge).

The 7.0 km of standard gauge rail is a continuation of track from the North Star to NSW/QLD Border project and extends from the NSW/QLD border to the tie-in point with the South Western Line at Kurumbul. The remainder of railway for the Project will be dual standard/narrow gauge to enable interoperability with the existing Queensland Rail network.

The Project is located in the local government areas of Goondiwindi and Toowoomba regional councils. The Project will ultimately accommodate trains up to 3,600 m long, but initially will be constructed for 1,800 m long train sets.

The Project commences at the NSW/QLD border, the median line of the Macintyre River, approximately 18 km to the south east of Goondiwindi near Kurumbul. From this crossing point the alignment heads in a northerly direction for approximately 6 km before joining the Queensland Rail South Western Line to the east of Kildonan. The South Western Line is followed through Yelarbon towards Inglewood before turning off and becoming a greenfield alignment near Whetstone. The alignment skirts the hills to the west of Inglewood and then follows a new corridor that is approximately parallel with Inglewood-Millmerran Road, until joining the Millmerran Branch Line between Millmerran and Yandilla.

© ECO LOGICAL AUSTRALIA PTY LTD

The Millmerran Branch Line is disused in parts due to the 2011 flood impacts, however the line is regarded as operational. The Millmerran Branch Line crosses the Condamine River floodplain and associated watercourses and waterways. The alignment continues via Pampas and Brookstead and deviates to the north and around Pittsworth, following the northern side of the Gore Highway. The alignment follows the intent of this existing rail corridor through to Southbrook, although geometric constraints prevent it from remaining within the corridor.

From Southbrook the alignment is greenfield once again and traverses to the west of Toowoomba Wellcamp Airport. The alignment passes to the west of Gowrie Mountain and crosses the Warrego Highway before termination between Leeson Road and Draper Road, on the southern outskirts of Kingsthorpe.

A broad 2 km wide impact assessment area was identified, within which lies the rail corridor including rail tracks and associated infrastructure (**Figure 1**). The focus of the assessment for aquatic ecology and surface water is those parts of the rail corridor that intersect with watercourses, waterways or other aquatic ecology or surface water values, hereafter referred to as the impact assessment area. The impact assessment area comprises those aspects of the aquatic environment that may be directly impacted by the Project, and adjacent areas that may be subject to indirect impacts. While the distance over which indirect impacts may occur is variable, the impact assessment area is defined as the area located within a 2 km buffer from the proposed rail alignment.

© ECO LOGICAL AUSTRALIA PTY LTD

Fig 1. Border to Gowrie rail corridor and impact assessment area

Legend

- Border to Gowrie Rail Alignment
- Impact Assessment Area

0 15 30
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

2 Legislation and guidelines

This section provides an overview of legislation and guidelines that are relevant to the assessment of aquatic ecology and surface water.

2.1 Commonwealth legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth; EPBC Act) is the key piece of Commonwealth environmental protection legislation. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – defined in the EPBC Act as Matters of National Environmental Significance (MNES).

The EPBC Act requires that proposals, or actions, that have the potential to significantly impact on MNES or the environment of Commonwealth land be referred to the Australian Minister for the Environment.

The Project was referred to the Minister for the Environment on 16 February 2018 and was subsequently deemed to be a controlled action due to potentially significant impacts on listed threatened species and communities (Section 18 and 18A of the EPBC Act).

2.1.2 Water Act 2007

The *Water Act 2007* (Cth) provides the legislative framework for ensuring that Murray Darling Basin (Australia's largest water resource) is managed in accordance with Australia's national interests. Watercourses of the impact assessment area are located within the Murray Darling Basin and are subject to the Murray Darling Basin Plan – a strategic plan for the integrated and sustainable management of water resources in the Murray Darling Basin. The Queensland Government has prepared Healthy Waters Management Plans to meet accreditation requirements under the Commonwealth *Water Act 2007* – Basin Plan 2012 (Commonwealth of Australia 2012).

The Act recognises that Australian states in which the Murray Darling Basin is located continue to manage water resources within their jurisdictions. The Act:

- Establishes the Murray Darling Basin Authority with the functions and powers, including enforcement powers, needed to ensure that Basin water resources are managed in an integrated and sustainable way
- Establishes a Commonwealth Environmental Water Holder to manage the Commonwealth's environmental water to protect and restore the environmental assets of the Murray Darling Basin, and outside the Basin where the Commonwealth owns water
- Provides the Australian Competition and Consumer Commission with a key role in developing and enforcing water charge and water market rules along the lines agreed in the National Water Initiative
- Gives the Bureau of Meteorology water information functions that are in addition to its existing functions under the *Meteorology Act 1955*
- Gives the Productivity Commission a role in reporting on the effectiveness of the implementation of the Murray-Darling Basin Plan and water resource plans and the progress towards achieving the objectives and outcomes of the National Water Initiative.

© ECO LOGICAL AUSTRALIA PTY LTD

The Project spans three catchments (**Figure 2**). Between the NSW/QLD border and Gowrie, the Project is located within the Macintyre River catchment and from Yelarbon to Millwood the Project is located in the Macintyre Brook catchment of the Queensland Border Rivers drainage basin. North of Millwood the Project is located within the Condamine River catchment of the Balonne-Condamine drainage basin. Both the Queensland Border Rivers and Balonne-Condamine drainage basins are situated within the Murray Darling Basin.

2.2 Queensland legislation

2.2.1 Planning Act 2016

The purpose of the *Planning Act 2016* (Qld) is to provide an efficient, effective, transparent, integrated, coordinated and accountable system of land use planning, development assessment and dispute resolution to facilitate the achievement of ecological sustainability. The Project will be likely to trigger approval requirements for some aspects of development under the *Planning Act 2016*, following completion of the EIS.

2.2.2 Environmental Protection Act 1994

The objective of the *Environmental Protection Act 1994* (Qld; EP Act) is to protect Queensland's environment by promoting ecologically sustainable development. The EP Act has been designed to achieve its objective by setting out a program for the identification and protection of environmental values and through a range of regulatory tools. The EP Act outlines a 'general environmental duty', which specifies that persons must not carry out an activity that causes, or is likely to cause, environmental harm, unless the person takes all reasonable and practical measures to prevent or minimise the harm.

The quality of Queensland waters is protected under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity), which is a subordinate instrument to the EP Act. Environmental values and water quality objectives are being progressively determined for areas of Queensland under the EPP Water and Wetland Biodiversity. Healthy Waters Management Plans were published for the impact assessment area in 2019, specifying environmental values and water quality objectives for several water quality zones (see **Section 4.1**).

Post-EIS approvals may involve Environmentally Relevant Activities and will be regulated under the EP Act.

2.2.3 Water Act 2000

The *Water Act 2000* (Qld) (Water Act) provides the framework to deliver sustainable water planning, allocation management and supply processes to ensure security of water resources in Queensland. Water suppliers are the primary focus of the Water Act through the administration of the *Water Regulation 2016*. The Project involves works within watercourses that are defined under the Water Act, and may require a Riverine Protection Permit to excavate, place fill or disturb native vegetation in a watercourse.

2.2.4 Vegetation Management Act 1999

The *Vegetation Management Act 1999* (Qld) (VM Act) regulates and manages the process and impacts of native vegetation clearance, including riparian vegetation fringing watercourses. The objectives of the VM Act include conservation of remnant regional ecosystems, prevention of the loss of biodiversity, maintenance of ecological processes, and conservation of vegetation in areas of high nature conservation value or lands vulnerable to land degradation.

Generally, clearing of relevant remnant or regulated regrowth vegetation requires a development approval under the *Planning Act 2016*, subject to a number of exemptions, including for Government supported transport infrastructure.

© ECO LOGICAL AUSTRALIA PTY LTD

2.2.5 Nature Conservation Act 1992

The object of the *Nature Conservation Act 1992* (Qld) *(*NC Act) is to conserve nature through an integrated and comprehensive conservation strategy for the whole of Queensland involving (but not limited to) the following:

- Gathering of information and community education
- Dedication and declaration of protected areas
- Management of protected areas
- Protection of native wildlife and its habitat
- Use of protected wildlife and areas to be ecologically sustainable
- Recognition of interest of Aboriginal people and Torres Strait Islanders in nature and their cooperative involvement in its conservation
- Cooperative involvement of landholders.

The NC Act requires permits for activities that include the taking of protected plants and the moving of protected animals, or activities in protected areas, which are likely to be required for the Project.

2.2.6 Biosecurity Act 2014

The *Biosecurity Act 2014* (Qld) ensures a consistent, modern, risk-based approach to biosecurity in Queensland. The *Biosecurity Act 2014* provides comprehensive biosecurity measures to safeguard Queensland's economy, agricultural and tourism industries and the environment from:

- Pests (e.g. Wild dogs and weeds)
- Diseases; and
- Contaminants

The *Biosecurity Regulation 2016* describes matters that are declared to be 'prohibited' or 'restricted' matters. There is a 'general biosecurity obligation' described under the *Biosecurity Act 2014*, which states that everyone is responsible for managing biosecurity risks that are under their control, or that they know about, or should reasonably be expected to know about. This Act is likely to apply to project activities such as the use of machinery for earthworks, and the dewatering of farm dams, which may result in the spread of weeds and pests, if practical precautions are not taken.

2.2.7 Fisheries Act 1994

Waterway barrier works are regulated under the *Fisheries Act 1994* and the *Planning Act 2016* when barriers to fish movement, including partial barriers, are installed across waterways. Barrier works include construction, raising of structures such as culvert crossings, bed level and low level crossings, weirs and dams, both permanent and temporary. The legislation allows for self-assessment for low impact, minor, temporary and some regularly rebuilt waterway barriers. Works that adhere to the standards and requirements of the Department of Agriculture and Fisheries (DAF) *Accepted development requirements for operational work that is constructing or raising waterway barrier works (1 October 2018*; Department of Agriculture and Fisheries 2018) are able to proceed without development approval. Also, some instream works and types of structures that comply with Fisheries Queensland's factsheet, "What is not a waterway barrier work? (DAF 2017a)" are not considered to be waterway barriers.

The Queensland Waterways for Waterway Barrier Works (WWBW) data set shows the extent of the *Fisheries Act 1994* interest in barrier works on waterways, including within the impact assessment area. This data layer also indicates whether waterway barrier works are likely to proceed under the relevant DAF self-assessable code or require a development approval.

2.3 Relevant guidelines, strategies and plans

2.3.1 ANZECC Guidelines (2000, 2018)

The *ANZECC Water Quality Guidelines* provide water managers with tools and guidance to assess, manage and monitor water quality. They include default guideline values, which if exceeded indicate that further analysis may be required to ensure aquatic ecosystems are adequately protected. These guidelines provide a starting point for assessing water quality, in conjunction with local guidelines.

2.3.2 Queensland Water Quality Guidelines

The *Queensland Water Quality Guidelines* (DEHP 2013) provide water quality guidelines values that are tailored to Queensland regions and water types, as well as outlining a framework for deriving and applying more locally-specific guidelines for waters in Queensland. However, there are no guidelines specified for the Murray Darling Basin of Queensland.

2.3.3 DES Water Monitoring and Sampling Manual

The *Monitoring and Sampling Manual* (DES 2018a) provides an overview of the common techniques, methods and standards for the collection, handling, quality assurance and control, custodianship and data management in relation to water quality samples. The manual helps to ensure that monitoring data are collected in a consistent and scientifically-accurate manner.

2.3.4 Queensland AusRivAS Sampling and Processing Manual

The *Queensland AusRivAS Sampling and Processing Manual* (DNRM 2001) describes a bioassessment methodology adopted by the Department of Natural Resources and Mines, with a focus on the assessment of macroinvertebrates in freshwater streams. It is the protocol used by the Queensland AusRivAS models and is adapted from the River Bioassessment Manual (Davies 1994).

2.3.5 AusRivAS habitat assessment protocol

The AusRivAS habitat assessment protocol (Parsons *et al*. 2002) describes a protocol for the physical assessment of stream and river condition. The protocol is a stand-alone method of physical and geomorphological assessment. However, it also provides for the biological assessment of stream condition using AusRivAS methods.

2.3.6 Local water quality guidelines

The *ANZECC Guidelines* (2000, 2018) recognise the importance of developing local water quality guidelines from regional data. In February 2019, the Department of Environment and Science (DES) published *Healthy Waters Management Plans for the Condamine River Basin* and *Queensland Border Rivers and Moonie River Basins* (DES 2019a, b) after a period of public consultation in 2018.

The Healthy Waters Management Plans have been prepared to meet accreditation requirements under the 'Commonwealth *Water Act 2007* – Basin Plan 2012'. The plans confirm the environmental values in terms of desired levels of aquatic ecosystem protection, water quality objectives and management responses under the EPP Water and Wetland Biodiversity. The plans therefore provide locally-relevant water quality guidelines for the assessment of surface water quality results obtained during field surveys for the Project.

2.3.7 Other guidelines

Several other guidelines were also consulted in relation to the assessment of fish passage at waterways at the NSW/QLD border, and the assessment of aquatic ecology values in Queensland:

- *Policy and guideline for fish habitat conservation and management* (NSW Government 2013)

- *Why do fish need to cross the road – fish passage requirements for waterway crossings* (Fairfull and Witheridge 2003)
- *What is a waterway?* (Queensland Government 2017)
- *Guidelines for groundwater dependent ecosystems* (Queensland Government 2018a)
- *Aquatic ecology – Assessment of aquatic ecological values* (Queensland Government 2018b)
- *What is a waterway barrier work?* (DAF 2017b) and *What is not a waterway barrier work?* (DAF 2017a)
- *Draft Biosecurity Plan for Invasive Plants and Animals* (TRC 2020)

© ECO LOGICAL AUSTRALIA PTY LTD

3 Methods

3.1 Overview of the impact assessment area

The proposed rail alignment is shown in **Figure 2** and incorporates two major basins of the Murray Darling river system; the Condamine and the Queensland Border Rivers. Major watercourses within the impact assessment area include the Macintyre River, Pariagara Creek, Condamine River and Bringalily Creek. However, the majority of watercourses and waterways in the impact assessment area are ephemeral, holding water only during the wet season or following periods of heavy rainfall.

3.2 Desktop assessment

A desktop assessment was undertaken to identify potential aquatic ecological features and constraints that may occur within the impact assessment area. The following databases and maps were reviewed:

- EPBC Act Protected Matters Search Tool (PMST), undertaken with a 10 km buffer around the rail alignment (approximately digitised into the online tool)
- Wildlife Online Database Search, a rectangular area that encompassed the entire rail alignment for all aquatic fauna and flora species listed and individual records of listed species
- Atlas of Living Australia database using a 10 km buffer around the rail alignment for all aquatic flora and aquatic fauna species listed and for all aquatic fauna records
- Queensland Matters of State Environmental Significance (MSES) mapping (DILGP 2015) which includes wetlands, and waterways mapped as per the spatial data layer Queensland waterways for waterway barrier works.
- DES Protected Plants Flora Survey Trigger Area mapping (DEHP 2014b), as it applies to aquatic plants
- DES wetland mapping (DES 2018b)
- VMA stream order mapping (DNRM 2015)
- Aquatic Conservation Assessments (ACA) and Aquatic Biodiversity Assessment Mapping Method (AquaBAMM) of DES (Queensland Globe 2019)
- Aerial imagery.

Reference was also made to previous information of relevance to the selection of a route for the Project, as described in EIS Chapter 2: Project Rationale.

Environmental values and water quality objectives for the Condamine River Basin and the Queensland Border Rivers Basin were determined by reviewing the guideline documents listed in **Section 2.3**.

3.3 Likelihood of occurrence assessment

The likelihood of occurrence of each aquatic species identified in the desktop assessment that is listed as threatened under the EPBC Act or listed as Endangered, Vulnerable or Near Threatened (EVNT) or Special Least Concern (SLC) under the NC Act was assessed, based on the species' known distribution, habitat quality within the impact assessment area, species occurrence within the region and species occurrence within the impact assessment area. Each species was assessed as known, likely, possible or unlikely to occur within the impact assessment area based on the following criteria:

- **Known** – the species has been recorded within the impact assessment area

© ECO LOGICAL AUSTRALIA PTY LTD

- **Likely** – the impact assessment area is within the species' known distribution; suitable good quality habitat occurs within the area and the species is known to occur within the region
- **Possible** - the impact assessment area is within the species' known distribution; marginal habitat occurs within the area and the species is known to occur within the region
- **Unlikely** – there is a low probability that the species will occur within the impact assessment area as it is outside the species known distribution, low quality habitat occurs within the area or the species is not known to occur within the region.

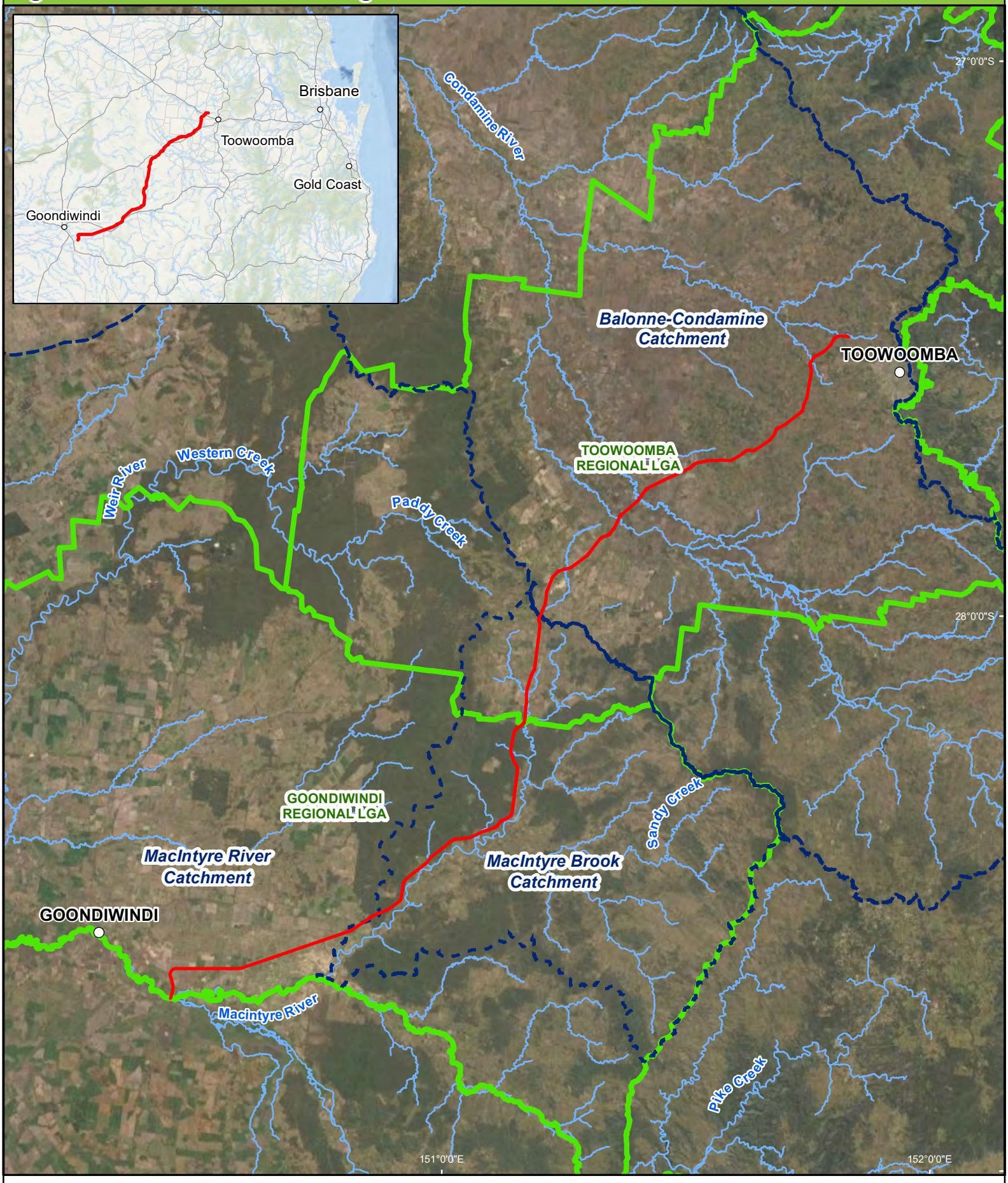
Likelihood assessments were initially conducted prior to undertaking field surveys, and then updated to include results post-field survey. Such updates were associated with:

- Changing the assessment of likelihood to 'known' in the event that a species was found to be present during the field surveys, or
- Reducing the likelihood of occurrence, based on an absence of habitat within the impact assessment area

The likelihood score was not downgraded in response to a failure to detect a species during field surveys, when habitat suitable for the species was identified within the impact assessment area. This approach accommodates natural changes in the distribution and abundance of some aquatic species over time, and was developed in acknowledgement of the limitations of field sampling methods, which may not capture all target species present at the time of sampling, particularly during dry periods.

© ECO LOGICAL AUSTRALIA PTY LTD

Fig 2. Border to Gowrie Rail Alignment



Legend

- Border to Gowrie Rail Alignment
- Watercourse
- Catchment
- Local Government Area

0 15 30
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 19/06/2020

3.4 Field surveys

3.4.1 General approach and timing of survey

A schedule of field activities was developed to determine the aquatic and surface water values of the impact assessment area. The focus of aquatic ecology assessments was to assess a representative number of sites along the rail alignment, with emphasis on habitat values at risk of disturbance.

In order to capture seasonal variation in the abundance of fish and macroinvertebrates, two aquatic ecology surveys were scheduled – one in June 2018 and one in November 2018. This timing was selected to be consistent with the *Queensland AusRivAS Sampling and Processing Manual* (DNRM 2001), which specifies that the preferred timing of surveys is May to July (referred to as the 'late wet') and October to December (referred to as the 'early wet'). Rainfall patterns across the Darling Downs are aligned with this survey timing, with highest rainfall generally occurring in the region between the months of October and March (BOM 2019). A delay between sampling and large rainfall events of at least four weeks is desirable, to allow macroinvertebrate communities to develop sufficiently following the disturbance associated with flood events (DNRM 2001).

Surface water quality values are likely to be more variable than those of aquatic ecology habitats, as they are influenced by runoff events from periods of rainfall and adjacent land use. Hence, four surface water field surveys were planned (as recommended in the AusRivAS manual) approximately three months apart, with two surveys undertaken at the same time as the aquatic ecology surveys and the remaining two surveys scheduled for September 2018 and February 2019.

However, the September 2018 water quality survey did not take place, due to dry conditions across the impact assessment area. Instead, two follow up water quality field assessments were scheduled for February and March 2019, when water was more likely to be present in local waterways. A final aquatic ecology survey was also scheduled for May 2019, to undertake further assessment of aquatic ecology values during the AusRivAS 'late wet' period. This approach resulted in the following five field surveys being completed:

- 11 to 20 June 2018 (aquatic ecology and surface water)
- 26 November to 3 December 2018 (aquatic ecology and surface water)
- 11 to 19 February 2019 (surface water only)
- 29 April to 2 May 2019 (surface water only)
- 15 to 19 May 2019 (aquatic ecology comprising macroinvertebrate and fish sampling). Water samples were also collected at the five aquatic ecology sites containing water during this survey, to assist with the interpretation of macroinvertebrate data

Field personnel undertaking the surveys were experienced in the assessment of aquatic ecology values and the collection and analysis of water quality samples. A principal level aquatic ecologist accredited in Queensland under the AusRivAS assessment method led and implemented all five field surveys.

3.4.2 Selection of sampling sites

Forty three sites adjacent to the rail alignment were initially selected as potentially suitable sampling sites. This number was significantly more than what was intended to be surveyed, but allowed for sites to be removed from the selection if land access proved to be problematic or if sites were found to be unsuitable when accessed in the field. The inclusion of a large number of potential sampling sites also provided greater certainty that sufficient water would be present at a representative selection of sites in the event that dry conditions were experienced.

© ECO LOGICAL AUSTRALIA PTY LTD

Sites were positioned as close as possible to locations where the proposed rail alignment traversed watercourses, waterways or drainage features. Sites were nominally assigned into one of the following categories:

- Aquatic ecology site – where an assessment of aquatic ecology habitat values and surface water quality was to be undertaken
- Surface water quality site – where assessment of surface water quality only was to be undertaken

The distribution of aquatic ecology and surface water quality sites along the rail alignment was determined from a range of factors, including:

- Mapping and aerial photography products which provide information on aquatic habitat features, including DAF waterway barriers and DES aquatic habitat mapping
- Inclusion of waterways with a variety of stream orders along the rail corridor, ensuring waterways of varying size and complexity were sampled
- Representation of a variety of aquatic habitat types and surrounding land uses (e.g. areas where remnant riparian vegetation was intact, and areas that had been subject to disturbance from existing infrastructure or agricultural land uses)
- A relatively even spread of survey sites along the rail alignment, to determine spatial variability in aquatic and water quality values
- Practicality of access to the site and the safety of field teams

Where practical, aquatic ecology sites were located at the intersection of the rail alignment and the waterway. A surface water quality site was also generally located upstream and downstream of the aquatic ecology site, if access was possible and the waterway would provide information useful to the impact assessment. This design in the layout of sites in clusters facilitated assessment of surface water and aquatic ecology values in areas where direct disturbance is proposed, as well as adjacent upstream and downstream areas. This approach also provided additional data on the waterway in the instance that the location of the rail corridor changed within the 2 km wide impact assessment area, during the design process.

Consistent and reliable access was obtained for 34 sites that were suitable for the aquatic ecology and surface water assessments. These 34 sites consisted of 12 sites where aquatic ecology and surface water quality assessments were conducted and 22 sites where surface water quality assessments were conducted. A summary of all sites identified for potential sampling is provided in **Table 2** with their location along the rail alignment shown in **Figure 3**. More detailed maps showing the location of sites in clusters relevant to sub-catchments are provided in **Figure 4a-g**.

Sites were assigned a number in approximate numerical order from west to east. On some occasions when a site could not be accessed, an alternative site was identified on public land nearby and labelled with the site number and the letter ‘R’ (e.g. Site 20R). This allowed the assessment of water quality information from areas adjacent to the original site.

Table 2 Sampling sites targeted during the field surveys and associated water quality zone as specified in relevant basin plan (see Section 4.1 for a description of water quality zones)

Site	Assessment type	Waterway	Tenure
Macintyre Barwon Floodplain Water Quality Zone			
1#	Aquatic ecology and surface water	Macintyre River	Private land
2	Aquatic ecology and surface water	Macintyre River	Private land
Lower Macintyre Brook Water Quality Zone			

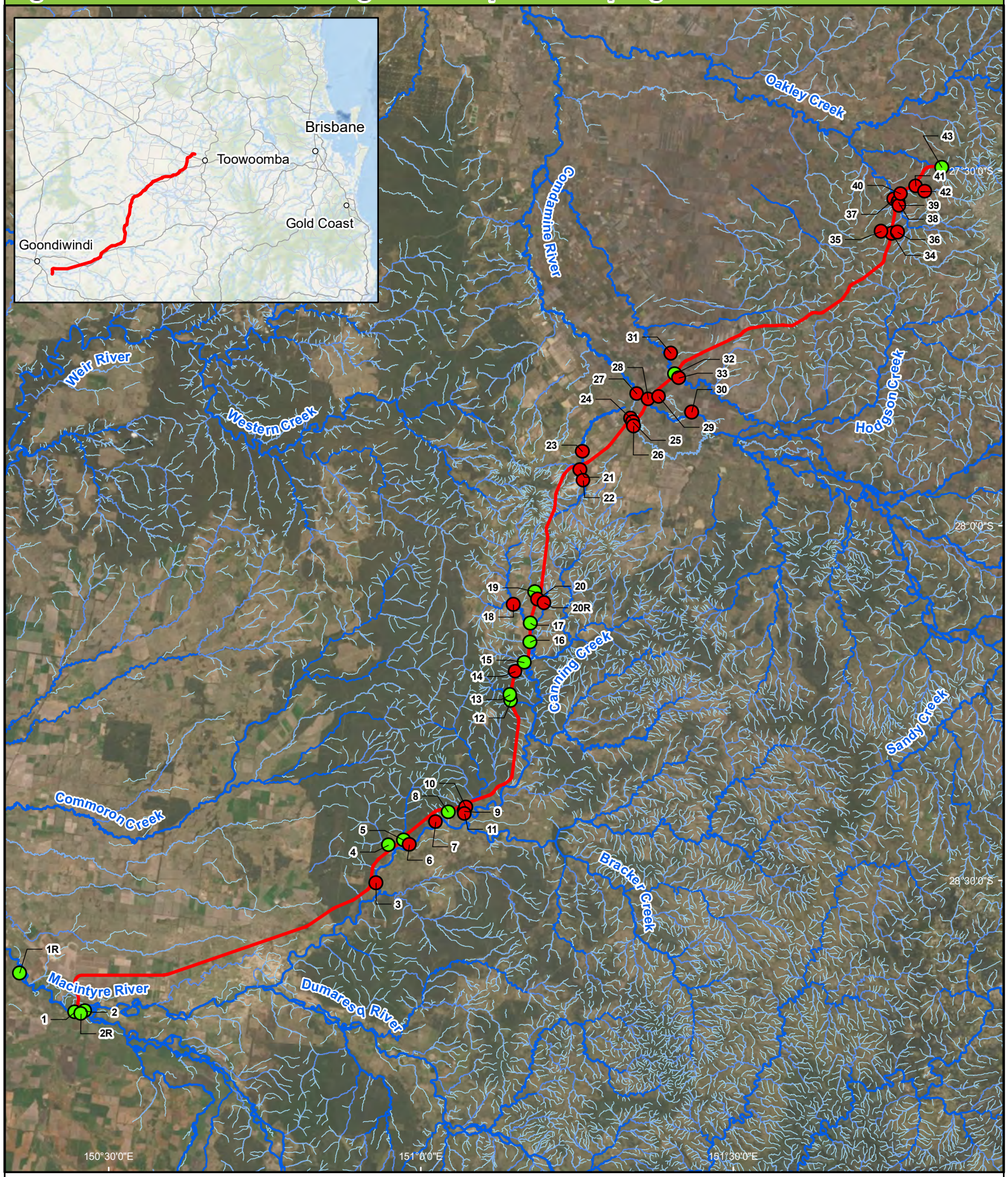
© ECO LOGICAL AUSTRALIA PTY LTD

Site	Assessment type	Waterway	Tenure
3	Surface water	Macintyre Brook	Public land
4	Aquatic ecology and surface water	Unnamed	Public land
5	Aquatic ecology and surface water	Unnamed	Private land
6	Surface water	Macintyre Brook	Private land
7	Surface water	Macintyre Brook	Public land
8	Aquatic ecology and surface water	Unnamed	Private land
Canning Creek Water Quality Zone			
9	Aquatic ecology and surface water	Pariagara Creek	Private land
10	Surface water	Pariagara Creek	Private land
11	Surface water	Canning Creek	Private land
12	Aquatic ecology and surface water	Unnamed	Public land
13	Aquatic ecology and surface water	Cattle Creek	Public land
14	Surface water	Unnamed	Private land
15	Aquatic ecology and surface water	Unnamed	Private land
16	Aquatic ecology and surface water	Unnamed	Private land
17	Aquatic ecology and surface water	Unnamed	Private land
18	Surface water	Unnamed	Public land
19	Aquatic ecology and surface water	Nicol Creek	Public land
20	Surface water	Nicol Creek	Private land
Southern Condamine Water Quality Zone			
21#	Aquatic ecology and surface water	Unnamed	Private land
22#	Surface water	Unnamed	Public land
23	Surface water	Unnamed	Public land
24	Surface water	Grasstree Creek	Public land
25#	Aquatic ecology and surface water	Grasstree Creek	Private land
26#	Surface water	Grasstree Creek	Private land
Central Condamine Water Quality Zone			
27	Surface water	Condamine River	Public land
28	Aquatic ecology and surface water	Condamine River	Private land
29	Surface water	Unnamed	Public land
30	Surface water	Condamine River	Public land
31	Surface water	Condamine River (North Branch)	Public land
32	Aquatic ecology and surface water	Condamine River (North Branch)	Public land
33	Surface water	Condamine River (North Branch)	Public land
Oakey Creek Water Quality Zone			
34#	Aquatic ecology and surface water	Unnamed	Private land
35	Surface water	Unnamed	Public land
36	Surface water	Unnamed	Public land
37#	Surface water	Westbrook Creek	Private land
38#	Aquatic ecology and surface water	Westbrook Creek	Private land
39	Surface water	Westbrook Creek	Public land
40	Surface water	Dry Creek	Public land
41#	Aquatic ecology and surface water	Dry Creek	Private land
42	Surface water	Dry Creek	Public land
43	Aquatic ecology and surface water	Unnamed	Public land

# indicates that access to the site was not reliable for all field surveys or the site was found not to be suitable for assessment

© ECO LOGICAL AUSTRALIA PTY LTD

Fig 3. Border to Gowrie Rail Alignment - Aquatic Sampling Sites



Legend

- Border to Gowrie Rail Alignment
- Major Watercourse
- Minor Watercourse

B2G Sample Sites

- Aquatic Site
- Surface Water Site

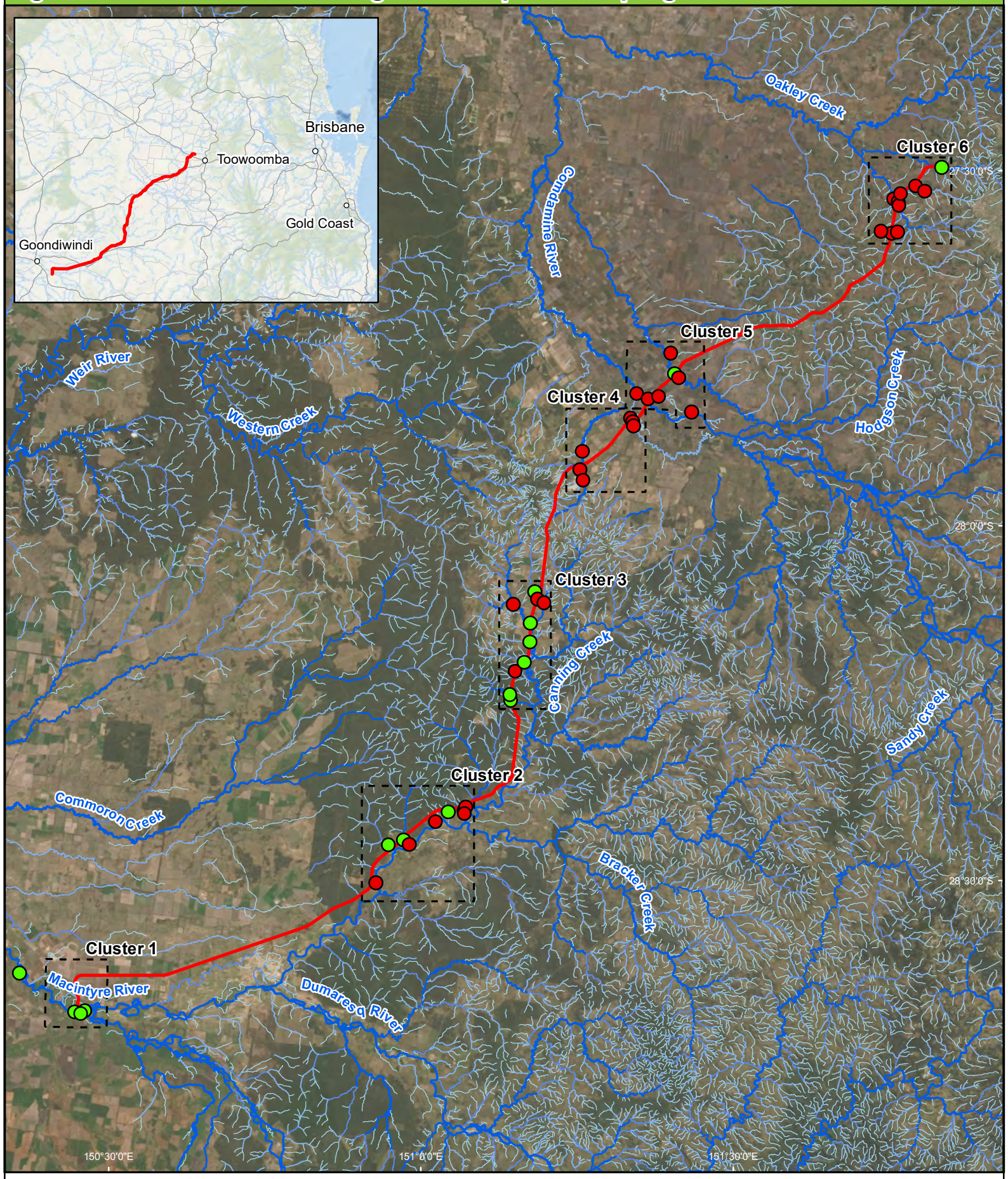
0 10 20
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

Fig 4a. Border to Gowrie Rail Alignment - Aquatic Sampling Sites



Legend

- Border to Gowrie Rail Alignment
- Major Watercourse
- Minor Watercourse

B2G Sample Sites

- Aquatic Site
- Surface Water Site
- Border to Gowrie Aquatic Site Clusters

0 10 20
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 56

N

eco logical AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

Fig 4b. Macintyre Barwon Floodplain Water Quality Zone (Cluster 1 of 6)

Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Watercourse

Stream Order

- 1
- 2
- 6
- 7
- 8
- 9

0 1 2

Kilometers

Datum/Projection:
GDA 1994 MGA Zone 56

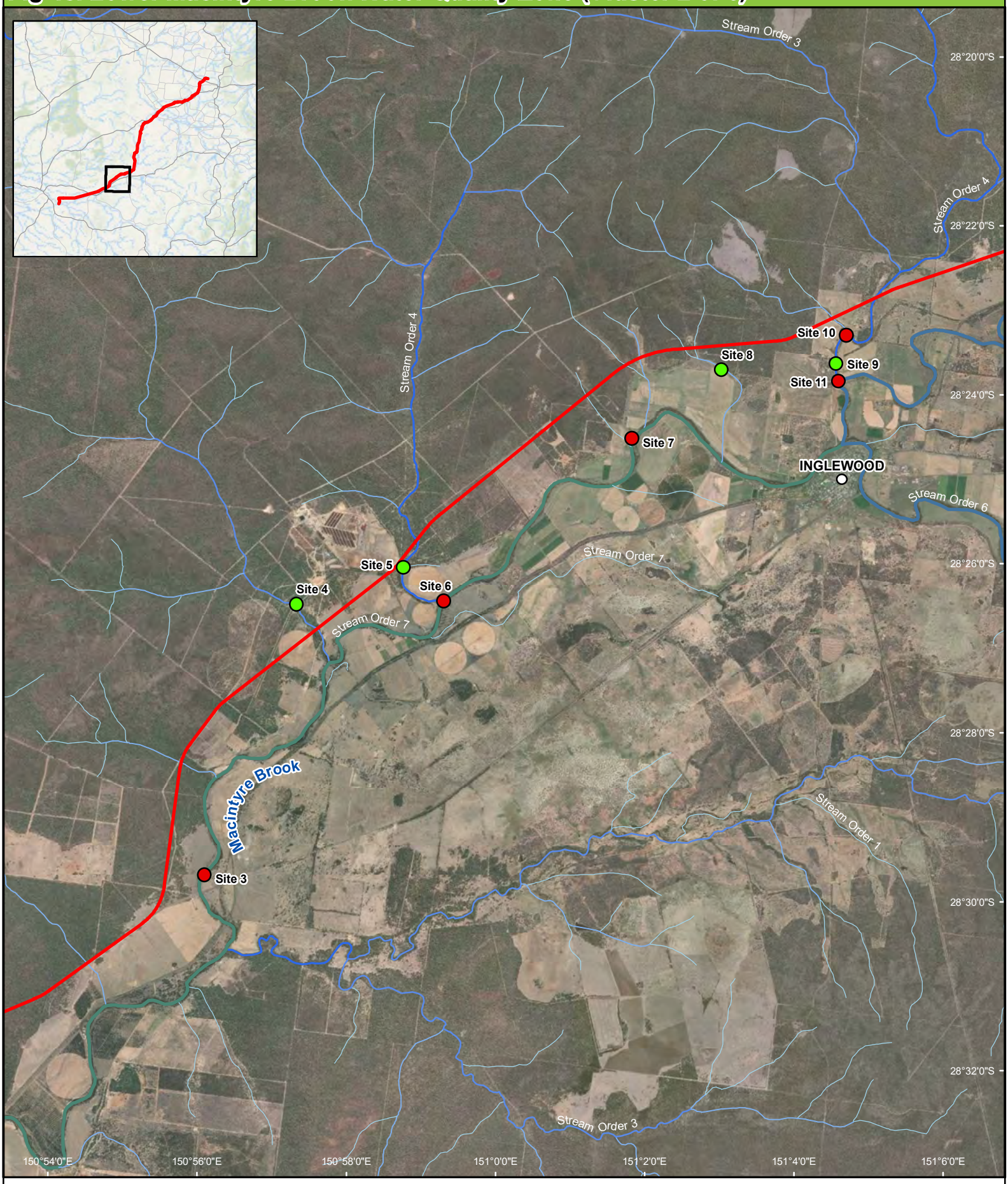
N

ecological AUSTRALIA

www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

Fig 4c. Lower Macintyre Brook Water Quality Zone (Cluster 2 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Watercourse

Stream Order

- 1
- 2
- 3
- 4
- 6
- 7

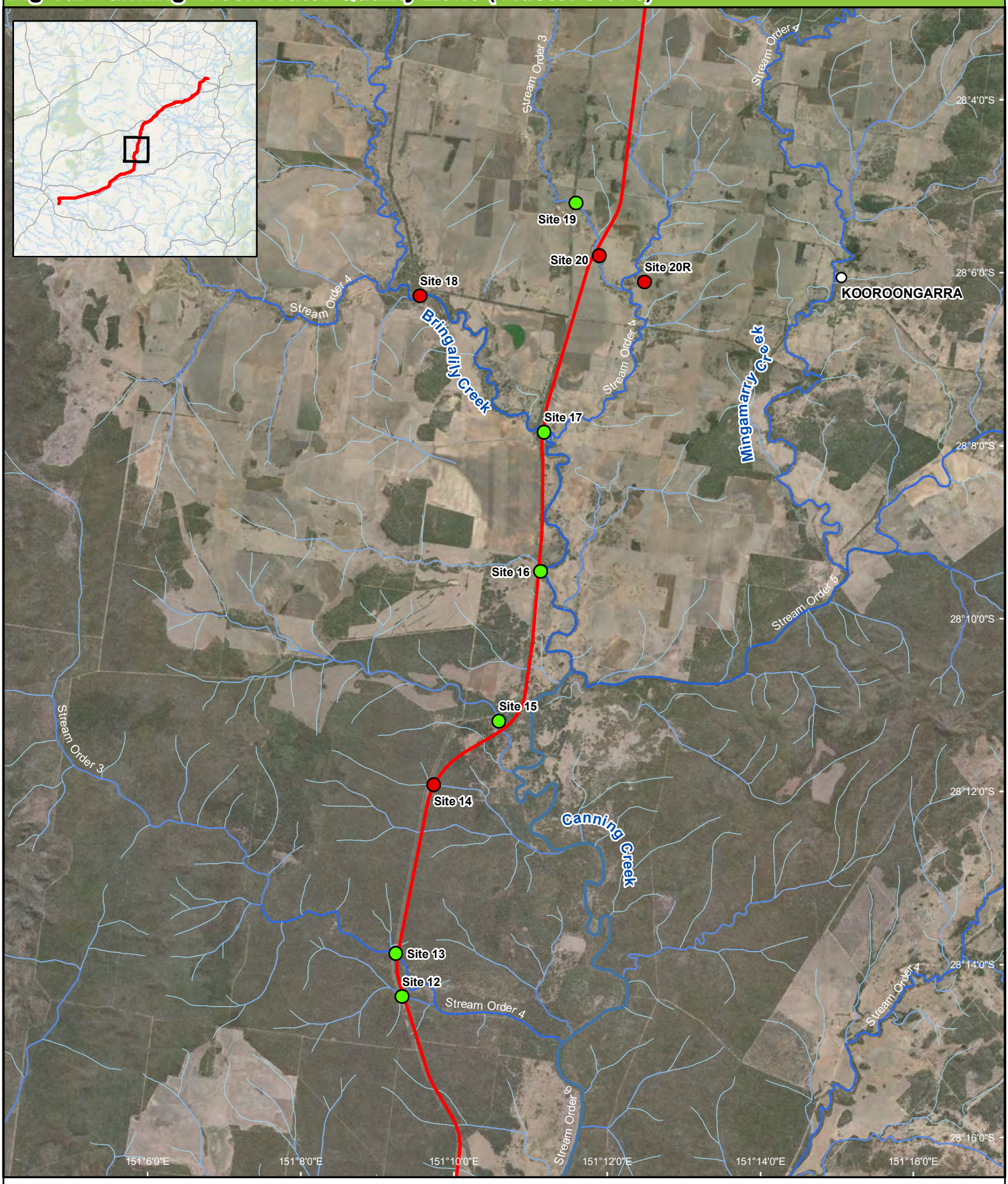
0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

eco logical AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

Fig 4d. Canning Creek Water Quality Zone (Cluster 3 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Watercourse

Stream Order

- 1
- 2
- 3
- 4
- 5
- 6

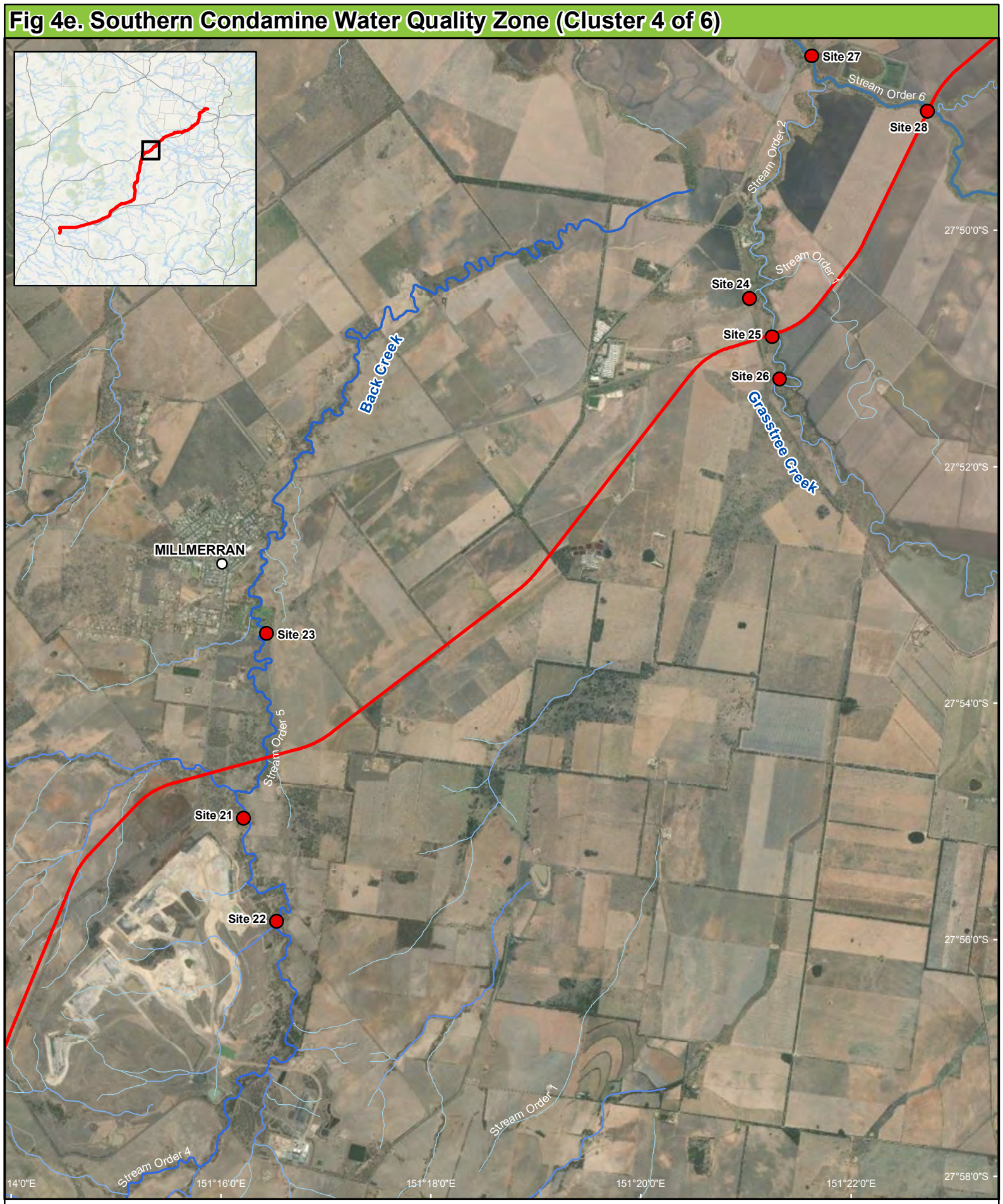
0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

eco logical AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

Fig 4e. Southern Condamine Water Quality Zone (Cluster 4 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Watercourse

Stream Order

- 1
- 2
- 3
- 4
- 5
- 6

0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

Fig 4f. Central Condamine Water Quality Zone (Cluster 5 of 6)

Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Watercourse

Stream Order

- 1
- 2
- 3
- 4
- 5
- 6

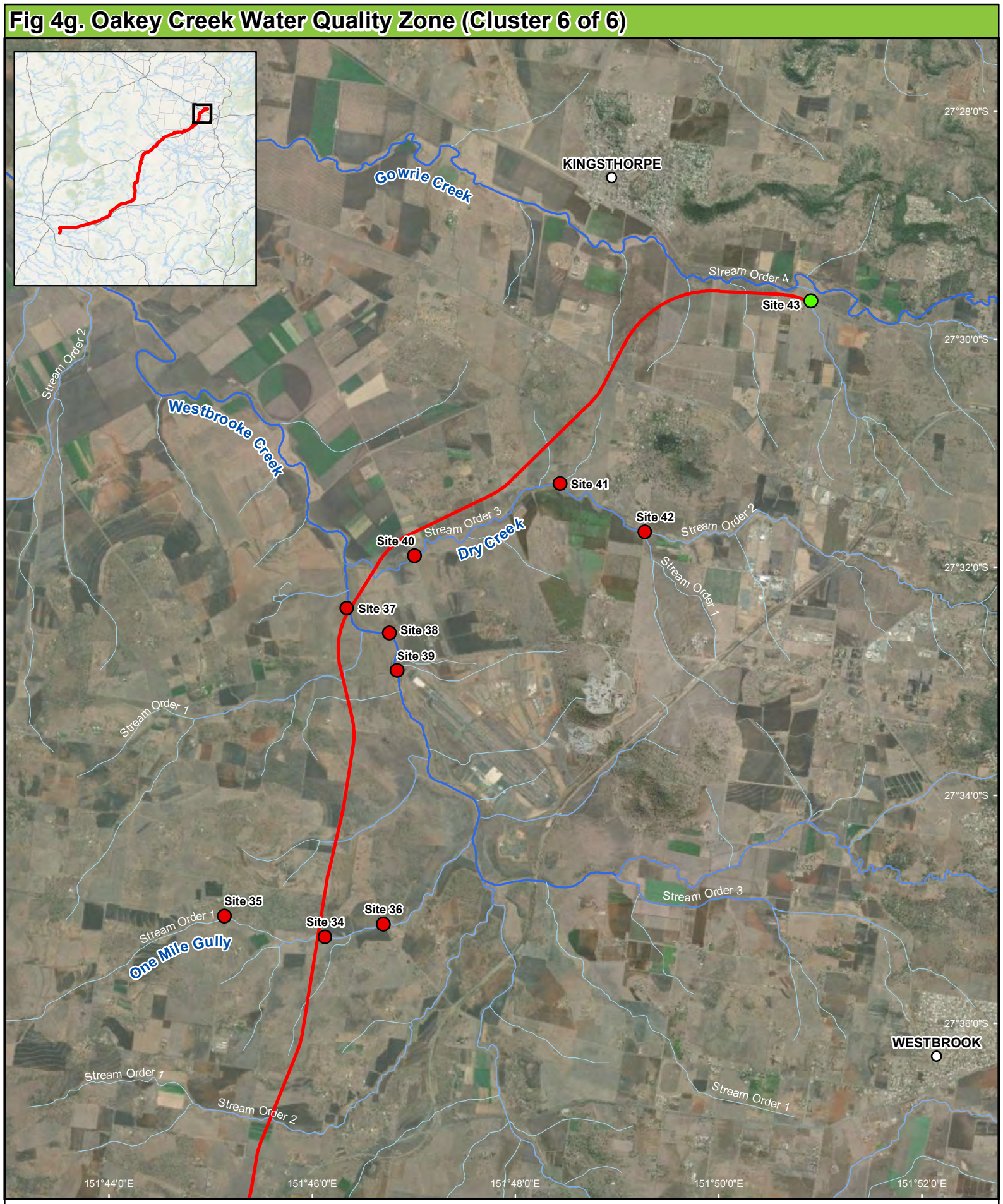
0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

Fig 4g. Oakey Creek Water Quality Zone (Cluster 6 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Watercourse

Stream Order

- 1
- 2
- 3
- 4
- 5

0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

www.ecoaus.com.au

Prepared by: PH Date: 18/06/2020

3.4.3 Aquatic ecology habitat assessment and sampling

Aquatic habitats were assessed at each aquatic ecology site in accordance with the AusRivAS physical habitat assessment protocol (Parsons *et al*. 2002). The following information was collected at each site:

- Site ID and name
- Date and time
- Location (latitude, longitude)
- Photographs in four directions aligned with the flow of water
- Planform sketch of the site
- Bank width and length of sampling site (100 m)
- Valley shape (steep, shallow, broad, gorge, symmetrical floodplain, asymmetrical floodplain)
- Local activities impacting on streams
- Floodplain features and local land uses
- Riparian zone composition including description of vegetation (trees >10 m in height, trees <10 m in height, shrubs and grasses/ferns/sedges)
- Shading of channel (<5 per cent, 6-25 per cent, 26-50 per cent, 51-75 per cent, >76 per cent)
- Extent of trailing bank vegetation (nil, slight, moderate, extensive)
- Native and exotic riparian vegetation (per cent composition)
- Regeneration of native woody vegetation
- Overall vegetation disturbance rating (extreme, very high, high, moderate, low or very low)
- Physical barriers to local fish passage (no passage, very restricted, moderately restricted, partly restricted, good passage, unrestricted passage)
- Type and extent of bars and dominant sediment particle size on bars
- Channel modifications, slope and shape
- Bank shape and slope
- Sediment and water oils
- Sediment and water odours
- Turbidity (visual assessment)
- Water level at time of sampling
- Artificial features of the sampling site
- Large woody debris
- Factors affecting bank stability
- Bedrock outcrops
- Artificial bank protection measures
- Extent of bedform features
- Macrophyte cover and composition
- Bed compaction
- Sediment matrix and angularity
- Bed stability
- Epifaunal substrate/available cover
- Pool substrate characterisation and variability
- Sediment deposition
- Channel alteration and sinuosity
- Bank stability
- Vegetative protection
- Riparian zone
- Filamentous algae, periphyton, moss and detritus cover

© ECO LOGICAL AUSTRALIA PTY LTD

- Substrate composition
- Bank material
- Cross section sketch

The information collected was used to inform an assessment of the suitability of aquatic habitats for key species of interest, such as the Murray Cod, Silver Perch and Bell's Turtle. General site observations and photographs of aquatic habitats were also recorded.

3.4.4 Macroinvertebrate surveys

Macroinvertebrate sampling was undertaken in November 2018 and May 2019. Macroinvertebrate samples were collected in accordance with the Queensland AusRivAS assessment manual (DNRM 2001).

Freshwater macroinvertebrate sampling was undertaken to gain an improved understanding of the aquatic values, waterway health and trophic interactions occurring at each site. Samples were collected from aquatic ecology survey sites that exhibited wetted habitat at the time of assessment. Due to dry conditions, this was limited to Site 2 (Macintyre River) and Site 16 (Bringalily Creek) in November 2018, and Site 2 (Macintyre River), Sites 6R and 7 (Macintyre Brook), Site 18 Bringalily Creek and Site 42 (Dry Creek) in May 2019.

Sampling was overseen by an AusRivAS accredited ecologist following AusRivAS protocols for Queensland streams (DNRM 2001). AusRivAS specifies a standardised, qualitative, rapid bioassessment method that aims to consistently sample a wide diversity of macroinvertebrates within a defined timeframe.

The bed and edge habitats were sampled separately at each site. A standard sized dip net with 250 µm mesh was used to sample macroinvertebrates. Following collection, the samples were transferred to plastic sorting trays, where the contents were sorted and live-picked for 30 minutes. Picked specimens were placed into specimen jars with 70per cent ethanol.

Samples were identified to AusRivAS taxonomic level in the laboratory under stereomicroscope. AusRivAS taxonomic identification was primarily to Family level, with the exception of lower Phyla such as Porifera, Nematoda and Nemertea, Oligochaetes (freshwater worms), Acarina (mites), and microcrustacea such as Ostracoda, Copepoda and Cladocera. Chironomids (midges) were identified to sub-family taxonomic level.

3.4.5 Fish surveys

For the June 2018 field trip, a limited fish survey was implemented involving the deployment of baited box traps and dip-netting, targeting small fish at sites containing water. At each site, up to seven baited box traps were deployed for approximately one hour, followed by dip-netting waterway edge habitats for a period of approximately 10 minutes with an Environet®.

For subsequent field trips in December 2018 and May 2019, the scope of works was expanded and a range of additional survey techniques were applied to assess fish assemblages at aquatic ecology sites that were suitable. Targeted fish survey methods were selected from the Survey Guidelines for Australia's Threatened Fish (SEWPAC 2011), and included backpack electrofishing (where water depth was <0.5 m), seine netting (2 – 5 mm mesh) and use of fyke nets. Where fyke nets were used, two nets were deployed overnight (one 3 mm stretched mesh and one 4 mm stretched mesh). Nets were dual wing in design, with each wing 4 m in length with a 0.6 m drop. The survey methods were adapted to suit the local conditions

© ECO LOGICAL AUSTRALIA PTY LTD

of the waterway, with the primary considerations being the depth of water and presence of woody debris which may foul nets.

Fish were identified to species level, with the number of each species captured, and size range for each species recorded. After processing, native fish were returned to the water, and pest species were euthanised by lethal dose of AQUI-S solution, followed by pithing or exsanguination to confirm death, in accordance with Animal Ethics Committee approval.

All sampling activities were undertaken in accordance with relevant conditions of General Fisheries and Animal Ethics permits held by Eco Logical Australia (General Fisheries Permit 196796 and Animal Ethics CA2018/07/1214) and DPM Envirosciences (General Fisheries Permit 192554 and Animal Ethics CA2017/03/1043).

3.4.6 Macro-crustaceans

Macro-crustaceans (those that can be seen with the naked eye) were collected as by-catch using fish sampling techniques (**Section 3.4.5**). Additionally, macro-crustacean specimens collected during macroinvertebrate sampling were retained for identification. All macro-crustaceans collected using fishing apparatus were returned to the water following identification. Identifications were undertaken to species level.

3.4.7 Freshwater turtles

Information on freshwater turtles was collected during field surveys through observations of habitat suitability (**Section 3.4.3**) and from incidental observations of turtles during field surveys while targeting fish and invertebrates. Freshwater turtles listed as Least Concern are likely to be abundant throughout waterways and wetlands of the impact assessment area. Relevant species include the Eastern snake-necked turtle (*Chelodina longicollis*), Broad-shelled river turtle (*Chelodina expansa*) and Murray turtle (*Emydura macquarii macquarii*).

3.4.8 Surface water quality sampling

Surface water quality data was collected at accessible aquatic ecology and surface water sampling sites in accordance with the DES Monitoring and Sampling Manual (DES 2018a). Information about site characteristics was recorded using the '*Water Quality Sampling Field Sheet'* (DNRM 2002).

The following values were recorded at each site:

- Site ID and name
- Date and time
- Sampling location (latitude, longitude and reach orientation looking downstream)
- Weather (rain in the past week, cloud cover, wind)
- Observations at water sampling site (within 2 m of sampling point or on closest bank) including:
  - Shading (per cent)
  - Water odour
  - Water surface condition
  - Algae (per cent) (on substrate, in water column)
  - Macrophytes (per cent) (emergent, submerged, floating, fringing)
  - Impact (per cent) (human, pastoral animals, non-pastoral animals)
- Percent of habitat types in 100 m reach
- Reach observations (of 100 m stream length). Reach observations include:
  - Upstream land use
  - Adjacent land use of left and right banks
  - Local catchment erosion

© ECO LOGICAL AUSTRALIA PTY LTD

    - Water colour
    - Sediment deposits
    - Algae cover
    - Water odour
    - Substrate colour
    - Water surface
    - Variety of habitat
    - Bars
    - Flow level
- Riparian zone characteristics and values (to a maximum 100 m width) which include:
    - Width of riparian zone (left and right bank)
    - Bare ground (per cent)
    - Grass (per cent)
    - Shrubs (per cent)
    - Trees <10 m high (per cent)
    - Trees >10m high (per cent)
    - Presence of exotic riparian species
    - Width of continuous tree zone from bank
    - Description of dominant riparian species
- Macrophytes (per cent) (native and exotic)

A multi-probed, battery operated water quality meter (YSI Professional Plus) was used to measure physio-chemical parameters. The device was calibrated in the field prior to the collection of data (**Appendix C**) and used to take measurements of the following parameters:

- Dissolved oxygen (DO) (mg/L) and saturation (per cent)
- pH
- Electrical conductivity (EC) (µs/cm)
- Temperature (°C)
- Turbidity (NTU)
- Total dissolved solids (TDS) (ppm)
- Oxidation reduction potential (ORP) (mV).

Water quality samples were collected using sampling containers prepared and provided by the National Association of Testing Authorities accredited laboratory Australian Laboratory Services (ALS). Nitrile gloves were worn during sampling and field teams maintained best practice protocols to assist in prevention of on-site contamination.

Water samples collected for the purpose of analysis for dissolved metals were filtered in the field through a 0.45 µm filter using a sterile syringe. Once collected, samples were immediately placed in a refrigerator or on ice in an esky and delivered with Chain of Custody forms to ALS for analysis of the following analytes:

- Conductivity and salinity
- Total suspended solids
- Total hardness as $CaCO_3$ (Alkalinity)
- Nutrient suite (ammonia, nitrite, nitrate, total nitrogen, total kjeldahl nitrogen (TKN), nitrogen oxides (NOx), reactive phosphorus (P) and total P)
- Organic nitrogen

© ECO LOGICAL AUSTRALIA PTY LTD

- Dissolved metals (eight metals suite: arsenic, cadmium, chromium, copper, nickel, lead, zinc and mercury)
- PAHs
- Chlorophyll *a*

Field surveys involving both aquatic ecology and surface water quality investigations were planned for a period of nine consecutive days, with those surveys involving only surface water quality investigations planned for six consecutive days. The impact assessment area is located approximately four hours' drive from the laboratory. In order to avoid a breach of holding times for some analytes, the following approach was taken to the delivery of samples to the laboratory:

- A mid-field trip consignment of all samples collected to date was dropped at the laboratory by the field team for analysis
- Water samples for chlorophyll *a* were filtered through a glass fibre filter in the field, with the filter paper double wrapped in aluminium foil and stored in a freezer, as described in DES (2018c). Application of this method extended the laboratory holding time for Chlorophyll *a* from two days to 28 days.

A range of quality assurance processes were implemented during sampling. These included the following:

- At one monitoring site for each field trip, a second suite of water samples (duplicates) were taken and labelled DUP. This sample was a 'blind duplicate' of another site (unknown to the laboratory) and provided an opportunity to determine within-laboratory variation in the results between samples collected from the same location. The relative percent difference was calculated for duplicate samples, with a criterion of <35% applied for further investigation.
- For each field trip, a container of distilled water was transported into the field, and alongside collection of relevant site water samples, laboratory sampling containers were filled with this water (including filtration of dissolved metals samples). The samples were labelled 'Blank' and maintained and assessed alongside relevant site water quality samples, providing an opportunity to identify if the sample collection and/or storage procedures resulted in contamination of the samples.

3.5 Weather conditions and site access

Conditions were generally dry in the months prior to the aquatic ecology and surface water field surveys in June and November 2018. More frequent rainfall preceded the surface water surveys of February and April 2019 and aquatic ecology survey of May 2019, resulting in a higher proportion of sampling sites containing water.

The BoM weather station at Leyburn, Queensland, is located approximately mid-way along the alignment, and provides an indication of rainfall patterns in the region during the survey. It recorded 348 mm of rain in the twelve month period from 1 April 2018 to 1 April 2019, a majority of which fell between July and December (**Figure 5**). In comparison with historical data available for the Leyburn local area (2000 to 2018), average annual rainfall is 535.9 mm ranging from 273 to 1,022 mm. During the twelve-month period in which the study took place, Leyburn received approximately 35% less rainfall than is generally expected in an average year.

© ECO LOGICAL AUSTRALIA PTY LTD

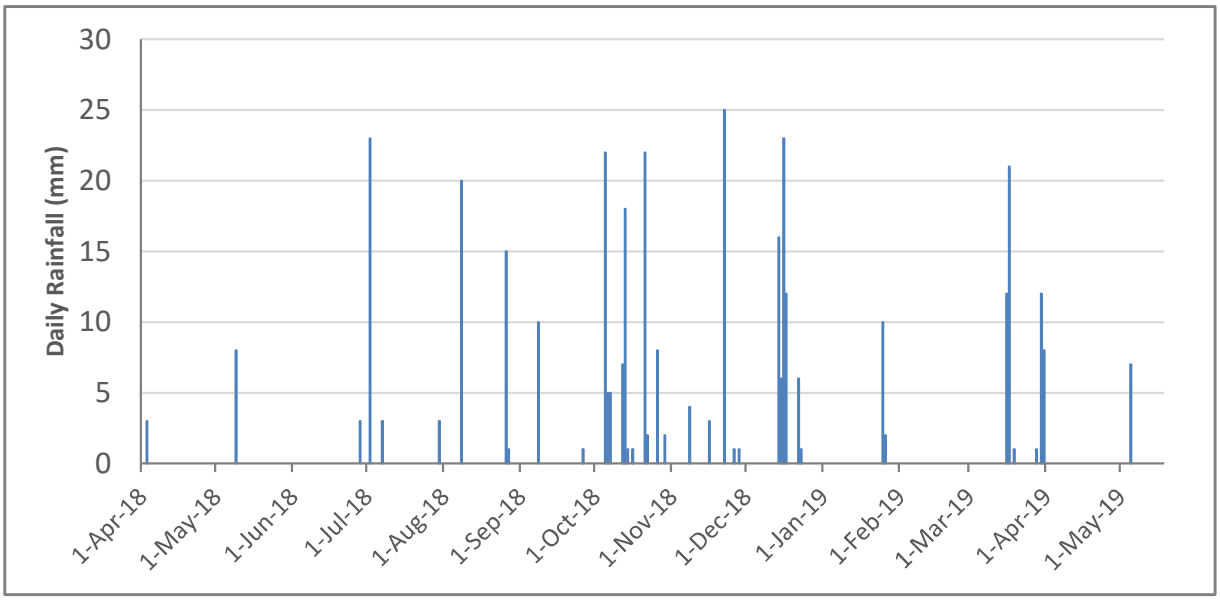


Figure 5 Rainfall data from Leyburn weather station from 1 April 2018 to 1 April 2019

The sampling sites assessed during the June 2018, November 2018, February 2019 and April 2019 field surveys are summarised in **Table 3**. In summary, the total number of sites assessed on each trip ranged from 31 to 35. Differences in sites visited among field trips related to difficulties in obtaining access to private land.

A majority of the sites were dry at the time of sampling in June and November 2018. In February 2019 approximately 50% of sites assessed contained water, increasing to 60% in April 2019. If dry sites were encountered, physical site characteristics were recorded.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 3 Sampling sites assessed during the four primary rounds of field surveys (- indicates not assessed)

Site	Assessment type	Waterway	June 2018 Survey date	Water Present?	November 2018 Survey date	Water Present?	February 2019 Survey date	Water Present?	April 2019 Survey date	Water Present?
1R	Surface water	Macintyre River	16/06/2018	Yes	-	-	-	-	-	-
2	Aquatic ecology	Macintyre River	-	-	29/11/2018	Yes	11/02/2019	Yes	29/04/2019	Yes
2R	Surface water	Macintyre River	16/06/2018	Yes	27/11/2018	Yes	11/02/2019	Yes	29/04/2019	Yes
3	Surface water	Macintyre Brook	17/06/2018	Yes	27/11/2018	Yes	12/02/2019	Yes	30/04/2019	Yes
4	Aquatic ecology and surface water	Unnamed	16/06/2018	No	27/11/2018	No	12/02/2019	No	30/04/2019	No
5	Aquatic ecology and surface water	Unnamed	16/06/2018	No	27/11/2018	No	12/02/2019	No	30/04/2019	No
6	Surface water	Macintyre Brook	16/06/2018	Yes	27/11/2018	Yes	12/02/2019	Yes	30/04/2019	Yes
7	Surface water	Macintyre Brook	17/06/2018	Yes	27/11/2018	Yes	12/02/2019	Yes	30/04/2019	Yes
8	Aquatic ecology and surface water	Unnamed	17/06/2018	No	28/11/2018	No	12/02/2019	No	30/04/2019	No
9	Aquatic ecology and surface water	Pariagara Creek	15/06/2018	No	28/11/2018	No	13/02/2019	No	30/04/2019	No
10	Surface water	Pariagara Creek	15/06/2018	No	28/11/2018	No	13/02/2019	No	30/04/2019	No
11	Surface water	Canning Creek	15/06/2018	Yes	28/11/2018	Yes	13/02/2019	Yes	30/04/2019	Yes
12	Aquatic ecology and surface water	Unnamed	17/06/2018	No	28/11/2018	No	12/02/2019	No	30/04/2019	No
13	Aquatic ecology and surface water	Cattle Creek	14/06/2018	No	28/11/2018	No	12/02/2019	No	30/04/2019	No
14	Surface water	Unnamed	14/06/2018	Yes	28/11/2018	Yes	13/02/2019	Yes	01/05/2019	Yes
15	Aquatic ecology and surface water	Unnamed	14/06/2018	No	29/11/2018	No	13/02/2019	No	01/05/2019	No
16	Aquatic ecology and surface water	Unnamed	13/06/2018	Yes	28/11/2018	Yes	13/02/2019	Yes	01/05/2019	Yes
17	Aquatic ecology and surface water	Unnamed	17/06/2018	No	28/11/18	No	13/02/2019	No	01/05/2019	No
18	Surface water	Unnamed	14/06/2018	No	30/11/2018	No	12/02/2019	Yes	01/05/2019	Yes

© ECO LOGICAL AUSTRALIA PTY LTD

Site	Assessment type	Waterway	June 2018 Survey date	Water Present?	November 2018 Survey date	Water Present?	February 2019 Survey date	Water Present?	April 2019 Survey date	Water Present?
19	Aquatic ecology and surface water	Nicol Creek	13/06/2018	No	30/11/2018	No	12/02/2019	No	01/05/2019	No
20	Surface water	Nicol Creek	14/06/2018	No	-	-	-	-	-	-
20R	Surface water	Nicol Creek	-	-	30/11/2018	No	12/02/2019	No	01/05/2019	Yes
23	Surface water	Unnamed	13/06/2018	No	26/11/2018	No	12/02/2019	Yes	01/05/2019	Yes
24	Surface water	Grasstree Creek	18/06/2018	Yes	30/11/2018	Yes	13/02/2019	Yes	-	-
27	Surface water	Condamine River	15/06/2018	Yes	26/11/2018	No	13/02/2019	Yes	02/05/2019	Yes
28	Surface water	Unnamed	-	--	-	-	13/02/2019	Yes	01/05/2019	Yes
29	Surface water	Unnamed	15/06/2018	No	26/11/2018	No	13/02/2019	No	01/05/2019	Yes
30	Surface water	Condamine River	14/06/2018	Yes	01/12/2018	Yes	14/02/2019	Yes	02/05/2019	Yes
31	Surface water	Condamine River (North Branch)	14/06/2018	No	30/11/2018	No	14/02/2019	No	02/05/2019	No
32	Aquatic ecology and surface water	Condamine River (North Branch)	14/06/2018	No	01/12/2018	No	14/02/2019	Yes	-	-
33	Surface water	Condamine River (North Branch)	14/06/2018	No	26/11/2018	Yes	14/02/2019	No	-	-
35	Surface water	Unnamed	12/06/2018	No	01/12/2018	No	14/02/2019	No	02/05/2019	No
36	Surface water	Unnamed	12/06/2018	No	01/12/2018	No	14/02/2019	No	02/05/2019	No
39	Surface water	Westbrook Creek	15/06/2018	Yes	01/12/2018	Yes	14/02/2019	Yes	02/05/2019	Yes
40	Surface water	Dry Creek	12/06/2018	Yes	01/12/2018	Yes	14/02/2019	No	02/05/2019	Yes
42	Surface water	Dry Creek	15/06/2018	Yes	01/12/2018	Yes	14/02/2019	Yes	02/05/2019	Yes
43	Aquatic ecology and surface water	Unnamed	12/06/2018	No	01/12/2018	No	14/02/2019	No	02/05/2019	No

© ECO LOGICAL AUSTRALIA PTY LTD

3.6 Survey limitations

Field surveys were undertaken during a period of long-term, below average rainfall across the impact assessment area. The local government areas of Toowoomba and Goondiwindi regional councils were subject to a drought declaration by DAF during the period of field surveys and associated impact assessment (DAF 2019), reflecting the dry conditions throughout the region. Results of the field surveys may therefore not be representative of environmental conditions during periods of average or above average rainfall. Surveys during dry conditions have the potential to yield different water quality results than those during wet periods. For example, water runoff containing sediments, nutrients and metals can be low or absent during dry conditions, resulting in good water quality. However, poor water quality can also arise in dry conditions due to high water temperatures reducing dissolved oxygen concentrations, and high evaporation rates causing the concentration of salts and other parameters in water. The quality of aquatic habitats also has the potential to be underestimated when assessed during dry conditions. These limitations have been considered in the interpretation of results.

A total of 21 of the proposed sampling sites were located on or required access through privately owned land. ARTC and FFJV coordinated access to private properties with the agreement of landholders. However, in some cases, access to private properties could not be negotiated or facilitated in the timeframes of the survey. In three cases, alternative sampling sites located on public land nearby were selected, where such areas provided suitable aquatic habitat and/or surface water values.

The laboratory holding times for some water quality analytes (e.g. reactive phosphorus, nitrite and nitrate: two days) were shorter than was practical for the transport of samples to the laboratory. The number of parameters affected was minimised by transporting samples to the laboratory every three to four days during field trips and using alternative methods for the preservation of samples where possible (e.g. chlorophyll *a* filter paper method; DES 2018c). Consequently, results for some parameters were obtained outside of the recommended holding times, and this has been considered when interpreting the results.

3.7 Data collation and analysis

3.7.1 Aquatic ecology physical habitat

The AusRivAS Physical Assessment Protocol is a standardised approach to assess various aquatic habitat parameters. A rating of either poor, fair, good or excellent was assigned to each habitat parameter from data recorded in the field, with an overall habitat rating calculated for low gradient streams (Parsons *et al*. 2002). The suitability of aquatic habitat for EVNT species was also determined, based on the results of the desktop assessment and field surveys.

3.7.2 Aquatic ecology macroinvertebrate communities

Macroinvertebrate data was used to calculate multiple community descriptors as described in the following sections.

Taxonomic richness

Taxonomic richness was calculated from the number of taxa present in each sample, providing an indication of community diversity at the site, with richness typically increasing with ecological condition.

PET

The Plecoptera, Ephemeroptera and Trichoptera (PET) richness was calculated from the number of taxa belonging to the three PET orders, in accordance with the method described in DNRM (2001). These three orders are widely accepted as being most sensitive to environmental change, such as habitat

degradation and pollution. A low PET richness score suggests that a site may be impacted by degradation or pollution, due to the absence of these pollution-sensitive taxa. Conversely, a high PET richness suggests a system free from degradation or pollution.

SIGNAL2

SIGNAL2 (Stream Invertebrate Grade Number – Average Level Version 2) indices were calculated, with each taxon allocated a score from 1 to 10 based on the method prescribed by Chessman (2003). Taxa with a low score are most tolerant of a range of environmental conditions, and those with a high score are more sensitive to pollution. The presence/absence data of each taxon were used to calculate the SIGNAL2 average for the site, in accordance with the protocols described by Chessman (2003).

Tolerant taxa

The percentage of tolerant taxa was calculated using the SIGNAL2 sensitivity grades derived from aquatic macroinvertebrate taxa at the Family level. Tolerant taxa are those with a SIGNAL2 score of 3 or less. Macroinvertebrate families in this group are expected to be able to tolerate changes to their environment, including habitat degradation and some pollution. An absence of the more sensitive taxa suggests environmental conditions may be too harsh for more sensitive taxa (those with SIGNAL2 score above 3) to tolerate.

AusRivAS

The macroinvertebrate and predictor variables (habitat) data was entered into the AusRivAS macroinvertebrate predictive modelling program – Version 3.2.2 (eWater 2017). The Queensland Regional Western spring and autumn models for bed and edge habitats were used (**Table 4** and **Table 5** respectively).

Table 4 AusRivAS habitat predictor model variables for QLD Regional Western November 2018 sampling

Code	Description	Input value for site	
		Site 2	Site 16
QLD Regional – Western – Spring – Edge habitat			
ALKALINITY	Total carbonates, Hardness as $CaCO_3$ (mg/L)	70	100
DISTANCE FROM SOURCE	Distance from source (km)	180	30
LATITUDE	Latitude of site (decimal degrees)	-28.6642	-28.1563
LONGITUDE	Longitude of site (decimal degrees)	150.4678	151.1875
PROCESS ZONE	Process zone category (2 = erosional; 1 = transport; 0 = depositional)	1	1
QLD Regional – Western – Spring – Pool/Bed habitat			
BOULDER	Percent boulder (>256 mm) in habitat (%)	0	0
COBBLE	Percent cobble (64-256 mm) in habitat (%)	0	0
WETR	Range in wet season monthly rainfall means (mm)	33.8	35.1

Notes: Meteorology data for Site 2 derived from the 'New Kildonan TM' BoM monitoring station 41507 (approximately 2.5 km west). Meteorology data for Site 16 derived from the 'Duddawarra' BoM monitoring station 41543 (approximately 9 km north).

Table 5 AusRivAS habitat predictor model variables for QLD Regional Western May 2019 sampling

Code	Description	Input value for site				
		2	6R	7	18	42
QLD Regional – Western – Autumn – Edge habitat						
DRYRANGE	Range in dry season monthly rainfall means (mm)	7.5	7.5	7.5	7.5	11.0
LATITUDE	Latitude of site (decimal degrees)	-28.6631	-28.4459	-28.4075	-28.1032	-27.5277
MINTEMP	Mean daily minimum temperature (˚C)	11.5	11.5	11.5	11.5	11.9
MWMR	Mean wet season monthly rainfall (mm)	71.5	71.5	71.5	71.5	87.4
STORDER	Stream order	9	7	7	5	3
WETPERCENT	Percentage rainfall in wet season (%)	65.2	65.2	65.2	65.2	72.9
QLD Regional – Western – Autumn – Pool/Bed habitat						
PROCESS ZONE	Process zone category (2 = erosional; 1 = transport; 0 = depositional)	1	1	1	1	2
STORDER	Stream order	9	7	7	5	3
WETR	Range in wet season monthly rainfall means (mm)	32.2	32.2	32.2	32.2	38.9

Notes: Meteorology data for Sites 2, 6R, 7 and 18 derived from the 'Texas Post Office' BoM monitoring station 41100 (being the nearest station that records both rainfall and daily minimum temperature). Meteorology data for Site 42 derived from the 'Toowoomba Airport' BoM station 41529 (approx. 9 km east) for the period 1996-2019.

3.7.3 Surface water quality

This section describes the approach to the collation and analysis of surface water quality data, with particular emphasis on the potential influence of surface water quality on aquatic ecology values. A separate Surface Water Quality Technical Report (Appendix P of the draft EIS) has also been prepared and provides additional consideration of surface water quality information relevant to the Project.

Water quality results were compared with relevant environmental values and water quality objectives. Environmental values and water quality objectives (target values; annual medians) for the Condamine River Basin and the Queensland Border Rivers Basin have been developed by the DES, in collaboration with the Queensland Murray Darling Committee and other stakeholders (DES 2019a, b).

Where a specific parameter/trigger value was not available for the Condamine River Basin and the Queensland Border Rivers Basin, the ANZECC Guidelines (2000, 2018) were used (95 per cent level of protection for slightly to moderately disturbed ecosystems). The Queensland Water Quality Guidelines (DEHP 2013) were also used to guide the assessment, but do not include any guidelines for sections of the Murray Darling Basin within Queensland. Hence, assessment of water quality was generally based on the ANZECC Guidelines (2000, 2018) and local Guidelines (DES 2019a, b).

It is well established that there are several abiotic factors that can modify the toxicity and bioavailability of some metals to aquatic organisms (ANZECC 2018). The ANZECC Guidelines (2000) provide a formula

to adjust water quality trigger levels to account for the reduced toxicity of these metals to biota with increasing water hardness. However, the more recent ANZECC Guidelines (2018) identify limitations to this approach, particularly for copper. Therefore, hardness and dissolved metals results from the impact assessment area have been presented for comparison with relevant guideline values, without the calculation of hardness corrected trigger levels. Discussion of the potential for high hardness concentrations at some sites to reduce the toxicity of metals is provided in **Section 4.3**.

3.8 Approach to impact assessment

A qualitative assessment is the most appropriate method for aquatic ecology and surface water quality impacts, through application of a significance assessment, as described in EIS Chapter 4: Assessment methodology of the draft EIS. This method is preferred where an impact will occur, and the sensitivity or vulnerability of the environmental values and the magnitude of the impact are important. Sensitivity criteria, magnitude criteria and a significance matrix were established to facilitate the assessment (**Tables 6-9)**, and facilitate the assessment of Project impacts before and after the implementation of mitigation measures, to minimise the duration, intensity or extent of impacts.

The impact assessment method follows the mitigation hierarchy, which has the following sequential steps:

1. Avoidance (measures taken to avoid creating impacts, for example through the placement of infrastructure outside areas of key habitat)
2. Minimisation (measures to taken to reduce the duration, intensity or extent of impacts that cannot be avoided, i.e., mitigation measures)
3. Rehabilitation (measures taken to improve the environment following exposure to impacts that cannot be completely avoided or minimised)
4. Offset (measures taken to compensate for any residual adverse impacts after implementation of the previous three steps in the mitigation hierarchy.

For each potential impact, a pre-mitigation and post-mitigation scenario was assessed and a significance ranking determined. The initial assessment of potential impact (pre-mitigation) was undertaken assuming mitigation methods associated with Concept Assessment and reference design phases of the Project had been implemented (Phases 1 and 2). Following this assessment of impact significance, additional mitigation measures associated with future project phases (Project Assessment, Project Approval, Project Implementation and Project Close-out; Phases 3-6) were then considered. These additional mitigation measures align with the detail design, pre-construction, construction and operation phases of the Project. The need to offset or compensate for residual impacts that could not be avoided through adoption of reasonable mitigation measures was also considered.

Consideration was also given to the benefits of monitoring water quality and aquatic ecology values during various stages of the Project, with recommendations provided in **Section 5.2**.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 6 Sensitivity criteria

Sensitivity	Description
Major	• The environmental value is listed on a recognised or statutory state, national or international register as being of conservation significance and/ or • The environmental value is entirely intact and wholly retains its intrinsic value and/ or • The environmental value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region, state, country or the world and/ or • It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the environmental value. • Project activities would have an adverse effect on the value.
High	• The environmental value is listed on a recognised or statutory state, national or international register as being of conservation significance and/ or • The environmental value is intact and retains its intrinsic value and/ or • The environmental value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region and/ or • It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the environmental value. • Project activities would have an adverse effect on the value.
Moderate	• The environmental value is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers and/ or • The environmental value is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements and/ or • It is relatively well represented in the systems/areas in which it occurs, but its abundance and distribution are exposed to threatening processes and/ or • Threatening processes have reduced its resilience to change. Consequently, changes resulting from project activities may lead to degradation of the prescribed value and/ or • Replacement of unavoidable losses is possible due to its abundance and distribution.
Low	• The environmental value is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations e.g. historical societies and/ or • The environmental value is in a poor to moderate condition as a result of threatening processes, which have degraded its intrinsic value and/ or • It is not unique or rare and numerous representative examples exist throughout the system / area and/ or • It is abundant and widely distributed throughout the host systems / areas and/ or • There is no detectable response to change or change does not result in further degradation of the environmental value and/ or • The abundance and wide distribution of the environmental value ensures replacement of unavoidable losses is achievable.
Negligible	• The environmental value is not listed on any recognised or statutory register and is not recognised locally by relevant suitably qualified experts or organisations and/ or • It is not unique or rare and numerous representative examples exist throughout the system / area and/ or • There is no detectable response to change or change does not result in further degradation of the environmental value.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 7 Magnitude criteria

Magnitude	Description
Major	An impact that is widespread, permanent and results in substantial irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of environmental management controls are required to address the impact.
High	An impact that is widespread, long lasting and results in substantial and possibly irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of site-specific environmental management controls are required to address the impact.
Moderate	An impact that extends beyond the area of disturbance to the surrounding area but is contained within the region where the Project is being developed. The impacts are short term and result in changes that can be ameliorated with specific environmental management controls.
Low	A localised impact that is temporary or short term and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls.
Negligible	An extremely localised impact that is barely discernible and is effectively mitigated through standard environmental management controls.

Table 8 Significance matrix

Magnitude	Sensitivity				
	Major	High	Moderate	Low	Negligible
Major	Major	Major	High	Moderate	Low
High	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Low	Moderate	Moderate	Low	Negligible	Negligible
Negligible	Moderate	Low	Low	Negligible	Negligible

© ECO LOGICAL AUSTRALIA PTY LTD

Table 9 Significance classifications

Significance	Description
Major	Arises when an impact will potentially cause irreversible or widespread harm to an environmental value that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.
High	Occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the environmental value. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.
Moderate	Results in degradation of the environmental value due to the scale of the impact or its susceptibility to further change even though it may be reasonably resilient to change. The abundance of the environmental value ensures it is adequately represented in the region, and that replacement, if required, is achievable.
Low	Occurs where an environmental value is of local importance and temporary or transient changes will not adversely affect its viability provided standard environmental management controls are implemented.
Negligible	Does not result in any noticeable change and hence the proposed activities will have negligible effect on environmental values. This typically occurs where the activities are located in already disturbed areas.

3.9 Assessment of cumulative impacts

Projects with spatial and/or temporal overlap can result in cumulative impacts. Cumulative impacts may:

- Differ from those of an individual project when considered in isolation
- Be positive or negative
- Differ in severity and duration depending on the spatial and temporal overlap of projects occurring in an area.

It is a requirement of the ToR for this Project that the potential for cumulative impacts be considered. This section provides details of the methods for the assessment of cumulative impacts in relation to aquatic ecology values.

Cumulative impacts of the Project were qualitatively assessed. A list of applicable projects and operations for consideration in the cumulative impact assessment was developed for assessment by all EIS disciplines (**Table 10**). The potential for spatial and temporal overlap between the Project and other projects was considered, in relation to potential impacts on aquatic ecology and surface water quality values.

The approach used to identify and assess potential cumulative impacts of the Project was as follows:

- A review of the potential impacts identified within the draft EIS assessments. The environment at the time of the ToR is the baseline, prior impacts from past land use has not be considered
- A register of assessable projects was collated with timelines to demonstrate the temporal relationship between projects. This included:

  - Only 'state significant' or 'strategic' projects (i.e. coordinated projects under the SDPWO Act) that are in the public domain as being planned, constructed or operated at the time of the ToR were considered
  - Additional projects were considered where they were deemed to be of local significance, as occurring through consultation with community groups and stakeholders. These included:
  - Projects listed in Goondiwindi Regional Council and Toowoomba Regional Council Development Application databases
  - Development within Priority Development Areas and State Development Areas
  - Economic Development Queensland development projects
  - Community Infrastructure Designation projects
  - Projects within the public register of environmental authorities
  - Department of Transport and Main Roads infrastructure projects
  - Private infrastructure facilities
  - Development in accordance with Regional Planning Interests
  - The Inland Rail projects immediately adjacent to the Project, being the North Star to NSW/QLD Border and Gowrie to Helidon projects
- Identification and mapping of the assessable projects and the areas of influence. Current operational projects and commercial or agricultural operations that are in the area of influence around the Project are accounted for in the baseline assessment
- Where there is a potential overlap in impacts (either spatially or temporally), a cumulative impact assessment was undertaken to determine the nature of the cumulative impact. This includes:
  - Where possible the assessment method has been quantitative in nature however qualitative assessment has also been undertaken for certain environmental values
  - Where quantitative assessment has been possible, the significance of impact has been assessed in comparison to the same criteria or guidelines as adopted by the relevant technical impact assessments
  - Where impacts are expressed qualitatively, the probability, duration, and magnitude/intensity of the impacts have been considered as well as the sensitivity and value of the receiving environmental conditions

Some of the other projects in **Table 10** were in an operational phase at the time that the Border to Gowrie Project ToR were issued. Therefore, these other projects were influencing the existing environment at the time that the desktop and field assessments were carried out for the Border to Gowrie Project. The potential for the impacts of these operational projects to act cumulatively with those of the Project is therefore inherent within the impact assessment, which predicts the additional effects of the Project on the environmental baseline. Operational projects were therefore not carried forward to the assessment of cumulative impacts (refer **Section 5.4**).

© ECO LOGICAL AUSTRALIA PTY LTD

Table 10 Projects identified for consideration in the cumulative impact assessment for aquatic ecology

Projects	Status[#]	Description
Wetalla Water Pipeline (north of the Project)	Completed	This is part of the New Acland Coal Mine – Stage 3 expansion. A 45 km underground water pipeline to supply up to 5,500 ML of treated wastewater to the New Acland coal mine, which is earmarked for expansion.
New Acland (approximately 25 km northwest of the Project)	Approved with conditions	Expansion of the existing New Acland open-cut coal mine to up to 7.5 Mtpa.
Australia Pacific LNG Project (Walloons gas fields is approximately 20 km west of Millmerran)	Approved with conditions	Integrated liquefied natural gas (LNG) project. The Walloons gas fields area is the component closest to the Project.
Toowoomba Bypass (previously the Toowoomba Second Range Crossing)	Construction at time of ToR being issued Became operational in September 2019	DTMR has delivered a second range crossing that takes heavy vehicle highway traffic around north of Toowoomba rather than through it. The 41 km long bypass route runs from the Warrego Highway at Helidon Spa in the east to the Gore Highway at Athol in the west, via Charlton.
InterLink SQ – Global Logistics Centre and Industrial Park (located 8 km from Wellcamp International Airport)	Construction	InterLink SQ has two components, The InterLink Industrial Park, and the InterLink Global Logistics Centre (rail/road terminal). The Industrial Park is a master-planned logistics, warehousing and industrial estate that will provide opportunities for companies to co-locate in a logistics hub. The 140-hectare industrial park is approved, and construction has started. The InterLink Global Logistics Centre is an open access, intermodal terminal linking rail, road, sea and air. The 60 hectare site will include a three kilometre frontage along the Inland Rail route and will incorporate grain and commodities storage, processing and loading facilities, rail maintenance and provisioning, and a large container handling and storage area. The precinct will move 250,000 Import Export TEU's per year.
Toowoomba Wellcamp Airport (located 17 km west of Toowoomba CBD, and immediately south of Inland Rail corridor)	Operational – subject to expansion	The airport operates as an international cargo hub connecting Australia's leading primary producers and processors with growing consumer markets across the globe. The airport was constructed over 19 months from 2012 to 2014 and is the first major greenfield public airport development in Australia in over 50 years.

© ECO LOGICAL AUSTRALIA PTY LTD

Projects	Status[#]	Description
Wellcamp Business Park	Operational – subject to continuing construction and expansion	Part of the Toowoomba Enterprise Hub. 500 hectare industrial and commercial estate surrounds Brisbane West Wellcamp Airport and is fast becoming the commerce and industry hub of Toowoomba and regional south east Queensland.
Witmack Industry Park and Charlton Logistics Park	Operational – subject to continuing construction and expansion	Part of the Toowoomba Enterprise Hub. Witmack Industry Park and Charlton Logistics Park – Witmack Industry Park is one of Toowoomba's largest industrial land developments and offers large size industrial land parcels from 2 to 5 hectares. Charlton Logistics Park is the most recent addition to the Toowoomba Enterprise Hub and provides level and fully serviced 2 hectare sites. Due to its Warrego Highway location combined with easy access to the Second Range Crossing, Charlton Logistics Park is well suited for transport and logistics operators.
Commodore Mine and Millmerran Power Station (south of Millmerran)	Operational	The Commodore Mine is an open pit coal mine, located in the Surat Basin and began supplying coal to the 850 MW Millmerran Power Station in February 2003. Millmerran Power Station is a coal-fired power station that supplies base-load power and came on line early in 2003. It supplies enough electricity to power approximately 1.1 million homes.
Pittsworth Industrial Precinct and PIP Enabling Project (Pittsworth)	Construction	New road and sewerage infrastructure at Pittsworth Industrial Precinct will open up industrial land for industries servicing agriculture and the wider region.
Doug Hall Poultry (Millmerran)	Operational	Poultry farm with approximately 200 employees producing caged, cage free, free range and organic eggs. Operations include egg grading, a feed mill with output of 1,500 tonnes per week, piggery, cropping and solar farm.
Yarranbrook Feedlot (Inglewood)	Operational	Feedlot currently licensed for 25,000 head. Operations include pivot farms.
Sapphire Feedlot (Kildonan)	Operational	Cattle feedlot and grain production. The 6,000 head Sapphire Feedlot has capacity to grow to 8,700 head with the development to be rolled out in future.
Wyemo Piggery (Texas-Yelarbon Rd, Glenarbon)	Planned	Intensive animal industries – 55,000 standard pig units Environmentally relevant activities – 8,000 standard pig units
Yarranlea Solar	Approved with conditions	100 MW solar farm located at Yarranlea.
Goondiwindi Abattoir	Approved with conditions	Proposed beef processing of 72,000 tonnes per year.
Asterion Medicinal Cannabis Facility, Wellcamp	Planned	A medicinal cannabis cultivation, research and manufacturing facility, involving construction of a 40 ha glasshouse to produce 20,000 plants per day at full capacity. Medicinal grade cannabis grown at the facility will be manufactured into a range of medicinal products. Projected capital expenditure is $450 million.

© ECO LOGICAL AUSTRALIA PTY LTD

Projects	Status#	Description
North Star to Border (Inland Rail)	Reference design and EIS	The North Star to NSW/QLD Border section of the Inland Rail is a new freight rail corridor approximately 30 km in length. The new rail corridor will connect North Star (NSW) to the Queensland Rail South Western Line near Yelarbon just north the NSW/QLD border.
Gowrie to Helidon (Inland Rail)	Draft EIS being prepared	This project comprises 26 km of new dual gauge track between Gowrie (north-west of Toowoomba) and Helidon (east of Toowoomba). It crosses the two Local Government Areas of Toowoomba and Lockyer Valley. The Gowrie to Helidon section of Inland Rail will include a new 6.38 km tunnel to create an efficient route through the steep terrain of the Toowoomba Range.
Helidon to Calvert (Inland Rail)	Reference design and EIS	New 47 km dual gauge rail line connecting Helidon (east of Toowoomba) with Calvert (near Ipswich), via Placid Hills, Gatton, Forest Hill, Laidley and Grandchester, extending through the LGAs of Lockyer Valley and Ipswich City. The project includes a 1.1 km tunnel to create an efficient route through the steep terrain of the Little Liverpool Range.
Calvert to Kagaru (Inland Rail)	Reference design and EIS	New 53 km dual gauge track from Calvert to Kagaru to provide convenient access for freight to major proposed industrial developments at Ebenezer in the City of Ipswich, and at Bromelton near Beaudesert in the Scenic Rim Region. The project includes a 1.1 km tunnel through the Teviot Range.
Kagaru to Acacia Ridge (Inland Rail)	Reference design and EIS	Enhancements to, as well as commissioning of, dual gauge operations along the existing interstate track between Kagaru and Acacia Ridge. The project involves 49 km of existing track to be enhanced enabling double-stacking capability along the existing interstate route both south from Kagaru to Bromelton and north from Kagaru to Brisbane's major intermodal terminal at Acacia Ridge. It extends across three LGAs of Scenic Rim, Logan and Brisbane.
Cross River Rail	Construction	New 10.2 km passenger rail line from Dutton Park to Bowen Hills, which includes 5.9 km of tunnel under the Brisbane River and the CBD. The Project will include four new underground stations at Boggo Road, Woolloongabba, Albert Street and Roma Street, and upgrades to Dutton Park and Exhibition stations.

Operational projects were not carried forward to the assessment of cumulative impacts

© ECO LOGICAL AUSTRALIA PTY LTD

For those future projects with potential for cumulative impacts, further assessment was made by considering the probability and duration of impact, and the sensitivity of the receiving environment, which were all ranked on a scale of Low, Medium or High. An assessment matrix method (further detailed within **Table 11** and **Table 12**) was used to determine the significance of cumulative impacts with respect to beneficial or detrimental effects.

Following the identification of each potential cumulative impact, a relevance factor score of Low, Medium and High was determined in consideration of the impacts, in accordance with the assessment matrix given in **Table 11**. The significance of the impact was determined by using professional judgement to select the most appropriate relevance factor for each aspect in **Table 11**.

The sum of the relevance factors determined the impact significance and consequence which are summarised in **Table 12**. For example if an environmental value was considered to have a probability of impact of 2, duration of impact of 3, magnitude/intensity of impact of 1 and a sensitivity of receiving environment of 1, the significance of impact would be Medium (2+3+1+1 = 7).

If cumulative impacts were deemed to be of 'medium' or 'high' significance, additional mitigation measures were proposed, beyond those already proposed by the relevant technical impact assessments.

Table 11 Assessment matrix for assessment of cumulative impacts

Aspect	Relevance factor		
	Low	Medium	High
Probability of impact	1	2	3
Duration of impact	1	2	3
Magnitude/Intensity of impact	1	2	3
Sensitivity of receiving environment	1	2	3

Table 12 Impact significance criteria for cumulative impacts

Impact significance	Sum of relevance factors	Consequence
Low	1-6	Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general project monitoring program.
Medium	7-9	Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate.
High	10-12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate.

© ECO LOGICAL AUSTRALIA PTY LTD

4 Existing aquatic and surface water values

4.1 Environmental values and water quality objectives

A common approach to describing the existing condition of aquatic environments is to describe their environmental values and compare the results of water quality monitoring with relevant water quality guidelines. The *ANZECC Guidelines* (2000, 2018) provide water quality guidelines for some parameters, with a particular focus on biologically available (dissolved) metals. The slightly to moderately disturbed classification (95 per cent level of protection) is most appropriate to the waterways of the impact assessment area, due to their existing level of disturbance from adjacent land uses. However, the guidelines also encourage the development and application of local guidelines, based on water quality data collected from the region.

DES has published two reports relevant to the Project and the application of local water quality guidelines:

- *Healthy Waters Management Plan: Queensland Border Rivers and Moonie River Basins* (DES 2019a) and
- *Healthy Waters Management Plan: Condamine River Basin* (DES 2019b).

The Healthy Waters Management Plans have been prepared to meet accreditation requirements under the Commonwealth *Water Act 2007* – Basin Plan 2012 (Commonwealth of Australia 2012). Each plan has been adopted following a period of public consultation in 2018, and confirms the environmental values, desired levels of aquatic ecosystem protection, water quality objectives and management responses under the EPP Water and Wetland Biodiversity.

The Project intersects six sub-catchments recognised in the local guidelines for the development of environmental values, comprising:

- Macintyre Barwon Floodplain (Queensland Border Rivers Basin; sites 1 to 2);
- Lower Macintyre Brook (Queensland Border Rivers Basin; sites 3 to 8);
- Canning Creek (Queensland Border Rivers Basin; sites 9 to 20);
- Condamine River (Condamine River Basin; sites 21 to 30);
- Condamine River North Branch (Condamine River Basin; sites 31 to 33); and
- Upper Oakey (Condamine River Basin; sites 34 to 43).

The environmental values (DES 2019a, b) attributed to each of these sub-catchments are identified in **Table 13**. 'Aquatic ecosystems' is an environmental value common across all six sub-catchments.

The water quality objectives (DES 2019a and 2019b) most relevant to the Project relate to moderately disturbed surface water ecosystems described in the local guidelines; and the default ANZECC Guidelines (2000, 2018) for pesticides, heavy metals and other contaminants for slightly to moderately disturbed ecosystems (95% level of protection). The Project intersects six *Basin Plan* water quality zones comprising:

- Macintyre Barwon Floodplain (Queensland Border Rivers Basin; Sites 1 to 2);
- Lower Macintyre Brook (Queensland Border Rivers Basin; Sites 3 to 8);
- Canning Creek (Queensland Border Rivers Basin; Sites 9 to 20);
- Southern Condamine (Condamine River Basin; Sites 21 to 26);

© ECO LOGICAL AUSTRALIA PTY LTD

- Central Condamine (Condamine River Basin; Sites 27 to 33); and
- Oakey Creek (Condamine River Basin; Sites 34 to 43).

The water quality objectives differ for each of the six *Basin Plan* water quality zones and are summarised in **Table 14**.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 13 Environmental values for surface waters intersected by the Project (DES 2019a, b)

Environmental Values	Aquatic Ecosystems	Irrigation	Farm Supply	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial values
Condamine River Basin Sub-Catchment												
Upper Oakey (sites 34 to 43)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Condamine River North Branch (sites 31 to 33)	✓	✓	✓						✓	✓	✓	✓
Condamine River South Branch (sites 21 to 30)	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓
Queensland Border Rivers Basin Sub-Catchment												
Canning Creek (sites 9 to20)	✓	✓		✓					✓			✓
Lower Macintyre Brook (sites 3 to 8)	✓	✓	✓	✓		✓	✓		✓	✓		✓
Macintyre Barwon Floodplain (sites 1 to 2)	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓

© ECO LOGICAL AUSTRALIA PTY LTD

ity Zone			phosphorus		a	nitrogen	nitrogen	nitrogen	oxygen							
		NTU	µg/L	µg/L-P/L	µg/L	µg/L	µg/L-N/L	µg/L-N/L	mg/L	% Sat		µS/cm	mg/L	mg/L	ºC	mg
o 43)	Low flow	13	110	45	5	1,000	5	10	ID	60 to 110	7.7 to 8.3	510	NA	7	20:80 percentiles of natural monthly water temperature	14
	High flow	55	340	90	ID	1,280	ID	ID			7.4 to 8.1	380		7		6
es 27 to	Low flow	25	170	20	9	860	4	4			7.4 to 8.3	890		5		2
	High flow	220	950	500	4	2,200	480	ID			7.0 to 7.6	290		4		13
Sites 21	Low flow	9	45	15	5	590	3	6			7.2 to 7.9	170		3		8
	High flow	25	60	20	ID	830	ID	ID			7.0 to 7.6	160		2		1
ers Basin																
to 20)	Low flow	35	30	8	ID	520	6	10	ID	60 to 110	7.2 to 7.8	200	NA	2	20:80 percentiles of natural monthly water temperature	2
	High flow	50	40	ID	ID	600	ID	ID			6.9 to 7.9	165		3		6
(Sites 3	Low flow	11	55	11	ID	710	18	8			7.4 to 8.0	370		10		1
	High flow	25	70	ID	ID	910	ID	ID			7.2 to 8.0	250		10		2
odplain	Low flow	30	70	20	3	575	10	20			7.4 to 8.0	240		7		2
	High flow	110	150	ID	ID	900	195	ID			7.0 to 7.5	180		6		7

4.2 Results of desktop assessment

The desktop study identified one EVNT aquatic flora, four ENVT aquatic fauna and nineteen introduced aquatic flora which potentially could occur within the impact assessment area. In addition, important waterways and wetlands were also identified as meeting criteria for listing as MSES. These results are summarised in the following sections, and **Appendix B** provides a detailed table describing the likelihood of occurrence for EVNT listed aquatic flora and fauna.

4.2.1 EVNT aquatic flora

The Wetland*Info* database identifies 136 wetland indicator plant species as having previously been recorded from the Queensland Border Rivers drainage basin and 180 wetland indicator plant species as having previously been recorded from the Condamine River drainage sub-basin (DES 2018b). Of these, one is an EVNT species, being the Endangered (NC Act) fringing rush (*Fimbristylis vagans*), recorded from the Condamine River drainage sub-basin (DES 2018b), which has potential to occur in the impact assessment area (**Appendix B**).

4.2.2 Introduced aquatic flora

The Commonwealth Government recognises 32 weeds of national significance (WoNS) across Australia, based on their:

- invasiveness and impact characteristics;
- current distribution and potential area of spread; and
- current primary industry, environmental and socio-economic impact.

The *Biosecurity Act 2014* (Qld) lists Prohibited and Restricted biosecurity matters (including weed species) for Queensland.

There are 22 introduced wetland indicator plant species known from the Balonne-Condamine drainage basin (EHP 2016). Those invasive species, including WoNS and other introduced plants, considered to pose a particular threat to aquatic biodiversity, and that could potentially occur within the impact assessment area, are listed in **Table 15**.

Table 15 Introduced wetland indicator plants known to occur in the Balonne-Condamine drainage basin, and potential to occur in the impact assessment area

Scientific name	Common name	National status^	BA status*	Basin / sub-basin	
				Condamine	Border Rivers
Arundo donax	-			✓	✓
Berula erecta	Water parsnip			✓	
Cyperus eragrostis	-			✓	✓
Cyperus esculentus	Yellow nutgrass			✓	
Cyperus involucratus	-			✓	
Cyperus papyrus	Papyrus			✓	
Diplachne fusca var. uninervia	-			✓	
Echinochloa colona	Awnless barnyard grass			✓	✓
Echinochloa crus-galli	Barnyard grass			✓	✓
Eclipta prostrata	White eclipta			✓	✓
Egeria densa	Dense waterweed			✓	
Eichhornia crassipes	Water hyacinth	WoNS	R3		✓
Juncus articulatus	Jointed rush			✓	✓
Juncus bufonius	Toad rush			✓	✓

Scientific name	Common name	National status^	BA status*	Basin / sub-basin	
				Condamine	Border Rivers
Pistia stratiotes	Water lettuce		R3	✓	
Polypogon monspeliensis	Annual beardgrass			✓	✓
Salix babylonica	Weeping willow			✓	✓
Salvinia molesta	Salvinia	WoNS	R3		✓
Rorippa nasturtium-aquaticum	Watercress			✓	

Notes:

^ Species listed as WoNS; * species listed under the Queensland *Biosecurity Act 2014* (R3 = Category 3 Restricted Matter).

4.2.3 EVNT aquatic fauna

The Wetland*Info* database identifies 17 native fish species that have previously been recorded from the Queensland Border Rivers drainage basin and 27 native fish species from the Condamine drainage sub-basin (DES 2018b). Of these, two species are listed as EVNT (see **Appendix B** for further details) and have historically been recorded from both catchments:

- Murray Cod (*Maccullochella peelii*) – Vulnerable (EPBC Act); and
- Silver Perch (*Bidyanus bidyanus*) – Critically Endangered (EPBC Act).

The Murray Cod occurs naturally within the Condamine and Queensland Border Rivers drainage basins and is found within Queensland and other Australian states. This species prefers deep water with in-stream habitat such as boulders, logs, and overhanging vegetation, and are sensitive to habitat alterations, such as altered flow regimes and overfishing (Allen *et al*. 2002). Suitable habitat for the Murray Cod occurs within the impact assessment area, including sites on the Macintyre River, Macintyre Brook, Canning Creek and the Condamine River. Bringalily Creek represents marginal habitat for the Murray Cod. The Murray Cod is known to occur within the impact assessment area (**Appendix B**), including the Macintyre River and Macintyre Brook (**Section 4.4.5**). The species also has potential to occur in the impact assessment area within large river systems such as the Condamine River. Draft referral guidelines for the Murray Cod identify that important populations of the species are present in the Macintyre River and Macintyre Brook (DotE 2016).

The Silver Perch prefers faster-flowing water, including rapids and races, and more open sections of river throughout the Murray Darling Basin (TSSC 2013). The Silver Perch was assessed as unlikely to occur in the impact assessment area, due to a lack of recent records from the region, and the presence of only small areas of habitat that may be suitable for the species (**Appendix B**).

The Wetland*Info* database identifies five turtle species that have previously been recorded from the Queensland Border Rivers drainage basin and six turtle species from the Condamine drainage sub-basin (DES 2018b). Of these, two are listed as EVNT:

- Bell's turtle (*Wollumbinia belli*) – Vulnerable (EPBC Act and NC Act) – Queensland Border Rivers drainage basin; and
- Southern snapping turtle (*Elseya albagula*) – Critically Endangered (EPBC Act); Endangered (NC Act) – Condamine drainage sub-basin.

The Bell's turtle inhabits narrow sections of rivers in granite country in northern NSW on the New England Tablelands, and in south-east Queensland near Stanthorpe, at the headwaters of the Queensland Border

Rivers catchment (DES 2018d). It is considered unlikely to occur in the impact assessment area (refer to **Appendix B**).

Southern snapping turtles are not typically found in the Condamine drainage sub-basin, but are generally found throughout the Fitzroy, Burnett, and Mary Rivers to the north. This species prefers flowing waters (Cogger 2014) but has been captured by the study team in a variety of habitats including deep, isolated, yet permanent, pools in both the Fitzroy and Burnett River catchments. The southern snapping turtle's appearance is superficially very similar to that of the Least Concern saw-shelled turtle (*Wollumbinia latisternum*), being differentiated by the intergular scutes on their plastron (underside of shell). It is suspected that multiple database records may be misidentifications by less experienced observers who have not handled and carefully inspected the plastron of suspected southern snapping turtles. It is unlikely that the southern snapping turtle occurs within the Condamine drainage sub-basin, and even less likely that it occurs within the impact assessment area.

The Wetland*Info* database (DES 2018b) identifies the Platypus (*Ornithorhynchus anatinus*) as having previously been recorded from both the Queensland Border Rivers drainage basin and the Condamine drainage sub-basin. This species is listed as SLC, for cultural reasons, under the NC Act, and is known to occur in the impact assessment area (**Appendix B**).

A detailed description of EVNT species including information on their distribution, life history and habitat requirements is provided in Appendix L of the draft EIS (Matters of National Environmental Significance Technical Report).

4.2.4 Introduced fishes

The Wetland*Info* database identified four introduced fish species that have previously been recorded from the catchments intersected by the Project. The mosquitofish (*Gambusia holbrooki*), goldfish (*Carassius auratus*) and European carp (*Cyprinus carpio*) have been recorded from both the Queensland Border Rivers drainage basin and the Condamine drainage sub-basin (DES 2018b). The guppy (*Poecilia reticulata*) has been recorded from the Condamine drainage sub-basin only (DES 2018b).

Introduced fishes can cause a variety of issues within the aquatic environment, such as competing with native fish for food and habitat, preying on native species, habitat disturbance and introduction of disease. Typically, established introduced species have a wide range of environmental tolerances, habitat requirements and food requirements. In addition, they tend to have high reproductive rates and be early maturing, allowing populations to become readily established. These attributes often allow introduced fishes to be more adaptable to changes in the environment, whether natural or manmade, than some native fish species.

4.2.5 MSES wetlands, watercourses and groundwater dependent ecosystems

The Queensland Mapping and Classification project is a system which provides maps displaying Queensland's wetland data. Within this classification system there are five wetland types identified:

- Marine: Consists of an open ocean overlying the continental shelf and associated high energy coastline
- Estuarine: Are wetlands with oceanic water that is occasionally diluted with freshwater run off from the land
- Riverine: Are systems which include all wetlands and deep water habitats contained within a channel
- Lacustrine: Are systems which are typically extensive areas of deep water habitat and wetlands (excluding those dominated by trees)

© ECO LOGICAL AUSTRALIA PTY LTD

- Palustrine: Consists of all non-tidal wetlands which are dominated by trees, shrubs and persistent emergent, emergent mosses or lichens.

The Queensland Wetland Classification Mapping identifies several wetland types and values along and within 10 km of the rail alignment (**Figure 6** and **Figure 7**). These include riverine, palustrine and lacustrine wetland systems as well as mapped Regional Ecosystems (REs) that potentially contain wetland values. Riverine wetlands and REs which potentially contain riverine wetland values are common throughout the alignment as are palustrine wetlands and their RE counterparts. Lacustrine wetlands are also mapped within proximity to the alignment however these water bodies are relatively small. For the majority, areas consisting of a mosaic of REs containing a small proportion of potential wetland values (1 to 50 per cent) frequently intersect the alignment.

Multiple palustrine wetlands and some REs (11.3.4 and 11.3.5) with potential riverine wetland values along the alignment have been identified in the Queensland Referable Wetland Mapping as of High Ecological Significance (HES) as recognised under the *Environmental Protection Regulation 2008*. However, none of these mapped wetlands occur within mapped High Ecological Value waters as outlined in the EPP (Water and Wetland Biodiversity). The closest HES wetland mapped within High Ecological Value waters is approximately 25 km east of the Gowrie end of alignment.

Similarly, many of the wetlands (palustrine, lacustrine and mosaic) mapped along the alignment are also mapped as wetlands under the *Vegetation Management Act 1999* (VM Act). These wetlands predominantly occur in the eastern and western extents of the alignment.

There are mapped VM Act watercourses that intersect the alignment, with stream orders ranging from 1 to 9 as follows:

- Stream order 9: one watercourse
- Stream order 6: one watercourse
- Stream order 5: two watercourses
- Stream order 4: six watercourses
- Stream order 3: seven watercourses
- Stream order 2: 22 watercourses
- Stream order 1: 49 watercourses

The mapped VM Act watercourses that are also recognised under the *Water Act 2000* and intersect the alignment include:

- Westbrook Creek
- Condamine River
- Grasstree Creek
- Macintyre River
- Pariagara Creek
- Back Creek
- Bringalily Creek
- Nicol Creek
- Dry Creek

A watercourse determination may be required for works affecting watercourses that are not mapped under the *Water Act 2000.* ARTC is an approved entity for the purpose of the DNRME Riverine Protection Permit exemption requirements, and works can be undertaken providing that they meet the guidelines of the exemption.

© ECO LOGICAL AUSTRALIA PTY LTD

Fish waterways relevant to waterway barrier works have been identified along the alignment, with maps provided in **Appendix F**. These waterways reflect areas that provide fish passage, and are defined under the *Fisheries Act 1994*. The number of waterway intersections with the centre of the rail alignment by risk classification are as follows:

- Low risk (green) – 43 waterways
- Moderate risk (amber) – 28 waterways
- High risk (red) – 7 waterways
- Major risk (purple) – 10 waterways

The level of risk relating to each waterway will be considered by the design team responsible for the design of infrastructure such as culverts, bridges and other potential barriers to fish movement. This will occur during the detail design stage of the Project.

Groundwater-dependent ecosystems (GDEs) are ecosystems that rely upon groundwater for their continued persistence. Some GDEs are entirely dependent on groundwater resources while others may utilise this intermittently. There are three types of GDEs:

- Aquatic GDEs: surface ecosystems dependent on the surface expression of groundwater
- Terrestrial GDEs: surface ecosystems dependent on the subsurface presence of groundwater
- Subterranean GDEs: include caves and aquifers

Both aquatic and terrestrial GDEs have been mapped by DES along the alignment from approximately halfway along the section to the NSW/QLD border. The mapping is suitable for use at a regional scale, and is produced from an assessment of vegetation mapping, wetland mapping, expert knowledge and the results of existing research.

Terrestrial GDEs are most dominant and concentrated in the mid-section, while aquatic GDEs are scattered towards the NSW/QLD border end of alignment. The terrestrial GDEs are associated with Canning Creek and Macintyre Brook, both of which intercept the rail alignment.

Several ephemeral springs (sourced from bedrock aquifer systems) have been mapped by DES adjacent to the Gowrie end of the alignment, and include:

- Leigh Spring
- Stone Spring
- Springside Spring
- Jimna Springs
- Wellcamp Spring
- Eustondale Spring
- Merigandan Creek.

4.2.6 AquaBAMM / Aquatic Conservation Assessments

The Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM) is a methodology developed by the Department of Environment and Science to assess conservation values of aquatic ecosystems in Queensland (DEHP 2015). The method combines a multitude of different criterion scores related to biodiversity and species richness, presence of threatened species or community, presence of priority species or ecosystem, ecosystem complexity (e.g. uniqueness of geomorphology) and landscape connectivity (Clayton et.al 2006). A summary score (AquaScore) is produced and classified into one of five rankings;

- Very High
- High
- Medium
- Low
- Very Low

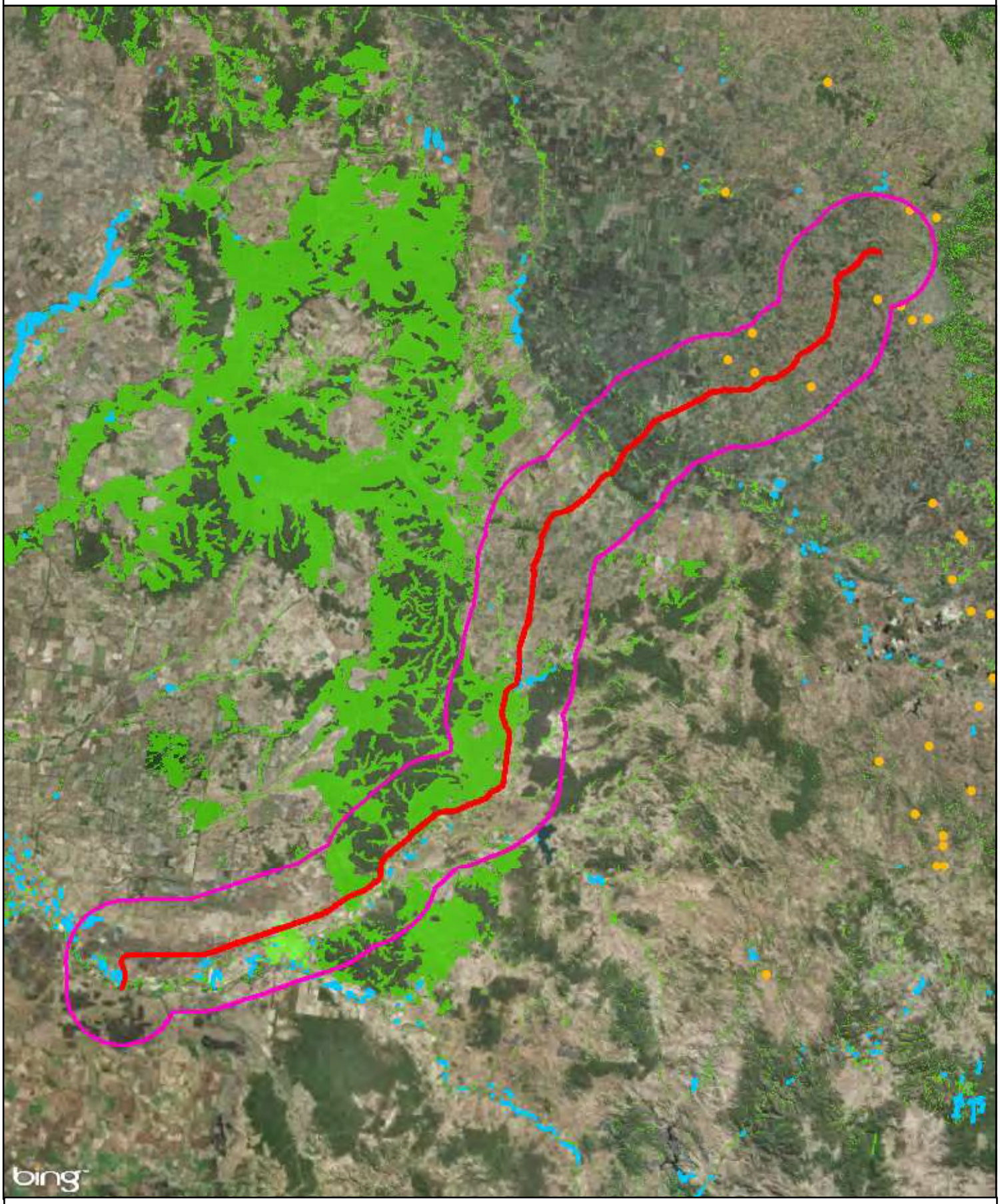
The rail alignment passes through a diversity of aquatic systems which have been assessed and mapped according to available AquaBAMM spatial data and reporting (Queensland Globe 2019). The results of assessment are presented in **Table 16**. The vast majority of sites have an AquaScore of Medium or higher, indicating that aquatic ecosystems of the impact assessment area are in relatively good condition.

Table 16 AquaBAMM / ACA score for survey sites

AquaScore for Conservation Value	Survey Site Number
Very High	1R, 2, 2R, 3, 4, 5, 6, 7, 8, 9, 10, 11, 29, 30
High	12, 13, 14, 15
Medium	18,19, 20, 20R, 21, 22, 23, 24, 25, 26, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43
Low	16, 17, 27
Very Low	-

© ECO LOGICAL AUSTRALIA PTY LTD

Figure 6. Groundwater Dependent Ecosystem (GDE) values along alignment



Legend

- Rail alignment
- Rail Alignment with 10 Km buffer
- Springs associated with GDE
- Terrestrial GDE
- Aquatic GDE
- Subterranean GDE

0 12.5 25 50
Kilometers

Datum/Projection:
GDA 1994 MGA Zone 56

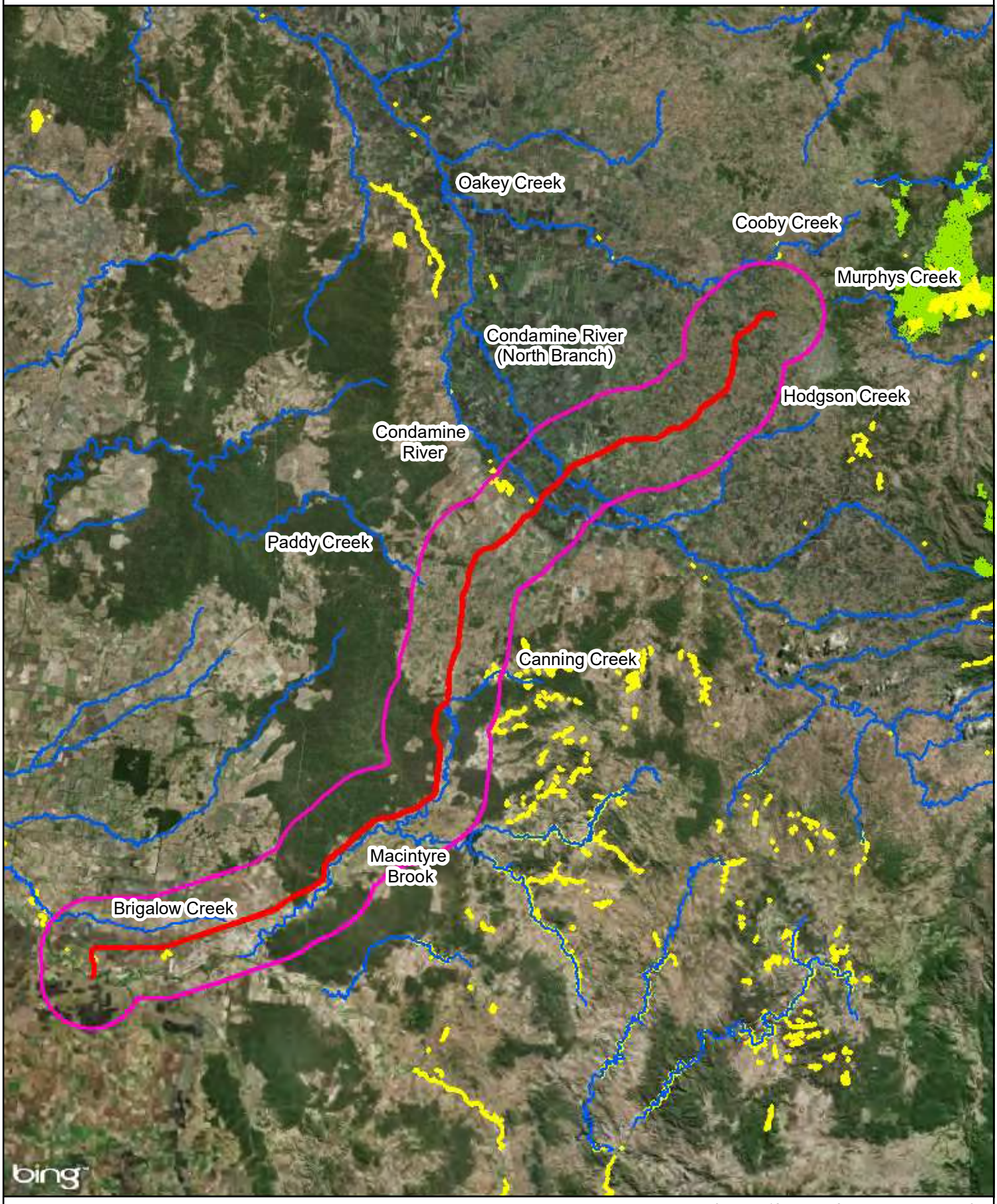
N

eco logical AUSTRALIA
www.ecoaus.com.au

© Eco Logical Australia Pty. Ltd. This map is not guaranteed to be free from error or omission. Eco Logical Australia Pty. Ltd. and its employees disclaim liability for any act done on the information in the map and any consequences of such acts or omissions.

Prepared by: TI

Figure 7. Wetland and watercourse values along alignment



Legend

- Rail alignment
- Rail alignment with 10km buffer
- Major watercourse
- High ecological significance wetlands
- High ecological value waters

0 12.5 25 50
Kilometers

Datum/Projection:
GDA 1994 MGA Zone 56

N

eco logical AUSTRALIA
www.ecoaus.com.au

© Eco Logical Australia Pty. Ltd. This map is not guaranteed to be free from error or omission. Eco Logical Australia Pty. Ltd. and its employees disclaim liability for any act done on the information in the map and any consequences of such acts or omissions.

Prepared by: TI

4.2.7 Endangered ecological community (NSW)

The aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River is listed as an endangered ecological community (EEC) under the New South Wales *Fisheries Management Act 1994*. The lowland catchment of the Darling River has been greatly modified since European settlement, with many aquatic habitats degraded, and native species in decline (NSW DPI 2007).

The listed ecological community includes the Border Rivers, including the Macintyre River, which is traversed by the rail alignment at the southern extent of the impact assessment area. The Macintyre River provides habitat typical of the listed ecological community, which includes meandering channels, deep channels, pools, wetlands, gravel beds and flood plains. A Priority Actions Statement has been developed for the EEC (NSW DPI 2019), involving a range of recovery actions including habitat protection, rehabilitation of disturbed areas and pest control.

4.3 Results of surface water field surveys

Water quality results are presented in the following sections and are grouped to facilitate assessment of sites consistent with the six sub-catchments in the local water quality guidelines (DES 2019a, b). Water quality results outside (i.e. exceeding a maximum guideline or below a minimum guideline) both the local guideline (which is an annual median) and the ANZECC (2000, 2018) guideline (for slightly to moderately disturbed ecosystems; 95 per cent level of protection) were highlighted as being 'outside the guideline'. A median value has been calculated for each site. The median should be interpreted cautiously at sites where there is a small number of data points.

Laboratory certificates of analysis are provided in **Appendix D**.

4.3.1 Macintyre Barwon Floodplain (Queensland Border Rivers Basin; sites 1 to 2)

Water quality at sites within the Macintyre Barwon Floodplain was relatively good, with a slightly alkaline pH and low EC (**Table 17**). Local guidelines for turbidity and total suspended solids during low flow conditions were exceeded in November 2018. Nutrient levels were below local water quality guidelines, with the exception of reactive phosphorus. Chlorophyll *a* concentrations were also slightly elevated across most sampling surveys, including during November 2018 despite the turbid water conditions (**Table 18**).

Dissolved metal concentrations were generally low, with only one exceedance of the *ANZECC Guideline* (2018) for copper at Site 2 in November 2018 (**Table 19**). Hardness concentrations were consistently at or above 60 mg/L and may provide some protection to biota from the toxic effects of some metals, which reduce with increased hardness (see Table 3.4.4 of the ANZECC Guidelines 2000).

The concentration of PAHs was below the laboratory level of detection at all sites for all surveys.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 17 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – physico-chemical

Physico-chemical		pH units	Temp (ºC)	DO (% Sat)	EC (µS/cm)	Salinity (g/kg)	Turbidity (NTU)	TSS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness (mg/L)
Limit of Reporting		0.01	0.1	0.1	1	0.01	0.1	5	1	1	1
ANZECC		6.5 to 7.5		90 to 110	30 to 350		2 to 25				
Basin Plan Low flow High flow		 7.4 to 8.0 7.0 to 7.5		 60 t0 110 60 to 110	 240 180		 30 110	 25 70			
Site	Field Trip										
1R	Jun 2018	7.45	13.5	52.5	283	0.14	25.9	28	13	11	78
2	Jun 2018	Not sampled									
	Nov 2018	7.74	25.5	83.8	224	0.10	53.2	27	12	10	71
	Feb 2019	6.77	28.7	101.6	211	0.11	22.9	23	13	11	78
	Apr 2019	7.23	21.6	76.2	216	0.10	11.2	10	16	13	93
	May 2019	7.76	16.8	84.6	299	0.14	13.0	12	15	8	70
	Median	**7.49**	**23.55**	**84.2**	**220**	**0.11**	**18.0**	**17.5**	**14**	**10.5**	**74.5**
2R	Jun 2018	7.61	14.0	57.5	239	0.12	13.4	<5	10	8	58
	Nov 2018	7.27	25.0	90.2	223	0.1	96.0	43	12	9	67
	Feb 2019	7.31	28.9	89.5	211	0.11	25.7	24	13	11	78
	Apr 2019	7.68	22.3	71.6	215	0.10	12.2	7	16	13	93
	Median	**7.46**	**23.65**	**80.55**	**219**	**0.11**	**19.6**	**24**	**12.5**	**10**	**72.5**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 18 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – nutrients

Nutrients (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll *a* (µg/l)
Limit of Reporting		0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.01	0.01	1
ANZECC		0.013			0.015				0.03	0.015	-
Basin Plan Low flow High flow		 0.02 ID			 0.010 0.195			 0.575 0.9	 0.07 0.15	 0.02 ID	 3 ID
Site	Trip										
1R	Jun 2018	0.02	<0.01	<0.01	<0.01	0.6	0.6	0.6	0.1	<0.01	<2
	Nov 2018	Not sampled									
	Feb 2019	Not sampled									
	Apr 2019	Not sampled									
	Median	**0.02**	**<0.01**	**<0.01**	**<0.01**	**0.60**	**0.60**	**0.60**	**0.10**	**<0.01**	**<2**
2	Jun 2018	Not sampled									
	Nov 2018	<0.01	<0.01	<0.01	<0.01	0.5	0.5	0.5	0.12	0.04	9
	Feb 2019	0.07	<0.01	0.17	0.17	0.5	0.6	0.8	0.16	0.13	2
	Apr 2019	0.03	<0.01	<0.01	<0.01	0.5	0.5	0.5	0.08	0.04	5
	May 2019	0.02	<0.01	<0.01	0.02	0.7	0.7	0.7	0.03	<0.01	7
	Median	**0.03**	**<0.01**	**<0.01**	**0.01**	**0.50**	**0.55**	**0.6**	**0.1**	**0.04**	**6**
2R	Jun 2018	0.02	<0.01	<0.01	<0.01	0.5	0.5	0.5	0.05	0.01	<1
	Nov 2018	<0.01	<0.01	0.02	0.02	0.5	0.5	0.5	0.015	0.04	5
	Feb 2019	0.03	<0.01	0.16	0.16	0.6	0.6	0.8	0.16	0.13	2
	Apr 2019	0.02	<0.01	<0.01	<0.01	0.4	0.4	0.4	0.06	0.03	4
	Median	**0.02**	**<0.01**	**0.09**	**0.09**	**0.50**	**0.50**	**0.50**	**0.06**	**0.04**	**4**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 19 Water quality results for Sites 1R, 2 and 2R in the Macintyre Barwon Floodplain – dissolved metals

Dissolved metals (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
Limit of Reporting		0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.0001
ANZECC		0.024	0.0002	0.0033[#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan									
Site	Trip								
1R	Jun 2018	0.002	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Nov 2018	Not sampled							
	Feb 2019	Not sampled							
	Apr 2019	Not sampled							
	Median	**0.002**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**0.002**	**<0.005**	**<0.0001**
2	Jun 2018	Not sampled							
	Nov 2018	0.003	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	<0.0001
	Feb 2019	0.004	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.003	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.0001
	May 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Median	0.003	<0.0001	<0.001	0.0008	<0.001	0.001	<0.005	<0.0001
2R	Jun 2018	0.002	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Nov 2018	0.003	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Feb 2019	0.004	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.003	<0.0001	<0.001	0.001	<0.001	0.002	<0.005	<0.0001
	Median	**0.003**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**0.002**	**<0.005**	**<0.0001**

[#] Low reliability guideline (ANZECC 2018). Values outside of all guidelines are shaded orange

4.3.2 Lower Macintyre Brook (Queensland Border Rivers Basin; sites 3 to 8)

Water quality at sites in the Lower Macintyre Brook was characterised by high EC and elevated concentrations of suspended sediment and nutrients, with low dissolved oxygen (**Table 20** and **Table 21)**. Such results are typical of dry season conditions, when streams form a series of isolated pools that are subject to evaporation. Dissolved metal concentrations were low, with no exceedances of the *ANZECC Guideline* (2018) and with the concentration of most metals below the laboratory level of detection (**Table 22**).

The concentration of PAHs was below the level of detection at all sites. Sites 4, 5 and 8 were dry at the time of field surveys (**Table 3**).

4.3.3 Canning Creek (Queensland Border Rivers Basin; sites 9 to 20)

Water quality at sites in the Canning Creek sub catchment was generally poor, characterised by alkaline pH and elevated concentrations of nutrients (**Table 23** and **Table 24**). EC results exceeded relevant guidelines at Site 16 but were otherwise good. Dissolved metal concentrations were generally low, with exceedances of the *ANZECC Guideline* (2018) for copper at Site 16 in November 2018, February 2019 and April 2019 (**Table 25**). Hardness concentrations at Site 16 of 100 mg/L may provide some protection to biota from the toxic effects of some metals, which reduce with increased hardness (see Table 3.4.4 of the ANZECC Guidelines 2000).

The concentration of PAHs was below the level of detection at all sites. Sites 9, 10, 12, 13, 15, 17 and 19 were dry at the time of field surveys (**Table 3**).

4.3.4 Southern Condamine (Condamine River Basin; sites 21 to 26)

Water quality at sites in the Southern Condamine (Sites 23 and 24) was characterised by alkaline pH, high EC and elevated concentrations of suspended sediment and nutrients (**Table 26** and **Table 27)**. Chlorophyll *a* results also exceeded relevant guidelines. Such results are typical of dry season conditions, when streams form a series of isolated pools that are subject to evaporation.

Dissolved metal concentrations were generally low, with only two exceedances of the *ANZECC Guideline* (2018) for copper and lead at Site 24 (**Table 28**). Hardness concentrations at Site 24 may provide some protection to biota from the toxic effects of some metals, which reduce with increased hardness (see Table 3.4.4 of the ANZECC Guidelines 2000).

The concentration of PAHs was below the level of detection at all sites. Sites 21, 22, 25 and 26 were found not to be suitable for assessment (**Table 2**).

© ECO LOGICAL AUSTRALIA PTY LTD

Table 20 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – physico-chemical

Guideline		pH units	Temp °C	DO %Sat	EC µS/cm	Salinity g/kg	Turbidity NTU	TSS	Calcium	Magnesium	Hardness as $CaCO_3$
Limit of Reporting		0.01	0.1	0.1	1	0.01	1	5	1	1	1
ANZECC		6.5 to 7.5		90 to 110	30 to 350		2 to 25		-	-	-
Basin Plan Low Flow High Flow		 7.4 to 8.0 7.2 to 8.0		 60 to 110 60 to 110	 370 250		 11 25	 10 25			
Site	Trip										
3	Jun 2018	5.58	10.7	46.1	383	0.2	9.7	<5	11	10	69
	Nov 2018	7.33	23.8	89.1	406	0.19	6.5	<5	14	10	76
	Feb 2019	6.65	25.1	50.1	357	0.19	6.9	8	15	10	79
	Apr 2019	7.77	19.6	63.4	423	0.20	14.7	12	20	12	99
	Median	**6.99**	**21.7**	**56.8**	**395**	**0.20**	**8.3**	**10**	**14.5**	**10**	**77.5**
6	Jun 2018	7.97	10.2	52.7	334	0.17	17.2	20[@]	9	8	55
	Nov 2018	7.08	21.0	51.4	427	0.2	20.8	14	15	10	79
	Feb 2019	7.20	25.1	49.7	389	0.20	15.1	12	16	10	81
	Apr 2019	7.45	18.4	53.1	433	0.21	13.7	10	20	12	99
	Median	**7.33**	**19.7**	**52.1**	**408**	**0.2**	**16.2**	**13**	**15.5**	**10**	**80**
7	Jun 2018	7.80	10.3	48.7	337	0.17	18.0	18	9	9	60
	Nov 2018	7.46	25.2	76.3	434	0.2	15.0	9	15	10	79
	Feb 2019	7.29	26.6	55.3	409	0.21	12.2	12	17	11	88
	Apr 2019	7.64	19.2	51.2	430	0.21	8.2	6	21	12	102
	May 2019	7.55	16.8	79.3	449	0.21	7.3	6	19	11	93
	Median	**7.55**	**19.2**	**55.3**	**430**	**0.21**	**12.2**	**9**	**17**	**11**	**88**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise. [@] Result was outside the relative percent difference criterion of 35% (see **Section 4.3.7**)

© ECO LOGICAL AUSTRALIA PTY LTD

Table 21 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll *a* (µg/L)
Limit of Reporting		0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.01	0.01	1
ANZECC		0.013			0.015				0.03	0.015	-
Basin Plan Low Flow High Flow		 0.008 ID			 0.018 ID			 0.71 0.91	 0.055 0.07	 0.011 ID	 ID ID
Site	Trip										
3	Jun 2018	0.04	<0.01	<0.01	<0.01	0.8	0.8	0.8	0.04	<0.01	<2
	Nov 2018	<0.01	<0.01	<0.01	<0.01	0.6	0.6	0.6	0.04	<0.01	7
	Feb 2019	0.04	<0.01	<0.01	<0.01	1	1	1	0.06	<0.01	12
	Apr 2019	0.02	<0.01	<0.01	<0.01	1.6	1.6	1.6	0.08	<0.01	65
	Median	**0.03**	**<0.01**	**<0.01**	**<0.01**	**0.9**	**0.9**	**0.9**	**0.05**	**<0.01**	**9.5**
6	Jun 2018	0.03	<0.01	0.05	0.05	0.8	0.8	0.8	0.04	<0.01	<2.0
	Nov 2018	<0.01	<0.01	<0.01	<0.01	0.7	0.7	0.7	0.05	<0.01	4
	Feb 2019	0.05	<0.01	<0.01	<0.01	1.2	1.2	1.2	0.06	<0.01	5
	Apr 2019	0.03	<0.01	<0.01	<0.01	1.1	1.1	1.1	0.04	<0.01	10
	Median	**0.03**	**<0.01**	**<0.01**	**<0.01**	**0.95**	**0.95**	**0.95**	**0.05**	**<0.01**	**4.5**
7	Jun 2018	0.04	<0.01	0.15	0.15	0.9	0.9	1	0.04	<0.01	<2
	Nov 2018	<0.01	<0.01	0.02	0.02	0.7	0.7	0.7	0.06	<0.01	5
	Feb 2019	0.05	<0.01	0.03	0.03	1	1	1	0.04	<0.01	6
	Apr 2019	0.03	<0.01	0.09	0.09	1.1	1.1	1.2	0.04	<0.01	14
	May 2019	0.05	<0.01	0.24	0.24	1	1	1.2	0.02	<0.01	7
	Median	**0.045**	**<0.01**	**0.09**	**0.09**	**1**	**1**	**1**	**0.04**	**<0.01**	**6.5**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 22 Water quality results for Sites 3, 6 and 7 in the Lower Macintyre Brook – dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
Limit of Reporting		0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.0001
ANZECC		0.024	0.0002	0.0033[#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan									
Site	Trip								
3	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	0.001	<0.001	<0.001	<0.005	<0.0001
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Median	**0.002**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**<0.0001**
6	Jun 2018	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Median	**0.0015**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**<0.0001**
7	Jun 2018	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Feb 2019	0.002	<0.0001	<0.001	0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	May 2019	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Median	**0.002**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**<0.0001**

[#] Low reliability guideline (ANZECC 2018). Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 23 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – physico-chemical

Guideline		pH units	Temp °C	DO %Sat	EC µS/cm	Salinity (g/kg)	Turbidity (NTU)	TSS	Calcium	Magnesium	Hardness as $CaCO_3$
Limit of Reporting		0.01	0.1	0.1	1	0.01	0.1	5	1	1	1
ANZECC		6.5 to 7.5		90 to 110	30 to 350		2 to 25		-	-	-
Basin Plan Low Flow High Flow		 7.2 to 7.8 6.9 to 7.9		 60 to 110 60 to 110	 200 165		 35 50	 25 60			
Site	Trip										
11	Jun 2018	8.18	10.4	67.6	213	0.15	17	15	11	7	56
	Nov 2018	8.21	23.7	103.1	286	0.13	21	14	13	6	57
	Feb 2019	7.00	25.7	65.0	236	0.12	25	23	12	6	55
	Apr 2019	7.27	16.6	66.0	297	0.14	64	104	16	8	73
	Median	**7.725**	**20.2**	**66.8**	**261**	**0.14**	**23**	**19**	**12.5**	**6.5**	**56.5**
14	Jun 2018	7.70	14.7	64.30	160	0.10	44	20	4	7	39
	Nov 2018	8.09	22.5	86.60	248	0.11	37	<5	5	9	50
	Feb 2019	8.19	28.0	101.40	307	0.16	74	39	6	12	64
	Apr 2019	7.46	19.2	61.70	353	0.17	104	44	7	16	83
	Median	**7.90**	**20.9**	**75.45**	**278**	**0.14**	**59**	**39**	**5.5**	**10.5**	**57**
16	Jun 2018	7.66	12.6	56.30	184	0.11	147	32	14	4	51
	Nov 2018	7.82	18.8	82.30	382	0.17	161	56	27	8	100
	Feb 2019	8.39	29.4	120.00	636	0.33	259	170	25	12	112
	Apr 2019	7.62	19.5	32.00	1255	0.62	>1000	2170	42	18	179
	Median	**7.74**	**19.2**	**69.30**	**509**	**0.25**	**161**	**113**	**26**	**10**	**106**
18	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	7.22	28.4	57.9	311	0.16	60.6	18	28	7	99
	Apr 2019	7.52	19.4	53.7	320	0.15	23.8	8	34	8	118
	May 2019	7.84	16.0	39.7	332	0.15	36.3	14	29	7	101
	Median	**7.52**	**19.4**	**53.7**	**320**	**0.15**	**36.3**	**14**	**29**	**7**	**101**
20R	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	Not Sampled									
	Apr 2019	7.31	19.9	32.8	154	0.08	8.63	10	19	6	72
	Median	**7.31**	**19.9**	**32.8**	**154**	**0.08**	**8.63**	**10**	**19**	**6**	**72**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 24 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll *a* (µg/L)
Limit of Reporting		0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.01	0.01	1
ANZECC		0.013			0.015				0.03	0.015	-
Basin Plan Low Flow High Flow		 0.001 ID			 0.006 ID			 0.52 0.60	 0.03 0.04	 0.008 ID	 ID ID
Site	Trip										
11	Jun 2018	0.02	<0.01	0.02	0.02	0.9	0.9	0.9	0.06	<0.01	<2
	Nov 2018	<0.01	<0.01	<0.01	<0.01	1.2	1.2	1.2	0.11	<0.01	40
	Feb 2019	0.04	<0.01	<0.01	<0.01	2.2	2.2	2.2	0.15	<0.01	23
	Apr 2019	0.02	<0.01	<0.01	<0.01	5.7	5.7	5.7	0.33	<0.01	460
	Median	**0.03**	**<0.01**	**<0.01**	**<0.01**	**1.7**	**1.7**	**1.7**	**0.13**	**<0.01**	**31.5**
14	Jun 2018	0.25	<0.01	<0.01	<0.01	1.0	1.2	1.2	0.03	<0.01	<1
	Nov 2018	<0.01	<0.01	<0.01	<0.01	0.7	0.7	0.7	0.03	<0.01	3
	Feb 2019	0.05	<0.01	<0.01	<0.01	1.6	1.6	1.6	0.07	<0.01	6
	Apr 2019	0.03	<0.01	<0.01	<0.01	2.3	2.3	2.3	0.10	<0.01	16
	Median	**0.04**	**<0.01**	**<0.01**	**<0.01**	**1.3**	**1.4**	**1.4**	**0.05**	**<0.01**	**4.5**
16	Jun 2018	0.02	<0.01	<0.01	<0.01	1.0	1.0	1.0	0.11	<0.01	<4
	Nov 2018	0.06	<0.01	0.01	0.01	1.3	1.4	1.4	0.17	<0.01	8
	Feb 2019	0.06	<0.01	0.02	0.02	4.1	4.2	4.2	0.31	<0.01	54
	Apr 2019	1.50	0.05	0.02	0.07	29.6	31.1	31.2	3.93	<0.01	545
	Median	**0.06**	**<0.01**	**0.015**	**0.015**	**2.7**	**2.8**	**2.8**	**0.24**	**<0.01**	**31**
18	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	0.03	<0.01	<0.01	<0.01	1.2	1.2	1.2	0.10	<0.01	7
	Apr 2019	0.02	<0.01	<0.01	<0.01	0.8	0.8	0.8	0.04	<0.01	4
	May 2019	0.02	<0.01	<0.01	<0.01	0.8	0.8	0.8	0.04	<0.01	5
	Median	**0.02**	**<0.01**	**<0.01**	**<0.01**	**0.8**	**0.8**	**0.8**	**0.04**	**<0.01**	**5**
20R	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	Not Sampled									
	Apr 2019	0.02	<0.01	<0.01	<0.010	1.6	1.6	1.6	0.32	0.10	21
	Median	**0.02**	**<0.01**	**<0.01**	**<0.010**	**1.6**	**1.6**	**1.6**	**0.32**	**0.10**	**21**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

© ECO LOGICAL AUSTRALIA PTY LTD

Table 25 Water quality results for Sites 11, 14, 16 and 18 in Canning Creek and Site 20R in Nicol Creek – dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
Limit of Reporting		0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.0001
ANZECC		0.024	0.0002	0.0033[#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan									
Site	Trip								
11	Jun 2018	0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Nov 2018	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Feb 2019	0.003	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Median	**0.002**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**<0.0001**
14	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Nov 2018	0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Median	**0.001**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**		**<0.005**	**<0.0001**
16	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Nov 2018	0.001	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	<0.0001
	Feb 2019	0.003	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	<0.0001
	Apr 2019	0.004	<0.0001	<0.001	0.002	<0.001	0.009	<0.005	<0.0001
	Median		**<0.0001**	**<0.001**	**0.002**	**<0.001**	**0.002**	**<0.005**	**<0.0001**
18	Jun 2018	Not Sampled							
	Nov 2018	Not Sampled							
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	0.001	<0.001	0.002	<0.005	<0.0001
	May 2019	<0.001	<0.0001	<0.001	0.001	<0.001	0.002	<0.005	<0.0001
	Median	**0.001**	**<0.0001**	**<0.001**	**0.001**	**<0.001**	**0.002**	**<0.005**	**<0.0001**
20R	Jun 2018	Not Sampled							
	Nov 2018	Not Sampled							
	Feb 2019	Not Sampled							
	Apr 2019	0.003	<0.0001	<0.001	<0.001	<0.001	0.004	0.008	<0.0001
	Median	**0.003**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**0.004**	**0.008**	**<0.0001**

[#] Low reliability guideline (ANZECC 2018). Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 26 Water quality results for Site 23 and 24 in the Southern Condamine – physico-chemical

Guideline		pH units	Temp ºC	DO %Sat	EC µS/cm	Salinity (g/kg)	Turbidity (NTU)	TSS	Calcium	Magnesium	Hardness as $CaCO_3$
Limit of Reporting		0.01	0.1	0.1	1	0.01	0.1	5	1	1	1
ANZECC		6.5 to 7.5		90 to 110	30 to 350		2 to 25		-	-	-
Basin Plan Low Flow High Flow		 7.2 to 7.9 7.0 to 7.6		 60 to 110 60 to 110	 170 160		 9 25	 8 17			
Site	Trip										
23	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	7.18	32.0	84.70	267	0.14	8.0	8	23	8	90
	Apr 2019	7.38	19.3	68.60	290	0.14	31.1	18	30	10	116
	Median	**7.28**	**25.65**	**76.65**	**278**	**0.14**	**19.6**	**13**	**26.5**	**9**	**103**
24	Jun 2018	7.77	7.9	45.90	345	0.16	239	98	14	11	80
	Nov 2018	8.18	30.9	89.50	580	0.27	251	194	27	18	142
	Feb 2019	7.42	27.2	47.80	281	0.14	135	60	13	8	65
	Apr 2019	Not Sampled									
	Median	**7.77**	**27.2**	**47.80**	**345**	**0.16**	**239**	**98**	**14**	**11**	**80**

Values outside of guidelines are shaded orange. All units mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 27 Water quality results for Site 23 and 24 in the Southern Condamine – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll *a* (µg/L)
Limit of Reporting		0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.01	0.01	1
ANZECC		0.013			0.015				0.03	0.015	-
Basin Plan Low Flow High Flow		 0.006 ID			 0.003 ID			 0.595 0.830	 0.045 0.060	 0.015 0.020	 5 ID
Site	Trip										
23	Jun 2018	Not Sampled									
	Nov 2018	Not Sampled									
	Feb 2019	0.03	<0.01	<0.01	<0.01	1.4	1.4	1.4	0.10	0.02	2
	Apr 2019	0.02	<0.01	<0.01	<0.01	0.9	0.9	0.9	0.06	<0.01	7
	Median	0.025	**<0.01**	**<0.01**	**<0.01**	**1.15**	**1.15**	**1.15**	**0.08**	**<0.01**	**4.5**
24	Jun 2018	0.04	<0.01	<0.01	<0.01	0.5	0.5	0.5	0.07	<0.01	<4
	Nov 2018	0.08	<0.01	0.01	0.01	4.1	4.2	4.2	0.51	0.03	28
	Feb 2019	0.04	<0.01	<0.01	<0.01	1.8	1.8	1.8	0.35	0.07	9
	Apr 2019	Not Sampled									
	Median	**0.04**	**<0.01**	**0.01**	**<0.01**	**1.8**	**1.8**	**1.8**	**0.35**	**0.03**	**9**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

Table 28 Water quality results for Site 23 and 24 in the Southern Condamine – dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
Limit of Reporting		0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.0001
ANZECC		0.024	0.0002	0.0033[#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan									
Site	Trip								
23	Jun 2018	Not Sampled							
	Nov 2018	Not Sampled							
	Feb 2019	0.003	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
	Apr 2019	0.002	<0.0001	<0.001	<0.001	<0.001	0.003	<0.005	<0.0001
	Median	**0.0025**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**0.002**	**<0.005**	**<0.0001**
24	Jun 2018	<0.001	<0.0001	<0.001	0.001	<0.001	0.005	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	0.004	<0.001	0.006	<0.005	<0.0001
	Feb 2019	0.003	<0.0001	<0.001	0.001	0.006	<0.001	<0.005	<0.0001
	Apr 2019	Not Sampled							
	Median	**0.0020**	**<0.0001**	**<0.001**	**0.001**	**<0.001**	**0.005**	**<0.005**	**<0.0001**

[#] Low reliability guideline (ANZECC 2018). Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

4.3.5 Central Condamine (Condamine River Basin; sites 27 to 33)

Water quality at sites in the Central Condamine was characterised by alkaline pH and elevated concentrations of suspended sediment and nutrients (**Table 29** and **Table 30**). The high dissolved oxygen results indicate that algal growth occurs at some sites, producing high percent saturation of oxygen during the day from photosynthesis, and more than likely, consuming oxygen at night. The high chlorophyll *a* concentrations at most sites are consistent with this interpretation.

Results are typical of dry season conditions, when streams form a series of isolated pools that are subject to evaporation. Dissolved copper concentrations were consistently high, with dissolved Nickel concentrations also above the *ANZECC Guidelines* (2018) at some sites (**Table 31**). High hardness concentrations (>59 mg/L) may provide some protection to biota from the toxic effects of some metals, which reduce with increased hardness (see Table 3.4.4 of the ANZECC Guidelines 2000).

The concentration of PAHs was below the level of detection at all sites. Site 31 was dry at the time of field surveys (**Table 3**).

4.3.6 Oakey Creek (Condamine River Basin; sites 34 to 43)

Water quality at sites in the Oakey Creek sub catchment was characterised by alkaline pH and high EC (**Table 32**). Nutrient and chlorophyll *a* concentrations were also elevated across most sites (**Table 33**). Such results are typical of dry season conditions, when streams form a series of isolated pools that are subject to evaporation.

Dissolved copper concentrations were slightly elevated, with no other exceedances of the *ANZECC Guidelines* (2018; **Table 34**). Very high hardness concentrations (>200 mg/L) may provide some protection to biota from the toxic effects of some metals, which reduce with increased hardness (see Table 3.4.4 of the ANZECC Guidelines 2000).

The concentration of PAHs was below the level of detection at all sites. Sites 35, 36 and 43 were dry at the time of field surveys (**Table 3**) and Sites 34, 37, 38 and 41 were found not to be suitable for assessment (**Table 2**).

© ECO LOGICAL AUSTRALIA PTY LTD

Table 29 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine – physico-chemical

Guideline		pH units	Temp °C	DO %Sat	EC µS/cm	Salinity (g/kg)	Turbidity (NTU)	TSS	Calcium	Magnesium	Hardness as $CaCO_3$
Limit of Reporting		0.01	0.1	0.1	1	0.01	0.1	5	1	1	1
ANZECC		6.5 to 7.5		90 to 110	30 to 350		2 to 25		-	-	-
Basin Plan Low Flow High Flow		 7.4 to 8.3 7.0 to 7.6		 60 to 110 60 to 110	 890 290		 25 220	 25 130			
Site	Trip										
27	Jun 2018	8.50	10.0	85.0	352	0.28	51.8	28	40	24	199
	Nov 2018	Not sampled									
	Feb 2019	8.34	30.3	134.1	503	0.26	87.5	74	37	25	195
	Apr 2019	7.72	17.2	50.6	233	0.11	671	214	21	12	102
	Median	**8.34**	**17.2**	**85.0**	**352**	**0.26**	**87.5**	**74**	**37**	**24**	**195**
28	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	9.13	35.2	233.6	519	0.27	75.6	73	26	22	156
	Apr 2019	7.93	23.1	21.1	315	0.15	477	175	30	18	149
	Median	**8.53**	**29.15**	**127.35**	**417**	**0.21**	**276.3**	**124**	**28**	**20**	**152.5**
29	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	Not sampled									
	Apr 2019	8.04	22.0	35.0	307	0.14	77.8	48	33	23	177
	Median	**8.04**	**22.0**	**35.0**	**307**	**0.14**	**77.8**	**48**	**33**	**23**	**177**
30	Jun 2018	-	14.3	65.5	356	0.22	30.0	11	29	18	146
	Nov 2018	8.83	28.8	104.6	507	0.24	98.1	63	22	19	133
	Feb 2019	8.45	25.1	59.6	365	0.19	43.0	35	25	16	128
	Apr 2019	7.71	18.7	70.4	449	0.21	95.6	70	34	26	192
	Median	**8.45**	**21.9**	**67.95**	**407**	**0.215**	**69.3**	**49**	**27**	**18.5**	**139.5**
32	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	7.8	23.4	82.2	588	0.30	11.5	95	37	27	204
	Apr 2019	Not sampled									
	Median	**7.8**	**23.4**	**82.2**	**588**	**0.30**	**11.5**	**95**	**37**	**27**	**204**
33	Jun 2018	Not sampled									
	Nov 2018	7.7	25.2	106.8	212	0.10	42.9	15	12	7	59
	Feb 2019	Not sampled									
	Apr 2019	Not sampled									
	Median	**7.7**	**25.2**	**106.8**	**212**	**0.10**	**42.9**	**15**	**12**	**7**	**59**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

© ECO LOGICAL AUSTRALIA PTY LTD

Table 30 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll *a* (µg/L)
Limit of Reporting		0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.01	0.01	1
ANZECC		0.013			0.015				0.03	0.015	-
Basin Plan Low Flow High Flow		 0.004 ID			 0.004 0.480			 0.86 2.2	 0.17 0.95	 0.02 0.50	 9 4
Site	Trip										
27	Jun 2018	0.03	<0.01	<0.01	<0.01	0.90	0.9	0.9	0.11	<0.01	5
	Nov 2018	Not sampled									
	Feb 2019	0.05	<0.01	0.01	0.01	2.20	2.2	2.2	0.23	<0.01	53
	Apr 2019	0.08	<0.01	<0.01	<0.01	1.40	1.5	1.5	0.51	0.04	24
	Median	**0.05**	**<0.01**	**<0.01**	**<0.01**	**1.40**	**1.5**	**1.5**	**0.51**	**0.04**	**24**
28	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	0.07	<0.01	<0.01	<0.01	5.10	5.2	5.2	0.43	0.02	56
	Apr 2019	0.04	<0.01	<0.01	<0.01	1.50	1.5	1.5	0.31	0.01	26
	Median	**0.055**	**<0.01**	**<0.01**	**<0.01**	**3.30**	**3.35**	**3.35**	**0.37**	**0.015**	**41**
29	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	Not sampled									
	Apr 2019	0.03	<0.01	<0.01	<0.01	1.80	1.8	1.8	0.66	0.37	18
	Median	**0.03**	**<0.01**	**<0.01**	**<0.01**	**1.80**	**1.8**	**1.8**	**0.66**	**0.37**	**18**
30	Jun 2018	0.02	<0.01	<0.01	<0.01	0.50	0.5	0.5	0.07	<0.01	<2
	Nov 2018	0.10	0.01	0.03	0.04	4.50	4.6	4.6	0.39	0.05	57
	Feb 2019	0.06	<0.01	<0.01	<0.01	5.10	5.2	5.2	0.43	0.02	50
	Apr 2019	0.03	<0.01	<0.01	<0.01	3.30	3.3	3.3	0.38	<0.01	72
	Median	**0.045**	**<0.01**	**<0.01**	**<0.01**	**3.9**	**3.95**	**3.95**	**0.385**	**<0.01**	**54**
32	Jun 2018	Not sampled									
	Nov 2018	Not sampled									
	Feb 2019	0.09	<0.01	<0.01	<0.01	3.70	3.8	3.8	0.43	0.03	90
	Apr 2019	Not sampled									
	Median	**0.09**	**<0.01**	**<0.01**	**<0.01**	**3.70**	**3.8**	**3.8**	**0.43**	**0.03**	**90**
33	Jun 2018	Not sampled									
	Nov 2018	0.03	<0.01	<0.01	<0.01	1.00	1.0	1.0	0.23	0.05	3
	Feb 2019	Not sampled									
	Apr 2019	Not sampled									
	Median	**0.03**	**<0.01**	**<0.01**	**<0.01**	**1.00**	**1.0**	**1.0**	**0.23**	**0.05**	**3**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

© ECO LOGICAL AUSTRALIA PTY LTD

Table 31 Water quality results for Sites 27, 28, 30, 32 and 33 in the Central Condamine –dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
Limit of Reporting		0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.0001
ANZECC		0.024	0.0002	0.0033[#]	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan									
Site	Trip								
27	Jun 2018	<0.001	<0.0001	<0.001	0.002	<0.001	0.006	<0.005	<0.0001
	Nov 2018	Not sampled							
	Feb 2019	0.002	<0.0001	<0.001	<0.001	<0.001	0.007	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	0.002	<0.001	0.008	<0.005	<0.0001
	Median	**0.001**	**<0.0001**	**<0.001**	**0.002**	**<0.001**	**0.007**	**<0.005**	**<0.0001**
28	Jun 2018	Not sampled							
	Nov 2018	Not sampled							
	Feb 2019	0.005	<0.0001	<0.001	0.002	<0.001	0.012	<0.005	<0.0001
	Apr 2019	0.001	<0.0001	<0.001	0.005	<0.001	0.011	<0.005	<0.0001
	Median	**0.003**	**<0.0001**	**<0.001**	**0.0035**	**<0.001**	**0.0115**	**<0.005**	**<0.0001**
29	Jun 2018	Not sampled							
	Nov 2018	Not sampled							
	Feb 2019	Not sampled							
	Apr 2019	0.003	<0.0001	<0.001	0.005	<0.001	0.015	<0.005	<0.0001
	Median	**0.003**	**<0.0001**	**<0.001**	**0.005**	**<0.001**	**0.015**	**<0.005**	**<0.0001**
30	Jun 2018	<0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.0001
	Nov 2018	0.002	<0.0001	<0.001	0.003	<0.001	0.004	<0.005	<0.0001
	Feb 2019	0.001	<0.0001	<0.001	<0.001	<0.001	0.003	<0.005	<0.0001
	Apr 2019	<0.001	<0.0001	<0.001	0.001	<0.001	0.006	<0.005	<0.0001
	Median	**<0.001**	**<0.0001**	**<0.001**	**0.001**	**<0.001**	**0.0035**	**<0.005**	**<0.0001**
32	Jun 2018	Not sampled							
	Nov 2018	Not sampled							
	Feb 2019	0.003	<0.0001	<0.001	<0.001	<0.001	0.011	<0.005	<0.0001
	Apr 2019	Not sampled							
	Median	**0.003**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**0.011**	**<0.005**	**<0.0001**
33	Jun 2018	Not sampled							
	Nov 2018	<0.001	<0.0001	<0.001	0.004	<0.001	0.008	<0.005	<0.0001
	Feb 2019	Not sampled							
	Apr 2019	Not sampled							
	Median	**<0.001**	**<0.0001**	**<0.001**	**0.004**	**<0.001**	**0.008**	**<0.005**	**<0.0001**

[#] Low reliability guideline (ANZECC 2018). Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

© ECO LOGICAL AUSTRALIA PTY LTD

Table 32 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – physico-chemical

Guideline		pH units	Temp °C	DO %Sat	EC µS/cm	Salinity (g/kg)	Turbidity (NTU)	TSS	Calcium	Magnesium	Hardness as $CaCO_3$
Limit of Reporting		0.01	0.1	0.1	1	0.01	0.1	5	1	1	1
ANZECC		6.5 to 7.5		90 to 110	30 to 350		2 to 25		-	-	-
Basin Plan Low flow High flow		 7.7 to 8.3 7.4 to 8.1		 60 to110 60 to110	 510 375		 13 55	 14 65			
Site	Trip										
39	Jun 2018	8.12	14.0	75.5	2318	1.25	11.3	8	73	137	746
	Nov 2018	8.36	28.2	121.6	1731	0.86	20.5	14	65	94	549
	Feb 2019	8.54	29.4	148.2	2632	1.48	35.2	30	42	169	801
	Apr 2019	8.24	20.3	106.2	1843	0.92	21.9	20	87	122	720
	Median	**8.30**	**24.3**	**113.9**	**2080**	**1.09**	**21.2**	**17**	**69**	**130**	**733**
40	Jun 2018	8.42	10.4	74.6	1320	0.69	8.1	10	51	82	465
	Nov 2018	8.25	24.8	92.0	692	0.33	12.5	9	32	38	236
	Feb 2019	Not Sampled									
	Apr 2019	8.13	20.4	88.6	680	0.33	40.6	26	37	48	290
	Median	**8.25**	**20.4**	**88.6**	**692**	**0.33**	**12.5**	**10**	**37**	**48**	**290**
42	Jun 2018	8.52	9.80	72.8	1287	0.69	4.6	6	55	81	471
	Nov 2018	8.30	32.5	116.7	1157	0.56	6.1	10	49	67	398
	Feb 2019	8.44	30.8	146.6	1339	0.73	10.3	8	43	91	482
	Apr 2019	8.15	22.9	85.0	850	0.41	14.6	12	48	60	367
	May 2019	8.25	16.2	105.4	1339	0.64	5.5	<5	62	86	509
	Median	**8.3**	**22.9**	**105.4**	**1287**	**0.64**	**6.1**	**9**	**49**	**81**	**471**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

© ECO LOGICAL AUSTRALIA PTY LTD

Table 33 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – nutrients

Guideline (mg/L)		Ammonia	Nitrite	Nitrate	NOx	Organic N	TKN	Total N	Total P	Reactive P	Chlorophyll *a* (µg/L)
Limit of Reporting		0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.01	0.01	1
ANZECC		0.013			0.015				0.03	0.015	-
Basin Plan Low flow High flow		 0.010 ID			 0.005 ID			 1.000 1.280	 0.110 0.340	 0.045 0.09	 5 ID
Site	Trip										
39	Jun 2018	0.04	0.01	0.51	0.52	0.3	0.3	0.8	0.02	<0.01	<1
	Nov 2018	0.05	<0.01	<0.01	<0.01	0.4	0.5	0.5	0.11	<0.01	13
	Feb 2019	0.06	<0.01	<0.01	<0.01	0.9	1.0	1.0	0.08	<0.01	12
	Apr 2019	0.04	<0.01	0.07	0.07	0.6	0.6	0.7	0.06	<0.01	31
	Median	**0.045**	**<0.01**	**<0.01**	**<0.01**	**0.5**	**0.55**	**0.75**	**0.07**	**<0.01**	**12.5**
40	Jun 2018	0.02	<0.01	<0.01	<0.01	0.3	0.3	0.3	0.02	<0.01	<1
	Nov 2018	0.06	0.02	0.72	0.74	0.3	0.4	1.1	0.20	0.02	7
	Feb 2019	Not Sampled									
	Apr 2019	0.02	0.02	0.90	0.92	0.3	0.3	1.2	0.06	0.02	4
	Median	**0.02**	**0.02**	**0.72**	**0.74**	**0.3**	**0.3**	**1.1**	**0.06**	**0.02**	**4**
42	Jun 2018	0.02	<0.01	1.25	1.25	0.2	0.2	1.4	0.01	<0.01	<1
	Nov 2018	0.05	<0.01	0.82	0.82	0.2	0.2	1.0	0.17	0.01	<1
	Feb 2019	0.06	0.02	0.69	0.71	0.3	0.4	1.1	0.02	<0.01	3
	Apr 2019	0.05	0.02	1.25	1.27	0.2	0.2	1.5	0.04	0.02	2
	May 2019	0.03	0.02	1.38	1.4	0.2	0.2	1.6	<0.01	<0.01	1
	Median	**0.05**	**0.02**	**1.25**	**1.25**	**0.2**	**0.2**	**1.4**	**0.03**	**<0.01**	**1**

Values outside of all guidelines are shaded orange. All units mg/L unless stated otherwise

© ECO LOGICAL AUSTRALIA PTY LTD

Table 34 Water quality results for Sites 39, 40 and 42 in the Oakey Creek – dissolved metals

Guideline (mg/L)		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
Limit of Reporting		0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.0001
ANZECC		0.024	0.0002	0.0033#	0.0014	0.0034	0.011	0.008	0.00006
Basin Plan									
Site	Trip								
39	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.004	<0.005	<0.0001
	Nov 2018	<0.001	<0.0001	<0.001	0.002	<0.001	0.007	<0.005	<0.0001
	Feb 2019	<0.001	<0.0001	<0.001	0.001	<0.001	0.006	<0.005	<0.0001
	Apr 2019	<0.001	<0.0001	<0.001	0.002	<0.001	0.010	<0.005	<0.0001
	Median	**<0.001**	**<0.0001**	**<0.001**	**0.002**	**<0.001**	**0.005**	**<0.005**	**<0.0001**
40	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Nov 2018	<0.001	<0.0001	<0.001	0.003	<0.001	0.004	<0.005	<0.0001
	Feb 2019	Not Sampled							
	Apr 2019	<0.001	<0.0001	<0.001	0.002	<0.001	0.003	<0.005	<0.0001
	Median	**<0.001**	**<0.0001**	**<0.001**	**0.002**	**<0.001**	**0.002**	**<0.005**	**<0.0001**
42	Jun 2018	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Nov 2018	<0.001	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	<0.0001
	Feb 2019	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Apr 2019	<0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.0001
	May 2019	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.005	<0.0001
	Median	**<0.001**	**<0.0001**	**<0.001**	**<0.001**	**<0.001**	**0.002**	**<0.005**	**<0.0001**

[#] Low reliability guideline (ANZECC 2018). Values outside of guidelines are shaded orange. All results mg/L unless stated otherwise.

© ECO LOGICAL AUSTRALIA PTY LTD

4.3.7 Quality assurance results

Relative percent differences for duplicate samples in June 2018 (Site 6), November 2018 (Site 3), February 2019 (Site 6), April 2019 (Site 6) and May 2019 (Site 7) were below the acceptance criterion of 35 per cent for all parameters except Total Suspended Solids (TSS) in June 2018, which was 58 per cent (raw TSS values of 11 and 20 mg/L).

When sampling pools of water that are not well mixed, there is potential for one sample to have quantities of detritus or sediment that differs slightly from the duplicate sample. With other assessed duplicate parameters showing a high degree of uniformity, the lack of mixing appears to be the principal driver of error. Also, the results of these samples are close to the laboratory limit of reporting for TSS of 5 mg/L. The relative percent difference variable is sensitive to small differences between values at low concentrations, close to the limit of reporting.

Results for field blank samples were at or below the laboratory level of detection for all samples on all field trips, except ammonia in November 2018 (0.03 mg/L) and April (0.02 mg/L), when the results were slightly above the laboratory limit of detection of 0.01 mg/L. These results indicate that the process of collecting the field blank may have resulted in some very minor contamination of the distilled water. However, several other samples in the November 2018 batch had concentrations of ammonia below the laboratory limit of detection, so any contamination was localised in this batch of samples.

Overall, the quality assurance results indicate a high level of reliability in the data collected.

4.4 Results of aquatic ecology surveys

4.4.1 Aquatic flora

Fourteen species of aquatic plants were detected from the aquatic survey in June and November 2018 (**Table 35**). No EVNT aquatic flora species were detected.

Table 35 Aquatic flora detected within the Project aquatic survey sites June and November 2018

Scientific name	Common name	Survey period	Site (and approximate % cover in reach)												
			2	4	5	8	9	12	13	15	16	17	19	32	43
Arundinella nepalensis	Reed grass	June 2018	-	1			4		1	1		2			
		November 2018		1			4		1	1					
Carex appressa	Tall sedge	June 2018	-		14					3					
		November 2018			14		1		1	3					
Cyperus exaltatus	Tall flat sedge	June 2018	-						1	1			2	1	
		November 2018	1						1				1	1	
Cyperus gracilis	Slender flat-sedge	June 2018	-			1									
		November 2018	1			1									
Cyperus pygmaeus	Dwarf flat-sedge	June 2018	-								5			1	
		November 2018									5			1	
Eleocharis acuta	Spikerush	June 2018	-						1				2		
		November 2018							1				2		
Eleocharis plana	Ribbed spikerush	June 2018	-											5	
		November 2018			1	20								5	
Juncus usitatus	Common rush	June 2018	-		1		3	5	5	5	5	3	2	60	
		November 2018	3		1	1	3	3	5	5	5	3	2	60	
Leptochloa digitata	Umbrella cane grass	June 2018	-								5		20		
		November 2018									5		20		
Ludwigia peploides subsp. montevidensis	Water primrose	June 2018	-									30			
		November 2018													

Scientific name	Common name	Survey period	Site (and approximate % cover in reach)												
			2	4	5	8	9	12	13	15	16	17	19	32	43
Marsilea drummondii	Common nardoo	June 2018	-												
		November 2018	1										1		
Persicaria attenuata	Hairy knotweed	June 2018	-											5	
		November 2018	1											5	
Persicaria decipiens	Slender knotweed	June 2018	-											1	
		November 2018	3											1	
Persicaria orientalis	Lady's Thumb	June 2018													
		November 2018	1									1			
Phragmites australis	Common reed	June 2018	-								15				
		November 2018	2								20				
Scirpus sp.	Club rush	June 2018	-												
		November 2018											1		

- Access was not available to Site 2 during the June 2018 survey

The majority of aquatic flora species encountered during the June and November 2018 field surveys were common emergent species such as aquatic (or semi-aquatic) grasses, sedges and rushes.

The lack of both diversity and abundance of aquatic plants at some sites is likely to be indicative of dry physical conditions. More diverse aquatic communities may occur through recruitment during sustained flows or water pooling over the wetter months of the year.

4.4.2 Physical habitat

The overall physical habitat assessment scores were Fair to Good for each aquatic site surveyed in June and November 2018, with no difference between the two surveys. Channel flow status rated poor at most sites due to the dry conditions encountered at the times of assessment. Epifaunal substrate/available cover also rated poor at most sites, owing to the dominance of silt/clay substrates and general lack of substrate complexity. This is generally a reflection of the natural clay-rich bed substrates, as opposed to siltation. Bed and bank stability rated high at most sites, owing largely to good vegetative bank protection and reasonably intact riparian zones across the impact assessment area (**Table 36**). Site descriptions for Aquatic Ecology sites are provided in **Appendix A**.

Table 36 AusRivAS physical habitat assessment scores for the Project aquatic survey sites, June and November 2018

Habitat parameter		Site (and score)												
		2	4	5	8	9	12	13	15	16	17	19	32	43
Epifaunal substrate/available cover		G14	P5	P5	P4	P4	P3	F9	P5	G15	F7	F9	F7	P4
Pool substrate characterisation		G12	F7	F10	P3	F6	F7	F9	F6	F9	P3	G13	F7	P4
Pool variability		G14	P0	P0	P0	P0	P0	G13	F6	G13	G11	F6	F8	P0
Sediment deposition		G12	E16	E18	E16	P4	G13	E16	E16	G15	E16	F8	E16	E18
Channel flow status		E18	P0	P0	P0	P0	P0	P0	P0	E18	P0	P0	P0	P0
Channel alteration		G13	E16	G15	G15	G13	G13	E18	E18	E18	E16	G13	G11	F9
Channel sinuosity		F10	F7	P5	P5	F6	F6	G11	F7	G12	G13	F9	G13	F7
Bank stability	Left bank	G7	E9	E10	E9	G8	E9	G6	E9	F4	P2	F4	G7	F5
	Right bank	G7	E9	E10	E9	G8	E9	G7	E9	F4	P2	F4	G6	F5
Vegetation protection	Left bank	G7	G8	G7	G6	G6	G6	G6	G6	F4	F5	G6	F5	F5
	Right bank	G7	G8	G7	G6	G6	G6	G6	G6	F4	F5	G6	F5	F5
Riparian zone score	Left bank	G6	G8	E9	G8	G8	G6	E9	G7	F4	F5	G7	G7	P2

Habitat parameter		Site (and score)												
		2	4	5	8	9	12	13	15	16	17	19	32	43
	Right bank	G6	G8	E9	G6	G6	G6	E9	G7	F4	F5	G7	G8	P2
Total (low gradient) habitat score		**G 129**	**G 101**	**G 105**	**F 87**	**F 74**	**F 84**	**G 119**	**G 102**	**G 124**	**F 90**	**F 92**	**F 100**	**F 66**

Notes:
Ratings as per AusRivAS Physical Assessment Protocol (Parsons *et al*. 2002).
Categories for each habitat parameter: E = Excellent (green shading); G = Good (yellow shading); F = Fair (orange shading); P = Poor (pink shading).
Categories for total (low gradient stream) habitat score: E = 154-200; G = 101-153; F = 48-100; P = 0-47.

4.4.3 Macroinvertebrates and stream health

Taxonomic composition

A total of 26 taxa were identified from 523 aquatic macroinvertebrates collected from two sites in November 2018. Taxa richness was slightly more diverse in the samples collected from Bringalily Creek (Site 16; 19 taxa) than in the samples collected from the Macintyre River (Site 2; 18 taxa). Taxa richness was greater in the edge habitat at each site than in the bed habitat, likely owing to the greater habitat complexity and food sources.

A total of 54 taxa were identified from 1,785 aquatic macroinvertebrates collected from five sites in May 2019. Taxa richness was most diverse in the Macintyre River (Site 2; 34 taxa), with slightly lower diversity at sites 18 (30 taxa), 42 (29 taxa), 6R (28 taxa) and 7 (27 taxa). This is likely a reflection of the lower (yet sustained) flow producing greater habitat complexity at site 2, including varying depths, velocities and substrate sizes.

The most taxa-rich orders were Hemiptera (aquatic bugs), Coleoptera (beetles) and Diptera (true flies) in both the November 2018 and May 2019 sampling rounds. Other orders included Acarina (mites), Ephemeroptera (mayflies), Trichoptera (caddis flies), Zygoptera (damselflies), Epiprocta (dragonflies), Gastropoda (aquatic snails) and Veneroida (basket clams), Decapoda (in this case prawns, shrimp and yabbies), Collembola (spring tails), Lepidoptera (aquatic caterpillars), Ostracoda (seed shrimp), Copepoda (copepods), Cladocera (water fleas), Isopoda (isopods), Rhynchobdellida (jawless leeches) and Oligochaeta (segmented worms).

PET taxa

Five PET taxa were detected in samples collected from across the impact assessment area in November 2018, and seven PET taxa were detected in May 2019. Sites 2 (Macintyre River), 6R (Macintyre Brook) and 7 (Macintyre Brook) recorded the greatest number of PET taxa, with six PET taxa recorded from each site in May 2019. PET taxa consisted of three Ephemeroptera (mayfly) taxa: Baetidae, Caenidae and Leptophlebiidae; and four Trichoptera (caddis fly) taxa: Calamoceratidae (sleeping bag caddis), Ecnomidae (caseless caddis), Hydropsychidae (net spinning caddis) and Leptoceridae (stick caddis). No Plecoptera (stoneflies) were detected, nor were they expected to occur within the sites sampled, due to the absence of riffles and suitable substrates.

SIGNAL2 scores

SIGNAL2 scores were greater for the edge habitat samples than for the bed habitat samples at each of the two sites sampled in November 2018 and ranged from 2.88 in the bed habitat of Site 16 (Bringalily Creek) to 3.92 in the edge habitat of Site 2 (Macintyre River). The SIGNAL2 value of 3.36 for the edge

habitat sample collected from Site 16 in November 2018 falls within the 20:80 percentile range of 3.13 to 3.75 for slightly to moderately disturbed waters of the Dumaresq catchment within the Queensland Border Rivers basin (Negus *et al*. 2013, cited in DES 2019a).

SIGNAL2 scores were greater for the bed habitat samples than for the edge habitat samples at each of the five sites sampled in May 2019. This is likely a reflection of the retracting water level associated with lower flow, and greater habitat complexity at Site 2, including varying depths, velocities and substrate sizes. SIGNAL2 scores in May 2019 ranged from 3.25 in the edge habitat of Site 6R to 4.33 in the bed habitat of Site 18. The SIGNAL2 values for the edge habitat samples collected from sites 6R, 7 and 18 fall within or favourably above the 20:80 percentile range of 3.13 to 3.75 for slightly to moderately disturbed waters of the Dumaresq catchment within the Queensland Border Rivers basin (Negus *et al.* 2013, cited in DES 2019a).

No SIGNAL2 guidelines are yet available for the broader Macintyre River catchment, or the Condamine River catchment. However, the SIGNAL2 scores for Site 2 fall within or just outside the 20:80 percentile guideline range of 3.33 to 3.85 for bed habitats and 3.31 to 4.20 for edge habitats of slightly to moderately disturbed waters of the Queensland Central Region, as a guide for comparison (DEHP 2013). The SIGNAL2 scores for Site 42 fall within or just outside the 20:80 percentile guideline range of these guidelines.

Tolerant taxa

The percentage of tolerant macroinvertebrate taxa (i.e. those with SIGNAL2 score of three or less) in the edge habitats ranged from 40 to 63 per cent in the samples collected in November 2018 and from 52 to 55 per cent in the samples collected in May 2019. The percentage of tolerant macroinvertebrate taxa in the bed habitats ranged from 40 to 63 per cent in the samples collected in November 2018 and from 22 to 40 per cent in the samples collected in May 2019. The percentage of tolerant taxa in the edge habitat samples collected from Sites 6R, 7, 16 and 18 fall within the 20:80 percentile range of 37.93 to 65.00 per cent for slightly to moderately disturbed waters of the Dumaresq catchment within the Queensland Border Rivers basin (Negus *et al*. 2013, cited in DES 2019a).

No tolerant taxa guidelines are yet available for the broader Macintyre River catchment, or the Condamine River catchment. However, the tolerant taxa scores for Site 2 fall within or just outside the 20:80 percentile guideline range of 25 to 50 per cent for the bed habitat and 44 to 56 per cent for the edge habitat of slightly to moderately disturbed waters of the Queensland Central Region (as a guide for comparison; DEHP 2013). The tolerant taxa scores for Site 42 fall within the 20:80 percentile guideline range of these guidelines.

AusRivAS OE50

The AusRivAS OE50 assessment method describes the biological diversity of macroinvertebrates when compared with reference sites used to create the AusRivAS model. There are five categories of diversity, called bands: X, A, B, C and D. Band A (similar to reference) is assigned when results are similar to reference sites (the expected number of families within the range found at 80% of the reference sites). Band B (significantly impaired) is assigned when there are fewer families than expected, with a potential impact either on water or habitat quality. Band X (more biologically diverse than reference) is assigned when taxonomic richness is higher than reference because of naturally high biodiversity, an impact such as mild nutrient enrichment, or artificially sustained flow in a normally intermittent stream.

Overall, AusRivAS band ratings ranged from Band A (reference condition) to Band B (significantly impaired). Aquatic macroinvertebrate assemblages in the bed and edge habitats of Site 16 (Bringalily

Creek) were in reference condition (Band A; **Table 37**) in November 2018. This was also the case for bed and edge habitats samples collected from Site 18 (also Bringalily Creek) in May 2019, each in reference condition (Band A: **Table 37**). This suggests that most/all of the expected taxa were found and that existing upstream impacts on water quality and/or habitat condition have not resulted in a loss of macroinvertebrate diversity. Both the bed and edge habitat samples collected from Site 2 (Macintyre River) were slightly impaired (Band B).

Table 37 AusRivAS model outputs for sites sampled within the impact assessment area, November 2018

Site	Bed habitat		Edge habitat		Overall Band
	OE50	Band	OE50	Band	
November 2018					
2 (Macintyre River)	0.56	B	0.73	B	B
16 (Bringalily Creek)	0.85	A	0.99	A	A
May 2019					
2 (Macintyre River)	1.22	X	1.02	A	A
6R (Macintyre Brook)	0.61	B	0.92	A	B
7 (Macintyre Brook)	1.22	X	0.83	A	A
18 (Bringalily Creek)	0.91	A	1.10	A	A
42 (Dry Creek)	0.88	A	0.75	B	B

4.4.4 Macro-crustaceans

Three macro-crustacean families: Palaemonidae (freshwater prawns), Atyidae (freshwater shrimp) and Parastacidae (yabbies), were encountered within the impact assessment area. Individuals from the family Palaemonidae were identified as *Macrobrachium australiense*. Individuals from the family Atyidae were identified as *Paratya australiense*. Individuals from the family Parastacidae were identified as *Cherax destructor*.

4.4.5 Fish

There were no fish caught in bait traps during the June 2018 survey, predominantly due to dry conditions and limitations of the sampling method. A total of 202 fish were caught across the two sites in November 2018 with sufficient water for investigation (**Table 38**). These included common native and introduced species. No Murray Cod or Silver Perch were captured. However, both sites had habitat potentially suitable for the Murray Cod. The Agassiz's Glassfish (*Ambassis agassizii*) was captured at Site 2 in the Macintyre River, on the Queensland side of the state border. The western population of this species is listed as an endangered population in NSW (NSW DPI 2013).

A total of 1,865 fish were caught across the five sites in May 2019 with sufficient water for investigation (**Table 38**). These included native species and introduced species. Six Murray Cod were caught at Site 2 on the Macintyre River, with one Murray Cod captured at Site 7 on Macintyre Brook. Other species encountered included the Murray River Rainbowfish, Unspecked Hardyhead, Australian Smelt and Southern Purple Spotted Gudgeon.

Surveys confirmed the presence of several native and pest fish species across the impact assessment area. However, the presence and abundance of fish species at many sites is likely to have been limited by the dry conditions during the approximate 12 month survey period. A greater diversity and abundance of fish across waterways of the impact assessment area is therefore assumed for the purposes of impact

© ECO LOGICAL AUSTRALIA PTY LTD

assessment. The Murray Cod was confirmed to be present in the Macintyre River and Macintyre Brook, and is assumed to be present in other large waterways of the impact assessment area, including the Condamine River and larger tributaries. Many of the fish species found or assumed to be present in waterways of the impact assessment area undertake migrations, including Bony Bream, Murray River Rainbowfish, Australian Smelt and Murray Cod (Lintermans 2007).

Table 38 Summary of fish caught during November 2018 field surveys

Location	Date	Scientific name	Common name	No. captured	Size range (mm)^
Macintyre River (Site 2)	29 November 2018	*Ambassis agassizii*	Agassiz's glassfish#	1	35
		*Carassius auratus**	Common goldfish*	7	45 to 50
		*Gambusia holbrooki**	Eastern gambusia*	4	25 to 35
		Hypseleotris sp.	Carp Gudgeon	57	20 to 40
		Leiopotherapon unicolor	Spangled perch	2	30 to 45
		Melanotaenia fluviatilis	Murray river rainbowfish	2	35 to 45
		Nematalosa erebi	Bony bream	1	40
	15 -16 May 2019	*Craterocephalus fulvus*	Unspecked hardyhead	7	40 to 55
		*Gambusia holbrooki**	Eastern gambusia*	75	25 to 40
		Hypseleotris sp.	Carp Gudgeon	98	25 to 45
		Leiopotherapon unicolor	Spangled perch	17	60 to 80
		Melanotaenia fluviatilis	Murray river rainbowfish	75	35 to 75
		Maccullochella peelii	Murray cod#	6	310 to 450
		Retropinna semoni	Australian smelt	51	40 to 70
Macintyre Brook (Site 6R)	16 – 17 May 2019	*Hypseleotris sp.*	Carp gudgeon	685	25 to 45
		Craterocephalus fulvus	Unspecked hardyhead	19	35 to 55
		Tandanus tandanus	Freshwater catfish	18	90 to 420
		*Gambusia holbrooki**	Eastern gambusia*	147	25 to 40
		Melanotaenia fluviatilis	Murray river rainbowfish	27	35 to 50
		Retropinna semoni	Australian smelt	1	50
Macintyre Brook (Site 7)	16 – 17 May 2019	*Maccullochella peelii*	Murray cod#	1	490
		Hypseleotris sp.	Carp gudgeon	283	25 to 45
		Melanotaenia fluviatilis	Murray river rainbowfish	238	30 to 55
		Craterocephalus fulvus	Unspecked hardyhead	28	35 to 60
		*Carassius auratus**	Common goldfish*	1	150
		*Cyprinus carpio**	Common carp*	1	160
		*Gambusia holbrooki**	Eastern gambusia*	3	30
		Retropinna semoni	Australian smelt	5	40 to 45
Bringalily Creek (Site 16)	28 November 2018	*Carassius auratus**	Common goldfish*	3	80 to 250
		*Cyprinus carpio**	Common carp*	6	300 to 430
		Hypseleotris sp.	Carp Gudgeon	101	20 to 45
		Macquaria ambigua	Golden perch	3	23 to 29
		Melanotaenia fluviatilis	Murray river rainbowfish	15	35 to 55

Location	Date	Scientific name	Common name	No. captured	Size range (mm)^
Bringalily Creek (Site 18)	17 – 18 May 2019	*Leiopotherapon unicolor*	Spangled perch	52	45 to 70
		Hypseleotris sp.	Carp gudgeon	13	30 to 35
Dry Creek (Site 42)	18 May 2019	*Mogurnda adspersa*	Southern purple spotted gudgeon	14	50 to 80

^Estimated length from snout to tail fork, *Pest species euthanised, # Threatened species in QLD or NSW at location of capture.

4.4.6 Freshwater turtles

Habitat suitable for freshwater turtles was observed throughout the impact assessment area. This included major systems such as the Macintyre and Condamine Rivers, as well as smaller creeks and tributaries, many of which were dry at the time of the field surveys. Turtle nesting habitat was noted to be abundant along the Macintyre River and Macintyre Brook, with the Eastern snake-necked turtle recorded at Bringalily Creek. Due to ongoing dry conditions, many turtles are likely to have moved temporarily to constructed farm dams and other more permanent sources of water during the survey period. No habitat suitable for the Bell's turtle or Southern snapping turtle was identified during the field surveys.

4.5 Synthesis of existing aquatic ecology and surface water values

A summary of key aquatic ecology and surface water values is provided in the following sections, relative to the water quality zones identified by DES (2019a, b) for the implementation of local water quality guidelines. The water quality zones generally align with sub-catchments of the impact assessment area.

In general, aquatic ecology values can be summarised as:

- Biodiversity and nature conservation
- Riparian vegetation
- Habitat connectivity
- Bank stability
- Water quality
- Sediment quality
- Water resources

Macintyre Barwon Floodplain (Sites 1 and 2)

Sites within the Macintyre Barwon Floodplain were located on the largest watercourse in the region (the Macintyre River) and had a significant amount of water present in large pools and channels. Stream banks were generally well defined. However, some areas had been subject to tunnel and gully erosion. Disturbance to the aquatic habitats was noted as a result of both adjacent land use from agricultural grazing and construction of a bridge access.

Riparian vegetation cover was high although aquatic flora comprised only a small proportion of the vegetation present (approximately 2 per cent). Aquatic fauna was recorded at Site 2, with eight native species of fish that inhabit pools and streams of the floodplain, including the Murray Cod and Agassiz's Glassfish. Habitat value in general was assessed as good, with limited barriers to fish passage. Nesting habitat for freshwater turtles was also abundant along the Macintyre River.

Water quality was generally good, with elevated turbidity, EC and suspended sediment concentrations. Macroinvertebrate assemblages were consistent with those expected for slightly to moderately disturbed

aquatic ecosystems, indicating the presence of good water quality and habitat features in the period prior to assessment. Representative site photos are provided in **Figure 8**.

Figure 8 Macintyre Barwon Floodplain representative sites November 2018 (left: Site 1, right: Site 2)

Lower Macintyre Brook (sites 3 to 8)

Lower Macintyre Brook consists of several ephemeral drainage features, some of which were dry at the time of field surveys. When water was present, small standing pools were common along with larger deeper stream sections. The poorly defined low sloped banks were consistent with a low potential for erosion. Riparian vegetation was intact at most sites.

Adjacent land consisted of native forest as well as cropping (grain fed cattle and irrigation). Therefore, a moderate to high level of disturbance exists, particularly in areas where irrigation and agricultural runoff occurs. A Eucalypt woodland vegetation community was observed along the drainage, though some clearing has occurred on the floodplains. Aquatic flora persistence and biodiversity was variable, with up to 15 per cent cover in some parts and as low as 1 per cent cover in others.

Six species of native fish were identified at Sites 6R and 7 during field surveys in May 2019, including the Murray Cod. The Lower Macintyre Brook also has suitable habitat for the Platypus, which was observed in the June 2018 survey. Macroinvertebrate scores were variable between sites and generally indicative of good water quality and habitat features. Banks also provide suitable nesting habitat for freshwater turtles. Water flow obstructions were present, including at Site 4, where a dog proof fence intersected the waterway. Overall habitat value was rated from fair to good, with some parts of the brook providing effective fish passage, even at times of low flow. Water quality at sites in the Lower Macintyre Brook was characterised by high EC and elevated TSS and nutrients, with low dissolved oxygen. Representative site photos are provided in **Figure 9**.

© ECO LOGICAL AUSTRALIA PTY LTD

Figure 9 Lower Macintyre Brook representative sites, November 2018 (top left: Site 3, top right: Site 4, middle left: Site 5, middle right: Site 6, bottom left: Site 7, bottom right: Site 8)

Canning Creek (sites 9 to 20)

The Canning Creek water quality zone comprises a combination of ephemeral (some of which were dry at the time of assessment) and semi-permanent waterways (e.g. Sites 11, 14 and 16). Stream banks were variable across the impact assessment area, with some well-defined stream banks of varying slope as well as others that were flatter and less distinct waterway pathways.

© ECO LOGICAL AUSTRALIA PTY LTD

Adjacent land use included native forest, road reserve and cattle grazing. Areas which have been fenced off to grazing (e.g. Site 9) have experienced less vegetation disturbance than other areas which are subject to stock access. Erosion was observed to range from moderate to severe, with the invasion of exotic pastoral weed Lippia detected, which is known to outcompete native riparian flora and negatively affect bank stability (reported at Sites 9 and 17). Further disturbance has also occurred through the installation of box culverts and bridge access.

Vegetation communities consisted of scattered and clumped Eucalypt woodlands, while aquatic flora cover ranged from 5 per cent (Site 9) to more than 30 per cent (Sites 16 and 17). Aquatic fauna were confirmed at semi-permanent waterways of Sites 16 and 18 where five native species of fish were recorded. These sites also provided potential habitat for EVNT species Murray Cod and SLC Platypus. In general, habit value ranged from fair to good with effective fish passage existing at the majority of sites along Canning Creek.

Water quality within the Canning Creek water quality zone was generally poor, characterised by alkaline pH and elevated concentrations of nutrients. However, macroinvertebrate assemblages in Bringalily Creek were generally consistent with those expected for sites in reference condition (Band A). Representative site photos are provided in **Figure 10**.

© ECO LOGICAL AUSTRALIA PTY LTD

Figure 10 Canning Creek representative sites, November 2018 (top left: Site 10, top right: Site 12, middle left: Site 16, middle right: Site 18, bottom left: Site 19, bottom right: Site 11)

Southern Condamine (sites 21 to 26)

Southern Condamine comprised multiple ephemeral drainage features, most of which were dry at the times of assessment, with the exception of Site 24, which generally had water present. The majority of streams exhibited poorly defined, low sloped banks which were assessed as moderately stable. Adjacent land was utilised for agricultural practices such as cattle grazing, which had resulted in some bank erosion.

The riparian zone was particularly wide in some sections with a mix of native and exotic vegetation cover. Large trees such as eucalypts were often scattered, and the abundance of aquatic flora was variable. Areas which contained deeper channels and larger water bodies have the potential to support some

© ECO LOGICAL AUSTRALIA PTY LTD

aquatic flora and fauna species. This may include the Murray Cod during extended wet periods, when there are larger volumes of water in the Condamine River system. However, aquatic environments are considered unlikely to provide suitable habitat for any EVNT or SLC species during average to dry periods, due to their ephemeral nature. Water quality was characterised by alkaline pH, high EC and elevated concentrations of suspended sediment and nutrients. Representative site photos are provided in **Figure 11**.

Figure 11 Southern Condamine representative sites, November 2018 (top left: Site 24, top right: Site 24, bottom left: Site 23, bottom right: Site 24)

Central Condamine (sites 27 to 33)

Central Condamine consisted of several ephemeral drainage features, some of which were commonly dry at the time of field surveys (Sites 29, 31 and 32). Some small pools of water were sustained throughout the dry periods (Site 30), while others varied with season (Site 27 and 33). There was very little water in the channel, with water generally present in small pools with infrequent deeper stands. Generally, poorly defined low sloped banks existed, which were assessed as moderately stable. However, small areas of severe erosion were noted, particularly adjacent to agricultural cropping activities. Further disturbance as a result of the existing road bridge, culvert and evidence of littler/pollution were recorded at Site 32.

© ECO LOGICAL AUSTRALIA PTY LTD

Riparian zones consisted of Eucalypt woodlands, which were scattered and were sparse along some sections of the Condamine River. Native vegetation was dominant (with exotics also readily found), and aquatic flora was particularly abundant and diverse. Habitat values for aquatic fauna was found to be variable, depending on the nature of water presence.

Overall habitat value was limited, and the area is highly unlikely to provide suitable habitat for any EVNT or SLC aquatic flora or fauna species, nor were these detected. However, the Condamine River is recognised as known habitat of the Murray Cod, and the species may utilise waters of the river system during prolonged wetter periods. Water quality at sites in the Central Condamine was characterised by alkaline pH, high EC and elevated concentrations of suspended sediment and nutrients. Representative site photos are provided in **Figure 12**.

© ECO LOGICAL AUSTRALIA PTY LTD

Figure 12 Central Condamine representative sites, taken November 2018 (top: Site 33, bottom left: Site 29, bottom right: Site 29)

© ECO LOGICAL AUSTRALIA PTY LTD

Oakey Creek (sites 34 to 43)

Oakey Creek comprised multiple ephemeral drainage features, many of which were dry at the times of survey. Some small pools were sustained throughout drier periods. During wet periods, large deep stream channels would be common (these were not observed due to dry conditions). Stream bank slopes ranged from low to moderate, with a high potential for erosion during flood events. Prominent eroded banks and deepening of channels were particularly evident as a result of local land uses.

Adjacent areas consisted of agricultural land used for grazing, with riparian vegetation highly disturbed. This generally consisted of scattered non-remnant vegetation with sparse cover and often dominant exotic species. The riparian zone has been severely reduced in some parts of Oakey Creek (ranging from 0 – 6 m in width). Aquatic flora persistence and biodiversity were severely limited in most locations. One native fish species, the Southern Purple Spotted Gudgeon, was captured at Site 42 (Dry Creek). This site had a macroinvertebrate community typical of slightly to moderately disturbed ecosystems.

Although minimal potential fish habitat exists upstream, there is very restricted movement through waterways, as existing road culverts (such as at Site 43) have not allowed for fish passage. Overall habitat value was assessed as fair, although the area was highly unlikely to provide suitable habitat for any EVNT or SLC aquatic flora or fauna species, nor were these detected. Water quality at Oakey Creek was characterised by alkaline pH, high EC and high dissolved copper concentrations. Representative site photos are provided in **Figure 13**.

© ECO LOGICAL AUSTRALIA PTY LTD

Figure 13 Oakey Creek representative survey sites, taken November 2018 (top: looking west from Site 43, middle left: Site 43, middle right: Site 43, bottom left: Site 42, bottom right: Site 42)

© ECO LOGICAL AUSTRALIA PTY LTD

5 Impact assessment

5.1 Potential impacts of the Project

Potential impacts of the Project on aquatic ecology values are outlined in **Table 39**, with discussion provided in the following sections.

Clearing of riparian vegetation

Construction of rail infrastructure and associated access tracks, equipment laydown areas and crossings in proximity to waterways will be required during construction phases of the Project. This will result in the removal of habitat for some aquatic species including woody debris, and may result in minor changes in physical attributes of waterways (e.g. reduced shading and increased light penetration). The degree of riparian vegetation clearing and thus, the scale of impact, will vary across the alignment, depending on the size and scale of waterways and the extent of existing disturbance (e.g. existing rail infrastructure).

Clearing of vegetation for construction has the potential to alter temperature and light regimes of aquatic habitats. Increased light penetration into creeks which originally had dense canopy cover may potentially affect the flora composition of aquatic habitats, resulting in a reduction in the abundance and distribution of light-sensitive aquatic plants. Increased light can also be expected to promote the growth of algae and invasive aquatic plants, which may outcompete other plant species and reduce the complexity of aquatic habitats and species diversity. Increased light can also be expected to result in an increase in daytime water temperatures, affecting biological processes such as respiration rates of aquatic organisms, and displacing native species that are not tolerant of high temperatures.

Disturbance of aquatic habitat

The installation of artificial structures such as culverts and bridge pylons within waterways will result in some impacts on aquatic flora and fauna habitat values. Such works may involve the disturbance and removal of stream bed sediments, and changes in habitat structure from a soft bottom to a hard bottom. Some types of infrastructure may increase habitat availability for native and exotic fauna species that are able to utilise a broad range of habitats types, which are lacking in structural complexity. For example, naturally-occurring woody debris habitat generated by riparian vegetation may be replaced with bridge pylons or culverts, resulting in a change in the abundance and diversity of fish species in that location and adjacent areas.

Culverts have the potential to interrupt or become a barrier to aquatic fauna movement, which may affect species life stages and the ability to persist in the local area. Similarly, the installation of bridge support structures may impact on aquatic fauna habitat at a local scale, particularly that of benthos-dwelling species. Temperature and light regimes may also be altered by bridge structures at a local scale through shading of the central part of large waterways, which are not generally shaded by riparian vegetation.

Sediment runoff into waterways

Works adjacent to waterways will result in the exposure of soils which may be mobilised by rainfall and runoff into adjacent aquatic habitats, and also affect areas downstream. Stockpiling of soils close to waterways is also a potential source of sediment inputs into aquatic habitats. Increased runoff to waterways is likely to result in a decline in water quality, through an increase in turbidity and TSS concentrations, and potentially, an increase in the concentration of sediment-bound contaminants such as metals.

© ECO LOGICAL AUSTRALIA PTY LTD

Suspended sediments have the potential to impact on fish, freshwater turtles and some invertebrates by disrupting the function of gills (fish and some invertebrates), reducing underwater visibility for predatory species and displacing species that are not tolerant of variable and turbid water quality conditions. This may result in localised fish kills or the displacement of aquatic species to adjacent areas. Metals and other contaminants bound to sediments that wash into waterways may have toxic effects on aquatic organisms or reduce the quality of drinking water for stock. Such effects are likely to be relatively localised (over a scale of hundreds of metres), and will reduce with distance downstream from the source.

Altered hydrology

The installation of artificial structures such as culverts has the potential to alter natural stream flows and volumes in some locations (see EIS Chapter 12: Surface Water and Hydrology). Hydrologic and hydraulic modelling predicted minimal impacts from Project infrastructure on flood flows, floodplain coverage and flow velocities under a range of flow scenarios, including extreme events. Predicted changes in flow velocities were limited in scale to immediately upstream and downstream of culverts. At these locations, such changes may cause minor changes to the location, abundance and structure of aquatic habitats, such as pools, channels, riffles and dry creek beds. This can be expected to result in minor changes to the composition and diversity of aquatic organisms in affected locations.

Changes to the timing and quantity of water flow downstream during major rainfall events are expected to be minor. These changes, have some potential to affect fauna migration and breeding activities such as spawning in fish, which are often linked to water levels and flow rates. Connectivity for aquatic fauna across the flood plains of the impact assessment area is not expected to be affected, due to the design of railway infrastructure. For example, within the Condamine River flood plain, six bridge structures will be constructed, with the largest extending a length of 1,941 m. An extensive network of culverts has also been incorporated into the reference design, with a majority of culverts within the Condamine River flood plain having a width or diameter of >2 m. These design features will minimise changes to hydrology, and are adequate to facilitate continued connectivity among habitats of the flood plain by aquatic fauna, including fish and freshwater turtles. Further details on the predicted changes to hydrology are provided in the Hydrology and Flooding Technical Report (Appendix Q1 and Q2 of the draft EIS).

Changes to groundwater resources, affecting groundwater dependent ecosystems

Project activities have the potential to impact on groundwater resources through effects such as groundwater level reduction, alteration of aquifer flow patterns, the settlement of compressible substrates and reductions in groundwater quality. GDEs are susceptible to indirect impacts from changes to groundwater resources. For example, a reduction in groundwater level may cause spring wetlands to reduce in size or dry up, resulting in a contraction of wetland extent, loss of aquatic habitat and reduction in species diversity. A decline in groundwater quality may also affect aquatic organisms living underground (e.g. stygofauna) or present within surface waters that are sourced from impacted aquifers.

An evaluation of the potential impacts of the Project on groundwater resources (see EIS Chapter 13: Groundwater) concluded that the majority of potential impacts are temporary in nature and related to the construction phase of the Project. While a small number of locations were identified where construction activities have the potential to intersect shallow groundwater resources, engineering controls were assessed to be sufficient to mitigate the extent of impacts. Controls to reduce the risk of contamination of groundwater quality from Project activities (e.g. spills) are also in place and are similar to those related to surface water quality. Further details on the predicted changes to groundwater resources are provided in the Groundwater Technical Report (Appendix R of the draft EIS).

© ECO LOGICAL AUSTRALIA PTY LTD

Invasion of aquatic habitats by exotic pest species

Construction of new rail infrastructure has the potential to increase the abundance of weeds and pests and introduce new weed and pest species. The disturbance of existing weeds along the riparian corridor may result in the spread of propagules downstream, or the transport of propagules to other areas either on machinery or through natural dispersal once disturbed. Weed seeds and some pests may also be present on machinery brought in from other areas and be introduced to the local environment. Some farm dams likely to contain exotic species will need to be dewatered to facilitate construction of the Project. This may result in the spread of pest (e.g. exotic fish species) and weed species to adjacent waterways, if not managed appropriately, resulting in a reduction in aquatic habitat quality and species diversity. There are some species of weed that are present in one local government area of the impact assessment area, but are not known to be present in adjoining local government areas (GRC 2019; TRC 2020). The movement of machinery and vehicles across the impact assessment area during the pre-construction and construction phase of the Project has the potential to spread weeds into new localities.

Disturbance of fauna from noise, vibration and lighting

A range of construction activities are likely to result in an increase in noise and vibrations in the vicinity of waterways, reducing habitat quality and increasing disturbance to sensitive fauna. Noise may be created by earthworks, use of heavy machinery or piling in or adjacent to aquatic habitats. Species that are easily disturbed, such as Platypus, may move to adjacent areas to avoid being disturbed, if suitable habitat exists. Such noise and vibration may persist into the operation phase, at a reduced magnitude, and occur at frequent periods each time that a train traverses the alignment. Night works will involve the installation of temporary lighting for safety and operational purposes which may also result in disturbance to sensitive aquatic fauna. Such effects are likely to result in a reduction in aquatic habitat quality and species diversity at the locations affected, and adjacent areas.

Introduction of contaminants into waterways

Construction activities have the potential to result in the introduction of contaminants into waterways, resulting in declines in water quality (e.g. from fuel spills). Similarly, the use of herbicides during future track maintenance has the potential to impact on vegetation living in and adjacent to waterways. An increase in access to aquatic habitat by people during construction (i.e. construction workforce) has the potential to result in litter being deposited within or adjacent to waterways. Such contaminants can be expected to reduce water quality and the quality of aquatic habitats in areas affected, and adjacent areas downstream.

Impacts on EVNT species

The Project is unlikely to have a significant impact on any EVNT species. While the Murray Cod has been confirmed to occur within parts of the impact assessment area, and is assumed to be present in the larger rivers with suitable habitat, potential impacts of the Project on the species are of a low magnitude and localised in scale. Clearing of riparian vegetation and disturbance of aquatic habitats will be minimised to discrete locations where crossings occur. The design of crossings will generally include bridges in areas suitable for Murray Cod (e.g. large rivers such as the Macintyre River). An assessment of impacts on the Murray Cod in relation to significant impact criteria in the MNES Significant Impact Guidelines 1.1 (DoE 2013) is provided in **Appendix E**.

The Project is also unlikely to have a significant impact on the Silver Perch, Bell's turtle or the Southern snapping turtle, as these species are unlikely to be present in the impact assessment area. Measures in place to reduce impacts on the Murray Cod will also benefit the Silver Perch, in the event that a small

© ECO LOGICAL AUSTRALIA PTY LTD

number of individuals utilise habitat within the impact assessment area from time to time. The western population of Agassiz's Glassfish is listed as endangered under NSW legislation and was confirmed to be present in the Macintyre River. The Project is unlikely to influence threatening processes for this species, which primarily relate to predation from introduced fish species, habitat degradation and rapid fluctuations in water level from regulated flows (NSW DPI 2013).

© ECO LOGICAL AUSTRALIA PTY LTD

Table 39 Summary of potential impacts to aquatic ecology values

Aquatic Ecology Value	Delivery Phase	Description of potential impacts
Biodiversity and nature conservation	Pre-construction and construction	Clearing of riparian vegetation Removal of riparian and aquatic habitats including hollow-bearing trees, logs and burrows which will reduce the persistence of native species that utilise these habitats Disturbance of aquatic habitat Loss of submerged aquatic vegetation and woody debris, resulting in a reduction in aquatic habitat complexity and aquatic plant diversity River substrate disturbance (i.e. due to bridge or culvert construction) which may affect bottom dwelling aquatic flora and fauna and their associated habitats Loss of sensitive ecological processes through geomorphological alteration, including a change in photosynthesis and respiration rates from increases in sunlight and water temperature Mortality or displacement of EVNT species Invasion of aquatic habitats by exotic pest species Transmission and invasion of aquatic and terrestrial weeds (e.g. through vehicle and machinery movement) altering riparian and aquatic vegetation community composition Disturbance of fauna from noise, vibration and lighting Disturbance of aquatic fauna from noise, vibration and lighting Changes to groundwater resources, affecting groundwater dependent ecosystems Reduction in groundwater level, resulting in the loss of wetland habitat and an alteration of species composition within GDEs
	Operation	Disturbance of aquatic habitat Mortality or displacement of EVNT species Invasion of aquatic habitats by exotic pest species Transmission of aquatic and terrestrial weeds (through railway) may alter riparian vegetation community composition Disturbance of fauna from noise, vibration and lighting

© ECO LOGICAL AUSTRALIA PTY LTD

Aquatic Ecology Value	Delivery Phase	Description of potential impacts
		Disturbance of aquatic fauna from noise, vibration and lighting
Riparian vegetation	Pre-construction and construction	Clearing of riparian vegetation Changes in community structure and composition due to clearing Reduction in shading and increase in light penetration into aquatic habitats, resulting in higher stream temperatures and conditions suitable for the proliferation of algae Invasion of aquatic habitats by exotic pest species Vegetation clearing allowing the colonisation of exotic species
	Operation	Invasion of aquatic habitats by exotic pest species Transmission of aquatic and terrestrial weeds (through railway) may alter riparian vegetation
Habitat connectivity	Pre-construction and construction	Altered hydrology Introduction of physical barriers to aquatic fauna movement through the construction of culverts, bridges, fencing and other infrastructure that affects the existing hydrological conditions Construction of temporary bunding to achieve a dry work area at creek crossings.
	Operation	Altered hydrology Introduction of physical barriers to aquatic fauna movement through the construction of culverts, bridges, fencing and other infrastructure that affects the existing hydrological conditions
Bank stability	Pre-construction and construction	Clearing of riparian vegetation Construction works involving disturbance to the riparian corridor may result in erosion and scouring of streambanks, which are an important component of aquatic habitats. This may result in unstable stream banks unable to support vegetation or tolerate extreme rainfall or flooding events. Disturbance of aquatic habitat Smothering of benthic aquatic habitat due to erosion, sediment transport and sediment deposition. Physical disturbance of stream beds and banks during construction of creek crossings

© ECO LOGICAL AUSTRALIA PTY LTD

Aquatic Ecology Value	Delivery Phase	Description of potential impacts
		Invasion of aquatic habitats by exotic pest species Establishment of weeds such as Lippia (recorded in region) in new areas which out compete native species and affect the integrity of stream banks
	Operation	Invasion of aquatic habitats by exotic pest species Establishment of weeds such as Lippia (recorded in region) in new areas which out compete native species and affect the integrity of stream banks
Water quality	Pre-construction and construction	Sediment runoff into waterways Declines in water quality due to runoff from disturbed areas or discharge of water generated from construction activities (e.g. dewatering of a dry work area). This may include increased concentrations of suspended sediments, nutrients, metals and hydrocarbons, which may reduce the suitability of water to support environmental values (e.g. aquatic ecosystems and stock watering). Introduction of contaminants into waterways Spills of contaminants to waterways and in adjacent areas during works, resulting in pollution of local waterways and areas downstream and toxic effects on aquatic organisms. Spills of contaminants to groundwater, resulting in pollution of GDEs and toxic effects on aquatic organisms.
	Operation	Introduction of contaminants into waterways Spills of contaminants to waterways from train and associated infrastructure, resulting in pollution of local waterways and areas downstream and toxic effects on aquatic organisms.
Sediment quality	Pre-construction and construction	Introduction of contaminants into waterways Spills of contaminants to waterways and in adjacent areas during works, resulting in pollution of local waterways and areas downstream and toxic effects on aquatic ecosystems. Sediment runoff into waterways Physical disturbance of soils and mobilisation of contaminants (e.g. metals) to waterways from rainfall runoff, decreasing water quality. Increase in salinity from interplay between works, runoff and sodic or dispersive soils.

© ECO LOGICAL AUSTRALIA PTY LTD

Aquatic Ecology Value	Delivery Phase	Description of potential impacts
	Operation	Introduction of contaminants into waterways Spills of contaminants to waterways and in adjacent areas during works, resulting in pollution of local waterways and areas downstream and toxic effects on aquatic ecosystems.
Water resources	Pre-construction and construction	Altered hydrology Changes in watercourse pathway and flow characteristics, including the alteration of habitat composition (ponding, channels and dry creek beds) and flow regime. Changes in water availability: riparian community structure and species composition. Temporary changes in hydrology through bunding to create a dry work area.
	Operation	Altered hydrology Changes in watercourse pathway and flow characteristics, including the alteration of habitat composition (ponding, channels and dry creek beds) and flow regime. Changes in water availability: riparian community structure and species composition. Altered flow regimes which result in changes to aquatic ecology and surface water.

© ECO LOGICAL AUSTRALIA PTY LTD

5.2 Mitigation measures

5.2.1 Mitigation through the reference design phase

Development of the reference design has progressed in parallel with the impact assessment process. As a consequence, design solutions for avoiding, minimising or mitigating impacts have been incorporated into the reference design as appropriate and where possible.

Mitigation measures and controls that are relevant to aquatic ecology and have been factored into the reference design, or otherwise implemented by the Project, are summarised in **Table 40**.

Table 40 Initial mitigations of relevance to aquatic ecology

Aquatic ecology value	Initial mitigation measures
Biodiversity and nature conservation Riparian vegetation	• The Project has been positioned to maximise the use of existing rail corridors and to be co-located with existing road infrastructure, where possible. Co-location with existing linear infrastructure minimises the need to develop natural and rural landscapes that have not previously been subject to disturbance for a similar purpose • Greenfield components of the Project have been aligned to minimise: - the extent of impact to remnant vegetation and - the extent of impact to areas of known habitat potential - the number of watercourses and waterways traversed by the Project • The Project footprint has been restricted to what is anticipated to be required to construct, operate and maintain the works in a safe and efficient manner. Restricting the footprint minimises the extent of disturbance required to vegetation and habitats • Greenfield components of the Project have been aligned to minimise the extent of impact to remnant vegetation, and the number of watercourses and waterways traversed by the Project. Clearing of remnant vegetation will be restricted to the minimum required to enable the safe construction, operation and maintenance of the rail corridor, including minimising the disturbance of sensitive areas such as: - Habitat for critically endangered, endangered and vulnerable flora and fauna species - Critically endangered and endangered Threatened Ecological Communities - Riparian vegetation - Steep slopes - Along river banks • The Project has been developed to minimise impacts to watercourses, waterways, riparian vegetation and in-stream flora and habitats by adopting a crossing structure hierarchy where bridges are preferred to culverts, where practical • Bridge structures are provided in the reference design over the following watercourses and waterways, to minimise disturbance of aquatic habitats:

Aquatic ecology value	Initial mitigation measures
	Macintyre River, Macintyre Brook, Pariagara Creek, Cattle Creek, Native Dog Creek, Bringalily Creek, Nicol Creek, Back Creek, Grasstree Creek, Condamine River, Condamine River North Branch, Westbrook Creek and Dry Creek. Further details on the location and length of bridge structures is provided in the Hydrology and Flooding Technical Report (Appendix Q1 and Q2 of the draft EIS) and reference design drawings (Volume III of the draft EIS)
Bank stability Water quality	• The Project footprint has been established to accommodate temporary (i.e. sediment control basins) and permanent (i.e. scour protection, vegetated swales) erosion and sediment control devices during construction and operation of the Project • Bridges have been designed to minimise impacts to the bed, banks and environmental flows of waterways in accordance with requirements of the *Fisheries Act 1994* • Scour and erosion protection measures have been incorporated into the design in areas determined to be at risk, such as around culvert headwalls, drainage discharge pathways and bridge abutments
Habitat connectivity	• Waterway crossing structures (including culverts and bridges) have been designed to maintain aquatic fauna (e.g. for Silver Perch and Murray Cod) passage and minimise the risk of blockages in reference to the Accepted development requirements for operational work that is constructing or raising waterway barrier works (1 October 2018; DAF 2018) • The Project incorporates bridge and culvert structures to maintain existing flow paths and flood flow distributions, such as across the Condamine River floodplain where six bridges have been incorporated into the design with a combined length of 6 km
Water resources	• Bridge and culvert structures have been located and sized to avoid increases in peak water levels, velocities and duration of inundation • No watercourses, as defined and mapped under the *Water Act 2000*, are required to be diverted by the Project. A watercourse determination may be required for works affecting watercourses that are not mapped under the *Water Act 2000*. ARTC is an approved entity for the purpose of the Department of Natural Resources, Mines and Energy Riverine Protection Permit exemption requirements, and works can be undertaken providing that they meet the guidelines of the exemption.

5.2.2 Proposed mitigation measures

In order to manage and mitigate Project risks, additional mitigation measures have been proposed for implementation in future phases of Project delivery. These proposed mitigation measures have been identified to address Project-specific issues and opportunities including legislative requirements and accepted government plans, policy and practices.

Mitigation measures been proposed for implementation in future phases of Project delivery have been grouped and presented, as follows:

- **Table 41** identifies overarching mitigation and management measures for all ecological values
- **Table 42** provides mitigation measures specific to MNES and MSES aquatic ecological receptors that occur within the Project footprint.

The mitigation measures presented in **Table 41 and Table 42** have been considered in the assessment of residual risk, as documented in **Section 5.3**.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 41 Aquatic ecology and surface water quality mitigation measures

Delivery phase	Aquatic ecology value and potential impacts	Mitigation and management measures
Detail design	Value Biodiversity and nature conservation Potential impacts Clearing of riparian vegetation Disturbance of aquatic habitat Invasion of aquatic habitats by exotic pest species	■ The Project will be refined during detail design to minimise the footprint to the extent required for the construction works and safe operation and maintenance of the Project. Confirmation of the construction approach will be achieved through the engagement of a construction contractor. ■ A Biodiversity Management Sub-plan will be developed as part of the CEMP. This plan should include appropriate criteria, directives and procedures in relation to: – Requirements for pre-clearing surveys, including aquatic and riparian habitats – Staging works so that they avoid breeding periods of the Murray Cod (September and October) as much as possible within areas of habitat (large waterways) – Staged and sequential clearing protocols – Animal handling protocols (e.g. for freshwater turtle species), including relocation and emergency care – Relocation of plants and habitats, including instream woody debris (where applicable) – Requirements for inspections and corrective actions during construction and rehabilitation activities – Biodiversity/fauna and flora management actions to be undertaken by suitably qualified persons – Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction. – Corrective actions should the outcomes not achieve to the objectives adopted ■ Construction areas including compounds, stockpiles, fuel storage areas, laydown areas and staff parking will be located and established outside the tree protection zone as defined in AS4970-2009 Protection of trees on development sites. ■ Develop a Soil Management Sub-plan which includes the following procedures and protocols relevant to potential impacts on land resources: – Soil/land conservation objectives for the Project – Management of problem soils, such as: ■ Acid sulfate soils, which may occur in proximity to wetland features and water storages, and have a low potential to occur within the impact assessment area.

© ECO LOGICAL AUSTRALIA PTY LTD

		▪ Erosive or dispersive soils, such as sodosols that are expected to be encountered between the Macintyre River and Yelarbon as well as along the fertile lands north of Inglewood to the west of Kooroongarra ▪ Cracking clays (vertosols) that are expected to be encountered between Kooroongarra and Millmerran and from Yandilla to Gowrie ▪ Saline soils, particularly in high salinity hazard areas such as between Kurumbul and Yelarbon. – Specification of the type and location of erosion and sediment controls (see below) – Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material – Vehicle, machinery and imported fill hygiene protocols and documentation, in accordance with the requirements of the *Biosecurity Act 2014* – Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction. ▪ A Rehabilitation and Landscaping Management Sub-plan will be developed for the Project, as a component of the CEMP. This Sub-plan will establish the following: – Location-specific objectives for rehabilitation, reinstatement and/or stabilisation. Objectives will differ for within the rail corridor and outside of the rail corridor. Rehabilitation requirements for watercourses and waterways will be in accordance with the intent of: ▪ Riverine protection permit exemption requirements (WSS/2013/726) ▪ Accepted development requirements for operational work that is constructing or raising waterway barrier works (DAF 2018), including requirements for the duration of works and the dimensions and design of culverts and other instream structures. – Timeframes for rehabilitation and/or reinstatement/stabilisation works to be achieved – Details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, consistent with the agreed objectives – Consideration for maintenance or performance issues of rehabilitation e.g. vegetation that does not grow and obscure signals or impact the longevity of rail infrastructure – Procedures, timeframes, measurable performance objectives and responsibilities for monitoring the success of rehabilitation and/or reinstatement/stabilization areas – Corrective actions should the outcomes not achieve to the objectives adopted

© ECO LOGICAL AUSTRALIA PTY LTD

Delivery phase	Aquatic ecology value and potential impacts	Mitigation and management measures
		– Where temporary construction facilities/borrow pits are required, land shall be returned to stable condition that complies with the conditions of applicable landowner agreements and regulatory approvals, e.g. Development Approval and/or Environmental Authority (EP Act) – Constructed landscape treatments shall be classified by type and documented to enable ongoing data management for life of the Project (i.e. beyond design). ■ A Biosecurity Management Sub-plan will be developed as a component of the CEMP. This Sub-plan will include: – Requirements for pre-clearing and operational surveys to determine the risk of weeds (e.g. Lippia) or pest animals (e.g. *Gambusia holbrooki*, Cane Toad) being present – Maps of the existing extent, confirmed through surveys, and severity of weed infestation and weed management requirements – Site hygiene and waste management procedures to deter pest animals – Weed surveillance and treatment during construction and rehabilitation activities – Requirements in relation to pesticide and herbicide use, including any limitations on use. Restrictions may apply in proximity to waterways, known areas of MNES or MSES habitat or land uses sensitive to spray-drift from the application of pesticides and herbicides – Vehicle, machinery and imported fill hygiene protocols and documentation – Erosion and sediment control risks associated with broad scale weed removal or treatment. – Corrective actions should the measures not achieve the adopted objectives.
	<u>Value</u> Water resources <u>Potential impacts</u> Altered hydrology	■ Design modifications during detail design will be subject to re-runs of the existing flood models to demonstrate continued compliance with the design objectives of the Project, including for extent and time of inundation, afflux and flow velocities.
	<u>Value</u> Habitat connectivity Bank stability <u>Potential impacts</u> Disturbance of aquatic habitat	■ Where the Project is unable to comply with the Accepted development requirements for operational work that is constructing or raising waterway barrier works (DAF 2018), a development approval for operational work that is constructing or raising waterway barrier works will be required ■ ARTC is an approved entity for the purpose of the Department of Natural Resources, Mines and Energy Riverine Protection Permit exemption requirements (DNRME 2019). Where the Project is

© ECO LOGICAL AUSTRALIA PTY LTD

Delivery phase	**Aquatic ecology value and potential impacts**	**Mitigation and management measures**
	Altered hydrology Sediment runoff into waterways	unable to comply with the exemption requirements, a riverine protection permit will be required for works within a watercourse. ■ The detail design will be developed so that no watercourses, as defined and mapped under the *Water Act 2000*, are required to be diverted for the Project. ■ The detail design will be developed to ensure that the potential for diversion of waterways as defined under the *Fisheries Act 1994* and mapped according to the spatial data layer, Queensland waterways for waterway barrier works, is minimised ■ Design modifications during the detail design will be subject to re-runs of the existing flood models to demonstrate continued compliance with the design objectives of the Project, including for extent and time of inundation, afflux and flow velocities. ■ A Soil Management Sub-plan, inclusive of erosion and sediment controls, and Surface Water Management Sub-plan will be developed as components of the CEMP.
	<u>Value</u> Water quality <u>Potential impacts</u> Sediment runoff into waterways Introduction of contaminants into waterways Invasion of aquatic habitats by exotic pest species	■ A Surface Water Management Sub-plan will be developed as a component of the CEMP. The Sub-plan will provide a surface water monitoring framework for the Project that establishes: – Additional monitoring and sampling required to establish baseline water quality conditions, as a continuation of data collected during existing environment within the draft EIS. Baseline water quality conditions will preferentially utilise water quality monitoring sites used within the draft EIS, with consideration of construction activities, seasonality and waterway sensitivity. These will be monitored, at a minimum monthly, for a period of 12-24 months prior to construction to determine baseline conditions as a reference for monitoring of impact (as per *Queensland Water Quality Guidelines* 2009). – Waterway-specific water quality criteria, based on baseline data, ANZECC/ARMCANZ, QWQG and relevant WQOs – Frequency and location of surface water sampling during construction of the Project, with consideration for: ■ Construction activities with potential to impact water quality ■ Seasonality ■ Sensitivity of receiving waterway – Further details of the surface water monitoring framework are provided in the Surface Water Quality Technical Report (Appendix P of the draft EIS)

© ECO LOGICAL AUSTRALIA PTY LTD

Delivery phase	Aquatic ecology value and potential impacts	Mitigation and management measures
		– A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment, including definition of instances (including accidental discharge of contaminants and sediments) that trigger contingency and ameliorative measures – *In situ* water quality parameters and laboratory analysis required for samples collected at each sampling location – QA/QC requirements for surface water sampling and analysis – Location specific impact thresholds – Responses to impact threshold exceedances (to be determined after the establishment of baseline water quality conditions) – Data management and reporting requirements ■ Dewatering of surface water storages, including private dams, will be required to comply with the *Biosecurity Act 2014* to take reasonable measure to avoid the spread of pest species (with capacity to affect water quality). A strategy for managing dewatering in order to meet water quality objectives will be required. ■ Dewatering/extraction of water from artificial impoundments will be undertaken after consultation with relevant stakeholders (e.g. impoundment owners) with relevant approvals (water plans under *Water Regulation 2016*) and agreements obtained.
Pre-construction	<u>Value</u> Biodiversity and nature conservation Riparian vegetation <u>Potential impacts</u> Clearing of riparian vegetation Disturbance of aquatic habitat Invasion of aquatic habitats by exotic pest species	■ The Biodiversity Management Sub-plan, as a component of the CEMP, will be implemented (refer above). ■ Protected plant surveys, in accordance with the requirements of the NC Act, will be undertaken as required in support of pre-construction enabling works. Such works may include additional geotechnical investigations to confirm the viability of borrow pit locations, re-fencing works or the establishment of accommodation camps. ■ Prior to any pre-construction clearing works being undertaken, the clearing extents/site boundary/limit of works will be clearly defined with flagging or marking tape. 'No go' areas will also be marked. ■ A qualified Fauna Spotter Catcher will undertake pre-clearance surveys of vegetation. ■ The Fauna Spotter Catcher will supervise the subsequent clearing of vegetation. ■ The significant adverse residual impact to habitat for MNES and MSES will be confirmed for the Project at the conclusion of the detail design process and once the Project footprint is confirmed. ■ Re-calculated impacts will be used to confirm the Project's offset obligations under Commonwealth and State requirements

© ECO LOGICAL AUSTRALIA PTY LTD

Delivery phase	Aquatic ecology value and potential impacts	Mitigation and management measures
		■ A Draft Environmental Offsets Delivery Strategy - Queensland has been prepared for the Project (refer Appendix N: Draft offset strategy of the draft EIS). The Draft Environmental Offsets Delivery Strategy - Queensland will be revised and finalised to reflect significant residual impacts calculated at the conclusion of the detail design phase. The finalised Environmental Offsets Delivery Strategy will provide for the staged delivery of offsets where appropriate, ahead of relevant clearing works being undertaken. The Environmental Offsets Delivery Strategy will be finalised in consultation with relevant Commonwealth and State regulatory agencies, including the Department of Agriculture, Water and the Environment (Commonwealth) and DES (Queensland). ■ The Rehabilitation and Landscape Management Sub-plan, as a component of the CEMP, will be implemented (refer above) ■ Undertake pre-construction survey and mapping of weeds within the Project footprint, in accordance with the Biosecurity Management Sub-plan (refer above)

© ECO LOGICAL AUSTRALIA PTY LTD

Delivery phase	**Aquatic ecology value and potential impacts**	**Mitigation and management measures**
Construction	Value Biodiversity and nature conservation Riparian vegetation Potential impacts Clearing of riparian vegetation Disturbance of aquatic habitat	■ Prior to any construction clearing works being undertaken, the clearing extents/site boundary/limit of works will be clearly defined with flagging or marking tape. 'No go' areas will also be marked. ■ A qualified Fauna Spotter Catcher will undertake pre-clearance surveys of vegetation. ■ The Fauna Spotter Catcher will supervise the subsequent clearing of vegetation. ■ Clearing extents will be limited to that required to undertake and operate the works, avoiding impacts to native vegetation and habitats as far as practicable. ■ The Rehabilitation and Landscape Management Sub-plan, as a component of the CEMP, will be implemented (refer above). Rehabilitation and landscaping will occur sequentially as work fronts are completed. ■ The salvage and relocation of fish will be managed in accordance with DAF Guidelines for Fish Salvage. ■ An appropriately qualified person will be consulted to make an assessment on the method of recovery, transport and release of fish and other aquatic fauna, as required. As a minimum, the following will be implemented: – Relocation will be undertaken by a suitably qualified person – Dewatering pumps will have an intake screen – Records of all fish recovered and the location of their release will be maintained. ■ In the event of a spill incident during construction, any impacted aquatic environments will be assessed for the presence of fauna. If necessary, salvage and recovery efforts will be undertaken.
	Value Biodiversity and nature conservation Riparian vegetation Potential impacts Introduction of contaminants to waterways Altered hydrology	■ Plant maintenance activities and refuelling must be carried out a minimum of 50 m from riparian vegetation and waterways, where practical, with appropriate interception measures in place to avoid impacts to waterways, aquatic habitats, and groundwater. ■ Works within or adjacent to watercourses will be conducted in accordance with: – Riverine protection permit exemption requirements (WSS/2013/726) or conditions of a riverine protection permit issued for the Project – Accepted development requirements for operational work that is constructing or raising waterway barrier works (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works.
	Value	■ Construction tasks will be scheduled to avoid, where possible, bulk earthwork activities within the 1% AEP during periods of elevated flood risk. Where works cannot be scheduled outside of this

© ECO LOGICAL AUSTRALIA PTY LTD

Delivery phase	**Aquatic ecology value and potential impacts**	**Mitigation and management measures**
	Water quality Sediment quality <u>Potential impacts</u> Sediment runoff into waterways Introduction of contaminants into waterways	time period, activity-specific flood readiness and response planning will be required. This planning will be developed in consultation with the relevant local government and QFES during the construction phase, to reduce the potential for sediment discharge into waterways. ■ Laydown areas and other construction facilities that are located within the 1% AEP will be temporary. Their planning and function in supporting construction will reflect the local flood risk. For example, hazardous goods will not be bulk stored in these locations. ■ Mobile plant will not be stored in the 1% AEP when not scheduled for, or in use for construction purposes. ■ Surface water monitoring will be undertaken in accordance with the monitoring procedure established in the Surface Water Management Sub-plan, as a component of the CEMP. ■ In the event that water quality objectives cannot be achieved for waters to be released, alternate treatment/disposal options are to be implemented to achieve the water criteria relevant for the waterway in question (refer to **Section 2.3**). ■ The Soil Management Sub-plan, including erosion and sediment control plans, will be implemented as a component of the CEMP (refer above). ■ ARTC's Enviroline will be advertised for the Project to enable members of the public to notify ARTC of issues, including concerns regarding erosion and sediment control.
	<u>Value</u> Biodiversity and nature conservation Riparian vegetation <u>Potential impacts</u> Invasion of aquatic habitats by aquatic species	■ The Biosecurity Management Sub-plan, as a component of the CEMP, will be implemented (refer above). ■ The effectiveness of weed hygiene measures will be monitored as a component of the environmental monitoring procedure for the Project. ■ Any vegetated material containing, or with the potential to contain, weed seed material will not be used for on-site mulching or erosion protection. ■ ARTC's Enviroline will be advertised for the Project to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.
Operation	<u>Value</u> Biodiversity and nature conservation Riparian vegetation: <u>Potential impacts</u>	■ Maintenance activities and refuelling must be carried out a minimum of 20 m from riparian vegetation and waterways, with appropriate interception measures in place to avoid impacts to waterways, aquatic habitats, and groundwater. ■ Works within or adjacent to watercourses and waterways will be conducted in accordance with the intent of:

© ECO LOGICAL AUSTRALIA PTY LTD

Delivery phase	**Aquatic ecology value and potential impacts**	**Mitigation and management measures**
	Introduction of contaminants into waterways Disturbance of aquatic habitat Altered hydrology Invasion of aquatic habitats by exotic pest species	– Riverine protection permit exemption requirements (WSS/2013/726) or conditions of a riverine protection permit issued for the Project – Accepted development requirements for operational work that is constructing or raising waterway barrier works (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works. ■ Weed management protocols for the operational rail corridor and other ARTC facilities will be in accordance with the requirements of the *Biosecurity Act 2014* and incorporated into the Operation Environmental Management Plan. These protocols will include: – Site hygiene and waste management procedures to deter pest animals – Weed surveillance and treatment during operation and maintenance activities – Requirements in relation to pesticide and herbicide use, including any limitations on use. Restrictions may apply in proximity to waterways, known areas of MNES or MSES habitat or land uses sensitive to spray-drift from the application of pesticides and herbicides – Vehicle, machinery and imported fill hygiene protocols and documentation – Erosion and sediment control risks associated with broad scale weed removal or treatment. – Corrective actions should the outcomes not achieve the adopted objectives ■ ARTC's Enviroline will be advertised for the Project to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 42 Impact mitigation measures specific to aquatic MNES and MSES that occur in the Project footprint

Sensitive environmental receptor	Project phase	Receptor-specific mitigation and management measures (in addition to those specified in Table 41)
Murray cod	**Construction**	■ Construction activities scheduled to avoid/minimise instream works and associated riparian habitat in identified habitat, where possible. ■ Construction works will, where possible, take place outside of the wet season when flows in floodplain systems are more likely ■ Pre-construction surveys of watercourse crossings that are identified as potential habitat if suitable waterholes are present (i.e. Condamine River floodplain channels and Macintyre River) to identify whether the species occurs. Surveys will follow the Survey guidelines for Australia's threatened fish (DSEWPaC 2011b). ■ Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, an appropriately qualified person will be consulted to make an assessment on the method of recovery, transport and release of fish and will follow relevant State (DAF) fish salvage guidelines during construction activities. ■ Where possible, instream habitat will be reinstated to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and allow fish passage). ■ Implementation of the Biosecurity Management Sub-plan, Soil Management Sub-plan and the Surface Water Management Sub-plan.
	Operation	■ Maintenance of erosion and sediment controls within the rail corridor with specific reference to maintaining the pre-construction condition watercourses and drainage features that adjoin the rail corridor. ■ Maintenance of the effectiveness of cross drainage structure (e.g. culverts) to ensure continued connectivity of watercourses and drainage features that are aligned across the rail corridor.
Platypus	**Construction**	■ Construction activities scheduled to avoid/minimise instream works and associated riparian habitat in identified habitat, where possible. ■ Construction works will, where possible, take place outside of the wet season when flows in floodplain systems are more likely ■ Pre-construction surveys of watercourse crossings that are identified as potential habitat if suitable waterholes are present (i.e. Condamine River floodplain channels and Macintyre River) to identify whether the species occurs. ■ Where a temporary impoundment or diversion are required for construction purposes and the species is found to be present, an appropriately qualified person will be consulted to make an assessment on the requirement for a species management program should breeding places (i.e. burrows) be present.

Sensitive environmental receptor	Project phase	Receptor-specific mitigation and management measures (in addition to those specified in Table 41)
		■ Where possible, instream habitat will be reinstated to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and passage). ■ Implementation of the Biosecurity Management Sub-plan, Soil Management Sub-plan and the Surface Water Management Sub-plan.
	Operation	■ Maintenance of erosion and sediment controls within the rail corridor with specific reference to maintaining the pre-construction condition watercourses and drainage features that adjoin the rail corridor. ■ Maintenance of the effectiveness of cross drainage structure (e.g. culverts) to ensure continued connectivity of watercourses and drainage features that are aligned across the rail corridor.

5.3 Impact assessment

Potential impacts to aquatic ecology values associated with the Project in the pre-construction, construction and operation phases are outlined in **Table 43**. These impacts have been subjected to a significance assessment as per the methodology detailed in **Section 3.8**, based on the sensitivity of aquatic ecology values to the potential impact, and the likely magnitude of the impact. Each of the potential impacts to aquatic ecology values in **Table 39** has been carried forward into the significance assessment presented in **Table 43**.

Results of the significance assessment are also summarised in **Table 44** for the pre-construction and construction phases of the Project, from the perspective of the key aquatic ecology values identified in **Table 39**. Significance ratings are derived from the highest residual significance as assessed in **Table 43**, and provide a summary of how environmental significance varies across aquatic ecology values and the various modes of potential impact from Project construction activities. Residual significance associated with the pre-construction and construction phase was higher than the operation phase for all aquatic ecology values, with the exception of habitat connectivity and bank stability.

The initial significance assessment was undertaken on the assumption that the design considerations (or initial mitigation measures) factored into the reference design phase (**Table 40**) have been implemented. Additional mitigation and management measures, including those listed in relevant management plans, were then applied as appropriate to the phase of the Project to reduce the level of potential impacts. These are documented in **Section 5.2.2** (**Table 41 and Table 42**).

The residual risk level of the potential impacts was then reassessed after mitigation and management measures in **Table 41** and **Table 42** were applied. The pre-mitigated risk levels were compared with the residual risk levels in order to assess the effectiveness of the mitigation and management measures.

The assessment has identified that the significance of impacts to aquatic ecology and associated surface water quality values range from Negligible to Moderate (**Table 44**). The following impacts were assessed to be the highest risk (moderate):

- Invasion of aquatic habitats by weed and pest species during the construction phase
- Declines in water and sediment quality from bank erosion, and the runoff of sediments and contaminants into waterways during the construction phase.

© ECO LOGICAL AUSTRALIA PTY LTD

These impacts were considered to be the highest risk to aquatic ecology values, due to the relatively disturbed nature of the impact assessment area, and the potential for Project-related activities to result in further deterioration of aquatic ecology values.

The residual significance of other potential impacts on aquatic ecology values (i.e., potential impacts other than those related to biosecurity and the quality of water and sediment) was assessed to be Negligible or Low.

The residual significance of changes to groundwater levels on GDEs was assessed to be Low, due to the temporary nature of potential impacts during the construction phase, and availability of engineering design controls to reduce the extent of impacts. Existing hydrogeological and processes sustaining GDEs and wetlands are unlikely to be affected by the Project.

There will be some impacts on riparian vegetation, and on the interaction between terrestrial and aquatic ecosystems (e.g. through a reduction in shading of waterways by riparian vegetation). However, the localised scale of such impacts resulted in a residual significance rating of Low.

The residual significance of changes in hydrology and flood plain inundation were assessed to be Negligible during construction and Low during operations. This is primarily a result of the large number of bridges and culverts included in the reference design for the project, which will minimise changes to existing hydrological conditions which facilitate migration of aquatic fauna and connectivity across the flood plains of the impact assessment area.

With the implementation of appropriate environmental management and design practices (**Table 40, Table 41 and Table 42**), impacts will be minimised or confined to the localised area. Key mitigation measures to reduce impacts on aquatic ecology values include:

- Designing waterway crossings to avoid disturbance of aquatic habitats, avoid obstructions to fauna passage and minimise alterations to the natural hydrological regime. This will be achieved through use of bridge designs in preference to culverts or through application of the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018)
- Erosion and sediment control measures, such as the storage of soil stockpiles away from waterways and the use of silt fences, will reduce the potential for construction activities to add to existing high concentrations of TSS in local aquatic habitats. The cumulative effect of the Project with existing agricultural practices will be important to take into consideration when designing and implementing management plans
- Spills and the discharge of contaminants to waterways will be avoided, and rapidly cleaned up when they occur. This will maintain existing water quality values, which are characterised by low concentrations of dissolved metals and organic contaminants, which may be toxic to biota.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 43 Results of significance assessment for impacts on aquatic ecology

Potential Impact (and associated aquatic ecology value)	Phase	Initial significance[1]			Residual Significance[2]	
		Sensitivity	Magnitude	Significance	Magnitude	Significance
Biodiversity and nature conservation Removal of riparian and aquatic habitats including hollow-bearing trees, logs and burrows which will reduce the persistence of native species that utilise these habitats Loss of submerged aquatic vegetation and woody debris, resulting in a reduction in aquatic habitat complexity and aquatic plant diversity River substrate disturbance (i.e. due to bridge or culvert construction) which may affect bottom dwelling aquatic flora and fauna and their associated habitats Loss of sensitive ecological processes through geomorphological alteration, including a change in photosynthesis and respiration rates from increases in sunlight and water temperature Reduction in groundwater level, resulting in the loss of wetland habitat and an alteration of species composition within GDEs	Pre-construction and construction	Moderate	Moderate	Moderate	Low	Low
	Operation		Negligible	Low	Negligible	Low
Biodiversity and nature conservation Transmission and invasion of aquatic and terrestrial weeds (e.g. through vehicle and machinery movement) altering riparian and aquatic vegetation community composition	Pre-construction and construction	Moderate	High	High	Moderate	Moderate
	Operation		Low	Low	Low	Low
Biodiversity and nature conservation Disturbance of aquatic fauna from noise, vibration and lighting	Pre-construction and construction	Low	Moderate	Low	Low	Negligible
	Operation		Low	Negligible	Negligible	Negligible
Biodiversity and nature conservation Mortality or displacement of EVNT species.	Pre-construction and construction	Moderate	Moderate	Moderate	Low	Low
	Operation		Low	Low	Low	Low
Riparian vegetation Changes in community structure and composition due to clearing	Pre-construction and construction	Moderate	Moderate	Moderate	Low	Low

© ECO LOGICAL AUSTRALIA PTY LTD

Potential Impact (and associated aquatic ecology value)	Phase	Initial significance[1]			Residual Significance[2]	
		Sensitivity	Magnitude	Significance	Magnitude	Significance
Vegetation clearing allowing the colonisation of exotic species Reduction in shading and increase in light penetration into aquatic habitats, resulting in higher stream temperatures and conditions suitable for the proliferation of algae Transmission of aquatic and terrestrial weeds (through railway) may alter riparian vegetation	Operation		Negligible	Low	Negligible	Low
<u>Habitat connectivity</u> Introduction of physical barriers to aquatic fauna movement through the construction of culverts, bridges, fencing and other infrastructure that affects the existing hydrological conditions	Pre-construction and construction	Low	Moderate	Low	Low	Negligible
Construction of temporary bunding to achieve a dry work area at creek crossings.	Operation	Moderate	Moderate	Moderate	Low	Low
<u>Bank stability</u> Construction works involving disturbance to the riparian corridor may result in erosion and scouring of streambanks, which are an important component of aquatic habitats. This may result in unstable stream banks unable to support vegetation or tolerate extreme rainfall or flooding events.	Pre-construction and construction	Moderate	Moderate	Moderate	Low	Low
Smothering of benthic aquatic habitat due to erosion, sediment transport and sediment deposition. Physical disturbance of stream beds and banks during construction of creek crossings Establishment of weeds such as Lippia (recorded in region) in new areas which out compete native species and affect the integrity of stream banks	Operation	Low	Moderate	Low	Low	Negligible

© ECO LOGICAL AUSTRALIA PTY LTD

Potential Impact (and associated aquatic ecology value)	Phase	Initial significance[1]			Residual Significance[2]	
		Sensitivity	Magnitude	Significance	Magnitude	Significance
<u>Water quality and sediment quality</u> Declines in water quality due to runoff from disturbed areas or discharge of water generated from construction activities (e.g. dewatering of a dry work area). This may include increased concentrations of suspended sediments, nutrients, metals and hydrocarbons, which may reduce the suitability of water to support environmental values (e.g. aquatic ecosystems and stock watering). Spills of contaminants to waterways and in adjacent areas during works, resulting in pollution of local waterways and areas downstream and toxic effects on aquatic organisms.	Pre-construction and construction	Moderate	Moderate	Moderate	Moderate	Moderate
Spills of contaminants to groundwater, resulting in pollution of GDEs and toxic effects on aquatic organisms. Spills of contaminants to waterways from train and associated infrastructure, resulting in pollution of local waterways and areas downstream and toxic effects on aquatic organisms. Physical disturbance of soils and mobilisation of contaminants (e.g. metals) to waterways from rainfall runoff, decreasing water quality. Increase in salinity from interplay between works, runoff and sodic or dispersive soils.	Operation		Negligible	Low	Negligible	Low
<u>Water resources</u> Changes in watercourse pathway and flow characteristics, including the alteration of habitat composition (ponding, channels and dry creek beds) and flow regime.	Pre-construction and construction	Low	Medium	Low	Low	Negligible
Changes in water availability: riparian community structure and species composition. Temporary changes in hydrology through bunding to create a dry work area. Altered flow regimes which result in changes to aquatic ecology and surface water.	Operation	Moderate	Moderate	Moderate	Low	Low

1. Includes implementation of initial mitigation measures specified in **Table 40**
2. Assessment of residual risk once the mitigation measures identified in **Table 41** and **Table 42**

© ECO LOGICAL AUSTRALIA PTY LTD

Table 44 Residual significance assessment

Aquatic Ecology Value	Potential Impact	Residual significance (Pre-construction and construction phases)
Biodiversity and nature conservation	Disturbance of aquatic habitat Changes to groundwater resources, affecting groundwater dependent ecosystems	Low
	Invasion of aquatic habitats by exotic pest species	Moderate
	Disturbance of fauna from noise, vibration and lighting	Negligible
	Impacts on EVNT species	Low
Riparian vegetation	Clearing of riparian vegetation	Low
Habitat connectivity	Disturbance of aquatic habitat Altered hydrology	Negligible
Bank stability	Sediment runoff into waterways Altered hydrology	Low
Water quality Sediment quality	Sediment runoff into water courses Introduction of contaminants into waterways	Moderate
Water resources	Altered hydrology	Negligible

5.4 Cumulative impacts on aquatic and surface water values

Twenty three projects were initially identified as having potential to contribute to cumulative impacts in combination with the Border to Gowrie project (**Table 10**). These projects are either currently operational, expected to undergo future expansion or are currently going through an approval process. Of these, five projects were considered to be relevant to the assessment of impacts on aquatic ecology values (**Table 45**).

Projects relevant to the assessment of cumulative impacts are those that will be constructed or expanded in the future, and may cause impacts to existing aquatic ecology values that are additive to impacts from the Project. Examples of aquatic ecology values that may be affected include water quality (increases in turbidity and the concentration of nutrients and metals) and additional disturbance to the habitats of aquatic fauna over a broad geographic area within the Murray Darling Basin. Only five of the initial 23 projects identified meet these criteria, as listed in **Table 45**.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 45 Projects considered for the cumulative impact assessment

Projects	Location	Description	Construction dates [1]
New Acland Coal Mine Stage 3	35 km northwest of Toowoomba 18 km north of the Project footprint	Expansion of the existing New Acland open-cut coal mine to up to 7.5 Mtpa.	2019-TBC
Goondiwindi Abattoir	Goondiwindi, QLD 13 km north of the Project footprint	A new beef abattoir located on the outskirts of Goondiwindi with beef processing of up to 72,000 tonnes per year.	TBC Approved with conditions by Goondiwindi Regional Council
Wyemo Piggery	Texas-Yelarbon Road, Glenarbon 8 km south of the Project footprint	A new intensive piggery, with approval for 55,000 pig units	TBC Approved with conditions by Goondiwindi Regional Council
North Star to NSW/QLD Border (Inland Rail)	Rail alignment from North Star, NSW to the NSW/QLD border Adjoins the Project at its southern limit	New 37 km rail corridor to connect North Star (NSW) to the Queensland Rail South West Rail Line just over the NSW/QLD border.	2021 – 2024
Gowrie to Helidon (Inland Rail)	Rail alignment from Gowrie to Helidon, QLD Adjoins the Project at its northern limit	New 26km dual gauge track between Gowrie (north-west of Toowoomba) and Helidon (east of Toowoomba), extending through the Local Government Areas of Toowoomba and Lockyer Valley. The Project includes a 6.38 km tunnel to create an efficient route through the steep terrain of the Toowoomba Range.	2021 – 2025

1 TBC – To be confirmed

The projects listed in **Table 45** were identified for their potential to have cumulative impacts on aquatic ecology values for the following reasons:

- Expansion of the existing New Acland Coal Mine has the potential to impact aquatic ecology and surface water quality values in sections of the Murray Darling Basin located downstream from the Project. The proposed mine expansion is located approximately 25 km to the north of Gowrie, at the eastern extent of the Project.
- The approved Goondiwindi Abattoir which will process 72,000 tonnes of beef per year is located on the Cunningham Highway approximately 30 km west of Yelarbon near the southern extent of the Project. The abattoir project has the potential to influence water quality in sections of the Murray Darling Basin located downstream from the Project.
- The Wyemo Piggery involves the intensive production of pork and is located on Texas-Yelarbon Road, Glenarbon, approximately 8 km south of the Project. The piggery project has the potential to influence water quality in sections of the Murray Darling Basin located upstream of the Project (Dumaresq River).
- The North Star to NSW/QLD Border and Gowrie to Helidon sections of the Inland Rail Program are located immediately adjacent to the Project and are likely to influence waterways immediately adjacent to and downstream of the Project in the Murray Darling Basin. These projects occur over smaller areas than the Border to Gowrie project, with large parts of the Gowrie to Helidon project located in coastal catchments east of the Great Dividing Range, and therefore of limited relevance to the assessment of cumulative impacts.

© ECO LOGICAL AUSTRALIA PTY LTD

Following consideration of the probability of impact, duration of impact, magnitude of impact and sensitivity of the receiving environment, the significance of cumulative impacts from other projects was assessed to be low (**Table 46**). The basis of the assessment is summarised as follows:

- The probability of impact was assessed as Low for all five other projects. The New Acland Coal Mine Stage 3, the Goondiwindi Abattoir and the Wyemo Piggery are located more than 8 km from the Project, and will be subject to conditions of an Environmental Authority (EP Act) that regulate the nature of water discharges to the environment, which may affect aquatic ecology values. The North Star to NSW/QLD Border and Gowrie to Helidon sections of the Inland Rail project have a similar level of environmental risk as the Project, and will be subject to a similar range of environmental management procedures to maintain impacts to the localised area. This will minimise the potential for cumulative impacts.
- The duration of impact was assessed to be Medium. While all other projects are likely to be operating for a period of more than 10 years, the construction phase of the Inland Rail projects, when impacts will be greatest, will be limited to a much shorter period of approximately 5 years.
- The magnitude/intensity of impact was assessed to be Low, due to the highly regulated nature of the other projects, which will be subject to a range of environmental management plans. Also, in the case of the mining, piggery and abattoir projects, conditions of an Environmental Authority (EP Act) will also apply and limit the nature of water discharges to the receiving environment. While there is a risk of spills or other types of environmental incidents occurring at the sites of the other projects, the impacts of these are likely to be localised, with minimal potential to act cumulatively with those of the Project.
- The sensitivity of the receiving environment was assessed to be Medium. The Murray-Darling Basin is highly modified from a range of existing land uses, including agriculture, infrastructure and mining. Existing aquatic ecology values are unlikely to be sensitive to the localised impacts from the Project acting cumulatively with the other projects. Some threatened species such as the Murray Cod are known to occur in the impact assessment area and waters downstream.

© ECO LOGICAL AUSTRALIA PTY LTD

Table 46 Summary of the results of a cumulative impact significance assessment for other relevant projects

Project	Potential cumulative impact	Factor affecting impact	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
New Acland Coal Mine Stage 3 – New Acland Coal Pty Ltd	Degradation of aquatic values	Probability of the impact	Low (1)	6	Low	Will be managed through: ■ Development and implementation of the sub-plans specified in **Table 41** and **Table 42**
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Goondiwindi Abattoir	Degradation of aquatic values	Probability of the impact	Low (1)	6	Low	Will be managed through: ■ Development and implementation of the sub-plans specified in **Table 41** and **Table 42**
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Wyemo Piggery	Degradation of aquatic values	Probability of the impact	Low (1)	6	Low	Will be managed through: ■ Development and implementation of the sub-plans specified in **Table 41** and **Table 42**
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
North Star to NSW/QLD Border (Inland Rail)	Degradation of aquatic values	Probability of the impact	Low (1)	6	Low	Will be managed through: ■ Development and implementation of the sub-plans specified in **Table 41** and **Table 42** ■ ARTC to ensure the compatibility of mitigation measures and controls across projects in the Inland Rail Program
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Gowrie to Helidon (Inland Rail)	Degradation of aquatic values	Probability of the impact	Low (1)	6	Low	Will be managed through:
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			

© ECO LOGICAL AUSTRALIA PTY LTD

Project	Potential cumulative impact	Factor affecting impact	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
		Sensitivity of the receiving environment	Medium (2)			■ Development and implementation of the sub-plans specified in **Table 41** and **Table 42** ■ ARTC to ensure the compatibility of mitigation measures and controls across projects in the Inland Rail Program

© ECO LOGICAL AUSTRALIA PTY LTD

6 Conclusions and Recommendations

Aquatic ecology and surface water values of the impact assessment area are variable across the rail alignment. Ephemeral waterways, which have been subject to previous disturbance from agricultural development and public infrastructure such as road crossings, are dominant. However, areas of less disturbed aquatic habitat are present, and on larger waterways, these provide good quality habitat for a variety of aquatic fauna. Water quality is variable across the impact assessment area, with the absence of flow during dry conditions a key driver in small waterways.

The sedge *Fimbristylis vagans* has potential to occur in the impact assessment area and is listed as Endangered under the *Nature Conservation Act 1992* (Qld). Larger waterways of the impact assessment area including of the Macintyre and Condamine catchments also provide habitat for the Murray Cod, which is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), and the Platypus, which is listed as Special Least Concern under the *Nature Conservation Act 1992* (Qld). The Agassiz's Glassfish (listed as an endangered population in NSW) was also confirmed to be present in the Macintyre River. Other listed flora and fauna species have been determined as unlikely to occur in the impact assessment area.

The sensitivity of aquatic ecology and surface water quality values to impacts from the Project range from negligible to moderate in scale. The highest sensitivities (moderate) are associated with:

- Invasion of aquatic habitats by weed and pest species during the construction phase
- Declines in water and sediment quality from bank erosion, and the runoff of sediments and contaminants into waterways during the construction phase.

However, these risks can be effectively managed through a range of design features (e.g. bridges spanning waterways in preference to culverts) and through the development and implementation of detailed environmental management plans during detail design, pre-construction, construction and operation phases of the Project.

In implementing the Project, it is recommended that actions are taken to minimise disturbance to aquatic habitats and riparian vegetation of major waterways within the impact assessment area as much as possible. In particular, the Macintyre River and Macintyre Brook have been confirmed to provide aquatic habitats utilised by threatened species, and disturbance of these values should be minimised through a range of design, engineering and on site controls, as outlined in **Section 5.2**.

© ECO LOGICAL AUSTRALIA PTY LTD

7 References

Allen G.R., Midgley S.H. and Allen M. 2002. *Field guide to the freshwater fishes of Australia*, Western Australia Museum.

ANZECC 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Australian Museum. 2018. Platypus (*Ornithorhynchus anatinus),* viewed 22 July 2018, https://australianmuseum.net.au/learn/animals/mammals/platypus

Bureau of Meteorology (BOM) 2019. Climate statistics for Australian locations. http://www.bom.gov.au/climate/averages/tables/cw_041097_All.shtml

Chessman B.C. 2003. New sensitivity grades for Australian river macroinvertebrates*, Marine and Freshwater Research*, vol., 54, pp 95-103.

Clayton P.D., Fielder D.P., Howell S. and Hill, C.J. 2006. Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River Catchment, Environmental Protection Agency, Brisbane.

Cogger H.G. 2014. *Reptiles and Amphibians of Australia (Seventh Edition).* CSIRO Publishing, Collingwood.

Commonwealth of Australia 2012. Basin Plan 2012. Made under subparagraph 44(3)(b)(i) of the Water Act 2007.

Davies P.E. 1994. River Bioassessment Manual. Version 1.0, Monitoring River Health Initiative. National River Processes and Management Program, Canberra.

Department of Agriculture and Fisheries 2017a. What is not a waterway barrier work? Fact sheet https://www.daf.qld.gov.au/business-priorities/fisheries/habitats/policies-guidelines/factsheets/what-is-not-a-waterway-barrier-work

Department of Agriculture and Fisheries 2017b. What is a waterway barrier work? Fact sheet https://www.daf.qld.gov.au/business-priorities/fisheries/habitats/policies-guidelines/factsheets/what-is-a-waterway-barrier-work

Department of Agriculture and Fisheries 2018. Accepted development requirements for operational work that is constructing or raising waterway barrier works. Department of Agriculture and Fisheries, October 2018.

Department of Agriculture and Fisheries (DAF) 2019. Drought declarations in Queensland. https://www.longpaddock.qld.gov.au/drought/drought-declarations/

Department of Environment and Heritage (DEHP) 2013. *Queensland Water Quality Guidelines.* Department of Environment and Heritage Protection.

Department of Environment and Heritage (DEHP) 2015. *Aquatic Biodiversity Assessment and Mapping Methodology (AquaBAMM).* Department of Environment and Heritage Protection.

© ECO LOGICAL AUSTRALIA PTY LTD

Department of the Environment (DotE) 2013. Matters of National Environmental Significance Significant Impact Guidelines 1.1. *Environment Protection and Biodiversity Conservation Act 1999.* Commonwealth of Australia.

Department of the Environment (DotE) 2016. EPBC Act referral guidelines for the vulnerable Murry cod (*Maccullochella peelii*). Commonwealth of Australia.

Department of Environment and Energy 2017. *National Recovery Plan for the White-throated Snapping Turtle (Elseya albagula).* Australian Government.

Department of Environment and Energy 2019a. *Maccullochella peelii* in Species Profile and Threats Database, viewed 22 July 2018, http://www.environment.gov.au/sprat.

Department of Environment and Energy 2019b. *Wollumbinia belli* in Species Profile and Threats Database, viewed 22 July 2018, http://www.environment.gov.au/sprat

Department of Environment and Science (DES) 2018a. *Monitoring and Sampling Manual. EPP (Water) 2009,* Queensland Government, viewed 22 July 2018. https://www.ehp.qld.gov.au/water/monitoring/sampling-manual/pdf/monitoring-sampling-manual-2018.pdf

Department of Environment and Science (DES) 2018b. WetlandInfo, viewed 22 July 2018, https://wetlandinfo.ehp.qld.gov.au/wetlands/

Department of Environment and Science (DES) 2018c. *Chlorophyll a sample collection methods. Physical and chemical assessment.* https://www.ehp.qld.gov.au/water/monitoring/sampling-manual/pdf/physical-and-chemical-assesssment-chlorophyll-a-sample-collection-methods.pdf

Department of Environment and Science (DES) 2018d. Bell's turtle – *Wollumbinia belli*, viewed 22 July 2018, https://www.ehp.qld.gov.au/wildlife/animals-az/bells_turtle.html

Department of Environment and Science (DES) 2019a. *Healthy Waters Management Plan: Queensland Border Rivers and Moonie River Basins.* Queensland Government, Brisbane.

Department of Environment and Science (DES) 2019b. *Healthy Waters Management Plan: Condamine River Basin*. Queensland Government, Brisbane.

Department of Infrastructure, Local Government and Planning (DILGP 2015). State Planning Policy interactive mapping system.

Department of Natural Resources and Mines (DNRM) 2001. Queensland Australian River Assessment System (AusRivAS) Sampling and Processing Manual. Queensland Government, Rocklea

Department of Natural Resources and Mines (DNRM) 2002. Water quality sampling field sheet – AEF003.

Department of Natural Resources and Mines (DNRM) 2015. *Vegetation Management Act 1999* Stream Order Mapping.

Department of Natural Resources, Mines and Energy (DNRME) 2019. Letter approving the listing of ARTC as an approved entity in DNRME's Riverine protection permit exemption requirements, dated 11 November 2019.

© ECO LOGICAL AUSTRALIA PTY LTD

Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) 2018. Terms of reference for an environmental impact statement: Inland Rail – Border to Gowrie project. Queensland Government, November 2018.

Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) 2011. Survey guidelines for Australia's threatened fish. Guidelines for detecting fish listed as threatened under the EPBC Act. https://www.environment.gov.au/system/files/resources/6c9817ee-517b-4c13-9d8c-e66a61514f53/files/survey-guidelines-fish.pdf

Fairfull S. and Witheridge G. 2003. Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla.

Goondiwindi Regional Council (GRC) 2019. Biosecurity Strategy 2019 – 2022. https://www.grc.qld.gov.au/downloads/file/639/grc-pmp-2015-2019pdf

Lintermans M. 2007. Fishes of the Murray-Darling Basin: An introductory guide. Murray-Darling Basin Authority, Canberra.

NSW Department of Primary Industries 2006. Silver Perch *Bidyanus bidyanus* NSW Recovery plan, *Threatened Species Recovery Planning Program,* NSW Department of Primary Industries, Nelsons Bay.

NSW Department of Primary Industries 2007. Lowland Darling River Aquatic Ecological Community. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/634557/Lowland-Darling-River-aquatic-ecological-community.pdf

NSW Department of Primary Industries 2013. Olive Perchlet (western population) – *Ambassis agassizii*. Prime fact 176.

NSW Department of Primary Industries 2019. Priorities Action Statement – Actions for Lowland Darling River Aquatic Endangered Ecological Community. https://www.dpi.nsw.gov.au/fishing/species-protection/what-current/endangered/darling-river-eec/priorities-action-statement-actions-for-lowland-darling-river-aquatic-endangered-ecological-community

NSW Government 2013. Policy and guideline for fish habitat conservation and management.

Parsons M., Thomas M. and Norris R. 2002. Australian River Assessment System: AusRivAS Physical Assessment Protocol, *Monitoring River Health Initiative Technical Report* no 22, Commonwealth of Australian and University of Canberra, Canberra.

Queensland Globe, 2019. Aquatic conservation Assessments, Queensland Government, viewed 20 May 2019, https://qldglobe.information.qld.gov.au/

Queensland Government 2017. What is a waterway? Department of Agriculture and Fisheries (DAF), viewed 22 July 2018 July, https://www.daf.qld.gov.au/business-priorities/fisheries/habitats/policies-guidelines/factsheets/what-is-a-waterway

Queensland Government 2018a. Guidelines for Groundwater Dependent Ecosystems. Department of Environment and Science.

Queensland Government 2018b. Aquatic ecology – Assessment of aquatic ecological values. Department of Environment and Science.

© ECO LOGICAL AUSTRALIA PTY LTD

Toowoomba Regional Council (TRC) 2020. Draft Biosecurity Plan for Invasive Plants and Animals. https://yoursay.tr.qld.gov.au/toowoomba-regional-council-biosecurity-plan

Threatened Species Scientific Committee (TSSC) 2013. Conservation Advice: *Bidyanus bidyanus* (silver perch), viewed 22 July 2018, http://www.environment.gov.au/biodiversity/threatened/species/pubs/76155-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) 2014. Conservation Advice: *Elseya albagula* (White-throated snapping turtle), viewed 22 July 2018, http://www.environment.gov.au/biodiversity/threatened/species/pubs/81648-conservation-advice.pdf

WetlandInfo 2019. *Fimbristylis vagans, WetlandInfo.* Department of Environment and Science, Queensland, viewed 22 July 2018, https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?fimbristylis-vagans.

© ECO LOGICAL AUSTRALIA PTY LTD

Appendix A: Site Descriptions for Aquatic Ecology Sites

Site descriptions for Aquatic Ecology Sites are provided on the following pages.

Site descriptions for Surface Water Sites are provided in the Surface Water Quality Technical Report (Appendix P of the Project EIS)

© ECO LOGICAL AUSTRALIA PTY LTD

Season: Spring

Site Code: 2 **Location:** Macintyre River **Latitude:** 28° 39' 52" **Longitude:** 150° 28' 01" **Date:** 29/11/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Permanent watercourse; Baseflow at the time of assessment; symmetrical floodplain valley shape; two stage shaped channel; defined bed and banks; bank slope vertical; bank shape concave; no distinct floodplain; no obvious channel modifications; Moderate deposition regarding bank stability; upstream and adjacent land use is predominantly native and non-native pasture for cattle grazing; bankfull width approximately 56 m; bankfull height approximately 5 m (from stream bed); substrate composition 40% sand (0.06-2 mm) and 60% silt / clay (<0.06 mm); bank material 5% gravel (2-16 mm), 55% sand (0.06-2 mm) and 40% silt / clay (<0.06 mm); 10% large woody debris; < 10% filamentous algae cover, < 10% periphyton, < 10% moss detected and < 10% detritus cover.

Riparian vegetation

Riparian zone approximately 25 m left bank and 25 m right bank; longitudinal vegetation extent semi-continuous; vegetation community *Eucalyptus tereticornis or E. camaldulensis* woodland fringing drainage lines, vegetation characterised by sparse cover (35% estimated crown cover) of trees >10 m, dominated by Queensland blue gum (*E. tereticornis*) with occasional river she-oak (*Casuarina cunninghamiana*) and white sally wattle (*Acacia floribunda*) ; sparse cover (40%) of trees <10 m, dominated by snow-in-summer (*Melaleuca linariifolia*) with occasional *E. camaldulensis, sally wattle (A. salicina)*; very sparse (10%) shrub layer, dominated by spiny-headed mat-rush (*Lomandra longifolia*) with occasional *Acacia* sp. and common reed (Phragmites Australis) and mid-dense (60%) groundcover, dominated by dayflower (C*ommelina* sp.) and green panic (*Megathyrsus maximus*) regeneration of native woody vegetation present.

Vegetation disturbance: Moderate.

Aquatic flora

Macrophyte cover approximately 2% cover; emergent macrophytes included slender flat sedge (Cyperus gracilis) (1%), common rush (*Juncus usitatus*) (1%); common reed (*Phragmites australis*) (2%), tall flat sedge (*Cyperus exaltatus*) (1%) and slender knotweed (Persicaria decipiens) (1%).

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Good passage expected during times of flow. Located in Purple zone (Major risk of impact on fish movement)

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

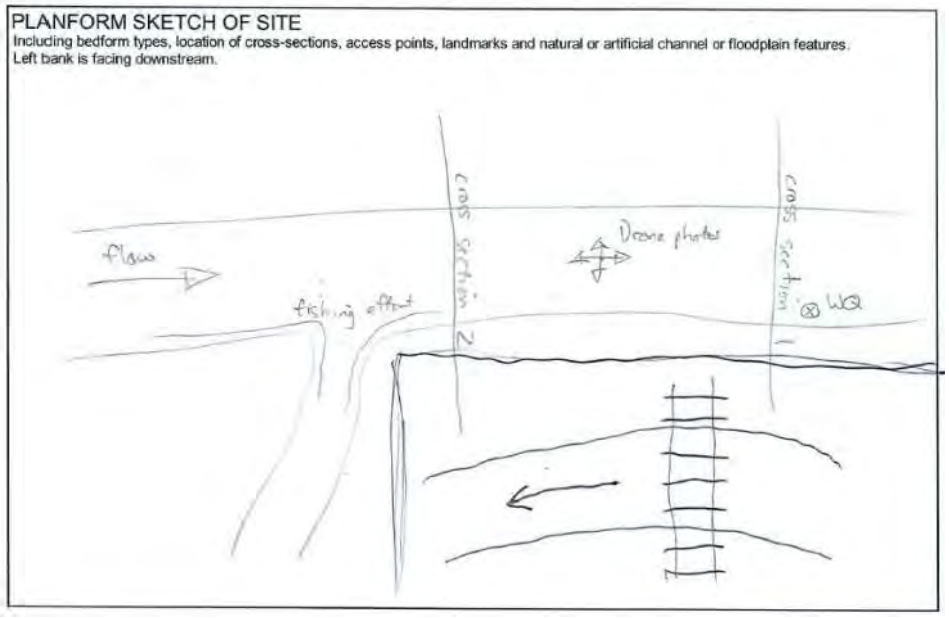
The Murray cod (*Maccullochella peelii*) Vulnerable EPBC Act was confirmed to be present at this site, with six individual caught in the May 2019 field trip . Additionally, the Critically Endangered (EPBC Act) silver perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) platypus are recorded from the Border Rivers catchment (DES 2018b). The study reach provides habitat for the Murray cod and potential habitat for the platypus but is unlikely to provide habitat for the silver perch or Bell's turtle. Agassiz's Glassfish (listed as Endangered in NSW) was also found in the June 2018 field trip (on the Queensland side of the river).

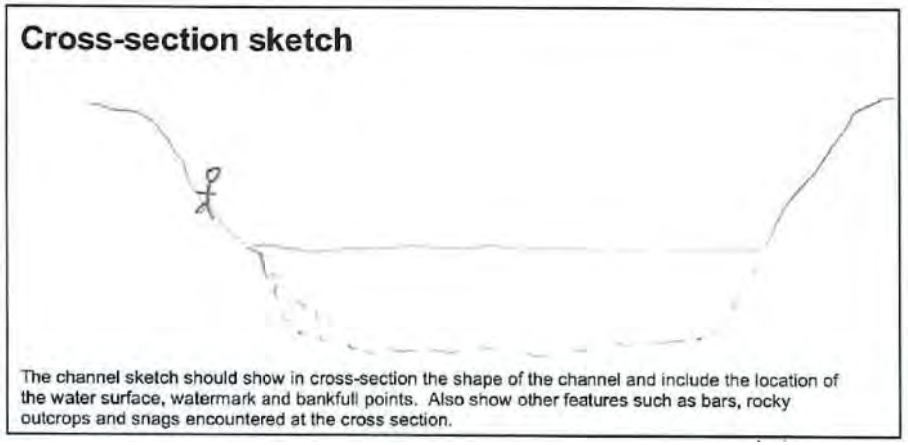
Physico-chemical water quality

Collection time: 16:15; water temp.: 28.7°C; specific conductivity: 211.0 µS/cm (fresh); turbidity: 22.9; dissolved oxygen: 101.6%, 7.86 mg/L; pH: 6.77; Redox: 104.6 mV.
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Good (14); Pool substrate characterisation: Good (12); Pool variability: Good (14); Sediment deposition: Good (12); Channel flow status: Excellent (18); Channel alteration: Good (13); Channel sinuosity: Fair (10); Bank Stability: Good (left bank 7; right bank 7); Vegetative protection: Good (left bank 7; right bank 7); Riparian zone score: Good (left bank 6, right bank 6).
Overall habitat score: Good (129 out of 200).





Season: Autumn

Site Code: 4 **Location:** Unnamed tributary of Macintyre Brook **Latitude:** 28° 26’ 21” **Longitude:** 150° 57’ 28” **Date:** 16/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral drainage feature; dry at the time of assessment; study reach positioned within undeveloped road reserve; broad valley setting; flat U shaped channel; poorly defined bed and banks; bank slope low; bank shape concave; no distinct floodplain; no obvious channel modifications; bed stable; upstream and adjacent land use is predominantly native forest; little local catchment erosion; bankfull width approximately 30 m; bankfull height approximately 1 m (from stream bed); substrate composition 95% sand (0.06-2 mm) and 5% silt / clay (<0.06 mm); bank material 40% gravel (2-16 mm), 50% sand (0.06-2 mm) and 10% silt / clay (<0.06 mm); 10% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover 35-65%.

Riparian vegetation

Riparian zone approximately 20 m left bank and 20 m right bank; longitudinal vegetation extent continuous; vegetation community appears to be RE 11.3.25 (‘*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines’), with sparse cover (40% estimated crown cover) of trees >10 m, dominated by Queensland blue gum (*E. tereticornis*) and rough-barked apple (*Angophora floribunda*), with occasional Baradine red gum (*E. chloroclada*); sparse cover (30%) of trees <10 m, dominated by Queensland blue gum and white cypress pine (*Callitris glaucophylla*); very sparse (15%) shrub layer, including *Acacia* sp., velvet tree pear (*Opuntia tomentosa*) and spiny-headed mat-rush (*Lomandra longifolia*); mid-dense (50%) groundcover, dominated by lovegrass (*Eragrostis* sp.), with frequent wiregrass (*Aristida* sp.); regeneration of native woody vegetation present.

Vegetation disturbance: Low to Moderate.

Aquatic flora

Macrophyte cover approximately 1% cover; fringing macrophytes included reed grass (*Arundinella nepalensis*) (1%); study reach dominated by terrestrial flora.

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Very restricted passage expected during low flow, base flow and high flow, including dog-proof fence (chicken wire) on upstream side of road reserve. Located in Red zone (High risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

Physico-chemical water quality

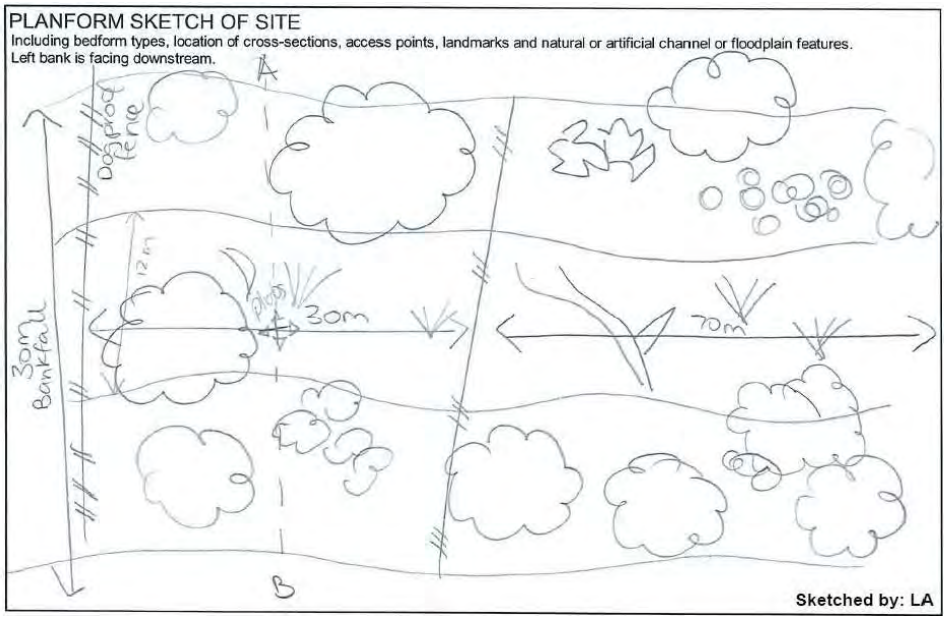
Dry at the time of the site visit.

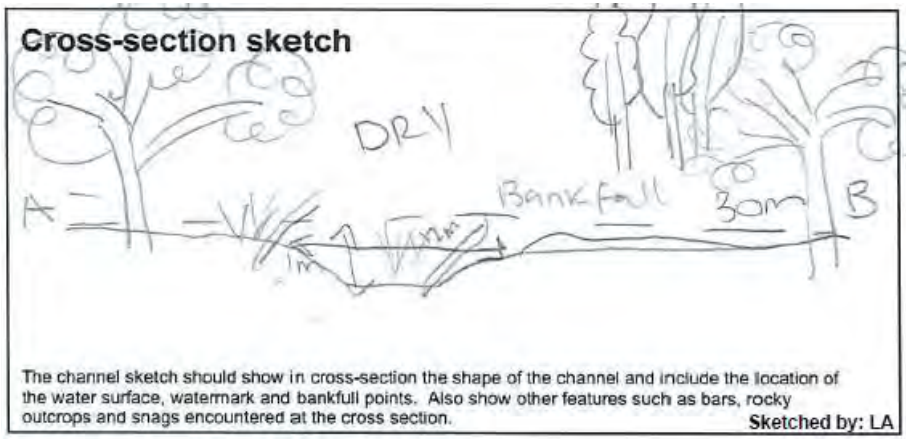
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Poor (5); Pool substrate characterisation: Fair (7); Pool variability: Poor (0); Sediment deposition: Excellent (16); Channel flow status: Poor (0); Channel alteration: Excellent (16); Channel sinuosity: Fair (7); Bank Stability: Excellent (left bank 9; right bank 9); Vegetative protection: Good (left bank 8; right bank 8); Riparian zone score: Good (left bank 8, right bank 8).

Overall habitat score: Good (101 out of 200).





Season: Autumn

Site Code: 5 **Location:** Unnamed tributary of Macintyre Brook **Latitude:** 28° 25' 58" **Longitude:** 150° 58' 54" **Date:** 16/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral drainage feature; dry at the time of assessment; symmetrical floodplain valley setting; widened channel; poorly defined bed and banks; bank slope flat (<10°); bank shape concave; no floodplain features present; no obvious channel modifications; potential for runoff from nearby pivot irrigation; bed stable; upstream land use predominantly native forest; adjacent land use beyond left bank is irrigated cropping, with grazing on the right bank; little local catchment erosion; bankfull width approximately 65 m; bankfull height approximately 0.5 m (from stream bed); substrate composition 100% silt / clay (<0.06 mm); bank material 100% silt / clay (<0.06 mm); 5% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover 65-90%.

Riparian vegetation

Riparian zone approximately 25 m left bank and 25 m right bank; longitudinal vegetation extent continuous; vegetation community appears to be RE 11.3.25 ('*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'), with mid-dense cover (70% estimated crown cover) of trees >10 m, dominated by Queensland blue gum (*E. tereticornis*), with occasional coolibah (*E. coolabah*); very sparse cover (5%) of trees <10 m, dominated by Queensland blue gum; very sparse (1%) shrub layer, including velvet tree pear (*Opuntia tomentosa*); mid-dense (50%) groundcover, dominated by tall sedge (*Carex appressa*), with frequent gilgai grass (*Walwhalleya subxerophila*) and occasional *Sida* spp.; regeneration of native woody vegetation very limited (<1% cover).

Vegetation disturbance: Low to Moderate.

Aquatic flora

Macrophyte cover approximately 15% cover; fringing macrophytes included common rush (*Juncus usitatus*) (1%) and tall sedge (*Carex appressa*) (14%); study reach dominated by terrestrial flora.

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Good fish passage expected during low and base flow; unrestricted passage during high flow. Located in Purple zone (Major risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

Physico-chemical water quality

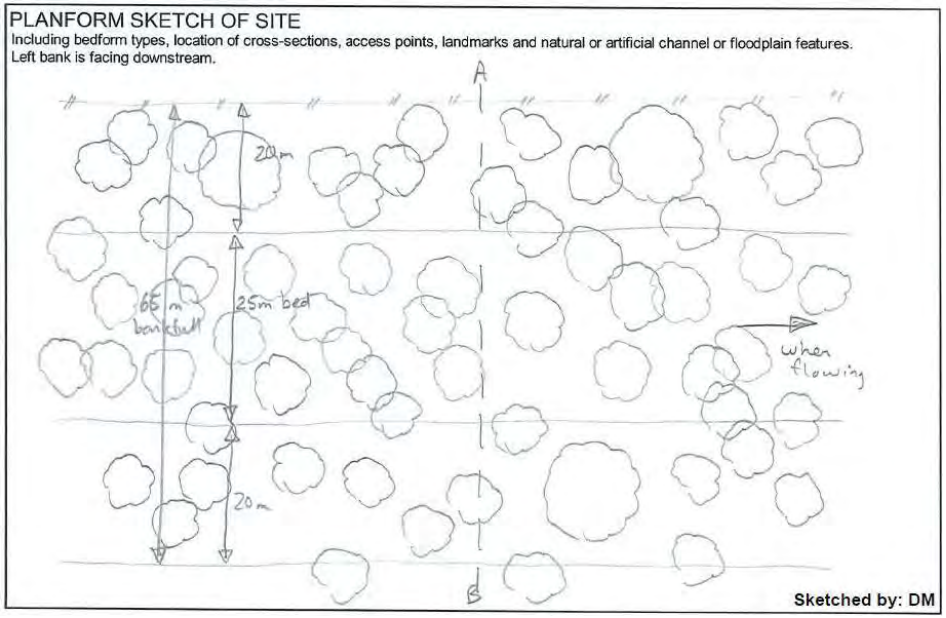
Dry at the time of the site visit.

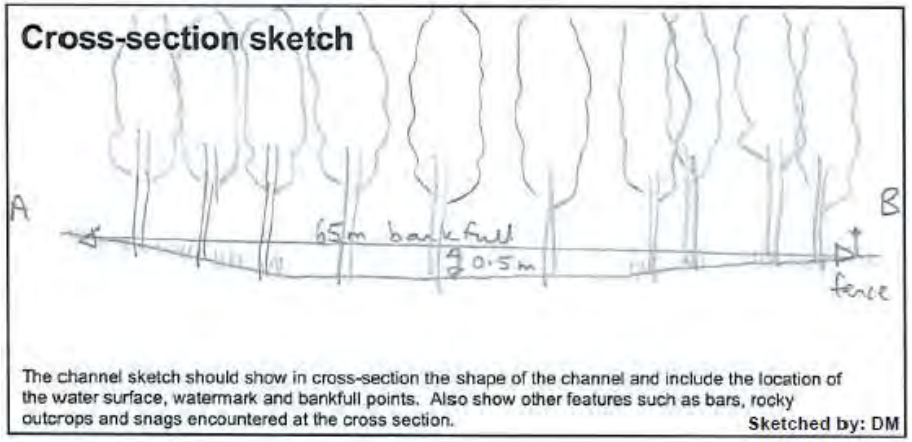
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Poor (5); Pool substrate characterisation: Fair (10); Pool variability: Poor (0); Sediment deposition: Excellent (18); Channel flow status: Poor (0); Channel alteration: Good (15); Channel sinuosity: Poor (5); Bank Stability: Excellent (left bank 10; right bank 10); Vegetative protection: Good (left bank 7; right bank 7); Riparian zone score: Excellent (left bank 9, right bank 9).

Overall habitat score: Good (105 out of 200).





Season: Autumn

Site Code: 8 **Location:** Unnamed tributary of Macintyre Brook **Latitude:** 28° 23' 39" **Longitude:** 151° 03' 12" **Date:** 17/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral drainage feature; dry at the time of assessment; symmetrical floodplain valley setting; widened channel; poorly defined bed and banks; bank slope flat (<10°); bank shape concave; no floodplain features present; no obvious channel modifications; potential for runoff from nearby dryland cropping; bed stable; upstream land use predominantly native forest; adjacent land use is native forest on the left bank, with dryland cropping on the right bank; little local catchment erosion; bankfull width approximately 60 m; bankfull height approximately 0.5 m (from stream bed); substrate composition 100% silt / clay (<0.06 mm); bank material 100% silt / clay (<0.06 mm); 15% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover <10%.

Riparian vegetation

Riparian zone approximately 20 m on the left bank and 20 m on the right bank; longitudinal vegetation extent semi-continuous; vegetation community appears to be RE 11.3.25 ('*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'), with sparse cover (20% estimated crown cover) of trees >10 m, dominated by Queensland blue gum (*E. tereticornis*); very sparse cover (10%) of trees <10 m, dominated by Queensland blue gum; sparse (20%) shrub layer, including Queensland blue gum regeneration and wattles (*Acacia* spp.); mid-dense (60%) groundcover, including heavily grazed grasses (unidentifiable), slender flat-sedge (*Cyperus gracilis*) and Mayne's pest (*Verbena aristigera*)*; regeneration of native woody vegetation abundant (>5% cover) and healthy.

Vegetation disturbance: Moderate to high (heavily grazed; intrusion of exotic species).

Aquatic flora

Macrophyte cover approximately 1% cover; fringing macrophytes included slender flat-sedge (*Cyperus gracilis*) (1%); study reach dominated by terrestrial flora.

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Unrestricted fish passage in times of low, base and high flow. Located in Amber zone (Moderate risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

© ECO LOGICAL AUSTRALIA PTY LTD

Physico-chemical water quality

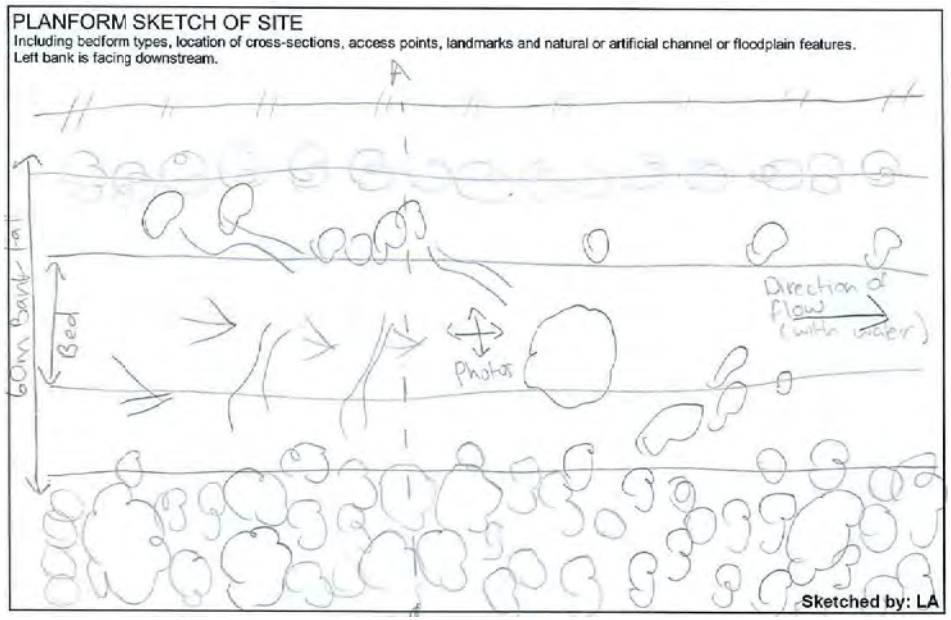
Dry at the time of the site visit.

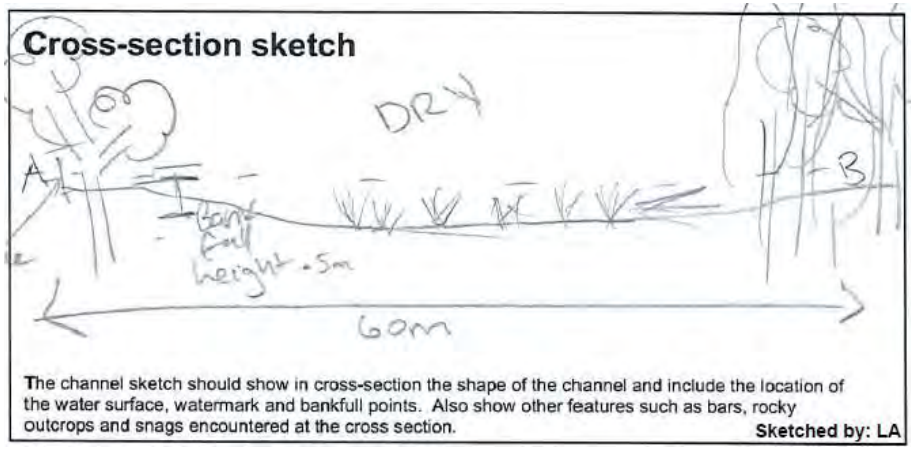
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Poor (4); Pool substrate characterisation: Poor (3); Pool variability: Poor (0); Sediment deposition: Excellent (16); Channel flow status: Poor (0); Channel alteration: Good (15); Channel sinuosity: Poor (5); Bank Stability: Excellent (left bank 9; right bank 9); Vegetative protection: Good (left bank 6; right bank 6); Riparian zone score: Good (left bank 8, right bank 6).

Overall habitat score: Fair (87 out of 200).





© ECO LOGICAL AUSTRALIA PTY LTD

Season: Autumn

Site Code: 9 **Location:** Pariagara Creek **Latitude:** 28° 23' 35" **Longitude:** 151° 04' 45" **Date:** 15/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral watercourse; dry at the time of assessment; symmetrical floodplain valley shape; flat U shaped channel; well defined bed and banks; bank slope low (10-30°); bank shape concave; no floodplain features present; no obvious channel modifications; bed moderately unstable – moderate sand deposition; upstream land use predominantly native forest; adjacent land use includes cattle grazing on crop stubble beyond the left bank, with native forest on the right bank; little local catchment erosion; bankfull width approximately 8 m; bankfull height approximately 1.8 m (from stream bed); substrate composition 100% sand (0.06-2 mm); bank material 95% sand (0.06-2 mm), 5% silt / clay (<0.06 mm); 5% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover 10-35%.

Riparian vegetation

Riparian zone approximately 20 m on the left bank and 20 m on the right bank; longitudinal vegetation extent continuous; fenced off from grazing; vegetation community appears to be RE 11.3.25 ('*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'), with mid-dense cover (75% estimated crown cover) of trees >10 m, dominated by Queensland blue gum (*E. tereticornis*), with abundant carbeen (*Corymbia tessellaris*), occasional rough-barked apple (*Angophora floribunda*) and white cypress pine (*Callitris glaucophylla*); sparse cover (30%) of trees <10 m, dominated by white cypress pine; very sparse (5%) shrub layer, including snow-in-summer (*Melaleuca linariifolia*) and spiny-headed mat-rush (*Lomandra longifolia*); mid-dense (70%) groundcover, dominated by common couch (*Cynodon dactylon*) and other native grasses; occasional weeds, including mother-of-millions (*Bryophyllum delagoense*); regeneration of native woody vegetation present.

Vegetation disturbance: Low (fenced off from grazing).

Aquatic flora

Macrophyte cover approximately 7%; fringing macrophytes included common rush (*Juncus usitatus*) (3% cover) and reed grass (*Arundinella nepalensis*) (4%); study reach dominated by terrestrial flora.

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Unrestricted fish passage in times of low, base and high flow. Located in Purple zone (Major risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

Physico-chemical water quality

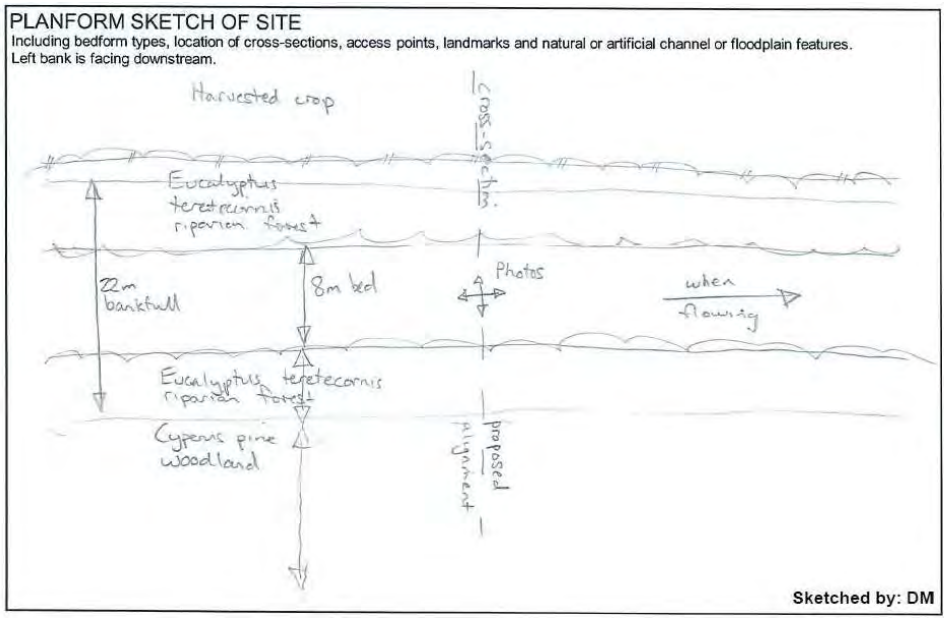
Dry at the time of the site visit.

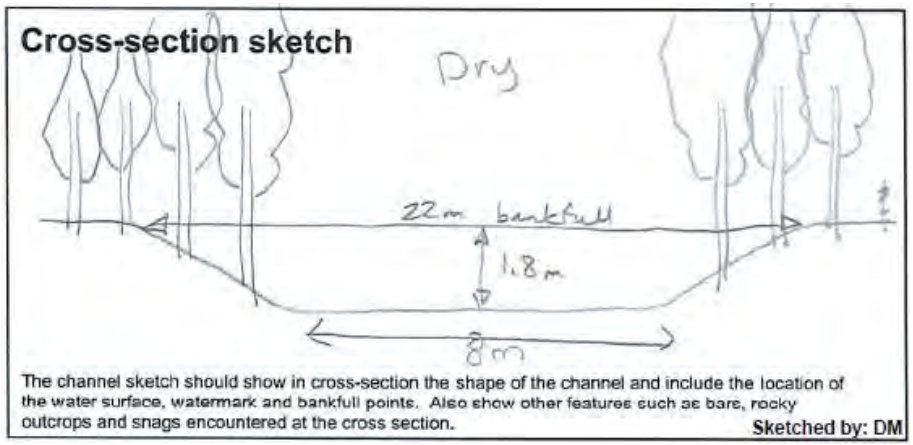
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Poor (4); Pool substrate characterisation: Fair (6); Pool variability: Poor (0); Sediment deposition: Poor (4); Channel flow status: Poor (0); Channel alteration: Good (13); Channel sinuosity: Fair (6); Bank Stability: Good (left bank 8; right bank 8); Vegetative protection: Good (left bank 6; right bank 6); Riparian zone score: Good (left bank 8, right bank 6).

Overall habitat score: Fair (74 out of 200).





Season: Autumn

Site Code: 12 **Location:** Unnamed tributary of Canning Creek **Latitude:** 28° 14' 17" **Longitude:** 151° 09' 21" **Date:** 17/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral drainage feature; dry at the time of assessment; broad valley setting; flat U shaped channel; poorly defined bed and banks; bank slope flat (<10°); bank shape concave; no floodplain features present; no obvious channel modifications; bed appears to be stable; upstream land use predominantly native forest; study reach within road corridor; adjacent land use dominated by native forest on left and right banks; little local catchment erosion; bankfull width approximately 40 m; bankfull height approximately 1 m (from stream bed); substrate composition 100% sand (0.06-2 mm); bank material 70% sand (0.06-2 mm), 30% silt / clay (<0.06 mm); 2% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover 35-65%.

Riparian vegetation

Riparian zone approximately 10 m on the left bank and 10 m on the right bank; longitudinal vegetation extent semi-continuous; non-remnant vegetation in road corridor comprising study reach; adjoining vegetation community appears to be RE 11.5.4 ('*Eucalyptus chloroclada*, *Callitris glaucophylla*, *C. endlicheri*, *Angophora leiocarpa* woodland on Cainozoic sand plains and/or remnant surfaces'), with sparse cover (25% estimated crown cover) of trees >10 m, including Baradine red gum (*Eucalyptus chloroclada*), white cypress pine (*Callitris glaucophylla*) and rusty gum (*Angophora leiocarpa*); sparse cover (20%) of trees <10 m, dominated by buloke (*Allocasuarina luehmannii*) and dirty gum; sparse (45%) shrub layer, including teatree (*Leptospermum* sp.) and wattles (*Acacia* spp.); mid-dense (65%) groundcover, dominated by lovegrass (*Eragrostis* sp.), with frequent native oatgrass (*Themeda avenacea*); regeneration of native woody vegetation abundant (>5% cover) and healthy.

Vegetation disturbance: Low (expected on rail alignment) to high (in road corridor).

Aquatic flora

Macrophyte cover approximately 5%; fringing macrophytes included common rush (*Juncus usitatus*) (5%); study reach dominated by terrestrial flora.

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Unrestricted fish passage in times of low, base and high flow. Located in Red zone (High risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

Physico-chemical water quality

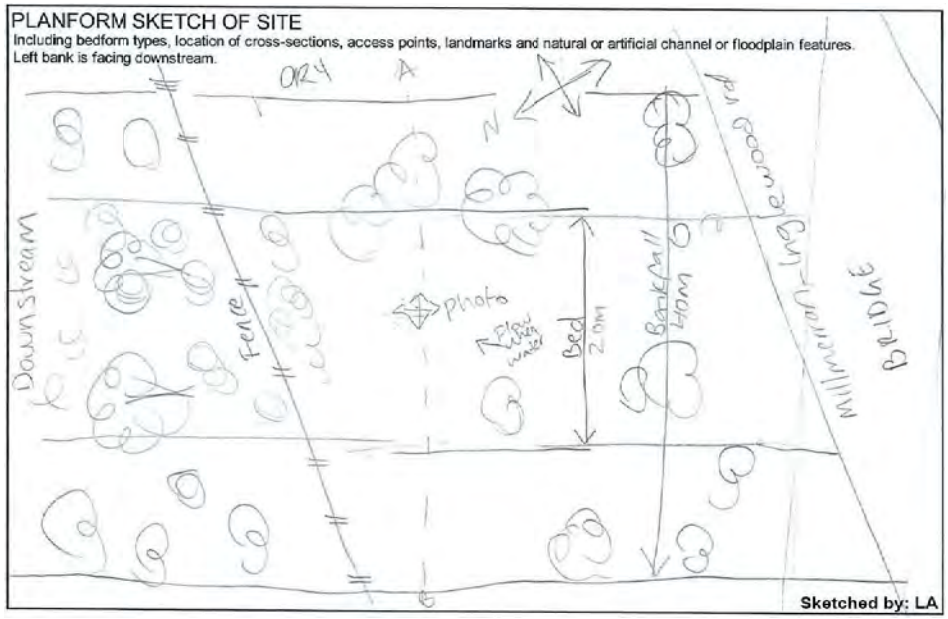
Dry at the time of the site visit.

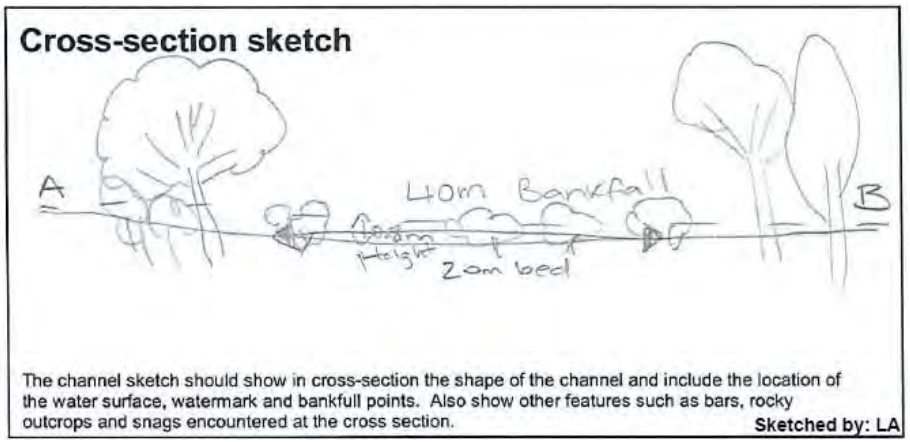
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Poor (3); Pool substrate characterisation: Fair (7); Pool variability: Poor (0); Sediment deposition: Good (13); Channel flow status: Poor (0); Channel alteration: Good (13); Channel sinuosity: Fair (6); Bank Stability: Excellent (left bank 9; right bank 9); Vegetative protection: Good (left bank 6; right bank 6); Riparian zone score: Good (left bank 6, right bank 6).

Overall habitat score: Fair (84 out of 200).





Season: Autumn

Site Code: 13 **Location:** Cattle Creek **Latitude:** 28° 13' 46" **Longitude:** 151° 09' 15" **Date:** 14/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral watercourse; dry at the time of assessment; symmetrical floodplain valley shape; two stage channel shape; bank slope flat (<10°); bank shape stepped; flood channels present; no obvious channel modifications; bed appears to be stable; upstream land use predominantly native forest; study reach within road corridor; adjacent land use dominated by native forest on left and right banks; little local catchment erosion; bankfull width approximately 60 m; bankfull height approximately 3 m (from stream bed); substrate composition 95% sand (0.06-2 mm) and 5% silt /clay (<0.06 mm); bank material 5% sand (0.06-2 mm) and 95% silt / clay (<0.06 mm); 1% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover 35-65%.

Riparian vegetation

Riparian zone approximately 30 m on the left bank and 60 m on the right bank; longitudinal vegetation extent semi-continuous; non-remnant vegetation in road corridor; adjoining vegetation community appears to be RE 11.3.4 ('*Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains'), with sparse cover (40% estimated crown cover) of trees >10 m, dominated by Baradine red gum (*Eucalyptus chloroclada*), Queensland blue gum (*E. tereticornis*) and rough-barked apple (*Angophora floribunda*); sparse cover (30%) of trees <10 m, including white cypress pine (*Callitris glaucophylla*); very sparse (10%) shrub layer; mid-dense (60%) groundcover, dominated by blady grass (*Imperata cylindrica*); regeneration of native woody vegetation abundant (>5% cover) and healthy.

Vegetation disturbance: Low (expected on rail alignment) to high (in road corridor).

Aquatic flora

Macrophyte cover approximately 8%; fringing macrophytes included common rush (*Juncus usitatus*) (5%); spikerush (*Eleocharis acuta*) (1%), reed grass (*Arundinella nepalensis*) (1%) and tall flatsedge (*Cyperus exaltatus*) (1%); study reach dominated by terrestrial flora.

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Unrestricted fish passage in times of low, base and high flow. Located in Purple zone (Major risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

Physico-chemical water quality

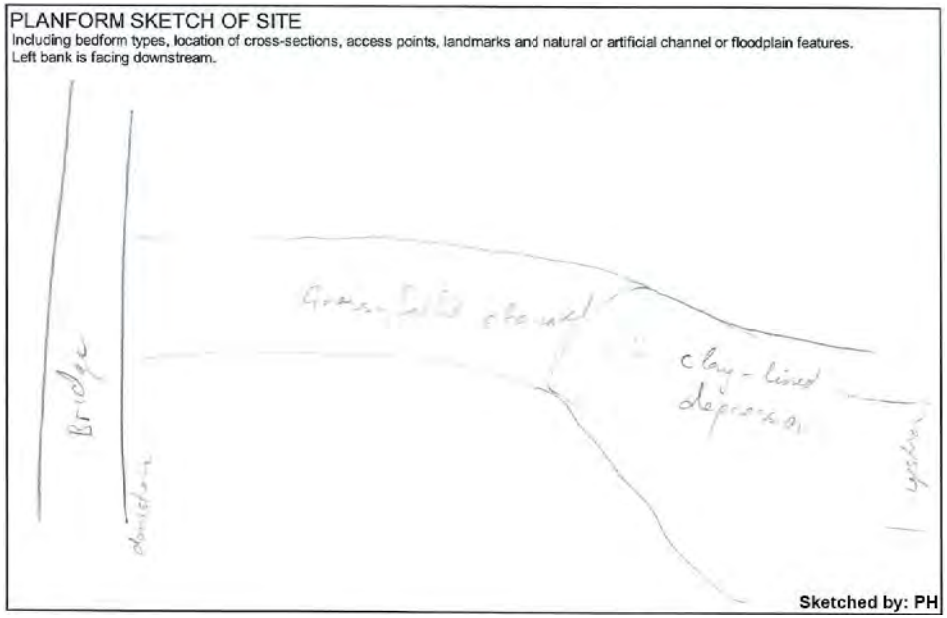
Dry at the time of the site visit.

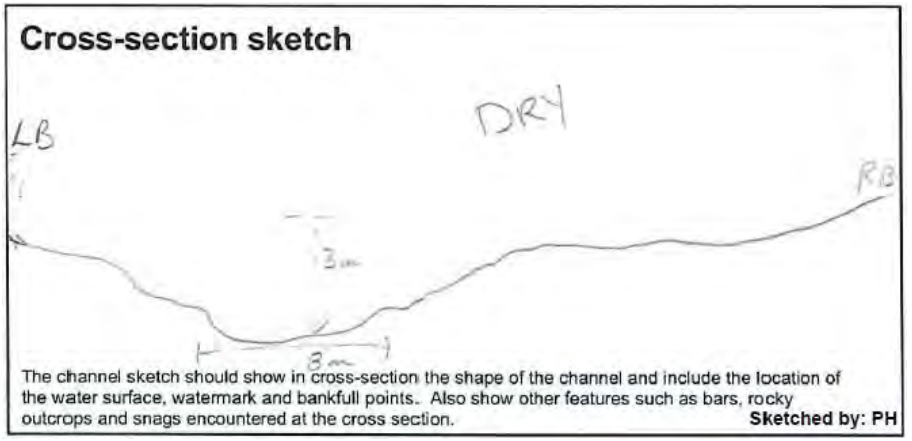
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Fair (9); Pool substrate characterisation: Fair (9); Pool variability (when wet): Good (13); Sediment deposition: Excellent (16); Channel flow status: Poor (0); Channel alteration: Excellent (18); Channel sinuosity: Good (11); Bank Stability: Good (left bank 6; right bank 7); Vegetative protection: Good (left bank 6; right bank 6); Riparian zone score: Excellent (left bank 9, right bank 9).

Overall habitat score: Good (119 out of 200).





Season: Autumn

Site Code: 15 **Location:** Native Dog Creek **Latitude:** 28° 11' 03" **Longitude:** 151° 10' 40" **Date:** 17/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral drainage feature; dry at the time of assessment; bridge and agricultural fence approximately 100 m upstream; broad valley shape; widened channel shape; bank slope flat (<10°); bank shape concave; no floodplain features present; no obvious channel modifications; bed appears to be stable; upstream land use predominantly native forest; adjacent land use dominated by native forest on left and right banks; little local catchment erosion; bankfull width approximately 30 m; bankfull height approximately 0.5 m (from stream bed); substrate composition 95% sand (0.06-2 mm) and 5% silt /clay (<0.06 mm); bank material 5% sand (0.06-2 mm) and 95% silt / clay (<0.06 mm); 5% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover 10-35%.

Riparian vegetation

Riparian zone approximately 12 m on the left bank and 12 m on the right bank; longitudinal vegetation extent semi-continuous; vegetation community appears to be RE 11.3.2 ('*Eucalyptus populnea* woodland on alluvial plains'), with sparse cover (25% estimated crown cover) of trees >10 m, dominated by poplar box (*Eucalyptus populnea*), with occasional Baradine red gum (*E. chloroclada*); very sparse cover (15%) of trees <10 m, including belah (*Casuarina cristata*), poplar box and white cypress pine (*Callitris glaucophylla*); very sparse (5%) shrub layer, including wilga (*Geijera parviflora*); mid-dense (65%) groundcover, heavily grazed; occasional weeds, including lippia (*Phyla canescens*)*, mother-of-millions (*Bryophyllum delagoense*); common prickly pear (*Opuntia stricta*) and velvet tree pear (*O. tomentosa*); regeneration of native woody vegetation very limited (<1% cover).

Vegetation disturbance: Moderate.

Aquatic flora

Macrophyte cover approximately 10%; fringing macrophytes included common rush (*Juncus usitatus*) (5%); tall sedge (*Carex appressa*) (3%), tall flatsedge (*Cyperus exaltatus*) (1%) and reed grass (*Arundinella nepalensis*) (1%); groundcover mostly dead / dry (likely to be identifiable in spring).

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Unrestricted fish passage in times of low, base and high flow. Located in Red zone (High risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

Physico-chemical water quality

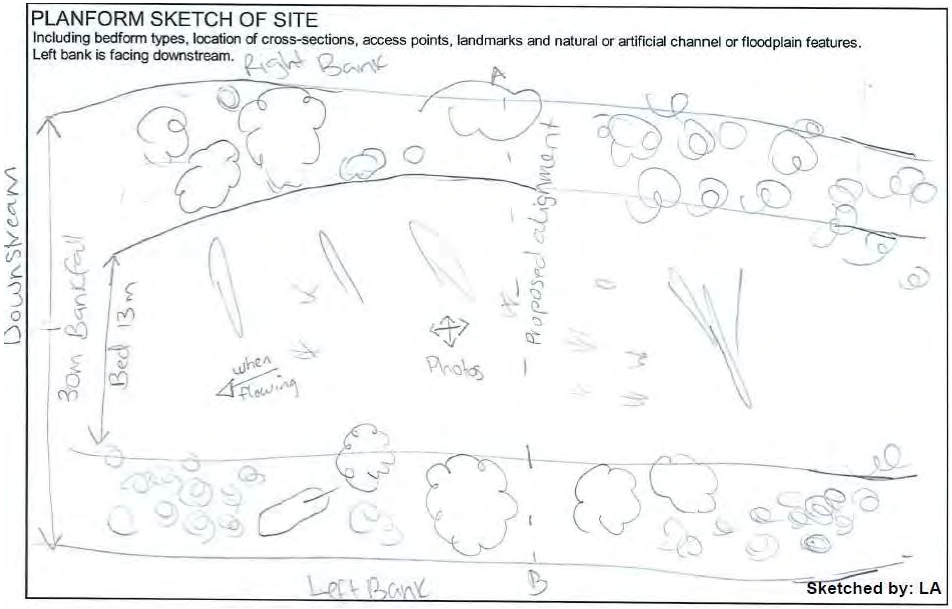
Dry at the time of the site visit.

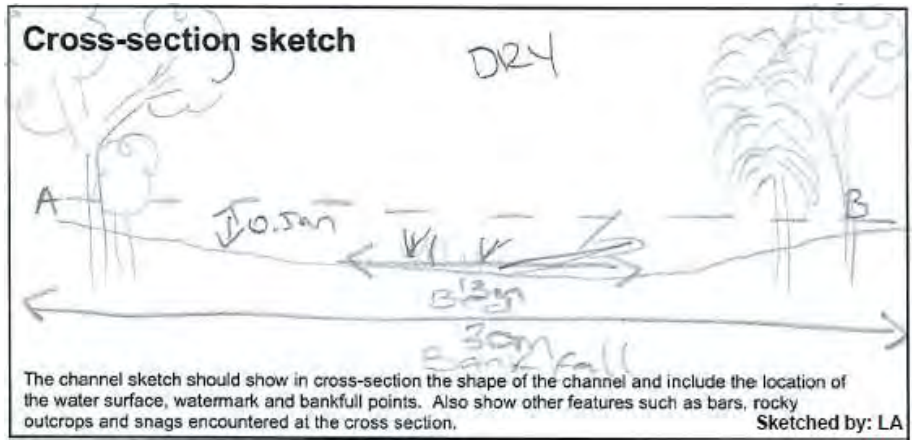
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Poor (5); Pool substrate characterisation: Fair (6); Pool variability (when wet): Fair (6); Sediment deposition: Excellent (16); Channel flow status: Poor (0); Channel alteration: Excellent (18); Channel sinuosity: Fair (7); Bank Stability: Excellent (left bank 9; right bank 9); Vegetative protection: Good (left bank 6; right bank 6); Riparian zone score: Good (left bank 7, right bank 7).

Overall habitat score: Good (102 out of 200).





Season: Autumn

Site Code: 16 **Location:** Bringalily Creek **Latitude:** 28° 09' 21" **Longitude:** 151° 11' 14" **Date:** 13/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Semi-permanent watercourse; water level low at the time of assessment; symmetrical floodplain valley shape; box channel shape; bank slope vertical (80-90°); bank shape wide lower bench on left bank, undercut on right bank; floodplain features include flood channels and floodplain scours; no obvious channel modifications; bed moderately unstable – eroding; upstream land use predominantly cattle grazing; adjacent land use predominantly cattle grazing; little local catchment erosion; bankfull width approximately 31 m; bankfull height approximately 3.8 m (from stream bed); substrate composition 100 silt /clay (<0.06 mm); bank material 100% silt / clay (<0.06 mm); 10% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover 10-35%.

Riparian vegetation

Riparian zone approximately 10 m on the left bank and 10 m on the right bank; longitudinal vegetation extent scattered; vegetation community appears to be RE 11.3.25 ('*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'), with very sparse cover (15% estimated crown cover) of trees >10 m, dominated by Queensland blue gum (*Eucalyptus tereticornis*), with occasional river red gum (*E. camaldulensis*), rough-barked apple (*Angophora floribunda*) and poplar box (*E. populnea*); no trees <10 m detected; no shrubs detected; mid-dense (80%) groundcover; regeneration of native woody vegetation very limited (<1% cover).

Vegetation disturbance: High.

Aquatic flora and fauna

Macrophyte cover approximately 30%; fringing macrophytes included common reed (*Phragmites australis*) (15% estimated cover), common rush (*Juncus usitatus*) (5%), dwarf flat-sedge (*Cyperus pygmaeus*) (5%), and umbrella canegrass (*Leptochloa digitata*) (5%).

Five eastern snake-necked turtle (*Chelodina longicollis*) shells observed; no fish catch (despite seven bait traps deployed for approximately two hours, supplemented by dip-netting with Enviro-net®). Waterbody better suited to back-pack electrofishing and fyke netting.

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Good passage expected during times of flow. Located in Purple zone (Major risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach provides potential habitat for the Murray Cod and Platypus, but is unlikely to provide habitat for the Silver Perch or Bell's turtle.

Physico-chemical water quality

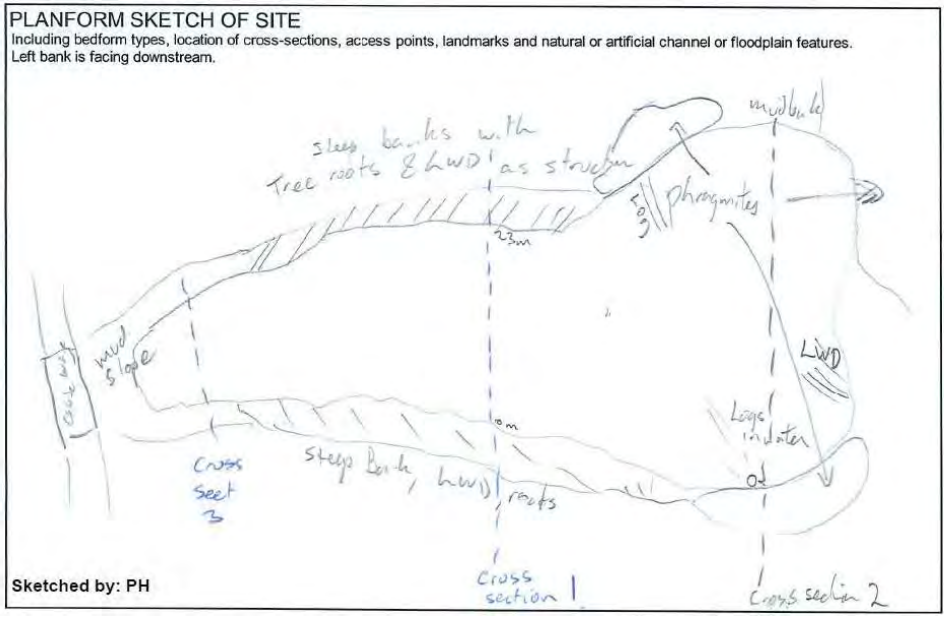
Collection time: 9:30; water temp.: 12.6°C; specific conductivity: 209.3 µS/cm (fresh); turbidity: 138 (poor clarity); dissolved oxygen: 62.1%, 6.64 mg/L (low, but expected for time of day); pH: 7.83 (mildly alkaline); Redox: 191.1 (moderately reducing).

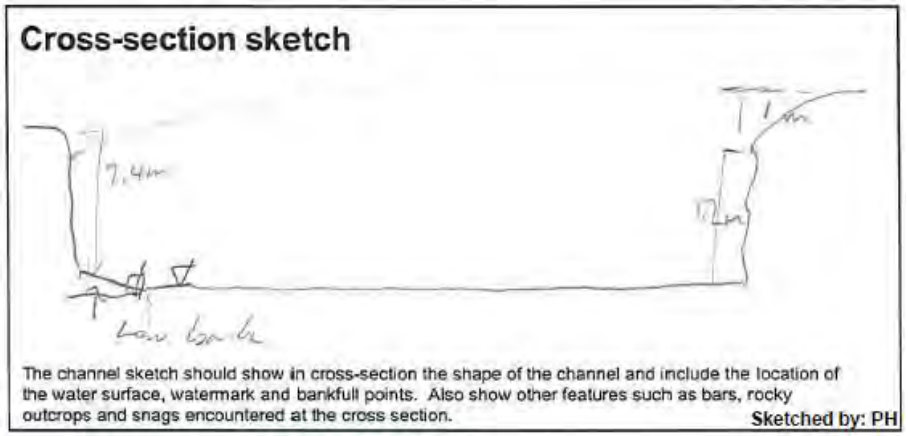
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Good (15); Pool substrate characterisation: Fair (9); Pool variability: Good (13); Sediment deposition: Good (15); Channel flow status: Excellent (18); Channel alteration: Excellent (18); Channel sinuosity: Good (12); Bank Stability: Fair (left bank 4; right bank 4); Vegetative protection: Fair (left bank 4; right bank 4); Riparian zone score: Fair (left bank 4, right bank 4).

Overall habitat score: Good (124 out of 200).





Season: Autumn

Site Code: 17 **Location:** Bringalily Creek **Latitude:** 28° 07' 44" **Longitude:** 151° 11' 20" **Date:** 17/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral watercourse; dry at the time of assessment; symmetrical floodplain valley shape; two stage channel shape; bank slope moderate (30-60°); bank shape stepped; no floodplain features present; no obvious channel modifications; bed moderately unstable – eroding, affected by cleared vegetation and stock access; upstream land use predominantly cattle grazing; adjacent land use cattle grazing on left and right banks (and within stream reach); some local catchment erosion, including stream bank erosion exacerbated by lippia (*Phyla canescens*) impacts, and cattle; bankfull width approximately 30 m; bankfull height approximately 3 m (from stream bed); substrate composition 100% silt / clay (<0.06 mm); bank material 30% sand (0.06-2 mm) and 70% silt / clay (<0.06 mm); 25% large woody debris; no filamentous algae, periphyton or moss detected; detritus cover <10%.

Riparian vegetation

Riparian zone approximately 10 m on the left bank and 10 m on the right bank; longitudinal vegetation extent comprises occasional clumps; vegetation community appears to be RE 11.3.25 ('*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'), with very sparse cover (15% estimated crown cover) of trees >10 m, dominated by Queensland blue gum (*Eucalyptus tereticornis*), with occasional rough-barked apple (*Angophora floribunda*); very sparse cover (5%) of trees <10 m, including Queensland blue gum; very sparse (1%) shrub layer, including *Mimosa* sp.; mid-dense (60%) groundcover, heavily grazed, dominated by common couch (Cynodon dactylon), with frequent lippia (*Phyla canescens*)*; no regeneration of native woody vegetation detected.

Vegetation disturbance: Very high (heavily impacted by sustained cattle grazing during drought conditions).

Aquatic flora

Macrophyte cover approximately 35%; fringing macrophytes included water primrose (*Ludwigia peploides* subsp. *montevidensis*) (30% estimated cover), common rush (*Juncus usitatus*) (3%) and reed grass (*Arundinella nepalensis*) (2%).

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Unrestricted fish passage in times of flow. Located in Purple zone (Major risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

Physico-chemical water quality

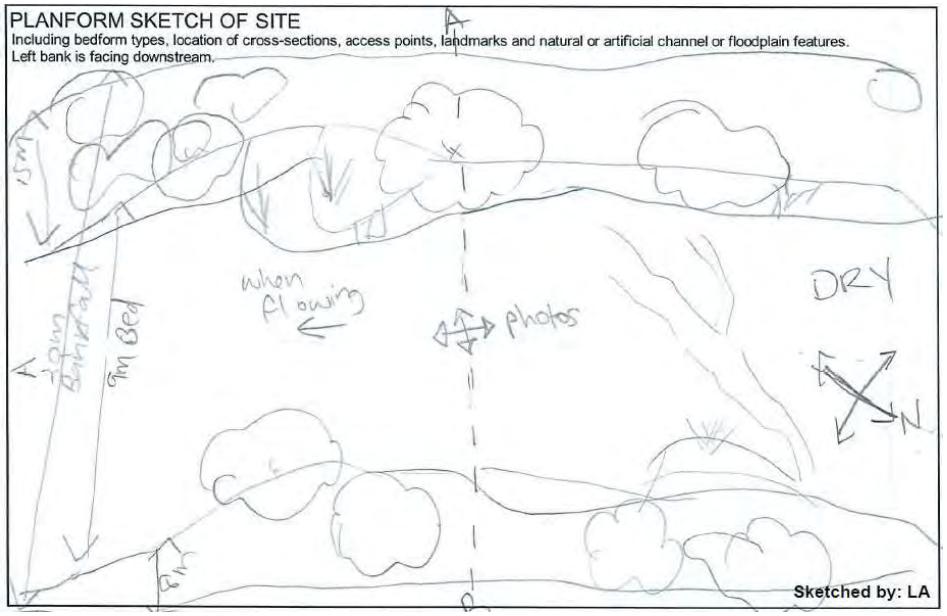
Dry at the time of the site visit.

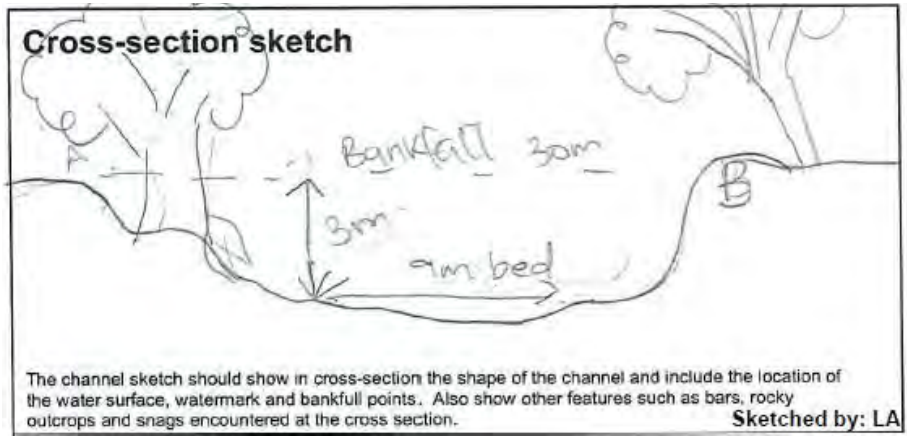
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Fair (7); Pool substrate characterisation: Poor (3); Pool variability (when wet): Good (11); Sediment deposition: Excellent (16); Channel flow status: Poor (0); Channel alteration: Excellent (16); Channel sinuosity: Good (13); Bank Stability: Poor (left bank 2; right bank 2); Vegetative protection: Fair (left bank 5; right bank 5); Riparian zone score: Fair (left bank 5, right bank 5).

Overall habitat score: Fair (90 out of 200).





Season: Autumn

Site Code: 19 **Location:** Nicol Creek **Latitude:** 28° 05' 07" **Longitude:** 151° 11' 46" **Date:** 13/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral watercourse; dry at the time of assessment; asymmetrical floodplain valley shape; two stage channel shape; bank slope steep (60-80%) on left bank, moderate (30-60%) on right bank; bank shape stepped; floodplain features include remnant channels, flood channels and flood scours; no obvious channel modifications; bed stable, although unstable in heavily grazed paddock immediately downstream; upstream land use predominantly cattle grazing and dryland cropping; study reach within road corridor, comprising native woodland; little local catchment erosion, including stream bank erosion exacerbated by lippia (*Phyla canescens*) impacts; bankfull width approximately 150 m; bankfull height approximately 1.5 m (from stream bed); substrate composition 5% sand (0.06-2 mm) and 95% silt / clay (<0.06 mm); bank material 100% silt / clay (<0.06 mm); no large woody debris, filamentous algae, periphyton or moss detected; detritus cover <10%.

Riparian vegetation

Riparian zone approximately 100 m on the left bank and 50 m on the right bank; longitudinal vegetation extent regularly spaced; vegetation community appears to be RE 11.3.2 ('*Eucalyptus populnea* woodland on alluvial plains'), with a very sparse cover (10% estimated crown cover) of trees >10 m, dominated by poplar box (*Eucalyptus populnea*), with occasional Queensland blue gum (*E. tereticornis*); very sparse cover (10%) of trees <10 m, including poplar box and brigalow (*Acacia harpophylla*); very sparse (5%) shrub layer, including poplar box regrowth; mid-dense (80%) groundcover; regeneration of native woody vegetation present.

Vegetation disturbance: Moderate.

Aquatic flora

Macrophyte cover approximately 25%; fringing macrophytes included umbrella canegrass (*Leptochloa digitata*) (20% estimated cover), common rush (*Juncus usitatus*) (2%), spikerush (*Eleocharis acuta*) (2%) and tall flatsedge (*Cyperus exaltatus*) (1%).

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Moderately restricted passage in times of flow. Located in Red zone (High risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

© ECO LOGICAL AUSTRALIA PTY LTD

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Vulnerable (EPBC Act and NC Act) Bell's turtle (*Wollumbinia belli*) and Special Least Concern (NC Act) Platypus are recorded from the Queensland Border Rivers catchment (DES 2018b). The study reach is highly unlikely to provide suitable habitat for these species.

Physico-chemical water quality

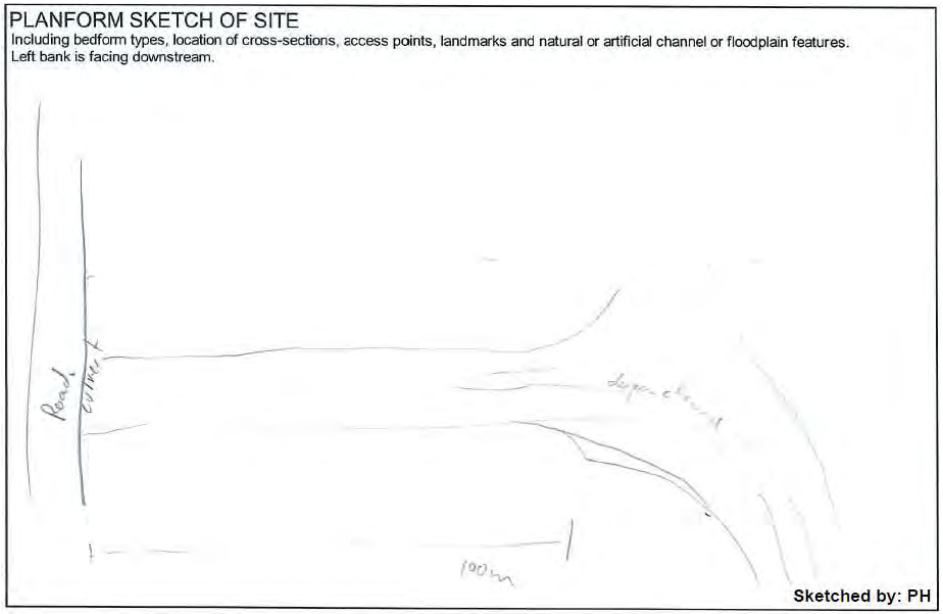
Dry at the time of the site visit.

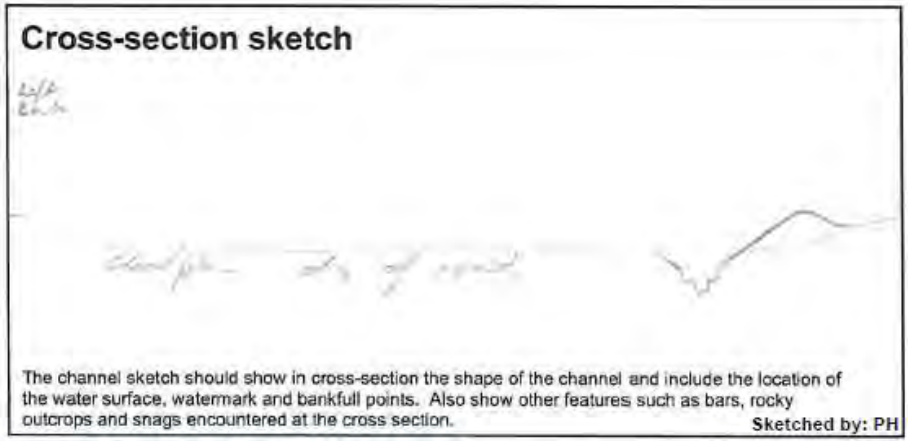
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Fair (9); Pool substrate characterisation: Good (13); Pool variability (when wet): Fair (6); Sediment deposition: Fair (8); Channel flow status: Poor (0); Channel alteration: Good (13); Channel sinuosity: Fair (9); Bank Stability: Fair (left bank 4; right bank 4); Vegetative protection: Good (left bank 6; right bank 6); Riparian zone score: Good (left bank 7, right bank 7).

Overall habitat score: Fair (92 out of 200).





Site Code: 32 **Location:** Condamine River (North) **Latitude:** 27° 46' 51" **Longitude:** 151° 25' 25" **Season:** Autumn **Date:** 14/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral watercourse; dry at the time of assessment; symmetrical floodplain valley shape; two stage channel shape; bank slope moderate (30-60%) on left bank, steep (60-80%) on right bank; bank shape stepped; no natural floodplain features present; no obvious channel modifications; bed stable; upstream and adjacent land use dominated by irrigated cropping on Vertosol floodplains; little local catchment erosion; bankfull width approximately 65 m; bankfull height approximately 3 m (from stream bed); substrate composition 5% boulder (>256 mm) and 95% silt / clay (<0.06 mm); bank material 5% boulder (>256 mm) and 95% silt / clay (<0.06 mm); no large woody debris, filamentous algae, periphyton or moss detected; detritus cover 10-35%.

Riparian vegetation

Riparian zone approximately 10 m on the left bank and 10 m on the right bank; longitudinal vegetation extent regularly spaced; narrow riparian corridor of RE 11.3.25 ('*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'), with a sparse cover (20% estimated crown cover) of trees >10 m, dominated by Queensland blue gum (*Eucalyptus tereticornis*); sparse cover (20%) of trees <10 m, dominated by beefwood (*Grevillea striata*); very sparse (10%) shrub layer; mid-dense (70%) groundcover; regeneration of native woody vegetation present.

Vegetation disturbance: High.

Aquatic flora

Macrophyte cover approximately 73%; fringing macrophytes included common rush (*Juncus usitatus*) (estimated cover 60%), ribbed spikerush (*Eleocharis plana*) (5%), hairy knotweed (*Persicaria attenuata*) (5%), slender knotweed (*P. decipiens*) (1%), tall flatsedge (*Cyperus exaltatus*) (1%) and dwarf flat-sedge (*Cyperus pygmaeus*) (1%).

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Partly restricted passage in times of flow. Located in Purple zone (Major risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Endangered (NC Act) fringing rush (*Fimbristylis vagans*) and Special Least Concern (NC Act) Platypus are recorded from the Condamine-Balonne Basin (DES 2018b). The study reach is unlikely to provide suitable habitat for these species, nor were any detected at the time of assessment.

© ECO LOGICAL AUSTRALIA PTY LTD

Physico-chemical water quality

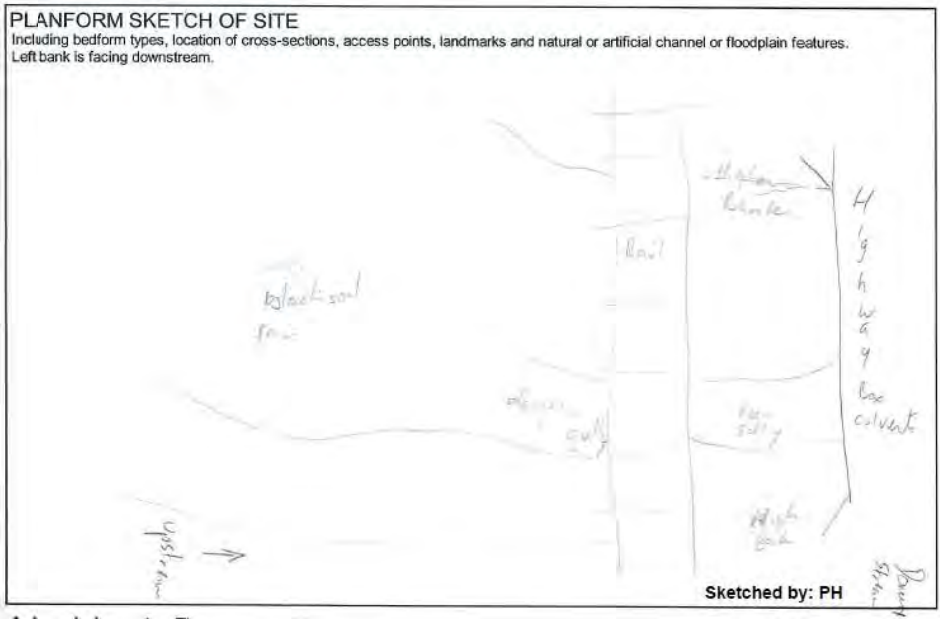
Dry at the time of the site visit.

Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Fair (7); Pool substrate characterisation: Fair (7); Pool variability (when wet): Fair (8); Sediment deposition: Excellent (16); Channel flow status: Poor (0); Channel alteration: Good (11); Channel sinuosity: Good (13); Bank Stability: Good (left bank 7; right bank 6); Vegetative protection: Fair (left bank 5; right bank 5); Riparian zone score: Good (left bank 7, right bank 8).

Overall habitat score: Fair (100 out of 200).



Site Code: 43 **Location:** Unnamed tributary of Gowrie Creek **Latitude:** 27° 29’ 38” **Longitude:** 151° 50’ 59” **Season:** Autumn **Date:** 12/06/2018

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral drainage feature; dry at the time of assessment; study reach is downstream of road and rail culvert crossings; symmetrical floodplain valley shape; flat U channel shape; bank slope moderate (30-60%) on left and right banks; bank shape concave; no natural floodplain features present; channel modifications include reinforced banks associated with road and rail crossings; bed stable; banks stable, although unstable (slumping) on adjoining land downstream; upstream and adjacent land use dominated by rainfed cropping; some local catchment erosion; bankfull width approximately 40 m; bankfull height approximately 3.5 m (from stream bed); substrate composition 100% silt / clay (<0.06 mm); bank material 100% silt / clay (<0.06 mm); no large woody debris, filamentous algae, periphyton or moss detected; detritus cover <10%.

Riparian vegetation

Riparian zone approximately 1 m on the left bank and 1 m on the right bank; longitudinal vegetation extent isolated / scattered; non-remnant vegetation, with a very sparse cover (2% estimated crown cover) of trees <10 m, including *Casuarina* sp. and *Corymbia* sp. (not accessible); no shrub layer; dense (95%) groundcover, including *Sorghum* sp., *Chloris* sp., *Setaria* sp. and *Eragrostis* sp.; no regeneration of native woody vegetation.

Vegetation disturbance: Very high.

Aquatic flora

No macrophytes detected.

Physical barriers to local fish passage and DAF waterway zoning and risk of impact

Very restricted passage (road culverts have not allowed for fish passage, although minimal potential fish habitat upstream). Located in Amber zone (Moderate risk of impact on fish movement).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species were detected. The Critically Endangered (EPBC Act) Silver Perch (*Bidyanus bidyanus*), Vulnerable (EPBC Act) Murray Cod (*Maccullochella peelii*), Endangered (NC Act) fringing rush (*Fimbristylis vagans*) and Special Least Concern (NC Act) Platypus are recorded from the Condamine-Balonne Basin (DES 2018b). The study reach is unlikely to provide suitable habitat for these species, nor were any detected at the time of assessment.

Physico-chemical water quality

© ECO LOGICAL AUSTRALIA PTY LTD

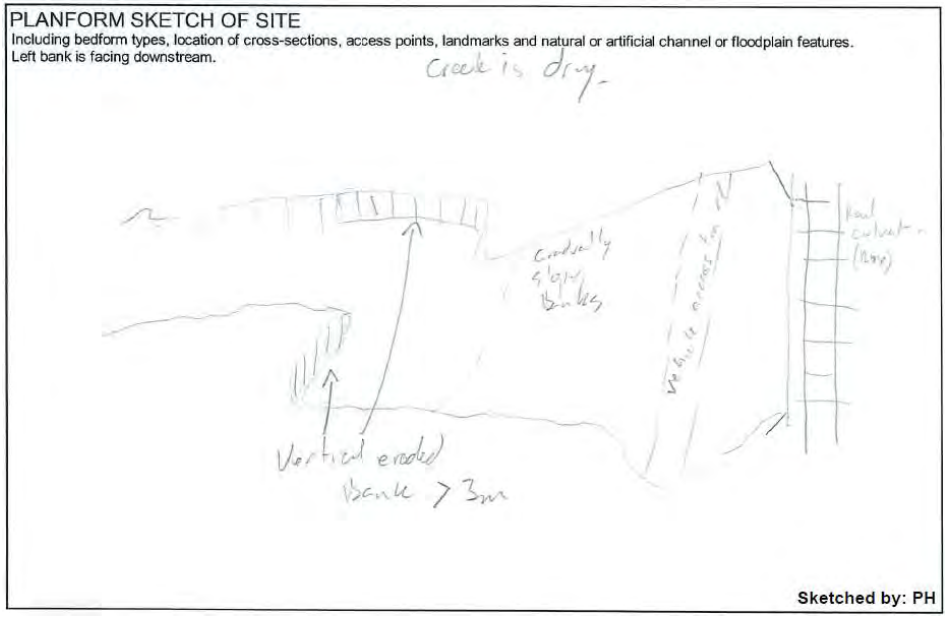
Dry at the time of the site visit.

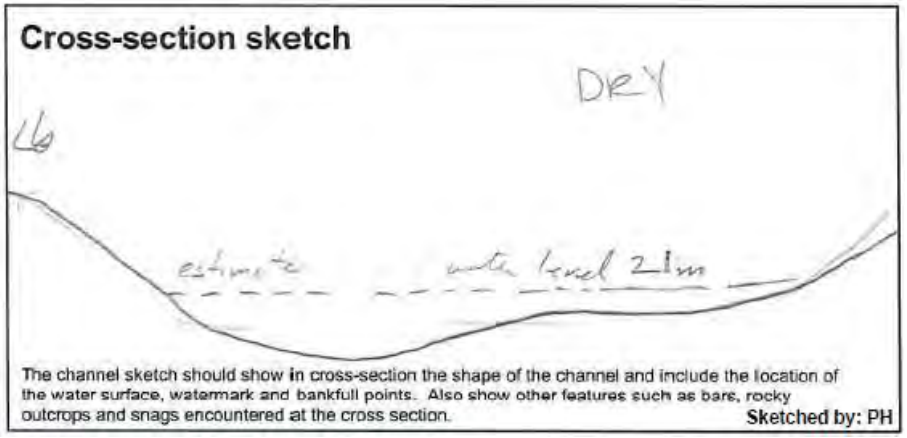
Summary: Normal.

Habitat scoring – Low gradient streams (as per AusRivAS Physical Habitat Assessment Protocol)

Epifaunal substrate / available cover: Poor (4); Pool substrate characterisation: Poor (4); Pool variability (when wet): Poor (0); Sediment deposition: Excellent (18); Channel flow status: Poor (0); Channel alteration: Fair (9); Channel sinuosity: Fair (7); Bank Stability: Fair (left bank 5; right bank 5); Vegetative protection: Fair (left bank 5; right bank 5); Riparian zone score: Poor (left bank 2, right bank 2).

Overall habitat score: Fair (66 out of 200).





Appendix B: Likelihood of Occurrence

Species Name	Common Name	Status		Likelihood	Habitat Description & Justification[3]
		NC Act[1]	EPBC Act[2]		
FAUNA					
Fish					
Maccullochella peelii	Murray Cod	-	V	Known	Murray Cod are main-channel specialists and are frequently found in the main channels of rivers and larger tributaries (DoEE 2018). Preferred microhabitat consists of complex structural features in streams such as large rocks, snags (pieces of large submerged woody debris), overhanging stream banks and vegetation, tree stumps, logs, branches and other woody structures. Such structures reduce or influence stream flows and provide Murray Cod with shelter from fast-flowing water. They also serve as predatory ambush points for foraging, particularly during the day (DoEE 2019a). Where areas of deep stream occur throughout the southern portion of the impact assessment area, such as in some reaches of Brigalily Creek, potential habitat for the species occurs. Most areas in the impact assessment area are unsuitable due to the ephemeral nature of the systems. Closest known records (within 10km of the impact assessment area) occur in Dumaresq River and the southern reach of Boonal Anabranch (ALA 2018). The Murray Cod was confirmed to be present in the impact assessment area during field surveys, at the Macintyre River and Macintyre Brook.
Bidyanus bidyanus	Silver Perch	-	CE	Unlikely	Silver Perch are a highly migratory freshwater fish and are endemic to the Murray-Darling system (including all states and sub-basins) (Allen *et al*. 2002). Silver Perch

© ECO LOGICAL AUSTRALIA PTY LTD

Species Name	Common Name	Status		Likelihood	Habitat Description & Justification[3]
		NC Act[1]	EPBC Act[2]		
					are consistently reported by anglers and researchers to show a general preference for faster-flowing water, including rapids and races, and more open sections of river and preference for submergent macrophytes, which may be important nursery areas for juveniles (DoEE 2018). Adult Silver Perch are omnivorous, taking a variety of small prey including zooplankton, aquatic insects, molluscs, small crustaceans and worms as well as algae (NSW DPI, 2006). A historical species record occurs in Back Creek, near Millmerran (within 10km of the impact assessment area; ALA 2018), however, due to the absence of fast-flowing water systems in the impact assessment area, the species is unlikely to occur in the impact assessment area.
Turtle					
Elseya albagula	Southern Snapping Turtle	E	CE	Unlikely	The southern snapping turtle is a habitat specialist (TSSC 2014). Within the river system it prefers clear, flowing, well-oxygenated waters. Water quality is an important aspect of the species ability to utilise habitat as due to its physiological adaptation to extract oxygen from water via cloacal respiration (DoEE 2017; TSSC 2014). Suitable habitat and species records are absent from the impact assessment area and surrounding region (ALA 2018). As such, the species is unlikely to occur in the impact assessment area.
Wollumbinia belli	Bell's Turtle	V	V	Unlikely	The species is restricted to upland streams (between 600 and 1100 m altitude) that contain permanent pools deeper than about 2 m, granite boulders and bedrock. Its habitat is often complex, with underwater caverns formed by boulders, logs and overhanging banks. In areas of lower velocity, the typical substratum is coarse granitic sand overlain by fine silt, algal growth, and dense beds of macrophytes

© ECO LOGICAL AUSTRALIA PTY LTD

Species Name	Common Name	Status		Likelihood	Habitat Description & Justification[3]
		NC Act[1]	EPBC Act[2]		
					(DoEE 2019b). It is absent from areas away from flowing streams, such as farm ponds and natural wetlands (DoEE 2019b). The species is unlikely to occur in the impact assessment area due to the absence of suitable habitat. No species records occur within 10km of the impact assessment area (ALA 2018).
Monotreme					
Ornithorhynchus anatinus	Platypus	SLC	-	Known	Preferred habitat for the species includes a river or a stream with earth banks and native vegetation that provides shading of the stream and cover near the bank. The presence of logs, twigs, and roots, as well as cobbled or gravel water substrate result in increased macroinvertebrate fauna (a main food source), and the Platypus also tends to be more abundant in areas with pool-riffle sequences (Australia Museum 2018). Platypus was observed in the Macintyre Brook, near Inglewood during the dry season survey. The species is also known to inhabit the Macintyre River (ALA 2018).
FLORA					
Monocots					
Fimbristylis vagans	-	E	-	Potential	*Fimbristylis vagans* is a species of plant in the family Cyperaceae, a sedge family of monocotyledonous flowering plants. The species is a wetland indicator (Wetland*Info* 2019). The species is associated with clay pans, open sedge land and sparse-tussock grasslands on shallow alluvial sand plains but may also occur in other ecosystems (other species of *Fibristylis* are common in pastures of central Queensland).

© ECO LOGICAL AUSTRALIA PTY LTD

Species Name	Common Name	Status		Likelihood	Habitat Description & Justification[3]
		NC Act[1]	EPBC Act[2]		
					The species was not detected during field surveys and no species records occur within 10km of the impact assessment area (ALA 2018).

[1]E = Endangered, V = Vulnerable and SLC = Special Least Concern under the NC Act.
[2]CE = Critically Endangered, E = Endangered, V = Vulnerable under the EPBC Act.
[3] Information should be cited as being from the Species Profile – Department of the Environment and Energy unless otherwise cited.

© ECO LOGICAL AUSTRALIA PTY LTD

Appendix C: Records of Calibration for Water Quality Meter

© ECO LOGICAL AUSTRALIA PTY LTD

DPM ENVIROSCIENCES

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004 (BZG) - TRIP 1 START
Date calibrated:	11/06/2018

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	19.4
pH 4	Dec 18	pH units	4.00	3.89	4.00	4.00
pH 7	Dec 18	pH units	7.02	6.84	7.02	7.02
pH 10	Dec 18	pH units	10.06	9.97	10.06	10.06
ORP	May 20	mV	240.2	239.2	240.2	240.2
SPC	Jan 19	µS/cm	1413	1340	1413	1413
Barometric pressure	N/A	mmHg		765.7	765.7	765.7
DO (zero)	N/A	%S	0.0	0.0	0.0	0.0
DO (sat.)	N/A	%S	100.0	94.5	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument in good condition. New batteries installed.

Signed: _____

Date: _____

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004 (BZG) - TRIP 1 FINISH
Date calibrated:	18/6/2018

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	18.0
pH 4	Dec 18	pH units	4.00	4.03	4.00	4.00
pH 7	Dec 18	pH units	7.03	7.00	7.03	7.03
pH 10	Dec 18	pH units	10.08	9.97	10.08	10.08
ORP	May 20	mV	241.2	240.3	241.2	241.2
SPC	Jan 19	µS/cm	1413	1414	1413	1413
Barometric pressure	N/A	mmHg		765.5	765.5	765.5
DO (zero)	N/A	%S	0.0	0.4	0.0	0.0
DO (sat.)	N/A	%S	100.0	104.4	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument maintained calibration. In good condition.

Signed: D Moore

Date: 18/6/2018

DPM ENVIROSCIENCES

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	P. HANCOCK
Calibrated for (job no.)	DPM18004 (BZG) - TRIP 2 START
Date calibrated:	26/11/2018

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	—
pH 4	Apr 20	pH units	4.00	3.99	4.00	4.00
pH 7	Jun 20	pH units	7.01	7.29	7.01	7.01
pH 10	May 20	pH units	10.01	9.96	10.01	10.01
ORP	May 20	mV	230.7	305.6	230.7	230.7
SPC	Apr 20	µS/cm	1413	1324	1413	1413
Barometric pressure	N/A	mmHg	—	717.7	717.7	717.7
DO (zero)	N/A	%S	0.0	-0.4	0.0	0.0
DO (sat.)	N/A	%S	100.0	78.9	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument in good condition. Battery level adequate. Spare batteries inside case.

Signed: H Moore

Date: 26/11/2018

DPM ENVIROSCIENCES

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004 (B2a) - TRIP 2 FINISH
Date calibrated:	2/12/2018

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	23.8
pH 4	Apr 20	pH units	4.00	4.00	4.00	4.00
pH 7	Jun 20	pH units	7.01	6.91	7.01	7.01
pH 10	May 20	pH units	10.01	10.05	10.01	10.01
ORP	May 20	mV	233.4	231.7	233.4	233.4
SPC	Apr 20	µS/cm	1413	1408	1413	1413
Barometric pressure	N/A	mmHg	716.7	716.7	716.7	716.7
DO (zero)	N/A	%S	0.0	-0.2	0.0	0.0
DO (sat.)	N/A	%S	100.0	104.7	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument has maintained calibration. Instrument in good condition.

Signed: J Moore

Date: 2/12/2018

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004 (B2G) - TRIP 3 START
Date calibrated:	10/2/2019

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	25.3
pH 4	Apr 20	pH units	4.01	3.97	4.01	4.01
pH 7	Jun 20	pH units	7.00	6.92	7.00	7.00
pH 10	May 20	pH units	9.98	9.96	9.98	9.98
ORP	May 20	mV	227.7	227.5	227.7	227.7
SPC	Apr 20	µS/cm	1413	1509	1413	1413
Barometric pressure	N/A	mmHg	745.6	745.6	745.6	745.6
DO (zero)	N/A	%S	0.0	0.0	0.0	0.0
DO (sat.)	N/A	%S	100.0	100.6	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:
Instrument in good condition. Batteries replaced.

Signed: D Moore

Date: 10/2/2019

DPM ENVIROSCIENCES

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004 (B2G) - Trip 3 finish
Date calibrated:	15/2/2019

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	28.0
pH 4	Apr 20	pH units	4.01	4.06	4.01	4.01
pH 7	Jun 20	pH units	6.99	7.04	6.99	6.99
pH 10	Apr 20	pH units	9.97	9.99	9.97	9.97
ORP	May 20	mV	224.6	222.3	224.6	224.6
SPC	Apr 20	µS/cm	1413	1414	1413	1413
Barometric pressure	N/A	mmHg	754.7	754.7	—	—
DO (zero)	~~N/A~~ Mar 20	%S	0.0	-0.2	0.0	0.0
DO (sat.)	N/A	%S	100.0	101.6	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:
Instrument has maintained calibration.
In good condition. Cleaned and stored for next use.

Signed: D Moore

Date: 15/2/2019

DPM ENVIROSCIENCES

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004
Date calibrated:	28/4/2019 - Commencement of Trip 4

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	22.1
pH 4	10/20	pH units	4.00	4.21	4.00	4.00
pH 7	10/20	pH units	7.01	7.17	7.01	7.01
pH 10	10/20	pH units	10.03	10.21	10.03	10.03
ORP	2/21	mV	233.8	225.8	233.8	233.8
SPC	1/21	µS/cm	1413	2268	1413	1413
Barometric pressure	N/A	mmHg		—	758.84	758.84
DO (zero)	N/A	%S	0.0	-0.1	0.0	0.0
DO (sat.)	~~N/A~~ 3/20	%S	100.0	109.0	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Last calibrated and used by Blue Earth Environmental. Advise BEE that their cal. solution for SPC needs replacing. Checked with two SPC cal. solution batches. Instrument in good condition.

Signed: H Moore

Date: 28/4/2019

DPM ENVIROSCIENCES

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. Moore
Calibrated for (job no.)	DPM18004
Date calibrated:	3/5/2019 - Completion of Trip 4

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	22.3
pH 4	10/20	pH units	4.00	4.09	4.00	4.00
pH 7	10/20	pH units	7.01	7.05	7.01	7.01
pH 10	10/20	pH units	10.03	10.01	10.03	10.03
ORP	2/21	mV	~~253~~ 235.0	239.5	235.0	235.0
SPC	1/21	µS/cm	1413	1402	1413	1413
Barometric pressure	N/A	mmHg		753.6	753.6	753.6
DO (zero)	~~N/A~~ 3/20	%S	0.0	-0.3	0.0	0.0
DO (sat.)	N/A ~~3/20~~	%S	100.0	98.7	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument has maintained calibration. In good condition. Cleaned and stored for next use.

Signed: JMoore

Date: 3/5/2019

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	D. MOORE
Calibrated for (job no.)	DPM18004
Date calibrated:	15/5/2019 - Commencement of Trip 5

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	22.2
pH 4	10/20	pH units	4.00	4.01	4.00	4.00
pH 7	10/20	pH units	7.01	7.01	7.01	7.01
pH 10	10/20	pH units	10.03	10.02	10.03	10.03
ORP	2/21	mV	235.0	236.1	235.0	235.0
SPC	1/21	µS/cm	1413	1410	1413	1413
Barometric pressure	N/A	mmHg	769.6	769.6	769.6	769.6
DO (zero)	3/20	%S	0.0	-0.1	0.0	0.0
DO (sat.)	N/A	%S	100.0	99.7	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

In good condition. Calibrated and ready for use.

Signed: JMoore

Date: 15/5/2019

DPM ENVIROSCIENCES

Form:	FRM-001
Title:	Water Quality Meter Calibration Certificate

Instrument make:	YSI Professional Plus
Display serial number:	14M100367
Sonde serial number:	14M100051
Calibrated by:	
Calibrated for (job no.)	
Date calibrated:	

Parameter	Calibration standard expiry date	Units	Before calibration		After calibration	
			Expected value	Measured value	Expected value	Measured value
Temperature	Factory cal.	°C	N/A	N/A	N/A	
pH 4	10/20	pH units	4.00	4.03	4.00	4.00
pH 7	10/20	pH units	7.00	7.04	7.00	7.00
pH 10	10/20	pH units	10.05	10.09	10.05	10.05
ORP	2/21	mV	1413	1438	1413	1413
SPC	1/21	µS/cm	238.0	237.4	238.0	238.0
Barometric pressure	N/A	mmHg	763.4	763.5	763.4	763.4
DO (zero)	3/20	%S	0.0	−0.8	0.0	0.0
DO (sat.)	N/A	%S	100.0	98.8	100.0	100.0

The instrument has been inspected for visible signs of wear, damage, cleanliness, and condition, and is verified to be in good working order.

Comments on the instrument:

Instrument has maintained calibration. In good condition. Cleaned and stored for next use.

Signed: JMoore

Date: 19/5/2019

Appendix D: Laboratory Certificates of Analysis, Chain of Custody and Quality Control

© ECO LOGICAL AUSTRALIA PTY LTD

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 3/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com
BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
GLADSTONE 48 Callemondah Drive Gladstone QLD 4680 Ph: 07 4976 7944 E: gladstone@alsglobal.com
MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com
NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4422 2063 E: nowra@alsglobal.com
PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
WOLLONGONG 1/19-21 Ralph Black Drive, Nth Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: Eco Logical Australia	TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☑ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE: Brisbane		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes No N/A
PROJECT: Inland Rail - Border to Gowrie EIS PROJECT NO 10558	ALS QUOTE NO.: BN/142/18 V2	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Miles Yeates	CONTACT PH: 0467 738 954	OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: David Moore and Peter Hancock	SAMPLER MOBILE:		
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):		
Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au			
Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
DATE/TIME: 15/6/18 3pm	DATE/TIME: 15/6/18 1500	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-6A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	ophyll a (filter paper	These samples are Batch 1 of a nine day field trip. A second batch of samples will follow in 5-6 days time. All metals samples are field filtered. Frozen Chlorophyll a filter paper samples will be included in Batch 2 (not in this batch).
1	Site 14	13/6/18 noon	W		4	X	X	X	X	X	X	X		
2	Site 42	12/6/18 noon	W		4	X	X	X	X	X	X	X		
3	Site 40	12/6/18 noon	W		4	X	X	X	X	X	X	X		
4	Site 39	12/6/18 noon	W		4	X	X	X	X	X	X	X		
5	Site 30	14/6/18 noon	W		4	X	X	X	X	X	X	X		
6	Site 27	15/6/18 noon	W		4	X	X	X	X	X	X	X		
7	Site 16	13/6/18 noon	W		4	X	X	X	X	X	X	X		
				TOTAL	28									

Environmental Division Brisbane
Work Order Reference
EB1814632

Telephone : +61 7 3243 7222

HT

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1814632**	Page	: 1 of 7
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Contact	: Customer Services EB
Address	: PO BOX 1422 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 8536 8667	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 15-Jun-2018 15:00
Order number	:	Date Analysis Commenced	: 15-Jun-2018
C-O-C number	: ----	Issue Date	: 21-Jun-2018 16:58
Sampler	: DAVID MOORE and PETER HANCOCK		
Site	: ----		
Quote number	: BN/142/18 V2		
No. of samples received	: 7		
No. of samples analysed	: 7		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Matt Frost	Senior Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075(SIM): Matrix spike shows poor recovery. Insufficient sample for re-extraction and re-analysis.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 14	Site 42	Site 40	Site 39	Site 30
				Client sampling date / time	13-Jun-2018 00:00	12-Jun-2018 00:00	12-Jun-2018 00:00	12-Jun-2018 00:00	14-Jun-2018 00:00
Compound	CAS Number	LOR	Unit		EB1814632-001	EB1814632-002	EB1814632-003	EB1814632-004	EB1814632-005
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		207	1380	1380	2440	449
EA020EC: Salinity									
Salinity	----	0.01	g/kg		0.10	0.69	0.69	1.25	0.22
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		20	6	10	8	11
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		39	471	465	746	146
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		4	55	51	73	29
Magnesium	7439-95-4	1	mg/L		7	81	82	137	18
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0.001
Nickel	7440-02-0	0.001	mg/L		0.001	0.002	0.002	0.004	0.003
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.25	0.02	0.02	0.04	0.02
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	1.25	<0.01	0.51	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	1.25	<0.01	0.52	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L		1.0	0.2	0.3	0.3	0.5
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		1.2	0.2	0.3	0.3	0.5
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 14	Site 42	Site 40	Site 39	Site 30
				Client sampling date / time	13-Jun-2018 00:00	12-Jun-2018 00:00	12-Jun-2018 00:00	12-Jun-2018 00:00	14-Jun-2018 00:00
Compound	CAS Number	LOR	Unit		EB1814632-001	EB1814632-002	EB1814632-003	EB1814632-004	EB1814632-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.2	1.4	0.3	0.8	0.5
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.03	0.01	0.02	0.02	0.07
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		26.6	29.0	25.7	26.1	29.8
2-Chlorophenol-D4	93951-73-6	1.0	%		74.9	74.4	69.9	69.2	76.1
2.4.6-Tribromophenol	118-79-6	1.0	%		61.2	52.6	48.6	46.4	52.2
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		79.1	78.2	75.7	79.4	82.1
Anthracene-d10	1719-06-8	1.0	%		105	103	95.9	101	108
4-Terphenyl-d14	1718-51-0	1.0	%		104	105	101	107	120

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 27	Site 16	----	----	----
				Client sampling date / time	15-Jun-2018 00:00	13-Jun-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB1814632-006	EB1814632-007	--------	--------	--------
					Result	Result	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		582	225	----	----	----
EA020EC: Salinity									
Salinity	----	0.01	g/kg		0.28	0.11	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		28	32	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		199	51	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		40	14	----	----	----
Magnesium	7439-95-4	1	mg/L		24	4	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		0.002	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L		0.006	0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.03	0.02	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L		0.9	1.0	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.9	1.0	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 27	Site 16	----	----	----
				Client sampling date / time	15-Jun-2018 00:00	13-Jun-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB1814632-006	EB1814632-007	--------	--------	--------
					Result	Result	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.9**	**1.0**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.11**	**0.11**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	----	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	----	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	----	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	----	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	----	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	----	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	----	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**28.2**	**26.8**	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**73.3**	**74.3**	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**46.5**	**53.2**	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**84.1**	**82.7**	----	----	----
Anthracene-d10	1719-06-8	1.0	%		**103**	**101**	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		**115**	**113**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2.4.6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1814632**	Page	: 1 of 10
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 15-Jun-2018
Site	: ----	Issue Date	: 21-Jun-2018
Sampler	: DAVID MOORE and PETER HANCOCK	No. of samples received	: 7
Order number	:	No. of samples analysed	: 7

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EK055G: Ammonia as N by Discrete Analyser	EB1814627--002	Anonymous	**Ammonia as N**	7664-41-7	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural							
Site 42, Site 39	Site 40,	----	----	----	15-Jun-2018	14-Jun-2018	**1**
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural							
Site 42, Site 39	Site 40,	----	----	----	15-Jun-2018	14-Jun-2018	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
PAH/Phenols (GC/MS - SIM)	0	11	0.00	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**19-Jun-2018**	10-Jul-2018	✓
Clear Plastic Bottle - Natural (EA010-P) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**19-Jun-2018**	11-Jul-2018	✓
Clear Plastic Bottle - Natural (EA010-P) Site 30	**14-Jun-2018**	**----**	----	----	**19-Jun-2018**	12-Jul-2018	✓
Clear Plastic Bottle - Natural (EA010-P) Site 27	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	13-Jul-2018	✓
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**19-Jun-2018**	19-Jun-2018	✓
Clear Plastic Bottle - Natural (EA025H) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**19-Jun-2018**	20-Jun-2018	✓
Clear Plastic Bottle - Natural (EA025H) Site 30	**14-Jun-2018**	**----**	----	----	**19-Jun-2018**	21-Jun-2018	✓
Clear Plastic Bottle - Natural (EA025H) Site 27	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	22-Jun-2018	✓
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**20-Jun-2018**	10-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**20-Jun-2018**	11-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 30	**14-Jun-2018**	**----**	----	----	**20-Jun-2018**	12-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 27	**15-Jun-2018**	**----**	----	----	**20-Jun-2018**	13-Jul-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**20-Jun-2018**	10-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**20-Jun-2018**	11-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 30	**14-Jun-2018**	**----**	----	----	**20-Jun-2018**	12-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 27	**15-Jun-2018**	**----**	----	----	**20-Jun-2018**	13-Jul-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**20-Jun-2018**	09-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**20-Jun-2018**	10-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) Site 30	**14-Jun-2018**	**----**	----	----	**20-Jun-2018**	11-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) Site 27	**15-Jun-2018**	**----**	----	----	**20-Jun-2018**	12-Dec-2018	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**20-Jun-2018**	10-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**20-Jun-2018**	11-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) Site 30	**14-Jun-2018**	**----**	----	----	**20-Jun-2018**	12-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) Site 27	**15-Jun-2018**	**----**	----	----	**20-Jun-2018**	13-Jul-2018	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**18-Jun-2018**	10-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**18-Jun-2018**	11-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) Site 30	**14-Jun-2018**	**----**	----	----	**18-Jun-2018**	12-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) Site 27	**15-Jun-2018**	**----**	----	----	**18-Jun-2018**	13-Jul-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**15-Jun-2018**	14-Jun-2018	×
Clear Plastic Bottle - Natural (EK057G) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**15-Jun-2018**	15-Jun-2018	✓
Clear Plastic Bottle - Natural (EK057G) Site 30	**14-Jun-2018**	**----**	----	----	**15-Jun-2018**	16-Jun-2018	✓
Clear Plastic Bottle - Natural (EK057G) Site 27	**15-Jun-2018**	**----**	----	----	**15-Jun-2018**	17-Jun-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**18-Jun-2018**	10-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**18-Jun-2018**	11-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) Site 30	**14-Jun-2018**	**----**	----	----	**18-Jun-2018**	12-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) Site 27	**15-Jun-2018**	**----**	----	----	**18-Jun-2018**	13-Jul-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) Site 42, Site 40, Site 39	**12-Jun-2018**	**19-Jun-2018**	10-Jul-2018	✓	**19-Jun-2018**	10-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) Site 14, Site 16	**13-Jun-2018**	**19-Jun-2018**	11-Jul-2018	✓	**19-Jun-2018**	11-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) Site 30	**14-Jun-2018**	**19-Jun-2018**	12-Jul-2018	✓	**19-Jun-2018**	12-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) Site 27	**15-Jun-2018**	**19-Jun-2018**	13-Jul-2018	✓	**19-Jun-2018**	13-Jul-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) Site 42, Site 40, Site 39	**12-Jun-2018**	**19-Jun-2018**	10-Jul-2018	✓	**19-Jun-2018**	10-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) Site 14, Site 16	**13-Jun-2018**	**19-Jun-2018**	11-Jul-2018	✓	**19-Jun-2018**	11-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) Site 30	**14-Jun-2018**	**19-Jun-2018**	12-Jul-2018	✓	**19-Jun-2018**	12-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) Site 27	**15-Jun-2018**	**19-Jun-2018**	13-Jul-2018	✓	**19-Jun-2018**	13-Jul-2018	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**15-Jun-2018**	14-Jun-2018	×
Clear Plastic Bottle - Natural (EK071G) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**15-Jun-2018**	15-Jun-2018	✓
Clear Plastic Bottle - Natural (EK071G) Site 30	**14-Jun-2018**	**----**	----	----	**15-Jun-2018**	16-Jun-2018	✓
Clear Plastic Bottle - Natural (EK071G) Site 27	**15-Jun-2018**	**----**	----	----	**15-Jun-2018**	17-Jun-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 42, Site 40, Site 39	**12-Jun-2018**	**19-Jun-2018**	19-Jun-2018	✓	**20-Jun-2018**	29-Jul-2018	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 14, Site 16	**13-Jun-2018**	**19-Jun-2018**	20-Jun-2018	✓	**20-Jun-2018**	29-Jul-2018	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 30	**14-Jun-2018**	**19-Jun-2018**	21-Jun-2018	✓	**20-Jun-2018**	29-Jul-2018	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 27	**15-Jun-2018**	**19-Jun-2018**	22-Jun-2018	✓	**20-Jun-2018**	29-Jul-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	26	**11.54**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	11	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Salinity	EA020-EC-P	WATER	In house: Referenced to APHA 2520B. Calculation from Electrical conductivity. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Organic Nitrogen as N (TKN - NH3) (discrete analyser)	EK060G	WATER	In house: Referenced to APHA 4500-Norg/4500-NH3. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 3/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 49 Callemondah Drive Gladstone QLD 4680 Ph: 07 4978 7944 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 1/26 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

Environmental Division Brisbane

Work Order Reference

EB1814715

CLIENT: Eco Logical Australia	TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☑ Standard TAT (List due date):	
OFFICE: Brisbane		☐ Non Standard or urgent TAT (List due date):	
PROJECT: Inland Rail - Border to Gowrie EIS PROJECT NO 10658	ALS QUOTE NO.: BN/142/18 V2	COC SEQUENCE NUMBER (Circle)	
ORDER NUMBER: PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	COC: 1 2 3 4 5 6 7	
PROJECT MANAGER: Miles Yeates	CONTACT PH: 0467 738 954	OF: 1 2 3 4 5 6 7	
SAMPLER: David Moore and Loren Appleby	SAMPLER MOBILE:	RELINQUISHED BY:	RECEIVED BY: Jess H
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):		
Email Reports to (will default to PM if no other addresses are listed): miles@ecoaus.com.au		DATE/TIME: 18	DATE/TIME: 18/6/18 1.40
Email Invoice to (will default to PM if no other addresses are listed): miles@ecoaus.com.au			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA026H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK055 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP006 Chlorophyll a (filter paper method)	
1	Site 14	13/6/18 noon	W		1								X	These samples are Batch 2 of a seven day field trip. Batch 1 samples were delivered on Friday 15/6/18 (EB1814632). All metals samples are field filtered. Frozen Chlorophyll a filter paper samples are included in this work order for both batches. Filter paper is 47mm GFF ~0.7 micron. Filtered volume is noted below and on jar. Filter paper was foil wrapped and kept frozen at ~17°C up to delivery.
2	Site 42	12/6/18 noon	W		1								X	Chl a: vol filtered 1,000 mL
3	Site 40	12/6/18 noon	W		1								X	Chl a: vol filtered 1,000 mL
4	Site 39	12/6/18 noon	W		1								X	Chl a: vol filtered 1,000 mL
5	Site 30	14/6/18 noon	W		1								X	Chl a: vol filtered 600 mL
6	Site 27	15/6/18 noon	W		1								X	Chl a: vol filtered 425 mL
7	Site 16	13/6/18 noon	W		1								X	Chl a: vol filtered 275 mL
8	Site 1R	16/6/18 noon	W		5	X	X	X	X	X	X	X	X	Chl a: vol filtered 500 mL
9	Site 2R	16/6/18 noon	W		5	X	X	X	X	X	X	X	X	Chl a: vol filtered 800 mL
10	Site 3	17/6/18 noon	W		5	X	X	X	X	X	X	X	X	Chl a: vol filtered 600 mL
11	Site 6	16/6/18 noon	W		5	X	X	X	X	X	X	X	X	Chl a: vol filtered 475 mL
12	Site 7	17/6/18 noon	W		5	X	X	X	X	X	X	X	X	Chl a: vol filtered 600 mL
13	Site 11	15/6/18 noon	W		5	X	X	X	X	X	X	X	X	Chl a: vol filtered 400 mL
14	DUP	16/6/18 noon	W		6	X	X	X	X	X	X	X		Duplicate of another site. 2 extra lab QA/QC amber bottles from this site.
15	FB	16/6/18 noon	W		4	X	X	X	X	X	X	X		Field blank sample
16	Site 24	18/6/18 noon	W		5	X	X	X	X	X	X	X	X	Chl a: vol filtered 250 mL
				TOTAL										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic; V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1814715**	Page	: 1 of 13
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Contact	: Customer Services EB
Address	: PO BOX 1422 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 8536 8667	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 18-Jun-2018 13:40
Order number	:	Date Analysis Commenced	: 19-Jun-2018
C-O-C number	: ----	Issue Date	: 22-Jun-2018 16:47
Sampler	: David Moore and Loren Appleby		
Site	:		
Quote number	: BN/142/18 V2		
No. of samples received	: 16		
No. of samples analysed	: 16		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP008 (Chlorphyll): The LOR has been raised due to the volume of filtered sample recieved
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**Site 14**	**Site 42**	**Site 40**	**Site 39**	**Site 30**
				Client sampling date / time	13-Jun-2018 12:00	12-Jun-2018 12:00	12-Jun-2018 12:00	12-Jun-2018 12:00	14-Jun-2018 12:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1814715-001**	**EB1814715-002**	**EB1814715-003**	**EB1814715-004**	**EB1814715-005**
					Result	Result	Result	Result	Result
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	<1	<1	<2
Volume	----	0.01	L		**1**	**1**	**1**	**1**	**.6**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 27	Site 16	Site 1R	Site 2R	Site 3
			Client sampling date / time	15-Jun-2018 12:00	13-Jun-2018 12:00	16-Jun-2018 12:00	16-Jun-2018 12:00	17-Jun-2018 12:00
Compound	CAS Number	LOR	Unit	EB1814715-006	EB1814715-007	EB1814715-008	EB1814715-009	EB1814715-010
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	----	----	298	251	410
EA020EC: Salinity								
Salinity	----	0.01	g/kg	----	----	0.14	0.12	0.20
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	----	----	28	<5	<5
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	----	----	78	58	69
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	----	----	13	10	11
Magnesium	7439-95-4	1	mg/L	----	----	11	8	10
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	----	----	0.002	0.002	<0.001
Cadmium	7440-43-9	0.0001	mg/L	----	----	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	----	----	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	----	----	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	----	----	0.002	0.002	<0.001
Lead	7439-92-1	0.001	mg/L	----	----	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	----	----	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	----	----	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	0.02	0.02	0.04
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	----	----	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	<0.01	<0.01	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	----	----	0.6	0.5	0.8
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	----	----	0.6	0.5	0.8
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 27	Site 16	Site 1R	Site 2R	Site 3
				Client sampling date / time	15-Jun-2018 12:00	13-Jun-2018 12:00	16-Jun-2018 12:00	16-Jun-2018 12:00	17-Jun-2018 12:00
Compound	CAS Number	LOR	Unit		EB1814715-006	EB1814715-007	EB1814715-008	EB1814715-009	EB1814715-010
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		----	----	0.6	0.5	0.8
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		----	----	0.10	0.05	0.04
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		----	----	<0.01	0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		5	<4	<2	<1	<2
Volume	----	0.01	L		.425	.275	.5	.8	.6
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		----	----	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		----	----	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		----	----	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		----	----	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		----	----	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		----	----	23.5	24.4	25.2
2-Chlorophenol-D4	93951-73-6	1.0	%		----	----	66.8	67.9	69.3
2.4.6-Tribromophenol	118-79-6	1.0	%		----	----	43.0	39.7	39.2
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		----	----	76.3	80.3	80.7
Anthracene-d10	1719-06-8	1.0	%		----	----	77.6	78.4	77.2

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	Site 27	Site 16	Site 1R	Site 2R	Site 3
				Client sampling date / time	15-Jun-2018 12:00	13-Jun-2018 12:00	16-Jun-2018 12:00	16-Jun-2018 12:00	17-Jun-2018 12:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1814715-006**	**EB1814715-007**	**EB1814715-008**	**EB1814715-009**	**EB1814715-010**
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**----**	**----**	**86.2**	**91.6**	**90.0**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 6	Site 7	Site 11	DUP	FB
				Client sampling date / time	16-Jun-2018 12:00	17-Jun-2018 12:00	15-Jun-2018 12:00	16-Jun-2018 12:00	16-Jun-2018 12:00
Compound	CAS Number	LOR	Unit		EB1814715-011	EB1814715-012	EB1814715-013	EB1814715-014	EB1814715-015
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		352	356	315	352	2
EA020EC: Salinity									
Salinity	----	0.01	g/kg		0.17	0.17	0.15	0.17	0.01
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		20	18	15	11	<5
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		55	60	56	60	<1
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		9	9	11	9	<1
Magnesium	7439-95-4	1	mg/L		8	9	7	9	<1
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		0.001	0.001	0.001	0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.03	0.04	0.02	0.04	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.05	0.15	0.02	0.05	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.05	0.15	0.02	0.05	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L		0.8	0.9	0.9	0.8	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.8	0.9	0.9	0.8	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 6	Site 7	Site 11	DUP	FB
				Client sampling date / time	16-Jun-2018 12:00	17-Jun-2018 12:00	15-Jun-2018 12:00	16-Jun-2018 12:00	16-Jun-2018 12:00
Compound	CAS Number	LOR	Unit		EB1814715-011	EB1814715-012	EB1814715-013	EB1814715-014	EB1814715-015
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.8**	**1.0**	**0.9**	**0.8**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.04**	**0.04**	**0.06**	**0.03**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<2	<2	<2	----	----
Volume	----	0.01	L		**.475**	**.6**	**.4**	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**23.2**	**20.2**	**21.0**	**22.4**	**21.7**
2-Chlorophenol-D4	93951-73-6	1.0	%		**63.0**	**57.2**	**58.6**	**64.5**	**61.7**
2.4.6-Tribromophenol	118-79-6	1.0	%		**36.0**	**32.4**	**32.8**	**36.2**	**36.9**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**73.6**	**70.4**	**71.2**	**78.6**	**68.2**
Anthracene-d10	1719-06-8	1.0	%		**72.6**	**68.3**	**69.3**	**78.5**	**69.2**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	Site 6	Site 7	Site 11	DUP	FB
				Client sampling date / time	16-Jun-2018 12:00	17-Jun-2018 12:00	15-Jun-2018 12:00	16-Jun-2018 12:00	16-Jun-2018 12:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1814715-011**	**EB1814715-012**	**EB1814715-013**	**EB1814715-014**	**EB1814715-015**
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**85.1**	**78.9**	**82.4**	**94.3**	**85.0**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 24	----	----	----	----
			Client sampling date / time	18-Jun-2018 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1814715-016	--------	--------	--------	--------
				Result	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**339**	----	----	----	----
EA020EC: Salinity								
Salinity	----	0.01	g/kg	**0.16**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**98**	----	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**80**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**14**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**11**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.005**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.04**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	----	----	----	----
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	**0.5**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.5**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 24	----	----	----	----
				Client sampling date / time	18-Jun-2018 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1814715-016	--------	--------	--------	--------
					Result	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.5**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.07**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	----	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<4	----	----	----	----
Volume	----	0.01	L		**.25**	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	----	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	----	----	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	----	----	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	----	----	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	----	----	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	----	----	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	----	----	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	----	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	----	----	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	----	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	----	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**21.2**	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**60.3**	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**32.3**	----	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**72.2**	----	----	----	----
Anthracene-d10	1719-06-8	1.0	%		**72.1**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**Site 24**	**----**	**----**	**----**	**----**
				Client sampling date / time	18-Jun-2018 12:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB1814715-016**	**--------**	**--------**	**--------**	**--------**
					Result	----	----	----	----
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**82.4**	**----**	**----**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2.4.6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1814715**	Page	: 1 of 10
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 18-Jun-2018
Site	:	Issue Date	: 22-Jun-2018
Sampler	: David Moore and Loren Appleby	No. of samples received	: 16
Order number	:	No. of samples analysed	: 16

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural						
Site 11	----	----	----	19-Jun-2018	17-Jun-2018	**2**
Clear Plastic Bottle - Natural						
Site 1R, Site 2R, Site 6, DUP, FB	----	----	----	19-Jun-2018	18-Jun-2018	**1**
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural						
Site 11	----	----	----	19-Jun-2018	17-Jun-2018	**2**
Clear Plastic Bottle - Natural						
Site 1R, Site 2R, Site 6, DUP, FB	----	----	----	19-Jun-2018	18-Jun-2018	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
PAH/Phenols (GC/MS - SIM)	1	20	5.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
PAH/Phenols (GC/MS - SIM)	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) Site 11	**15-Jun-2018**	**----**	----	----	**21-Jun-2018**	13-Jul-2018	✓
Clear Plastic Bottle - Natural (EA010-P) Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**21-Jun-2018**	14-Jul-2018	✓
Clear Plastic Bottle - Natural (EA010-P) Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**21-Jun-2018**	15-Jul-2018	✓
Clear Plastic Bottle - Natural (EA010-P) Site 24	**18-Jun-2018**	**----**	----	----	**21-Jun-2018**	16-Jul-2018	✓
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H) Site 11	**15-Jun-2018**	**----**	----	----	**20-Jun-2018**	22-Jun-2018	✓
Clear Plastic Bottle - Natural (EA025H) Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**20-Jun-2018**	23-Jun-2018	✓
Clear Plastic Bottle - Natural (EA025H) Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**20-Jun-2018**	24-Jun-2018	✓
Clear Plastic Bottle - Natural (EA025H) Site 24	**18-Jun-2018**	**----**	----	----	**21-Jun-2018**	25-Jun-2018	✓
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	13-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	14-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	15-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	16-Jul-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	13-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	14-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	15-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	16-Jul-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	12-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	13-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	14-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	15-Dec-2018	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	13-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	14-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	15-Jul-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	16-Jul-2018	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	13-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	14-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	15-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	16-Jul-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	17-Jun-2018	×
Clear Plastic Bottle - Natural (EK057G)							
Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	18-Jun-2018	×
Clear Plastic Bottle - Natural (EK057G)							
Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	19-Jun-2018	✓
Clear Plastic Bottle - Natural (EK057G)							
Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	20-Jun-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	13-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	14-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	15-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	16-Jul-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 11	**15-Jun-2018**	**19-Jun-2018**	13-Jul-2018	✓	**19-Jun-2018**	13-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**19-Jun-2018**	14-Jul-2018	✓	**19-Jun-2018**	14-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 3, Site 7	**17-Jun-2018**	**19-Jun-2018**	15-Jul-2018	✓	**19-Jun-2018**	15-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 24	**18-Jun-2018**	**19-Jun-2018**	16-Jul-2018	✓	**19-Jun-2018**	16-Jul-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 11	**15-Jun-2018**	**19-Jun-2018**	13-Jul-2018	✓	**19-Jun-2018**	13-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**19-Jun-2018**	14-Jul-2018	✓	**19-Jun-2018**	14-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 3, Site 7	**17-Jun-2018**	**19-Jun-2018**	15-Jul-2018	✓	**19-Jun-2018**	15-Jul-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 24	**18-Jun-2018**	**19-Jun-2018**	16-Jul-2018	✓	**19-Jun-2018**	16-Jul-2018	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	17-Jun-2018	×
Clear Plastic Bottle - Natural (EK071G)							
Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	18-Jun-2018	×
Clear Plastic Bottle - Natural (EK071G)							
Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	19-Jun-2018	✓
Clear Plastic Bottle - Natural (EK071G)							
Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	20-Jun-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP008: Chlorophyll a & Pheophytin a							
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 42, Site 40, Site 39	**12-Jun-2018**	**----**	----	----	**19-Jun-2018**	03-Jul-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 14, Site 16	**13-Jun-2018**	**----**	----	----	**19-Jun-2018**	04-Jul-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 30	**14-Jun-2018**	**----**	----	----	**19-Jun-2018**	05-Jul-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 27, Site 11	**15-Jun-2018**	**----**	----	----	**19-Jun-2018**	06-Jul-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 1R, Site 2R, Site 6	**16-Jun-2018**	**----**	----	----	**19-Jun-2018**	07-Jul-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 3, Site 7	**17-Jun-2018**	**----**	----	----	**19-Jun-2018**	08-Jul-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 24	**18-Jun-2018**	**----**	----	----	**19-Jun-2018**	09-Jul-2018	✓
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 11	**15-Jun-2018**	**20-Jun-2018**	22-Jun-2018	✓	**21-Jun-2018**	30-Jul-2018	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 1R, Site 2R, Site 6, DUP, FB	**16-Jun-2018**	**20-Jun-2018**	23-Jun-2018	✓	**21-Jun-2018**	30-Jul-2018	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 3, Site 7	**17-Jun-2018**	**20-Jun-2018**	24-Jun-2018	✓	**21-Jun-2018**	30-Jul-2018	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 24	**18-Jun-2018**	**20-Jun-2018**	25-Jun-2018	✓	**21-Jun-2018**	30-Jul-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	3	28	**10.71**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	20	**5.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	4	35	**11.43**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	4	35	**11.43**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	28	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Suspended Solids (High Level)	EA025H	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	20	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Salinity	EA020-EC-P	WATER	In house: Referenced to APHA 2520B. Calculation from Electrical conductivity. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Organic Nitrogen as N (TKN - NH3) (discrete analyser)	EK060G	WATER	In house: Referenced to APHA 4500-Norg/4500-NH3. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Chlorophyll a and Pheophytin a	EP008	WATER	In house: Referenced to APHA 10200 H. The pigments are extracted into aqueous acetone. The optical density of the extract before and after acidification at both 664 nm and 665 nm is determined spectrometrically.
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 3/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 48 Callemondah Drive Gladstone QLD 4680 Ph: 07 4978 7944 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 5735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

Environmental Division
Brisbane
Work Order Reference
EB1829378

Telephone : +61-7-3243 7222

CLIENT: Eco Logical Australia		TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☐ Standard TAT (List due date):	FOR L	
OFFICE: Brisbane			☐ Non Standard or urgent TAT (List due date):	Custody	N/A
PROJECT: Inland Rail - Border to Gowrie EIS	PROJECT NO 10558	ALS QUOTE NO.: BN/142/18 V2	COC SEQUENCE NUMBER (Circle)	Free ice receipt	N/A
ORDER NUMBER:	PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	COC: 1 2 3 4 5 6 7	Random	
PROJECT MANAGER: Miles Yeates	CONTACT PH: 0467 738 954		OF: 1 2 3 4 5 6 7	Other	
SAMPLER: David Moore and Peter Hancock	SAMPLER MOBILE:	RELINQUISHED BY:	RECEIVED BY:	RELINQUIS	
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 11.50am 30/11/18	DATE/TIME: 30-11-18 1245	DATE/TIME	
Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au					
Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au					

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS (MATRIX: Solid(S) Water(W))			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) — Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA028H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 6 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP008 Chlorophyll a (filter paper method)	These samples are Batch 1 of a nine day field trip. A second batch of samples will follow in 3-4 days time. All metals samples are field filtered.
1	Site 14	29/11/18	W		4	X	X	X	X	X	X	X		
2	Site 2R	27/11/18	W		4	X	X	X	X	X	X	X		
3	Site 2	29/11/18	W		4	X	X	X	X	X	X	X		
4	Site 16	28/11/18	W		4	X	X	X	X	X	X	X		
5	Site 11	28/11/18	W		4	X	X	X	X	X	X	X		
6	Site 3	27/11/18	W		4	X	X	X	X	X	X	X		
7	DUP	27/11/18	W		6	X	X	X	X	X	X	X		2 QA/QC Amber bottles
8	FB	29/11/18	W		4	X	X	X	X	X	X	X		
9	Site 6	27/11/18	W		4	X	X	X	X	X	X	X		
10	Site 33	26/11/18	W		4	X	X	X	X	X	X	X		
11	Site 7	27/11/18	W		4	X	X	X	X	X	X	X		
				TOTAL	46									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1829378**	Page	: 1 of 9
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Contact	: Customer Services EB
Address	: PO BOX 1422 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 8536 8667	Telephone	: +61-7-3243 7222
Project	: Inland Rail - Border to Gowrie EIS	Date Samples Received	: 30-Nov-2018 12:45
Order number	: 10558	Date Analysis Commenced	: 01-Dec-2018
C-O-C number	: ----	Issue Date	: 07-Dec-2018 08:35
Sampler	: DAVID MOORE, PETER HANCOCK		
Site	:		
Quote number	: BN/142/18 V2		
No. of samples received	: 11		
No. of samples analysed	: 11		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Minh Wills	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Tom Maloney	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075(SIM): Matrix spike shows poor recovery. Insufficient sample for re-extraction and re-analysis.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	14	2R	2	16	11
			Client sampling date / time	29-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	28-Nov-2018 00:00	28-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EB1829378-001	EB1829378-002	EB1829378-003	EB1829378-004	EB1829378-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	232	214	213	359	274
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.11	0.10	0.10	0.17	0.13
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	43	27	56	14
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	50	67	71	100	57
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	5	12	12	27	13
Magnesium	7439-95-4	1	mg/L	9	9	10	8	6
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.001	0.003	0.003	0.001	0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.002	0.002	<0.001
Nickel	7440-02-0	0.001	mg/L	0.001	0.002	0.002	0.002	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	0.06	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.02	<0.01	0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.02	<0.01	0.01	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	0.7	0.5	0.5	1.3	1.2
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	0.5	0.5	1.4	1.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	14	2R	2	16	11
				Client sampling date / time	29-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	28-Nov-2018 00:00	28-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EB1829378-001	EB1829378-002	EB1829378-003	EB1829378-004	EB1829378-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.7**	**0.5**	**0.5**	**1.4**	**1.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.03**	**0.15**	**0.12**	**0.17**	**0.11**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	**0.04**	**0.04**	<0.01	<0.01
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**28.7**	**26.6**	**21.4**	**22.9**	**20.0**
2-Chlorophenol-D4	93951-73-6	1.0	%		**76.6**	**69.6**	**62.1**	**61.7**	**55.8**
2.4.6-Tribromophenol	118-79-6	1.0	%		**58.3**	**52.3**	**47.0**	**44.7**	**42.0**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**97.9**	**73.9**	**85.2**	**82.1**	**75.9**
Anthracene-d10	1719-06-8	1.0	%		**95.9**	**90.7**	**80.6**	**79.9**	**74.3**
4-Terphenyl-d14	1718-51-0	1.0	%		**115**	**93.3**	**97.0**	**93.7**	**89.0**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	3	DUP	FB	6	33
			Client sampling date / time	27-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	27-Nov-2018 00:00	26-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EB1829378-006	EB1829378-007	EB1829378-008	EB1829378-009	EB1829378-010
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	386	388	<1	411	198
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.19	0.19	<0.01	0.20	0.10
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	<5	<5	14	15
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	76	76	<1	79	59
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	14	14	<1	15	12
Magnesium	7439-95-4	1	mg/L	10	10	<1	10	7
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	<0.001	0.002	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.001	<0.001	<0.001	<0.001	0.004
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.008
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.03	<0.01	0.03
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.01	<0.01	<0.01	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	0.6	0.7	<0.1	0.7	1.0
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.6	0.7	<0.1	0.7	1.0
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	3	DUP	FB	6	33
				Client sampling date / time	27-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	27-Nov-2018 00:00	26-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EB1829378-006	EB1829378-007	EB1829378-008	EB1829378-009	EB1829378-010
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.6**	**0.7**	<0.1	**0.7**	**1.0**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.04**	**0.04**	<0.01	**0.05**	**0.23**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.05**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**23.5**	**29.6**	**24.3**	**26.0**	**26.8**
2-Chlorophenol-D4	93951-73-6	1.0	%		**63.3**	**73.6**	**67.7**	**70.0**	**65.3**
2.4.6-Tribromophenol	118-79-6	1.0	%		**48.8**	**55.2**	**54.2**	**53.8**	**57.6**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**68.3**	**71.5**	**81.2**	**73.9**	**76.1**
Anthracene-d10	1719-06-8	1.0	%		**88.1**	**89.0**	**76.0**	**107**	**84.0**
4-Terphenyl-d14	1718-51-0	1.0	%		**91.0**	**92.2**	**92.2**	**110**	**88.1**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	7	----	----	----	----
				Client sampling date / time	27-Nov-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1829378-011	--------	--------	--------	--------
					Result	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		416	----	----	----	----
EA020EC: Salinity									
Salinity	----	0.01	g/kg		0.20	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		9	----	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		79	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		15	----	----	----	----
Magnesium	7439-95-4	1	mg/L		10	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		0.002	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.02	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.02	----	----	----	----
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L		0.7	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.7	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	7	----	----	----	----
				Client sampling date / time	27-Nov-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1829378-011	--------	--------	--------	--------
					Result	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.7**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	----	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	----	----	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	----	----	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	----	----	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	----	----	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	----	----	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	----	----	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	----	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	----	----	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	----	----	----	----
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L		<0.5	----	----	----	----
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	µg/L		<0.5	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**29.3**	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**71.8**	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**54.4**	----	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**71.9**	----	----	----	----
Anthracene-d10	1719-06-8	1.0	%		**90.6**	----	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		**96.2**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2.4.6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1829378**	Page	: 1 of 11
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Telephone	: +61-7-3243 7222
Project	: Inland Rail - Border to Gowrie EIS	Date Samples Received	: 30-Nov-2018
Site	:	Issue Date	: 07-Dec-2018
Sampler	: DAVID MOORE, PETER HANCOCK	No. of samples received	: 11
Order number	: 10558	No. of samples analysed	: 11

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons	EB1829378--007	DUP	**Acenaphthene**	83-32-9	60.5 %	70-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural 33	----	----	----	01-Dec-2018	28-Nov-2018	**3**
Clear Plastic Bottle - Natural 2R, 3, DUP, 6, 7	----	----	----	01-Dec-2018	29-Nov-2018	**2**
Clear Plastic Bottle - Natural 16, 11	----	----	----	01-Dec-2018	30-Nov-2018	**1**
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural 33	----	----	----	01-Dec-2018	28-Nov-2018	**3**
Clear Plastic Bottle - Natural 2R, 3, DUP, 6, 7	----	----	----	01-Dec-2018	29-Nov-2018	**2**
Clear Plastic Bottle - Natural 16, 11	----	----	----	01-Dec-2018	30-Nov-2018	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
PAH/Phenols (GC/MS - SIM)	3	33	9.09	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) 33	**26-Nov-2018**	**----**	----	----	**03-Dec-2018**	24-Dec-2018	✓
Clear Plastic Bottle - Natural (EA010-P) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**03-Dec-2018**	25-Dec-2018	✓
Clear Plastic Bottle - Natural (EA010-P) 16, 11	**28-Nov-2018**	**----**	----	----	**03-Dec-2018**	26-Dec-2018	✓
Clear Plastic Bottle - Natural (EA010-P) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**03-Dec-2018**	27-Dec-2018	✓
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H) 33	**26-Nov-2018**	**----**	----	----	**03-Dec-2018**	03-Dec-2018	✓
Clear Plastic Bottle - Natural (EA025H) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**03-Dec-2018**	04-Dec-2018	✓
Clear Plastic Bottle - Natural (EA025H) 16, 11	**28-Nov-2018**	**----**	----	----	**03-Dec-2018**	05-Dec-2018	✓
Clear Plastic Bottle - Natural (EA025H) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**03-Dec-2018**	06-Dec-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 33	**26-Nov-2018**	**----**	----	----	**04-Dec-2018**	24-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**04-Dec-2018**	25-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 16, 11	**28-Nov-2018**	**----**	----	----	**04-Dec-2018**	26-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**04-Dec-2018**	27-Dec-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 33	**26-Nov-2018**	**----**	----	----	**04-Dec-2018**	24-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**04-Dec-2018**	25-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 16, 11	**28-Nov-2018**	**----**	----	----	**04-Dec-2018**	26-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**04-Dec-2018**	27-Dec-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 33	**26-Nov-2018**	**----**	----	----	**04-Dec-2018**	25-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**04-Dec-2018**	26-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 16, 11	**28-Nov-2018**	**----**	----	----	**04-Dec-2018**	27-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**04-Dec-2018**	28-May-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 33	**26-Nov-2018**	**----**	----	----	**04-Dec-2018**	24-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**04-Dec-2018**	25-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 16, 11	**28-Nov-2018**	**----**	----	----	**04-Dec-2018**	26-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**04-Dec-2018**	27-Dec-2018	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) 33	**26-Nov-2018**	**----**	----	----	**01-Dec-2018**	24-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**01-Dec-2018**	25-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) 16, 11	**28-Nov-2018**	**----**	----	----	**01-Dec-2018**	26-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**01-Dec-2018**	27-Dec-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) 33	**26-Nov-2018**	**----**	----	----	**01-Dec-2018**	28-Nov-2018	×
Clear Plastic Bottle - Natural (EK057G) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**01-Dec-2018**	29-Nov-2018	×
Clear Plastic Bottle - Natural (EK057G) 16, 11	**28-Nov-2018**	**----**	----	----	**01-Dec-2018**	30-Nov-2018	×
Clear Plastic Bottle - Natural (EK057G) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**01-Dec-2018**	01-Dec-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) 33	**26-Nov-2018**	**----**	----	----	**01-Dec-2018**	24-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**01-Dec-2018**	25-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) 16, 11	**28-Nov-2018**	**----**	----	----	**01-Dec-2018**	26-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**01-Dec-2018**	27-Dec-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) 33	**26-Nov-2018**	**04-Dec-2018**	24-Dec-2018	✓	**04-Dec-2018**	24-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**04-Dec-2018**	25-Dec-2018	✓	**04-Dec-2018**	25-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) 16, 11	**28-Nov-2018**	**04-Dec-2018**	26-Dec-2018	✓	**04-Dec-2018**	26-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) 14, 2, FB	**29-Nov-2018**	**04-Dec-2018**	27-Dec-2018	✓	**04-Dec-2018**	27-Dec-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) 33	**26-Nov-2018**	**04-Dec-2018**	24-Dec-2018	✓	**04-Dec-2018**	24-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**04-Dec-2018**	25-Dec-2018	✓	**04-Dec-2018**	25-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) 16, 11	**28-Nov-2018**	**04-Dec-2018**	26-Dec-2018	✓	**04-Dec-2018**	26-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) 14, 2, FB	**29-Nov-2018**	**04-Dec-2018**	27-Dec-2018	✓	**04-Dec-2018**	27-Dec-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) 33	**26-Nov-2018**	**----**	----	----	**01-Dec-2018**	28-Nov-2018	×
Clear Plastic Bottle - Natural (EK071G) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**----**	----	----	**01-Dec-2018**	29-Nov-2018	×
Clear Plastic Bottle - Natural (EK071G) 16, 11	**28-Nov-2018**	**----**	----	----	**01-Dec-2018**	30-Nov-2018	×
Clear Plastic Bottle - Natural (EK071G) 14, 2, FB	**29-Nov-2018**	**----**	----	----	**01-Dec-2018**	01-Dec-2018	✓
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM)) 33	**26-Nov-2018**	**03-Dec-2018**	03-Dec-2018	✓	**03-Dec-2018**	12-Jan-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) 2R, 3, DUP, 6, 7	**27-Nov-2018**	**03-Dec-2018**	04-Dec-2018	✓	**03-Dec-2018**	12-Jan-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) 16, 11	**28-Nov-2018**	**05-Dec-2018**	05-Dec-2018	✓	**05-Dec-2018**	14-Jan-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) 14, 2, FB	**29-Nov-2018**	**05-Dec-2018**	06-Dec-2018	✓	**05-Dec-2018**	14-Jan-2019	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	3	27	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	3	33	**9.09**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	27	**7.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Salinity	EA020-EC-P	WATER	In house: Referenced to APHA 2520B. Calculation from Electrical conductivity. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Organic Nitrogen as N (TKN - NH3) (discrete analyser)	EK060G	WATER	In house: Referenced to APHA 4500-Norg/4500-NH3. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 3/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 45 Callemondah Drive Gladstone QLD 4680 Ph: 07 4979 7944 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

WOLLONGONG 1/19-21 Ralph Black Drive, North Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

Environmental Division Brisbane

Work Order Reference

EB1829489

Telephone : + 61-7-3243 7222

CLIENT: Eco Logical Australia	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☑ Standard TAT (List due date):	FOR LABORA
OFFICE: Brisbane		☐ Non Standard or urgent TAT (List due date):	Custody Seal Inta
PROJECT: Inland Rail - Border to Gowrie EIS PROJECT NO 10558	ALS QUOTE NO.: BN/142/18 V2	COC SEQUENCE NUMBER (Circle)	Free Ice / frozen I receipt?
ORDER NUMBER: PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	COC: 1 2 3 4 5 6 7	Random Sample
PROJECT MANAGER: Miles Yeates	CONTACT PH: 0467 738 954	OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: David Moore and Byron Hefferman	SAMPLER MOBILE:	RELINQUISHED BY: David Moore	RECEIVED BY: ANDREA LT
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 3/12/2018 14:25	DATE/TIME: 3.12.18 14.25
Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au			RELINQUISHED BY:
Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au			DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle re								
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP076B SIM PAHs (16 analytes)	EP008 Chlorophyll a (filter paper method)	These samples are Batch 2 of a seven day field trip. Batch 1 samples were delivered on Friday 30/11/18 (EB1829378). All metals samples are field filtered. Frozen Chlorophyll a filter paper samples are included in this work order for both batches. Filter paper is **47mm** GFF ~0.7 micron. Filtered volume is noted below and on jar. Filter paper was foil wrapped and kept frozen at minus 17°C up to delivery.
1	Site 14	29/11/18	W		1								X	Chl a: volume filtered 1,000 mL
2	Site 2R	27/11/18	W		1								X	Chl a: volume filtered 300 mL
3	Site 2	29/11/18	W		1								X	Chl a: volume filtered 300 mL
4	Site 16	28/11/18	W		1								X	Chl a: volume filtered 300 mL
5	Site 11	28/11/18	W		1								X	Chl a: volume filtered 300 mL
6	Site 3	27/11/18	W		1								X	Chl a: volume filtered 500 mL
—	DUP	27/11/18	W											No analysis this batch
—	FB	29/11/18	W											No analysis this batch
7	Site 6	27/11/18	W		1								X	Chl a: volume filtered 450 mL
8	Site 33	26/11/18	W		1								X	Chl a: volume filtered 650 mL
9	Site 7	27/11/18	W		1								X	Chl a: volume filtered 600 mL
10	Site 24	30/11/18	W		5	X	X	X	X	X	X	X	X	Chl a: volume filtered 100 mL
11	Site 30	01/12/18	W		5	X	X	X	X	X	X	X	X	Chl a: volume filtered 150 mL
12	Site 39	01/12/18	W		5	X	X	X	X	X	X	X	X	Chl a: volume filtered 500 mL
13	Site 40	01/12/18	W		5	X	X	X	X	X	X	X	X	Chl a: volume filtered 1000 mL
14	Site 42	01/12/18	W		5	X	X	X	X	X	X	X	X	Chl a: volume filtered 1000 mL
				TOTAL	34									

HT

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; U = Ultra Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1829489**	Page	: 1 of 8
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Contact	: Customer Services EB
Address	: PO BOX 1422 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 8536 8667	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 03-Dec-2018 14:25
Order number	:	Date Analysis Commenced	: 03-Dec-2018
C-O-C number	: ----	Issue Date	: 10-Dec-2018 17:21
Sampler	: DAVID MOORE AND BYRON HEFFERNON		
Site	:		
Quote number	: BN/142/18 V2		
No. of samples received	: 14		
No. of samples analysed	: 14		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Sarah Ashworth	Laboratory Manager - Brisbane	Brisbane Organics, Stafford, QLD
Tom Maloney	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Tom Maloney	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **FILTER** (Matrix: **WATER**)			Client sample ID	**Site 14**	**Site 2R**	**Site 2**	**Site 16**	**Site 11**
			Client sampling date / time	29-Nov-2018 00:00	27-Nov-2018 00:00	29-Nov-2018 00:00	28-Nov-2018 00:00	28-Nov-2018 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1829489-001**	**EB1829489-002**	**EB1829489-003**	**EB1829489-004**	**EB1829489-005**
				Result	Result	Result	Result	Result
EP008: Chlorophyll a & Pheophytin a								
Chlorophyll a	----	1	mg/m³	**3**	**5**	**9**	**8**	**40**
Volume	----	0.01	L	**1**	**0.3**	**0.3**	**0.3**	**0.3**

Analytical Results

Sub-Matrix: **FILTER** (Matrix: **WATER**)			Client sample ID	**Site 3**	**Site 6**	**Site 33**	**Site 7**	**----**
			Client sampling date / time	27-Nov-2018 00:00	27-Nov-2018 00:00	26-Nov-2018 00:00	27-Nov-2018 00:00	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1829489-006**	**EB1829489-007**	**EB1829489-008**	**EB1829489-009**	**--------**
				Result	Result	Result	Result	---
EP008: Chlorophyll a & Pheophytin a								
Chlorophyll a	----	1	mg/m³	**7**	**4**	**3**	**5**	**----**
Volume	----	0.01	L	**0.5**	**0.45**	**0.65**	**0.6**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 24	Site 30	Site 39	Site 40	Site 42
			Client sampling date / time	30-Nov-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00
Compound	CAS Number	LOR	Unit	EB1829489-010	EB1829489-011	EB1829489-012	EB1829489-013	EB1829489-014
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	570	511	1710	678	1140
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.27	0.24	0.86	0.33	0.56
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	194	63	14	9	10
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	142	133	549	236	398
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	27	22	65	32	49
Magnesium	7439-95-4	1	mg/L	18	19	94	38	67
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.004	0.003	0.002	0.003	0.002
Nickel	7440-02-0	0.001	mg/L	0.006	0.004	0.007	0.004	0.002
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.08	0.10	0.05	0.06	0.05
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.01	<0.01	0.02	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	0.01	0.03	<0.01	0.72	0.82
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.04	<0.01	0.74	0.82
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	4.1	4.5	0.4	0.3	0.2
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	4.2	4.6	0.5	0.4	0.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 24	Site 30	Site 39	Site 40	Site 42
				Client sampling date / time	30-Nov-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00
Compound	CAS Number	LOR	Unit		EB1829489-010	EB1829489-011	EB1829489-012	EB1829489-013	EB1829489-014
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		4.2	4.6	0.5	1.1	1.0
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.51	0.39	0.11	0.20	0.17
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		0.03	0.05	<0.01	0.02	0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		28	57	13	7	<1
Volume	----	0.01	L		0.1	0.15	0.5	1	1
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		21.4	21.1	23.6	22.8	19.7
2-Chlorophenol-D4	93951-73-6	1.0	%		50.6	56.7	62.5	64.2	56.1
2.4.6-Tribromophenol	118-79-6	1.0	%		39.1	48.8	52.1	58.9	43.3
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		85.2	81.5	84.3	94.4	80.5
Anthracene-d10	1719-06-8	1.0	%		91.2	87.6	90.1	95.7	90.8

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	Site 24	Site 30	Site 39	Site 40	Site 42
				Client sampling date / time	30-Nov-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00	01-Dec-2018 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1829489-010**	**EB1829489-011**	**EB1829489-012**	**EB1829489-013**	**EB1829489-014**
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**117**	**114**	**118**	**124**	**130**

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2.4.6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1829489**	Page	: 1 of 8
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 03-Dec-2018
Site	:	Issue Date	: 10-Dec-2018
Sampler	: DAVID MOORE AND BYRON HEFFERNON	No. of samples received	: 14
Order number	:	No. of samples analysed	: 14

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural						
Site 24	----	----	----	03-Dec-2018	02-Dec-2018	**1**
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural						
Site 24	----	----	----	03-Dec-2018	02-Dec-2018	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
PAH/Phenols (GC/MS - SIM)	0	19	0.00	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**03-Dec-2018**	29-Dec-2018	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 24	**30-Nov-2018**	**----**	----	----	**03-Dec-2018**	28-Dec-2018	✓
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**04-Dec-2018**	08-Dec-2018	✓
Clear Plastic Bottle - Natural (EA025H)							
Site 24	**30-Nov-2018**	**----**	----	----	**04-Dec-2018**	07-Dec-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**06-Dec-2018**	29-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 24	**30-Nov-2018**	**----**	----	----	**06-Dec-2018**	28-Dec-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**06-Dec-2018**	29-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 24	**30-Nov-2018**	**----**	----	----	**06-Dec-2018**	28-Dec-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**06-Dec-2018**	30-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 24	**30-Nov-2018**	**----**	----	----	**06-Dec-2018**	29-May-2019	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**06-Dec-2018**	29-Dec-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 24	**30-Nov-2018**	**----**	----	----	**06-Dec-2018**	28-Dec-2018	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**06-Dec-2018**	29-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 24	**30-Nov-2018**	**----**	----	----	**06-Dec-2018**	28-Dec-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**03-Dec-2018**	03-Dec-2018	✓
Clear Plastic Bottle - Natural (EK057G)							
Site 24	**30-Nov-2018**	**----**	----	----	**03-Dec-2018**	02-Dec-2018	✗
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**06-Dec-2018**	29-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 24	**30-Nov-2018**	**----**	----	----	**06-Dec-2018**	28-Dec-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**05-Dec-2018**	29-Dec-2018	✓	**05-Dec-2018**	29-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 24	**30-Nov-2018**	**05-Dec-2018**	28-Dec-2018	✓	**05-Dec-2018**	28-Dec-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**05-Dec-2018**	29-Dec-2018	✓	**05-Dec-2018**	29-Dec-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 24	**30-Nov-2018**	**05-Dec-2018**	28-Dec-2018	✓	**05-Dec-2018**	28-Dec-2018	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**03-Dec-2018**	03-Dec-2018	✓
Clear Plastic Bottle - Natural (EK071G)							
Site 24	**30-Nov-2018**	**----**	----	----	**03-Dec-2018**	02-Dec-2018	×
EP008: Chlorophyll a & Pheophytin a							
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**----**	----	----	**04-Dec-2018**	22-Dec-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 33	**26-Nov-2018**	**----**	----	----	**04-Dec-2018**	17-Dec-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 2R, Site 3, Site 6, Site 7	**27-Nov-2018**	**----**	----	----	**04-Dec-2018**	18-Dec-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 16, Site 11	**28-Nov-2018**	**----**	----	----	**04-Dec-2018**	19-Dec-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 14, Site 2	**29-Nov-2018**	**----**	----	----	**04-Dec-2018**	20-Dec-2018	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 24	**30-Nov-2018**	**----**	----	----	**04-Dec-2018**	21-Dec-2018	✓
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM))							
Site 30, Site 39, Site 40, Site 42	**01-Dec-2018**	**06-Dec-2018**	08-Dec-2018	✓	**06-Dec-2018**	15-Jan-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM))							
Site 24	**30-Nov-2018**	**06-Dec-2018**	07-Dec-2018	✓	**06-Dec-2018**	15-Jan-2019	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	8	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	19	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Suspended Solids (High Level)	EA025H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Salinity	EA020-EC-P	WATER	In house: Referenced to APHA 2520B. Calculation from Electrical conductivity. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Organic Nitrogen as N (TKN - NH3) (discrete analyser)	EK060G	WATER	In house: Referenced to APHA 4500-Norg/4500-NH3. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Chlorophyll a and Pheophytin a	EP008	WATER	In house: Referenced to APHA 10200 H. The pigments are extracted into aqueous acetone. The optical density of the extract before and after acidification at both 664 nm and 665 nm is determined spectrometrically.
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 3/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 48 Callemondah Drive Gladstone QLD 4680 Ph: 07 4978 7944 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 3-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5/585 Mai Ph: 02 4014 2500 E: sam

NOWRA 4/13 Geary Plac Ph: 02 4423 2063 E: nowra

PERTH 10 Hod Way Ma Ph: 08 9209 7655 E: sam

Environmental Division
Brisbane
Work Order Reference
EB1903762

Telephone: + 61-7-3243 7222

Road Smithfield NSW 2164 sydney@alsglobal.com

Court Bohle QLD 4818 nvironmental@alsglobal.com

h Black Drive, Nth Wollongong NSW 2500 y@alsglobal.com

CLIENT: Eco Logical Australia	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☒ Standard TAT (List due date):	
OFFICE: Brisbane		☐ Non Standard or urgent TAT (List due date):	
PROJECT: Inland Rail - Border to Gowrie EIS PROJECT NO 10558	ALS QUOTE NO.: BN/142/18 V2	COC SEQUENCE	
ORDER NUMBER: PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	COC: 1 2 3	
PROJECT MANAGER: Miles Yeates CONTACT PH: 0467 738 954		OF: 1 2 3	
SAMPLER: David Moore and Emma Blacklock SAMPLER MOBILE:	RELINQUISHED BY: David Moore	RECEIVED BY: Liam C	RECEIVED BY:
COC Emailed to ALS? (YES / NO) EDD FORMAT (or default):	DATE/TIME: 16:50 14/2/2019	DATE/TIME: 16:50 14/2/19	DATE/TIME:
Email Reports to (will default to PM if no other addresses are listed): miles@ecoaus.com.au		DATE/TIME:	
Email Invoice to (will default to PM if no other addresses are listed): miles@ecoaus.com.au			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

.Y (Circle)

pon Yes No N/A

Yes No N/A

ceipt: °C

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP008 Chlorophyll a (filter paper method)	All metals samples are field filtered. Frozen Chlorophyll a filter paper samples are included in this work order. Filter paper is 47mm GFF ~0.7 micron. Filtered volume is noted below and on jar. Filter paper was foil wrapped and kept frozen at minus 17°C up to delivery.
1	Site 2	11/2/19 - 12 noon	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL
2	Site 2R	11/2/19 - 12 noon	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL
3	Site 23	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL
4	Site 18	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 700 mL
5	Site 7	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 600 mL
6	Site 6	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL
7	Site 3	12/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL
8	Site 14	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL
9	Site 27	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 100 mL
10	Site 16	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 50 mL
11	Site 24	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL
12	Site 11	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL
13	Site 26	13/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 100 mL
14	Site 30	14/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 210 mL
15	Site 32	14/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 150 mL
16	Site 39	14/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 350 mL
17	Site 42	14/02/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL
18	DUP	12/02/2019 - 7 am	W		6	X	X	X	X	X	X	X		2 extra amber bottles QA/QC
19	FB	12/02/2019 - 7 am	W		4	X	X	X	X	X	X	X		
				TOTAL	95									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic; V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle, SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; Lf = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1903762**	Page	: 1 of 15
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Contact	: Customer Services EB
Address	: PO BOX 1422 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 8536 8667	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 14-Feb-2019 16:50
Order number	:	Date Analysis Commenced	: 14-Feb-2019
C-O-C number	: ----	Issue Date	: 21-Feb-2019 17:17
Sampler	: DAVID MOORE AND EMMA BLACKLOCK		
Site	:		
Quote number	: BN/142/18 V2		
No. of samples received	: 19		
No. of samples analysed	: 19		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Minh Wills	2IC Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075(SIM): Sample EB1903762-018 (DUP) shows poor matrix spike recovery due to matrix interference. Insufficient sample for re-extraction and re-analysis.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **FILTER** (Matrix: **WATER**)			Client sample ID	Site 2	Site 2R	Site 23	Site 18	Site 7
			Client sampling date / time	11-Feb-2019 12:00	11-Feb-2019 12:00	12-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1903762-001**	**EB1903762-002**	**EB1903762-003**	**EB1903762-004**	**EB1903762-005**
				Result	Result	Result	Result	Result
EP008: Chlorophyll a & Pheophytin a								
Chlorophyll a	----	1	mg/m³	**2**	**2**	**2**	**7**	**6**
Volume	----	0.01	L	**.5**	**.5**	**1**	**.7**	**.6**

Analytical Results

Sub-Matrix: **FILTER** (Matrix: **WATER**)				Client sample ID	Site 6	Site 3	Site 14	Site 27	Site 16
				Client sampling date / time	12-Feb-2019 07:00	12-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-006	EB1903762-007	EB1903762-008	EB1903762-009	EB1903762-010
					Result	Result	Result	Result	Result
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**5**	**12**	**6**	**53**	**54**
Volume	----	0.01	L		**.5**	**.5**	**.25**	**.1**	**.05**

Analytical Results

Sub-Matrix: **FILTER** (Matrix: **WATER**)				Client sample ID	Site 24	Site 11	Site 28	Site 30	Site 32
				Client sampling date / time	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	14-Feb-2019 07:00	14-Feb-2019 07:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1903762-011**	**EB1903762-012**	**EB1903762-013**	**EB1903762-014**	**EB1903762-015**
					Result	Result	Result	Result	Result
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**9**	**23**	**56**	**50**	**90**
Volume	----	0.01	L		**.25**	**.25**	**.1**	**.21**	**.15**

Analytical Results

Sub-Matrix: **FILTER** (Matrix: **WATER**)			Client sample ID	**Site 39**	**Site 42**	**----**	**----**	**----**
			Client sampling date / time	14-Feb-2019 07:00	14-Feb-2019 07:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1903762-016**	**EB1903762-017**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EP008: Chlorophyll a & Pheophytin a								
Chlorophyll a	----	1	mg/m³	**12**	**3**	**----**	**----**	**----**
Volume	----	0.01	L	**.35**	**1**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 2	Site 2R	Site 23	Site 18	Site 7
			Client sampling date / time	11-Feb-2019 12:00	11-Feb-2019 12:00	12-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00
Compound	CAS Number	LOR	Unit	EB1903762-001	EB1903762-002	EB1903762-003	EB1903762-004	EB1903762-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	228	230	289	339	450
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.11	0.11	0.14	0.16	0.21
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	23	24	8	18	12
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	78	78	90	99	88
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	13	13	23	28	17
Magnesium	7439-95-4	1	mg/L	11	11	8	7	11
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.003	0.002	0.002
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.07	0.03	0.03	0.03	0.05
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	0.17	0.16	<0.01	<0.01	0.03
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.17	0.16	<0.01	<0.01	0.03
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	0.5	0.6	1.4	1.2	1.0
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.6	0.6	1.4	1.2	1.0
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 2R	Site 23	Site 18	Site 7
				Client sampling date / time	11-Feb-2019 12:00	11-Feb-2019 12:00	12-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-001	EB1903762-002	EB1903762-003	EB1903762-004	EB1903762-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.8**	**0.8**	**1.4**	**1.2**	**1.0**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.16**	**0.16**	**0.10**	**0.10**	**0.04**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.13**	**0.13**	**0.02**	<0.01	<0.01
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**24.8**	**27.3**	**19.7**	**32.5**	**23.4**
2-Chlorophenol-D4	93951-73-6	1.0	%		**63.4**	**69.0**	**55.3**	**80.1**	**61.0**
2.4.6-Tribromophenol	118-79-6	1.0	%		**45.4**	**48.7**	**43.8**	**58.7**	**43.4**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**72.5**	**79.8**	**74.9**	**96.5**	**77.0**
Anthracene-d10	1719-06-8	1.0	%		**77.0**	**85.3**	**53.5**	**66.5**	**53.8**
4-Terphenyl-d14	1718-51-0	1.0	%		**78.0**	**85.3**	**53.7**	**66.4**	**54.8**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 6	Site 3	Site 14	Site 27	Site 16
				Client sampling date / time	12-Feb-2019 07:00	12-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-006	EB1903762-007	EB1903762-008	EB1903762-009	EB1903762-010
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		428	392	335	546	688
EA020EC: Salinity									
Salinity	----	0.01	g/kg		0.20	0.19	0.16	0.26	0.33
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		12	8	39	74	170
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		81	79	64	195	112
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		16	15	6	37	25
Magnesium	7439-95-4	1	mg/L		10	10	12	25	12
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		0.002	0.002	0.002	0.002	0.003
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0.002
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	0.007	0.002
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.05	0.04	0.05	0.05	0.06
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	0.01	0.02
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	0.01	0.02
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L		1.2	1.0	1.6	2.2	4.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		1.2	1.0	1.6	2.2	4.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 6	Site 3	Site 14	Site 27	Site 16
				Client sampling date / time	12-Feb-2019 07:00	12-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-006	EB1903762-007	EB1903762-008	EB1903762-009	EB1903762-010
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.2	1.0	1.6	2.2	4.2
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.06	0.06	0.07	0.23	0.31
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		24.5	25.5	27.4	23.7	25.1
2-Chlorophenol-D4	93951-73-6	1.0	%		62.8	60.7	61.4	56.5	58.9
2.4.6-Tribromophenol	118-79-6	1.0	%		39.6	35.3	33.0	31.5	42.6
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		77.4	74.0	81.7	75.7	76.5
Anthracene-d10	1719-06-8	1.0	%		55.1	50.8	57.9	53.3	54.4
4-Terphenyl-d14	1718-51-0	1.0	%		56.2	52.2	59.0	53.5	54.3

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 24	Site 11	Site 28	Site 30	Site 32
			Client sampling date / time	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	14-Feb-2019 07:00	14-Feb-2019 07:00
Compound	CAS Number	LOR	Unit	EB1903762-011	EB1903762-012	EB1903762-013	EB1903762-014	EB1903762-015
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	306	259	557	406	614
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.14	0.12	0.27	0.19	0.30
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	60	23	73	35	95
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	65	55	156	128	204
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	13	12	26	25	37
Magnesium	7439-95-4	1	mg/L	8	6	22	16	27
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.003	0.003	0.005	0.001	0.003
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.001	<0.001	0.002	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.006	<0.001	0.012	0.003	0.011
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.04	0.07	0.06	0.09
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	1.8	2.2	5.1	1.4	3.7
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.8	2.2	5.2	1.5	3.8
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 24	Site 11	Site 28	Site 30	Site 32
				Client sampling date / time	13-Feb-2019 07:00	13-Feb-2019 07:00	13-Feb-2019 07:00	14-Feb-2019 07:00	14-Feb-2019 07:00
Compound	CAS Number	LOR	Unit		EB1903762-011	EB1903762-012	EB1903762-013	EB1903762-014	EB1903762-015
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.8	2.2	5.2	1.5	3.8
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.35	0.15	0.43	0.18	0.43
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		0.07	<0.01	0.02	<0.01	0.03
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		25.9	25.7	21.6	19.8	25.4
2-Chlorophenol-D4	93951-73-6	1.0	%		65.7	66.7	38.5	49.0	63.0
2.4.6-Tribromophenol	118-79-6	1.0	%		43.0	50.6	19.8	23.5	49.2
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		79.3	79.1	68.8	69.7	75.2
Anthracene-d10	1719-06-8	1.0	%		56.6	54.1	45.6	49.1	52.7
4-Terphenyl-d14	1718-51-0	1.0	%		55.0	54.1	45.8	49.0	52.2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 39	Site 42	DUP	FB	----
				Client sampling date / time	14-Feb-2019 07:00	14-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00	----
Compound	CAS Number	LOR	Unit		EB1903762-016	EB1903762-017	EB1903762-018	EB1903762-019	--------
					Result	Result	Result	Result	---
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**2850**	**1450**	**424**	**1**	----
EA020EC: Salinity									
Salinity	----	0.01	g/kg		**1.48**	**0.73**	**0.20**	<0.01	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**30**	**8**	**14**	<5	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		**801**	**482**	**81**	<1	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**42**	**43**	**16**	<1	----
Magnesium	7439-95-4	1	mg/L		**169**	**91**	**10**	<1	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	**0.002**	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		**0.001**	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L		**0.006**	**0.002**	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.06**	**0.06**	**0.06**	**0.01**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.69**	<0.01	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.71**	<0.01	<0.01	----
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L		**0.9**	**0.3**	**0.9**	<0.1	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.0**	**0.4**	**1.0**	<0.1	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 39	Site 42	DUP	FB	----
				Client sampling date / time	14-Feb-2019 07:00	14-Feb-2019 07:00	12-Feb-2019 07:00	12-Feb-2019 07:00	----
Compound	CAS Number	LOR	Unit		EB1903762-016	EB1903762-017	EB1903762-018	EB1903762-019	--------
					Result	Result	Result	Result	---
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**1.0**	**1.1**	**1.0**	<0.1	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.08**	**0.02**	**0.06**	<0.01	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**21.8**	**25.4**	**25.8**	**28.6**	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**47.1**	**57.4**	**62.8**	**68.1**	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**31.7**	**40.5**	**55.4**	**77.7**	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**64.9**	**75.5**	**74.3**	**74.8**	----
Anthracene-d10	1719-06-8	1.0	%		**44.9**	**52.1**	**50.4**	**84.6**	----
4-Terphenyl-d14	1718-51-0	1.0	%		**46.5**	**54.7**	**52.7**	**103**	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2.4.6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1903762**	Page	: 1 of 13
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 14-Feb-2019
Site	:	Issue Date	: 21-Feb-2019
Sampler	: DAVID MOORE AND EMMA BLACKLOCK	No. of samples received	: 19
Order number	:	No. of samples analysed	: 19

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons	EB1903762--018	DUP	**Pyrene**	129-00-0	61.8 %	70-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Days overdue	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Days overdue
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural						
Site 2, Site 2R	----	----	----	14-Feb-2019	13-Feb-2019	**1**
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural						
Site 2, Site 2R	----	----	----	14-Feb-2019	13-Feb-2019	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
PAH/Phenols (GC/MS - SIM)	1	35	2.86	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
PAH/Phenols (GC/MS - SIM)	1	35	2.86	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Evaluation	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**19-Feb-2019**	11-Mar-2019	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**19-Feb-2019**	12-Mar-2019	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**19-Feb-2019**	13-Mar-2019	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**19-Feb-2019**	14-Mar-2019	✓
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**15-Feb-2019**	18-Feb-2019	✓
Clear Plastic Bottle - Natural (EA025H)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**15-Feb-2019**	19-Feb-2019	✓
Clear Plastic Bottle - Natural (EA025H)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**15-Feb-2019**	20-Feb-2019	✓
Clear Plastic Bottle - Natural (EA025H)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**15-Feb-2019**	21-Feb-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**19-Feb-2019**	11-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**19-Feb-2019**	12-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**19-Feb-2019**	13-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**19-Feb-2019**	14-Mar-2019	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**19-Feb-2019**	11-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**19-Feb-2019**	12-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**19-Feb-2019**	13-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**19-Feb-2019**	14-Mar-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**19-Feb-2019**	10-Aug-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**19-Feb-2019**	11-Aug-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**19-Feb-2019**	12-Aug-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**19-Feb-2019**	13-Aug-2019	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**19-Feb-2019**	11-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**19-Feb-2019**	12-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**19-Feb-2019**	13-Mar-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**19-Feb-2019**	14-Mar-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**15-Feb-2019**	11-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**15-Feb-2019**	12-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**15-Feb-2019**	13-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**15-Feb-2019**	14-Mar-2019	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**14-Feb-2019**	13-Feb-2019	×
Clear Plastic Bottle - Natural (EK057G)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**14-Feb-2019**	14-Feb-2019	✓
Clear Plastic Bottle - Natural (EK057G)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**14-Feb-2019**	15-Feb-2019	✓
Clear Plastic Bottle - Natural (EK057G)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**14-Feb-2019**	16-Feb-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**15-Feb-2019**	11-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**15-Feb-2019**	12-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**15-Feb-2019**	13-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**15-Feb-2019**	14-Mar-2019	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 2, Site 2R	**11-Feb-2019**	**20-Feb-2019**	11-Mar-2019	✓	**20-Feb-2019**	11-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**20-Feb-2019**	12-Mar-2019	✓	**20-Feb-2019**	12-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**20-Feb-2019**	13-Mar-2019	✓	**20-Feb-2019**	13-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**20-Feb-2019**	14-Mar-2019	✓	**20-Feb-2019**	14-Mar-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 2, Site 2R	**11-Feb-2019**	**20-Feb-2019**	11-Mar-2019	✓	**20-Feb-2019**	11-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**20-Feb-2019**	12-Mar-2019	✓	**20-Feb-2019**	12-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**20-Feb-2019**	13-Mar-2019	✓	**20-Feb-2019**	13-Mar-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**20-Feb-2019**	14-Mar-2019	✓	**20-Feb-2019**	14-Mar-2019	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**14-Feb-2019**	13-Feb-2019	×
Clear Plastic Bottle - Natural (EK071G)							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**----**	----	----	**14-Feb-2019**	14-Feb-2019	✓
Clear Plastic Bottle - Natural (EK071G)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**14-Feb-2019**	15-Feb-2019	✓
Clear Plastic Bottle - Natural (EK071G)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**14-Feb-2019**	16-Feb-2019	✓
EP008: Chlorophyll a & Pheophytin a							
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 2, Site 2R	**11-Feb-2019**	**----**	----	----	**14-Feb-2019**	04-Mar-2019	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 23, Site 18, Site 7, Site 6, Site 3	**12-Feb-2019**	**----**	----	----	**14-Feb-2019**	05-Mar-2019	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**----**	----	----	**14-Feb-2019**	06-Mar-2019	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008)							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**----**	----	----	**14-Feb-2019**	07-Mar-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM))							
Site 2, Site 2R	**11-Feb-2019**	**15-Feb-2019**	18-Feb-2019	✓	**19-Feb-2019**	27-Mar-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM))							
Site 23, Site 18, Site 7, Site 6, Site 3, DUP, FB	**12-Feb-2019**	**18-Feb-2019**	19-Feb-2019	✓	**19-Feb-2019**	30-Mar-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM))							
Site 14, Site 27, Site 16, Site 24, Site 11, Site 28	**13-Feb-2019**	**18-Feb-2019**	20-Feb-2019	✓	**19-Feb-2019**	30-Mar-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM))							
Site 30, Site 32, Site 39, Site 42	**14-Feb-2019**	**18-Feb-2019**	21-Feb-2019	✓	**19-Feb-2019**	30-Mar-2019	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	4	34	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	29	**10.34**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	4	30	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	4	31	**12.90**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	35	**2.86**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	4	31	**12.90**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	2	34	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	4	31	**12.90**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	2	34	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Suspended Solids (High Level)	EA025H	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	2	34	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	35	**2.86**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Salinity	EA020-EC-P	WATER	In house: Referenced to APHA 2520B. Calculation from Electrical conductivity. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Organic Nitrogen as N (TKN - NH3) (discrete analyser)	EK060G	WATER	In house: Referenced to APHA 4500-Norg/4500-NH3. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Chlorophyll a and Pheophytin a	EP008	WATER	In house: Referenced to APHA 10200 H. The pigments are extracted into aqueous acetone. The optical density of the extract before and after acidification at both 664 nm and 665 nm is determined spectrometrically.
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 5/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 46 Callemondah Drive Gladstone Qld 4680 Ph: 07 4978 7944 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

ORANGE 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555

TOWNSVILLE Ph: 07 4796 0600

WOLLONGONG Ph: 02 4225 3125

Environmental Division Brisbane

Work Order Reference

EB1911202

Telephone : +61-7-3243 7222

CLIENT: Eco Logical Australia	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☒ Standard TAT (List due date):	FOR LABORAT
OFFICE: Brisbane		☐ Non Standard or urgent TAT (List due date):	Custody Seal intac
PROJECT: Inland Rail - Border to Gowrie EIS PROJECT NO 10558	ALS QUOTE NO.: BN/142/18 V2	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7	Free ice / frozen ic receipt?
ORDER NUMBER: PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	OF: 1 2 3 4 5 6 7	Random Sample T
PROJECT MANAGER: Miles Yeates	CONTACT PH: 0467 738 954		Other comment:
SAMPLER: David Moore and Emma Blacklock	SAMPLER MOBILE:	RELINQUISHED BY: DM Moore	RECEIVED BY: DAN
COC Emailed to ALS? (YES)	EDD FORMAT (or default):	DATE/TIME: 2/5/19	DATE/TIME: 2/5/19 16:35
Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au			
Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: -18°C & 4°C

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020:EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-9A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP068 Chlorophyll a (filter paper method)	
1	Site 2	29/04/19 - 12 noon	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 850 mL
2	Site 2R	29/04/19 - 12 noon	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 850 mL
3	Site 3	30/04/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL
4	Site 6	30/04/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 800 mL
5	Site 7	30/04/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 750 mL
6	Site 11	30/04/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL
7	Site 14	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 250 mL
8	Site 16	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 12 mL
9	Site 18	1/05/2019 - 7 am	W	HT	5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL
10	Site 20R	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL
11	Site 23	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 600 mL
12	Site 27	2/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 125 mL
13	Site 28	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 75 mL
14	Site 29	1/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 300 mL
15	Site 30	2/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 150 mL
16	Site 39	2/05/2019 - 7 am	W		7	X	X	X	X	X	X	X	X	Chl a volume filtered: 700 mL, Two additional QA/QC bottles
17	Site 40	2/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 550 mL
18	Site 42	2/05/2019 - 7 am	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL
19	DUP	30/04/2019 - 7 am	W		4	X	X	X	X	X	X	X		
20	FB	30/04/2019 - 7 am	W		4	X	X	X	X	X	X	X		
				TOTAL	100									

All metals samples are field filtered.

Frozen Chlorophyll a filter paper samples are included in this work order. Filter paper is 47mm GFF ~0.7 micron. Filtered volume is noted below and on jar. Filter paper was foil wrapped and kept frozen at minus 17°C up to delivery.

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; U = Lugols Iodine Preserved Bottles, STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1911202**	Page	: 1 of 15
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Contact	: Customer Services EB
Address	: PO BOX 1422 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 8536 8667	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 02-May-2019 16:35
Order number	:	Date Analysis Commenced	: 02-May-2019
C-O-C number	: ----	Issue Date	: 10-May-2019 14:11
Sampler	: DAVID MOORE, EMMA BLACKLOCK		
Site	:		
Quote number	: BN/142/18 V2		
No. of samples received	: 20		
No. of samples analysed	: 20		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Santusha Pandra	Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 2	Site 2R	Site 3	Site 6	Site 7
			Client sampling date / time	29-Apr-2019 12:00	29-Apr-2019 12:00	30-Apr-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	CAS Number	LOR	Unit	EB1911202-001	EB1911202-002	EB1911202-003	EB1911202-004	EB1911202-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	210	211	419	428	425
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.10	0.10	0.20	0.21	0.21
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	10	7	12	10	6
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	93	93	99	99	102
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	16	16	20	20	21
Magnesium	7439-95-4	1	mg/L	13	13	12	12	12
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.003	0.003	0.002	0.001	0.002
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.001	0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.003	0.002	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.03	0.02	0.02	0.03	0.03
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	0.09
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	0.09
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	0.5	0.4	1.6	1.1	1.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.5	0.4	1.6	1.1	1.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 2R	Site 3	Site 6	Site 7
				Client sampling date / time	29-Apr-2019 12:00	29-Apr-2019 12:00	30-Apr-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-001	EB1911202-002	EB1911202-003	EB1911202-004	EB1911202-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.5**	**0.4**	**1.6**	**1.1**	**1.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.08**	**0.06**	**0.08**	**0.04**	**0.04**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.04**	**0.03**	<0.01	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**5**	**4**	**65**	**10**	**14**
Volume	----	0.01	L		**0.85**	**0.85**	**0.25**	**0.8**	**0.75**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**33.3**	**36.2**	**31.4**	**29.2**	**30.8**
2-Chlorophenol-D4	93951-73-6	1.0	%		**74.4**	**82.3**	**71.4**	**67.9**	**70.6**
2.4.6-Tribromophenol	118-79-6	1.0	%		**62.5**	**69.1**	**61.5**	**60.0**	**59.0**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**83.6**	**91.6**	**78.5**	**75.6**	**77.7**
Anthracene-d10	1719-06-8	1.0	%		**73.4**	**76.6**	**71.3**	**67.2**	**68.0**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	Site 2	Site 2R	Site 3	Site 6	Site 7
				Client sampling date / time	29-Apr-2019 12:00	29-Apr-2019 12:00	30-Apr-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1911202-001**	**EB1911202-002**	**EB1911202-003**	**EB1911202-004**	**EB1911202-005**
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**81.8**	**88.2**	**78.5**	**73.6**	**73.6**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 11	Site 14	Site 16	Site 18	Site 20R
				Client sampling date / time	30-Apr-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-006	EB1911202-007	EB1911202-008	EB1911202-009	EB1911202-010
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		293	349	1240	314	152
EA020EC: Salinity									
Salinity	----	0.01	g/kg		0.14	0.17	0.62	0.15	0.08
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		104	44	2170	8	10
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		73	83	179	118	72
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		16	7	42	34	19
Magnesium	7439-95-4	1	mg/L		8	16	18	8	6
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		0.001	0.001	0.004	0.001	0.003
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	0.002	0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		0.002	0.002	0.009	0.002	0.004
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	0.008
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.02	0.03	1.50	0.02	0.02
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	0.05	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	0.02	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	0.07	<0.01	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L		5.7	2.3	29.6	0.8	1.6
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		5.7	2.3	31.1	0.8	1.6
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 11	Site 14	Site 16	Site 18	Site 20R
				Client sampling date / time	30-Apr-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-006	EB1911202-007	EB1911202-008	EB1911202-009	EB1911202-010
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		5.7	2.3	31.2	0.8	1.6
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.33	0.10	3.93	0.04	0.32
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	0.10
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		460	16	545	4	21
Volume	----	0.01	L		0.25	0.25	0.012	1	0.5
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		28.3	25.5	28.2	30.9	25.8
2-Chlorophenol-D4	93951-73-6	1.0	%		67.4	60.4	67.3	71.6	64.6
2.4.6-Tribromophenol	118-79-6	1.0	%		64.9	39.8	60.8	48.6	49.8
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		71.6	59.4	57.6	69.3	61.4
Anthracene-d10	1719-06-8	1.0	%		67.0	66.1	59.8	52.9	68.9

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**Site 11**	**Site 14**	**Site 16**	**Site 18**	**Site 20R**
				Client sampling date / time	30-Apr-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1911202-006**	**EB1911202-007**	**EB1911202-008**	**EB1911202-009**	**EB1911202-010**
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**74.0**	**75.4**	**67.6**	**85.6**	**77.7**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 23	Site 27	Site 28	Site 29	Site 30
			Client sampling date / time	01-May-2019 07:00	02-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	02-May-2019 07:00
Compound	CAS Number	LOR	Unit	EB1911202-011	EB1911202-012	EB1911202-013	EB1911202-014	EB1911202-015
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	286	230	307	300	445
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.14	0.11	0.15	0.14	0.21
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	18	214	175	48	70
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	116	102	149	177	192
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	30	21	30	33	34
Magnesium	7439-95-4	1	mg/L	10	12	18	23	26
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	0.001	0.003	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	0.002	0.005	0.005	0.001
Nickel	7440-02-0	0.001	mg/L	0.003	0.008	0.011	0.015	0.006
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.02	0.08	0.04	0.03	0.03
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	0.9	1.4	1.5	1.8	3.3
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.9	1.5	1.5	1.8	3.3
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 23	Site 27	Site 28	Site 29	Site 30
				Client sampling date / time	01-May-2019 07:00	02-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	02-May-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-011	EB1911202-012	EB1911202-013	EB1911202-014	EB1911202-015
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.9**	**1.5**	**1.5**	**1.8**	**3.3**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	**0.51**	**0.31**	**0.66**	**0.38**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	**0.04**	**0.01**	**0.37**	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**7**	**24**	**26**	**18**	**72**
Volume	----	0.01	L		**0.6**	**0.125**	**0.075**	**0.3**	**0.15**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**29.5**	**26.4**	**26.2**	**23.7**	**24.3**
2-Chlorophenol-D4	93951-73-6	1.0	%		**70.6**	**62.8**	**58.8**	**59.2**	**60.8**
2.4.6-Tribromophenol	118-79-6	1.0	%		**51.0**	**41.5**	**30.4**	**41.7**	**41.2**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**66.4**	**59.6**	**66.8**	**61.6**	**60.9**
Anthracene-d10	1719-06-8	1.0	%		**78.9**	**69.0**	**74.8**	**68.9**	**69.8**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	Site 23	Site 27	Site 28	Site 29	Site 30
				Client sampling date / time	01-May-2019 07:00	02-May-2019 07:00	01-May-2019 07:00	01-May-2019 07:00	02-May-2019 07:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1911202-011**	**EB1911202-012**	**EB1911202-013**	**EB1911202-014**	**EB1911202-015**
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**92.2**	**81.3**	**87.4**	**81.2**	**83.7**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 39	Site 40	Site 42	DUP	FB
			Client sampling date / time	02-May-2019 07:00	02-May-2019 07:00	02-May-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	CAS Number	LOR	Unit	EB1911202-016	EB1911202-017	EB1911202-018	EB1911202-019	EB1911202-020
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1810	673	835	433	<1
EA020EC: Salinity								
Salinity	----	0.01	g/kg	0.92	0.33	0.41	0.21	<0.01
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	20	26	12	9	<5
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	720	290	367	99	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	87	37	48	20	<1
Magnesium	7439-95-4	1	mg/L	122	48	60	12	<1
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.010	0.003	0.003	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.02	0.05	0.03	0.02
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.02	0.02	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	0.07	0.90	1.25	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.07	0.92	1.27	<0.01	<0.01
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	0.6	0.3	0.2	1.0	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.6	0.3	0.2	1.0	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 39	Site 40	Site 42	DUP	FB
				Client sampling date / time	02-May-2019 07:00	02-May-2019 07:00	02-May-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	CAS Number	LOR	Unit		EB1911202-016	EB1911202-017	EB1911202-018	EB1911202-019	EB1911202-020
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.7**	**1.2**	**1.5**	**1.0**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	**0.06**	**0.04**	**0.04**	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	**0.02**	**0.02**	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**31**	**4**	**2**	**----**	**----**
Volume	----	0.01	L		**0.7**	**0.55**	**1**	**----**	**----**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**28.2**	**23.5**	**28.8**	**30.9**	**32.6**
2-Chlorophenol-D4	93951-73-6	1.0	%		**65.5**	**58.5**	**66.4**	**70.2**	**79.1**
2.4.6-Tribromophenol	118-79-6	1.0	%		**36.8**	**32.8**	**49.2**	**57.8**	**64.5**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**72.8**	**60.7**	**69.6**	**76.4**	**86.3**
Anthracene-d10	1719-06-8	1.0	%		**84.2**	**70.3**	**66.0**	**71.8**	**81.4**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	Site 39	Site 40	Site 42	DUP	FB
				Client sampling date / time	02-May-2019 07:00	02-May-2019 07:00	02-May-2019 07:00	30-Apr-2019 07:00	30-Apr-2019 07:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1911202-016**	**EB1911202-017**	**EB1911202-018**	**EB1911202-019**	**EB1911202-020**
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**100**	**87.3**	**75.1**	**75.8**	**93.3**

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2.4.6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1911202**	Page	: 1 of 13
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 02-May-2019
Site	:	Issue Date	: 10-May-2019
Sampler	: DAVID MOORE, EMMA BLACKLOCK	No. of samples received	: 20
Order number	:	No. of samples analysed	: 20

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural						
Site 2, Site 2R	----	----	----	02-May-2019	01-May-2019	**1**
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural						
Site 2, Site 2R	----	----	----	02-May-2019	01-May-2019	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
PAH/Phenols (GC/MS - SIM)	1	39	2.56	10.00	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)					
Suspended Solids (High Level)	4	30	13.33	15.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
PAH/Phenols (GC/MS - SIM)	1	39	2.56	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**03-May-2019**	29-May-2019	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**03-May-2019**	30-May-2019	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**03-May-2019**	27-May-2019	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**03-May-2019**	28-May-2019	✓
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**03-May-2019**	08-May-2019	✓
Clear Plastic Bottle - Natural (EA025H)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**03-May-2019**	09-May-2019	✓
Clear Plastic Bottle - Natural (EA025H)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**03-May-2019**	06-May-2019	✓
Clear Plastic Bottle - Natural (EA025H)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**03-May-2019**	07-May-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**08-May-2019**	29-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**08-May-2019**	30-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**08-May-2019**	27-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**08-May-2019**	28-May-2019	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**08-May-2019**	29-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**08-May-2019**	30-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**08-May-2019**	27-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**08-May-2019**	28-May-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**08-May-2019**	28-Oct-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**08-May-2019**	29-Oct-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**08-May-2019**	26-Oct-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**08-May-2019**	27-Oct-2019	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**08-May-2019**	29-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**08-May-2019**	30-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**08-May-2019**	27-May-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**08-May-2019**	28-May-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**02-May-2019**	29-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**02-May-2019**	30-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**02-May-2019**	27-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**02-May-2019**	28-May-2019	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**02-May-2019**	03-May-2019	✓
Clear Plastic Bottle - Natural (EK057G)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**02-May-2019**	04-May-2019	✓
Clear Plastic Bottle - Natural (EK057G)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**02-May-2019**	01-May-2019	×
Clear Plastic Bottle - Natural (EK057G)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**02-May-2019**	02-May-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**02-May-2019**	29-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**02-May-2019**	30-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**02-May-2019**	27-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**02-May-2019**	28-May-2019	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**07-May-2019**	29-May-2019	✓	**07-May-2019**	29-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**07-May-2019**	30-May-2019	✓	**07-May-2019**	30-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 2, Site 2R	**29-Apr-2019**	**07-May-2019**	27-May-2019	✓	**07-May-2019**	27-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**07-May-2019**	28-May-2019	✓	**07-May-2019**	28-May-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**07-May-2019**	29-May-2019	✓	**07-May-2019**	29-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**07-May-2019**	30-May-2019	✓	**07-May-2019**	30-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 2, Site 2R	**29-Apr-2019**	**07-May-2019**	27-May-2019	✓	**07-May-2019**	27-May-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**07-May-2019**	28-May-2019	✓	**07-May-2019**	28-May-2019	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**02-May-2019**	03-May-2019	✓
Clear Plastic Bottle - Natural (EK071G)							
Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**02-May-2019**	04-May-2019	✓
Clear Plastic Bottle - Natural (EK071G)							
Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**02-May-2019**	01-May-2019	×
Clear Plastic Bottle - Natural (EK071G)							
Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**----**	----	----	**02-May-2019**	02-May-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP008: Chlorophyll a & Pheophytin a							
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**----**	----	----	**02-May-2019**	22-May-2019	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**----**	----	----	**02-May-2019**	23-May-2019	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 2, Site 2R	**29-Apr-2019**	**----**	----	----	**02-May-2019**	20-May-2019	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 3, Site 6, Site 7, Site 11	**30-Apr-2019**	**----**	----	----	**02-May-2019**	21-May-2019	✓
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 14, Site 16, Site 18, Site 20R, Site 23, Site 28, Site 29	**01-May-2019**	**07-May-2019**	08-May-2019	✓	**07-May-2019**	16-Jun-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 27, Site 30, Site 39, Site 40, Site 42	**02-May-2019**	**07-May-2019**	09-May-2019	✓	**07-May-2019**	16-Jun-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 2, Site 2R	**29-Apr-2019**	**03-May-2019**	06-May-2019	✓	**07-May-2019**	12-Jun-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 3, Site 6, Site 7, Site 11, DUP, FB	**30-Apr-2019**	**03-May-2019**	07-May-2019	✓	**07-May-2019**	12-Jun-2019	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	3	26	**11.54**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	4	35	**11.43**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	26	**11.54**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	39	**2.56**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	3	30	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	3	39	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	4	30	**13.33**	**15.00**	×	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	3	39	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Suspended Solids (High Level)	EA025H	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	39	**2.56**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Salinity	EA020-EC-P	WATER	In house: Referenced to APHA 2520B. Calculation from Electrical conductivity. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Organic Nitrogen as N (TKN - NH3) (discrete analyser)	EK060G	WATER	In house: Referenced to APHA 4500-Norg/4500-NH3. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Chlorophyll a and Pheophytin a	EP008	WATER	In house: Referenced to APHA 10200 H. The pigments are extracted into aqueous acetone. The optical density of the extract before and after acidification at both 664 nm and 665 nm is determined spectrometrically.
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.

Environmental Division
Brisbane
Work Order Reference
EB1912777

CHAIN OF CUSTODY

ALS Laboratory, please tick →

ADELAIDE 3/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 48 Callemondah Drive Gladstone QLD 4680 Ph: 07 4978 7941 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 129 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Ph: 02 8784 8555 E:

TOWNSVILLE 14- Ph: 07 4796 0600 E:

WOLLONGONG 1 Ph: 02 4225 3125 E:

Telephone : + 61-7-3243 7222

CLIENT: Eco Logical Australia	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☒ Standard TAT (List due date):	FOR LABORATOR
OFFICE: Brisbane		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact?
PROJECT: Inland Rail - Border to Gowrie EIS PROJECT NO 10558	ALS QUOTE NO.: BN/142/18 V2	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bri
ORDER NUMBER: PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Miles Yeates CONTACT PH: 0467 738 954		OF: 1 2 3 4 5 6 7	Other comment:

SAMPLER: David Moore and Emily Messer	SAMPLER MOBILE:	RELINQUISHED BY:	RECEIVED BY: ANDREA U
COC Emailed to ALS? (NO)	EDD FORMAT (or default):	DATE/TIME: 20/5/19 7.50 pm	DATE/TIME: 20.5.19 7.50
Email Reports to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au		RELINQUISHED BY:	RECEIVED BY: DON
Email Invoice to (will default to PM if no other addresses are listed): milesy@ecoaus.com.au		DATE/TIME:	DATE/TIME: 20/5/19 7.50

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS (MATRIX: Solid(S) Water(W))			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) (Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required))								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	EA020-EC-P Conductivity and Salinity	EA025H Total Suspended Solids (TSS)	NT-1C Total Hardness as CaCO3	NT-8A Nutrients suite - Ammonia as N, Nitrite, Nitrate, Total N, TKN, NOx, Reactive P and Total P	EK060 Organic Nitrogen	W-2 Dissolved metals - 8 metals suite (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg) - samples are field filtered	EP075B SIM PAHs (16 analytes)	EP008 Chlorophyll a (filter paper method)	
1	Site 2	16/5/19 1200	W		5	X	X	X	X	X	X	X	X	All metals samples are field filtered. Frozen Chlorophyll a filter paper samples are included in this work order. Filter paper is 47mm GFF ~0.7 micron. Filtered volume is noted below and on jar. Filter paper was foil wrapped and kept frozen at minus 17°C up to delivery. Chl a volume filtered: 650mL
2	Site 6R	16/5/19 1200	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 500 mL
3	Site 7	16/5/19 1200	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000mL
4	Site 18	17/5/19 1200	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL
5	Site 42	18/5/19 1200	W		5	X	X	X	X	X	X	X	X	Chl a volume filtered: 1,000 mL
6	DUP	16/5/19 1200	W		6	X	X	X	X	X	X	X		+2 04/QC bottles
7	FB	16/5/19 1200	W		4	X	X	X	X	X	X	X		
				TOTAL	35									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; [illegible] = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag. LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

HT

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1912777**	Page	: 1 of 8
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Contact	: Customer Services EB
Address	: PO BOX 1422 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 8536 8667	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 20-May-2019 07:50
Order number	:	Date Analysis Commenced	: 20-May-2019
C-O-C number	: ----	Issue Date	: 28-May-2019 09:01
Sampler	: DAVID MOORE, EMILY MESSER		
Site	:		
Quote number	: BN/142/18 V2		
No. of samples received	: 7		
No. of samples analysed	: 7		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Santusha Pandra	Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 6R	Site 7	Site 18	Site 42
				Client sampling date / time	16-May-2019 12:00	16-May-2019 12:00	16-May-2019 12:00	17-May-2019 12:00	18-May-2019 12:00
Compound	CAS Number	LOR	Unit		EB1912777-001	EB1912777-002	EB1912777-003	EB1912777-004	EB1912777-005
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		290	437	440	320	1290
EA020EC: Salinity									
Salinity	----	0.01	g/kg		0.14	0.21	0.21	0.15	0.64
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		12	11	6	14	<5
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		70	86	93	101	509
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		15	18	19	29	62
Magnesium	7439-95-4	1	mg/L		8	10	11	7	86
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		0.002	0.001	0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	0.002	0.002
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.02	0.03	0.05	0.02	0.03
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	0.02
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.02	<0.01	0.24	<0.01	1.38
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.02	<0.01	0.24	<0.01	1.40
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser									
Organic Nitrogen as N	----	0.1	mg/L		0.7	1.1	1.0	0.8	0.2
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.7	1.1	1.0	0.8	0.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site 2	Site 6R	Site 7	Site 18	Site 42
				Client sampling date / time	16-May-2019 12:00	16-May-2019 12:00	16-May-2019 12:00	17-May-2019 12:00	18-May-2019 12:00
Compound	CAS Number	LOR	Unit		EB1912777-001	EB1912777-002	EB1912777-003	EB1912777-004	EB1912777-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.7**	**1.1**	**1.2**	**0.8**	**1.6**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.03**	**0.03**	**0.02**	**0.04**	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**7**	**11**	**7**	**5**	**1**
Volume	----	0.01	L		**0.65**	**0.5**	**1**	**1**	**1**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**30.4**	**28.9**	**25.5**	**34.0**	**27.9**
2-Chlorophenol-D4	93951-73-6	1.0	%		**84.6**	**80.4**	**68.5**	**93.3**	**69.9**
2.4.6-Tribromophenol	118-79-6	1.0	%		**60.0**	**54.1**	**40.3**	**51.4**	**25.2**
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**82.5**	**80.7**	**79.6**	**95.6**	**84.0**
Anthracene-d10	1719-06-8	1.0	%		**57.3**	**57.4**	**77.9**	**104**	**83.3**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	Site 2	Site 6R	Site 7	Site 18	Site 42
				Client sampling date / time	16-May-2019 12:00	16-May-2019 12:00	16-May-2019 12:00	17-May-2019 12:00	18-May-2019 12:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1912777-001**	**EB1912777-002**	**EB1912777-003**	**EB1912777-004**	**EB1912777-005**
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates - Continued									
4-Terphenyl-d14	1718-51-0	1.0	%		**60.8**	**61.4**	**82.5**	**112**	**89.7**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	DUP	FB	----	----	----
			Client sampling date / time	16-May-2019 12:00	16-May-2019 12:00	----	----	----
Compound	CAS Number	LOR	Unit	EB1912777-006	EB1912777-007	--------	--------	--------
				Result	Result	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**435**	<1	----	----	----
EA020EC: Salinity								
Salinity	----	0.01	g/kg	**0.21**	<0.01	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**7**	<5	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**93**	<1	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**19**	<1	----	----	----
Magnesium	7439-95-4	1	mg/L	**11**	<1	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	**0.001**	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.05**	<0.01	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.24**	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.24**	<0.01	----	----	----
EK060G:Organic Nitrogen as N (TKN-NH3) By Discrete Analyser								
Organic Nitrogen as N	----	0.1	mg/L	**1.0**	<0.1	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.0**	<0.1	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP	FB	----	----	----
				Client sampling date / time	16-May-2019 12:00	16-May-2019 12:00	----	----	----
Compound	CAS Number	LOR	Unit		EB1912777-006	EB1912777-007	--------	--------	--------
					Result	Result	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**1.2**	<0.1	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	<0.01	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	----	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	----	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	----	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	----	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	----	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	----	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	----	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**25.6**	**29.6**	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**70.1**	**78.5**	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**39.0**	**34.8**	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**72.4**	**82.0**	----	----	----
Anthracene-d10	1719-06-8	1.0	%		**57.3**	**89.2**	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		**63.3**	**95.6**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2.4.6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1912777**	Page	: 1 of 9
Client	: **ECO LOGICAL AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MILES YEATES	Telephone	: +61-7-3243 7222
Project	: 10558 Inland Rail - Border to Gowie EIS	Date Samples Received	: 20-May-2019
Site	:	Issue Date	: 28-May-2019
Sampler	: DAVID MOORE, EMILY MESSER	No. of samples received	: 7
Order number	:	No. of samples analysed	: 7

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural						
Site 2, Site 6R, Site 7, DUP, FB	----	----	----	20-May-2019	18-May-2019	**2**
Clear Plastic Bottle - Natural						
Site 18	----	----	----	20-May-2019	19-May-2019	**1**
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural						
Site 2, Site 6R, Site 7, DUP, FB	----	----	----	20-May-2019	18-May-2019	**2**
Clear Plastic Bottle - Natural						
Site 18	----	----	----	20-May-2019	19-May-2019	**1**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**22-May-2019**	13-Jun-2019	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 18	**17-May-2019**	**----**	----	----	**22-May-2019**	14-Jun-2019	✓
Clear Plastic Bottle - Natural (EA010-P)							
Site 42	**18-May-2019**	**----**	----	----	**22-May-2019**	15-Jun-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**21-May-2019**	23-May-2019	✓
Clear Plastic Bottle - Natural (EA025H) Site 18	**17-May-2019**	**----**	----	----	**21-May-2019**	24-May-2019	✓
Clear Plastic Bottle - Natural (EA025H) Site 42	**18-May-2019**	**----**	----	----	**21-May-2019**	25-May-2019	✓
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**25-May-2019**	13-Jun-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 18	**17-May-2019**	**----**	----	----	**25-May-2019**	14-Jun-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 42	**18-May-2019**	**----**	----	----	**25-May-2019**	15-Jun-2019	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**25-May-2019**	13-Jun-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 18	**17-May-2019**	**----**	----	----	**25-May-2019**	14-Jun-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Site 42	**18-May-2019**	**----**	----	----	**25-May-2019**	15-Jun-2019	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**25-May-2019**	12-Nov-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) Site 18	**17-May-2019**	**----**	----	----	**25-May-2019**	13-Nov-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) Site 42	**18-May-2019**	**----**	----	----	**25-May-2019**	14-Nov-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**27-May-2019**	13-Jun-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) Site 18	**17-May-2019**	**----**	----	----	**27-May-2019**	14-Jun-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) Site 42	**18-May-2019**	**----**	----	----	**27-May-2019**	15-Jun-2019	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**20-May-2019**	13-Jun-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) Site 18	**17-May-2019**	**----**	----	----	**20-May-2019**	14-Jun-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) Site 42	**18-May-2019**	**----**	----	----	**20-May-2019**	15-Jun-2019	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**20-May-2019**	18-May-2019	×
Clear Plastic Bottle - Natural (EK057G) Site 18	**17-May-2019**	**----**	----	----	**20-May-2019**	19-May-2019	×
Clear Plastic Bottle - Natural (EK057G) Site 42	**18-May-2019**	**----**	----	----	**20-May-2019**	20-May-2019	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**20-May-2019**	13-Jun-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) Site 18	**17-May-2019**	**----**	----	----	**20-May-2019**	14-Jun-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) Site 42	**18-May-2019**	**----**	----	----	**20-May-2019**	15-Jun-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**22-May-2019**	13-Jun-2019	✓	**22-May-2019**	13-Jun-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) Site 18	**17-May-2019**	**22-May-2019**	14-Jun-2019	✓	**22-May-2019**	14-Jun-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) Site 42	**18-May-2019**	**22-May-2019**	15-Jun-2019	✓	**22-May-2019**	15-Jun-2019	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**22-May-2019**	13-Jun-2019	✓	**22-May-2019**	13-Jun-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) Site 18	**17-May-2019**	**22-May-2019**	14-Jun-2019	✓	**22-May-2019**	14-Jun-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) Site 42	**18-May-2019**	**22-May-2019**	15-Jun-2019	✓	**22-May-2019**	15-Jun-2019	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**----**	----	----	**20-May-2019**	18-May-2019	×
Clear Plastic Bottle - Natural (EK071G) Site 18	**17-May-2019**	**----**	----	----	**20-May-2019**	19-May-2019	×
Clear Plastic Bottle - Natural (EK071G) Site 42	**18-May-2019**	**----**	----	----	**20-May-2019**	20-May-2019	✓
EP008: Chlorophyll a & Pheophytin a							
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 2, Site 6R, Site 7	**16-May-2019**	**----**	----	----	**21-May-2019**	06-Jun-2019	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 18	**17-May-2019**	**----**	----	----	**21-May-2019**	07-Jun-2019	✓
Glass Fibre Filter Paper (Chlorophyll) (EP008) Site 42	**18-May-2019**	**----**	----	----	**21-May-2019**	08-Jun-2019	✓
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 2, Site 6R, Site 7, DUP, FB	**16-May-2019**	**21-May-2019**	23-May-2019	✓	**23-May-2019**	30-Jun-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 18	**17-May-2019**	**21-May-2019**	24-May-2019	✓	**23-May-2019**	30-Jun-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) Site 42	**18-May-2019**	**21-May-2019**	25-May-2019	✓	**23-May-2019**	30-Jun-2019	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	3	29	**10.34**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	6	29	**20.69**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Suspended Solids (High Level)	EA025H	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Salinity	EA020-EC-P	WATER	In house: Referenced to APHA 2520B. Calculation from Electrical conductivity. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Organic Nitrogen as N (TKN - NH3) (discrete analyser)	EK060G	WATER	In house: Referenced to APHA 4500-Norg/4500-NH3. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Chlorophyll a and Pheophytin a	EP008	WATER	In house: Referenced to APHA 10200 H. The pigments are extracted into aqueous acetone. The optical density of the extract before and after acidification at both 664 nm and 665 nm is determined spectrometrically.
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.

Appendix E: Significant Impact Assessment – Murray Cod

A significant impact assessment is completed in the following tables in relation to the Significant Impact Guidelines of the EPBC Act (DotE 2013) and the draft referral guidelines for the Murray Cod (DotE 2016).

Significant Impact Guidelines of the EPBC Act for Vulnerable species (DotE 2013)

Significant impact criteria	Significant impact	Response to criteria
Lead to a long-term decrease in the size of an important population of a species	No	The recovery plan for Murray Cod identifies two important populations in the impact assessment area – the Queensland Border Rivers and upland reaches of the Condamine River. These are recognised for their representation as upland populations, evidence of natural recruitment and largely intact fish community. The Project will result in only localised disturbance to habitat for Murray Cod in a small number of locations. Impacts are not expected to affect the species at a population level.
Reduce the area of occupancy of an important population	No	The recovery plan for Murray Cod identifies two important populations in the impact assessment area – the Queensland Border Rivers and upland reaches of the Condamine River. These are recognised for their representation as upland populations, evidence of natural recruitment and largely intact fish community. The area of occupancy is unlikely to be affected by the Project. Bridges will be constructed over waterways in preference to culverts and fish passage will be accommodated in accordance with requirements of the *Fisheries Act 1994*. This will avoid reducing occupancy of a population or fragmenting a population.
Fragment an existing important population into two or more populations	No	
Adversely affect habitat critical to the survival of the species	No	Habitat critical to the survival of the species is defined in the draft referral guidelines (DotE 2016) as follows: "Any section of a waterway that comprises a connected system of habitats suitable for sustained use by a Murray cod population for sheltering, foraging, breeding and upstream and downstream movement is considered by the Department to be habitat critical to the survival of the species." Habitat critical to survival of the species is present within the impact assessment area, including in the Macintyre River and Macintyre Brook. However, impacts on these areas will be small in scale and localised. With the implementation of mitigation

© ECO LOGICAL AUSTRALIA PTY LTD

Significant impact criteria	Significant impact	Response to criteria
		measures, habitat critical to the survival of the species will not be adversely affected.
Disrupt the breeding cycle of an important population	No	The recovery plan for Murray Cod identifies two important populations in the impact assessment area – the Queensland Border Rivers and upland reaches of the Condamine River. These are recognised for their representation as upland populations, evidence of natural recruitment and largely intact fish community. Impacts on hydrology of the watercourses and waterways (important for breeding) will be minimised through design and fish passage will be maintained. This is an important mitigation measure to avoid impacts to important populations in upland areas.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No	Impacts to habitat will be localised and very small in scale, confined to a small number of crossings of large river systems in the impact assessment area. Bridges will be constructed at crossings in preference to culverts, minimising the disturbance of habitat features on stream banks and beds.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No	A range of invasive weed species are known to occur within the impact assessment area and the surrounding landscape. The clearing for infrastructure may facilitate the spread of invasive weed species in to species habitat. Hygiene procedures and a weed management plan is to be implemented to minimise the risk of introduction of weed species. The proposed Project is unlikely to heighten the risk of harm from existing pest species. The project is unlikely to introduce any non-native fish species, which is a key threat to the Murray Cod.
Introduce disease that may cause the species to decline	No	Currently, there is little known about diseases harmful to Murray Cod. Most relate to the introduction of noxious species from overseas. There is no evidence to suggest that the presence of Project infrastructure would introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	No	The Project is unlikely to interfere substantially with the recovery of the species, given the small scale of impacts on habitat and localised nature of disturbance.

Draft Referral Guidelines for the Murray Cod (DotE 2016)

The draft referral guidelines for Murray Cod provide species specific guidance on what factors may be high, medium and low risk of having significant impacts on the Murray Cod. An analysis of the potential impacts from the Project against the high and medium risk factors has been undertaken below.

Referral Guidelines risk factors for significant impacts	Significant impact	Response to Guidelines
Adverse affects on habitat critical to survival of the species		
Removing, modifying or degrading the structural elements of a significant proportion of the habitat	No	Where disturbance occurs to habitat critical to survival of the Murray Cod, this will be limited to small and localised areas and will not affect a significant proportion of habitat.
Causing the sedimentation of a significant proportion of the habitat causing a divergence of greater than 1.5 °C from the monthly median water temperature of a waterway in which the habitat occurs	No	The Project will have only localised impacts to water temperature and will not influence the overall temperature of waterways in which Murray Cod has been found. Localised changes to water temperature arising from shading from bridge structures or clearing of riparian vegetation are unlikely to influence the monthly median water temperature by more than 1.5 °C.
Reducing the water quality (especially relating to temperature, dissolved oxygen, acidity, salinity, chemical pollutants) of a significant proportion of the habitat outside the applicable minimum or maximum thresholds presented in the Australian and New Zealand guidelines for fresh and marine water quality: Volume 1 (2000) (ANZECC guidelines)	No	Water quality studies for the Project have demonstrated that water quality is impaired throughout the waterways of the impact assessment area due to current and ongoing land uses. Impacts on water quality from the Project are expected to be short-term during construction and localised to the immediate area surrounding works.
Creating a barrier which fragments habitat or alters the existing flow regime or hydrology of the habitat, for example eliminating flood pulse flows, creating weir pool effects or degrading spawning sites with low-flow accumulations of algal/periphytic growth or silt	No	Impacts of the Project on hydrology are likely to be minor and localised. Fish passage will be retained.
Adverse affects on an important population of the species		
Removing, modifying or degrading the structural elements of a significant proportion of habitat which the population may rely on for sheltering, foraging or breeding	No	Alterations to structural elements of habitat will be localised in scale and will not affect a significant proportion of habitat.

© ECO LOGICAL AUSTRALIA PTY LTD

Referral Guidelines risk factors for significant impacts	Significant impact	Response to Guidelines
Fragmenting the population or substantially inhibiting the population's breeding cycle, larval recruitment or the exchange of genetic material by restricting the upstream or downstream movement of the population, including freely drifting larvae	No	The Project will not cause fragmentation of the population of Murray Cod. Fish passage will be retained.
Disrupting the activity of a breeding population in a manner which is likely to substantially diminish recruitment of larvae into the local population during a single breeding season	No	The activity of a breeding population will not be disrupted. Where possible, works in locations occupied by important populations (e.g. Macintyre River and Macintyre Brook) will be avoided during the Murray Cod breeding season.
Reducing its genetic diversity	No	The Project will not impact on the genetic diversity of the species.
Decreasing the size of the population or of any given life-history cohort of that population over the long-term	No	The Project is highly unlikely to decrease the size of the Murray Cod population or of a particular cohort of the species in the long term. Any impacts on individuals within the population will be short term, during construction, and are likely to result in the displacement of individuals for short distances.
Substantially decreasing the size of the population, or of any given life-history cohort of that population, to the extent that its reproductive capacity is likely to be substantially diminished in the succeeding one or more breeding seasons	No	
introducing a predatory or competitive native or alien fish species or pathogen that is likely to be detrimental to the population	No	The Project is unlikely to result in the introduction of a predatory or competitive fish species. Biosecurity procedures will be in place to avoid introducing exotic fish species from farm dams that are dewatered during Project activities.
Other criteria for assessment		
An action that is likely to adversely affect a large area of habitat, which does not meet the description in these guidelines of habitat critical to the survival of the species, by: • substantially reducing the water quality (especially relating to temperature, dissolved oxygen, acidity, salinity, chemical pollutants) outside the applicable minimum or maximum thresholds presented in the ANZECC guidelines	No	Water quality studies for the Project have demonstrated that water quality is impaired throughout the waterways of the impact assessment area due to current and ongoing land uses. Impacts on water quality and hydrology will be minor and localised to the immediate area surrounding works. Impacts will not be substantial in scale.

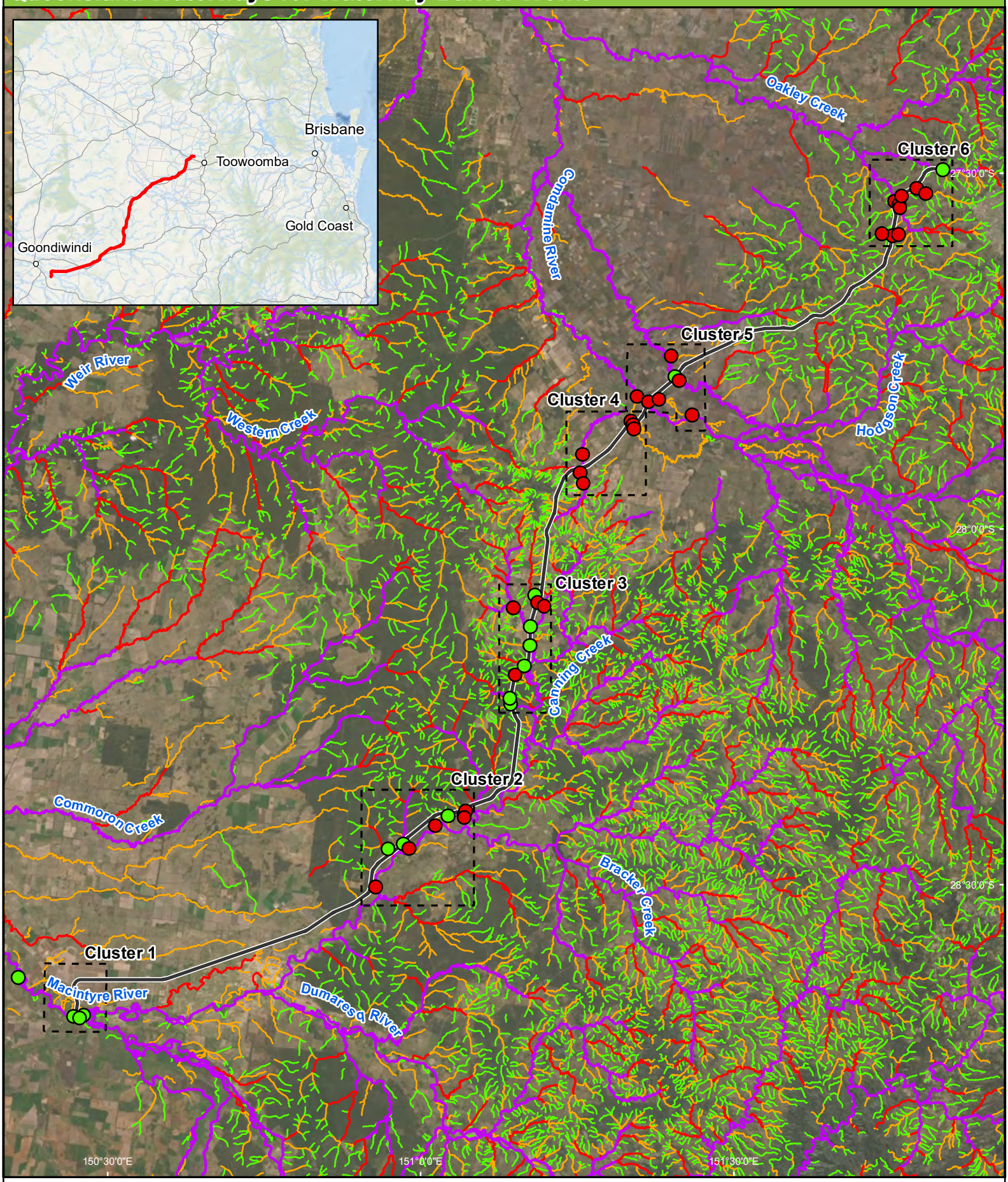
Referral Guidelines risk factors for significant impacts	Significant impact	Response to Guidelines
• substantially altering the existing flow regime or hydrology of the aquatic system		
An action that is likely to adversely affect a population, which is not considered an important population as indicated in these guidelines, by: • causing a long-term or substantial short-term decrease in the size of the population or of any given life-history cohort of that population, for example through an organised recreational fishing operation or event involving multiple anglers taking multiple Murray cod from an important population over a relatively short time period • causing a large reduction in the area of occupancy of the population • fragmenting the population or preventing the upstream or downstream movement of the population and the flow of genetic material • disrupting the activity of the breeding population in a manner which is likely to substantially diminish recruitment of larvae into the local population during a single breeding season • reducing the genetic diversity of the population • introducing a predatory or competitive native or alien fish species or pathogen that is likely to be detrimental to the population (such an impact could result from the action of an individual angler)	No	The Project does not involve angling or the take of Murray Cod. Any impacts on the species will be short term, localised and will not affect the area of occupancy of the species. Fish passage will be retained, allowing for continued movement of individuals and prey of the species. This will allow breeding migrations to continue. Larval recruitment of the species is unlikely to be affected by the project, with minimal, short term and localised impacts on hydrology and water quality. Biosecurity procedures will mitigate the risk of introducing pest species to habitat of the Murray Cod.

Appendix F: Maps showing the location of waterways that provide fish passage

The following map series shows the location of waterways that provide fish passage, as defined in the *Fisheries Act 1994*. Waterways are zoned according to the risk of impact on fish movement: Low risk (green), Moderate risk (amber), High risk (red) and Major risk (purple).

© ECO LOGICAL AUSTRALIA PTY LTD

Queensland Waterways for Waterway Barrier Works



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site
- B2G Aquatic Site Clusters

Queensland Waterways for Waterway Barrier Works

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major

0 10 20
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 15/06/2020

Macintyre Barwon Floodplain Water Quality Zone (Cluster 1 of 6)

Legend

Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Queensland Waterways for Waterway Barrier Works

- 1 - Low
- 2 - Moderate
- 4 - Major

0 1

Kilometers

Datum/Projection:
GDA 1994 MGA Zone 56

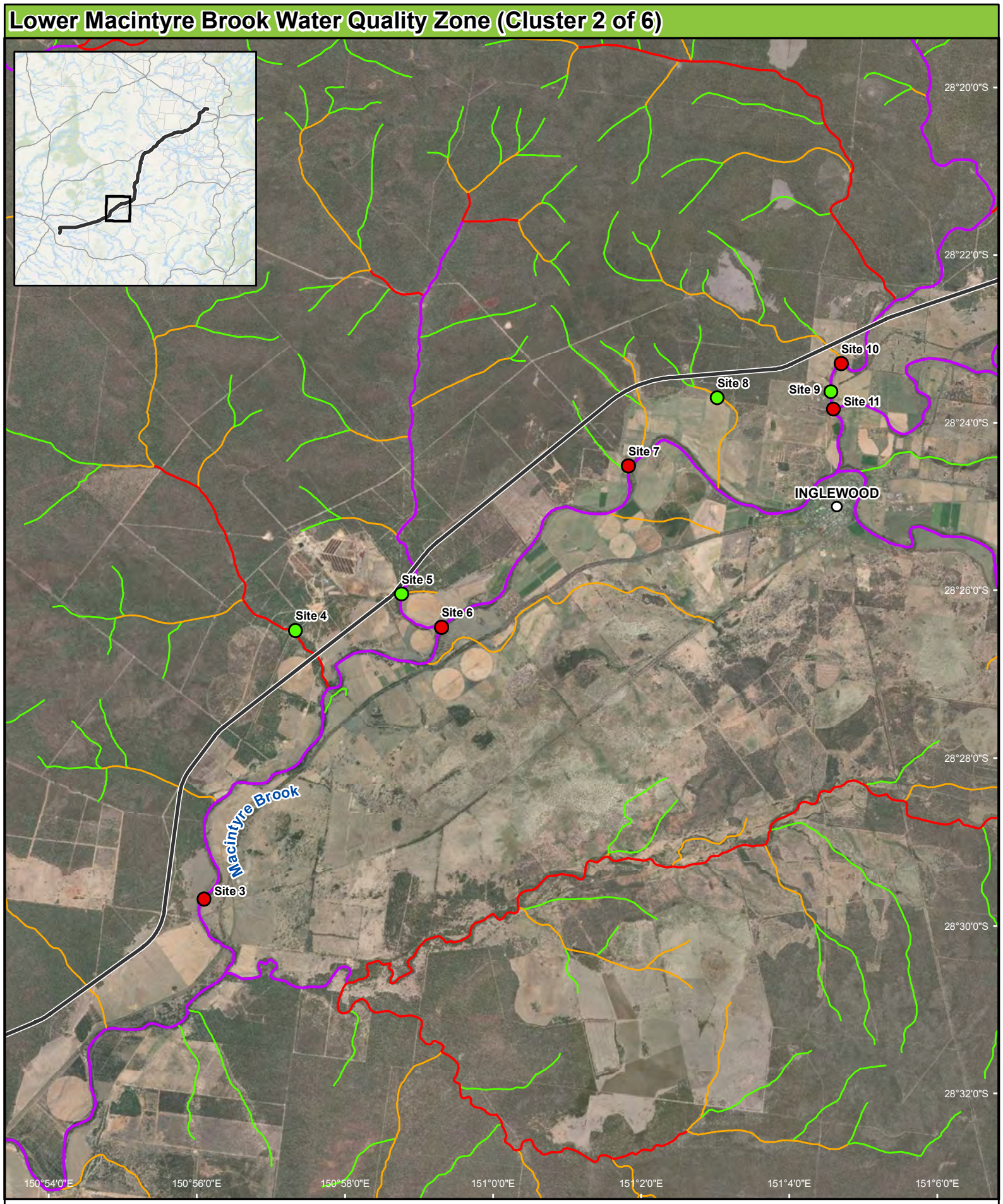
N

ecological AUSTRALIA

www.ecoaus.com.au

Prepared by: PH Date: 15/06/2020

Lower Macintyre Brook Water Quality Zone (Cluster 2 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Queensland Waterways for Waterway Barrier Works

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major

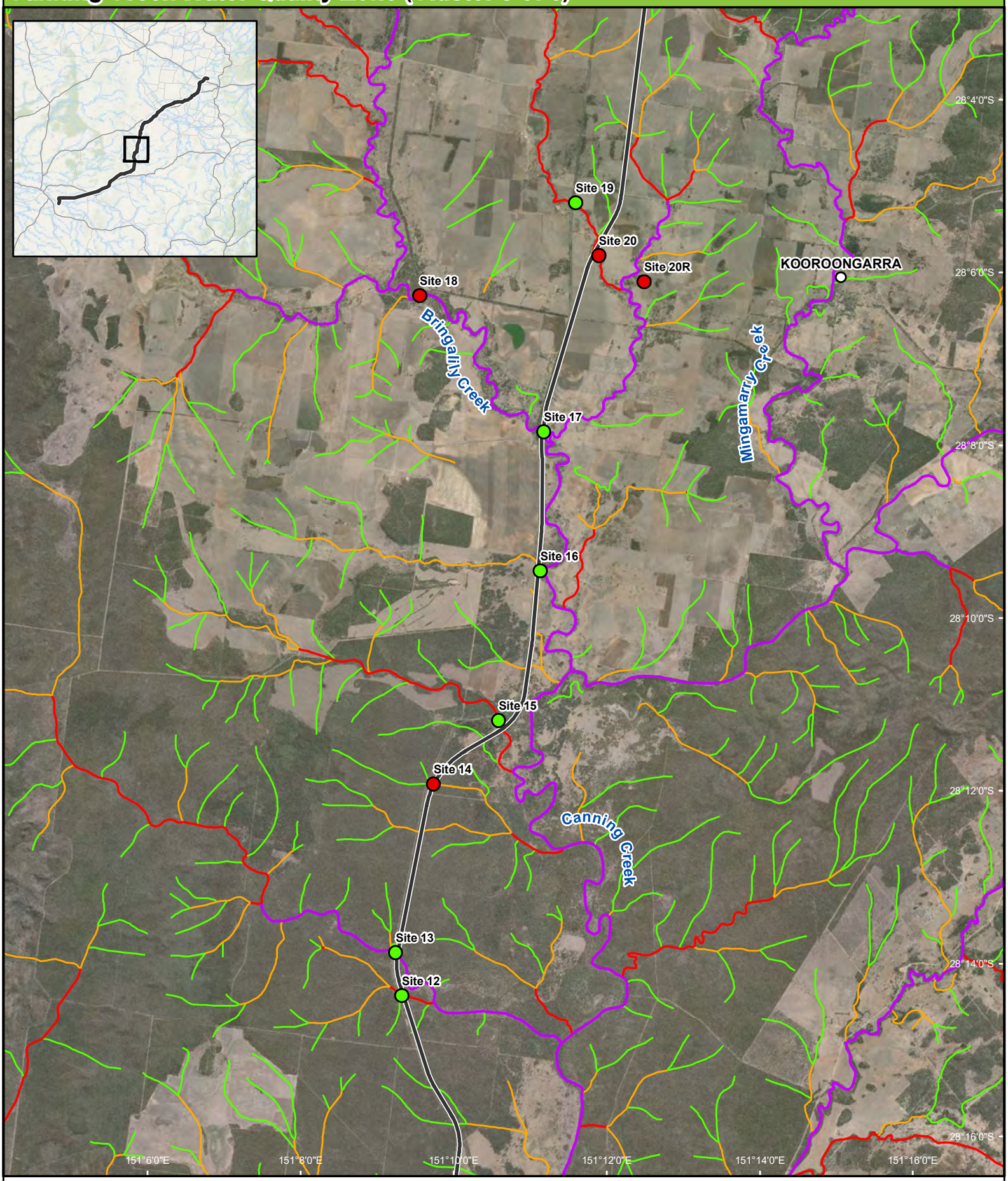
0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 15/06/2020

Canning Creek Water Quality Zone (Cluster 3 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Queensland Waterways for Waterway Barrier Works

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major

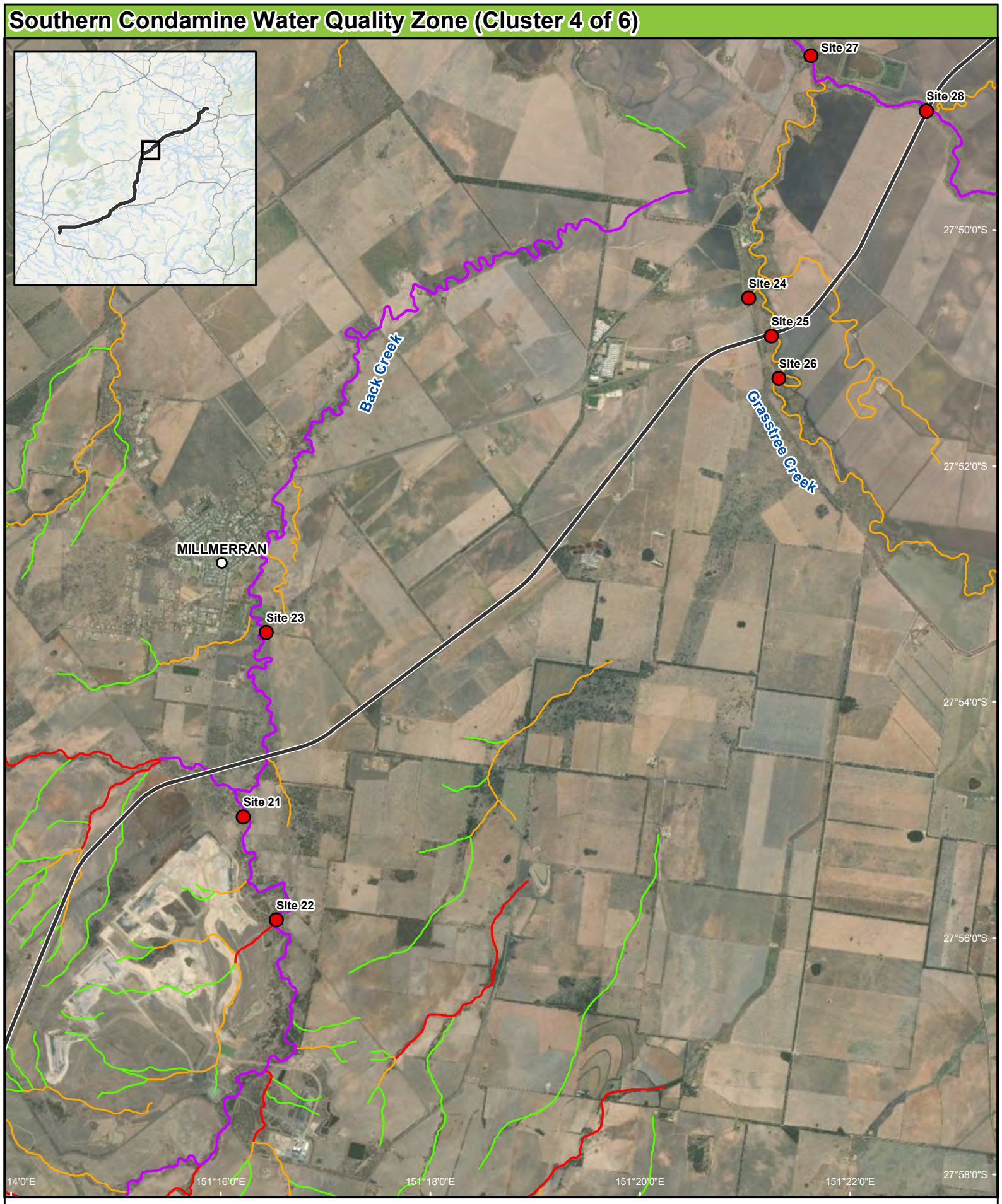
0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 15/06/2020

Southern Condamine Water Quality Zone (Cluster 4 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Queensland Waterways for Waterway Barrier Works

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major

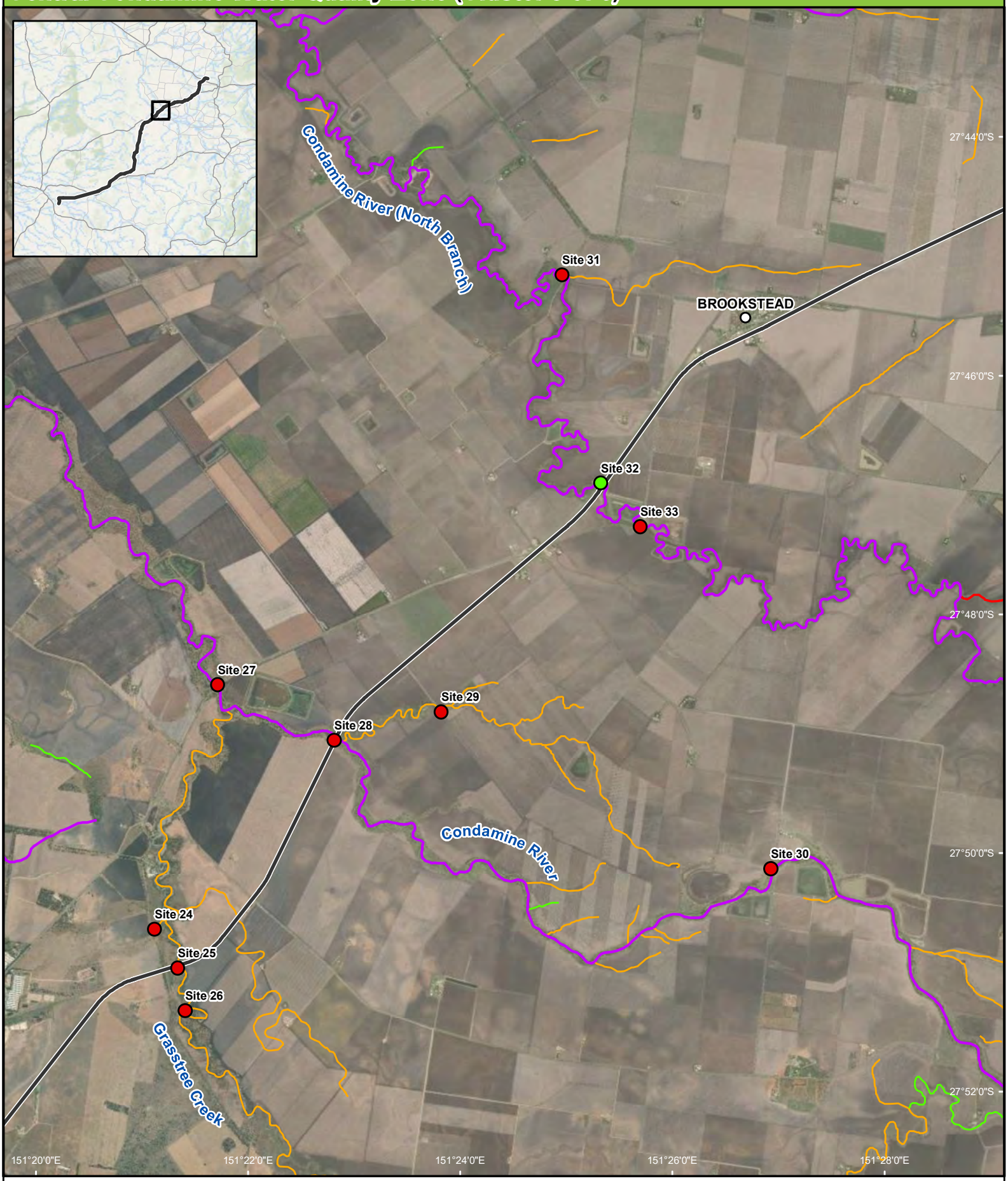
0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 15/06/2020

Central Condamine Water Quality Zone (Cluster 5 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Queensland Waterways for Waterway Barrier Works

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major

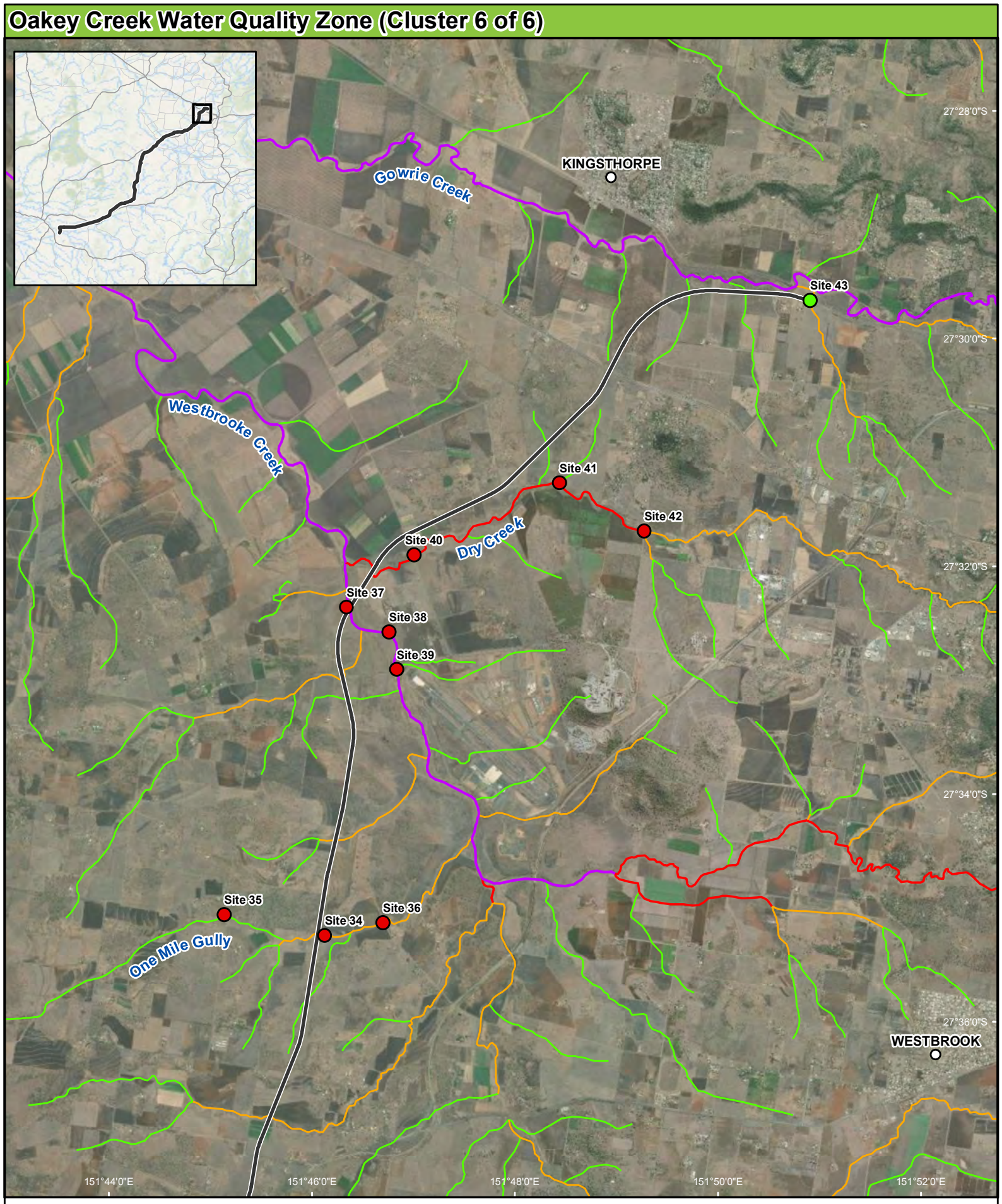
0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 15/06/2020

Oakey Creek Water Quality Zone (Cluster 6 of 6)



Legend

- Border to Gowrie Rail Alignment

B2G Sample Sites

- Aquatic Site
- Surface Water Site

Queensland Waterways for Waterway Barrier Works

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major

0 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 56

N

ecological AUSTRALIA
www.ecoaus.com.au

Prepared by: PH Date: 15/06/2020

ecological AUSTRALIA

bsi. ISO 14001 Environmental Management

bsi. AS/NZS 4801:2001 Occupational Health and Safety Management

bsi. ISO 9001 Quality Management

HEAD OFFICE
Suite 2, Level 3
668-672 Old Princes Highway
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 0145
F 02 9542 5622

COFFS HARBOUR
22 Ray McCarthy Drive
Coffs Harbour NSW 2450
T 02 6651 5484
F 02 6651 6890

PERTH
Level 1, Bishop's See
235 St Georges Terrace
Perth WA 6000
T 08 9227 1070
F 02 9542 5622

MELBOURNE
Level 1, 436 Johnston St
Abbotsford, VIC 3076
T 1300 646 131

SYDNEY
Suite 1, Level 1
101 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9542 5622

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 0125
F 02 9542 5622

ARMIDALE
92 Taylor Street
Armidale NSW 2350
T 02 8081 2685
F 02 9542 5622

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 9542 5622

BRISBANE
Suite 1, Level 3
471 Adelaide Street
Brisbane QLD 4000
T 07 3503 7192

HUSKISSON
Unit 1, 51 Owen Street
Huskisson NSW 2540
T 02 4201 2264
F 02 9542 5622

NAROOMA
5/20 Canty Street
Narooma NSW 2546
T 02 4302 1266
F 02 9542 5622

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1234
F 02 6372 9230

GOSFORD
Suite 5, Baker One
1-5 Baker Street
Gosford NSW 2250
T 02 4302 1221
F 02 9542 5622

ADELAIDE
2, 70 Pirie Street
Adelaide SA 5000
T 08 8470 6650
F 02 9542 5622

1300 646 131
www.ecoaus.com.au

0-0325-900-PES-00-RP-0001_0

Hydrobiology

eDNA SURVEY

BRISBANE | PERTH | SINGAPORE | PAPUA NEW GUINEA

ARTC INLAND RAIL

B22066

—

MARCH 2023

© Hydrobiology Pty Ltd 2023

Disclaimer: This document contains confidential information that is intended only for the use by Hydrobiology's Client. It is not for public circulation or publication or to be used by any third party without the express permission of either the Client or Hydrobiology Pty. Ltd. The concepts and information contained in this document are the property of Hydrobiology Pty Ltd. Use or copying of this document in whole or in part without the written permission of Hydrobiology Pty Ltd constitutes an infringement of copyright.

While the findings presented in this report are based on information that Hydrobiology considers reliable unless stated otherwise, the accuracy and completeness of source information cannot be guaranteed. Furthermore, the information compiled in this report addresses the specific needs of the client, so may not address the needs of third parties using this report for their own purposes. Thus, Hydrobiology and its employees accept no liability for any losses or damage for any action taken or not taken on the basis of any part of the contents of this report. Those acting on information provided in this report do so entirely at their own risk.

THIS COMPANY IS REGISTERED FOR GST.

STREET
1/22 Mayneview Street,
Milton 4064
QUEENSLAND

REGISTERED
c/- de Blonk Smith and
Young Accountants
GPO 119, Brisbane 4001
QUEENSLAND

POSTAL
PO Box 2151
Toowong 4066
QUEENSLAND

CONTACT
+61 (0)7 3721 0100 P
info@hydrobiology.biz

ABN 26 096 574 659

www.hydrobiology.biz

EXECUTIVE SUMMARY

Inland Rail is a 1,700 km rail freight project connecting Melbourne to Brisbane, divided into 13 sections. ARTC commissioned Hydrobiology to conduct eDNA surveys across the North Star to NSW/QLD Border, NSW/QLD Border to Gowrie, Helidon to Calvert, and Calvert to Kagaru sections, covering approximately 307 km of the Inland Rail. This survey was conducted to build on the existing investigations and reporting undertaken for a number of listed aquatic species. The eDNA survey targeted matters of national environmental significance (MNES) aquatic species, including Murray River cod (*Maccullochella peelii*), Mary River cod (*Maccullochella mariensis*), Australian lungfish (*Neoceratodus forsteri*) and silver perch (*Bidyanus bidyanus*). The eDNA survey also assessed the absence/presence of southern purple spotted gudgeon (*Mogurnda adspersa*) and olive perchlet (*Ambassis agassizii*), which are listed as endangered in NSW, and the platypus (*Ornithorhynchus anatinus*) which is listed as special least concern in Queensland. Habitat likelihood assessments were also conducted for the MNES species and the platypus.

MNES species the Murray River cod was detected at a total of four sites across two sections of the Inland Rail, detailed in Table 1-1. No eDNA for silver perch, Mary River cod or Australian lungfish were detected at any site within the study area. Platypus were detected at a total of five sites, all within the QLD/NSW border to Gowrie section. Olive perchlet and southern purple-spotted gudgeon were found at a total of six and four sites respectively, all of which were located within Queensland, where they are not listed as threatened. The lack of silver perch, Mary River cod and Australian lungfish is likely to be due to the absence of key habitat features (high flow rapids and races; macrophytes, respectively) and/or the distance from species endemic range. Most sites contained low to no-flow run and pool habitat within channels that were typically eroded, with signs of flood damage, had cleared riparian vegetation and contained a variety of microhabitat in the form of woody debris and detritus.

Habitat likelihood assessments were conducted for the MNES species and the platypus. The lack of high flow rapids and races and the absence of macrophyte beds throughout the surveyed area meant no sites were deemed as potential locations for the silver perch or Australian lungfish. However, for platypus and Murray River cod, a total of 11 and six sites, respectively were deemed as possible or likely locations for each species. A total of 10 sites contained suitable habitat for Mary River cod; however given the sites were outside their natural ranges and that fact that there were no eDNA detection or historical records for this species, they are considered unlikely to occur in the study area. Despite stocking efforts for a number of these species, it has been shown that such efforts do not result in improvements in natural populations.

Species specific habitat improvements were made for sites where target species were detected. Most suggestions focussed on increasing habitat complexity through the addition of natural and artificial structures, exclusion of livestock and through the regeneration or re-establishment of riparian vegetation.

Table 1-1 Sites where eDNA of MNES and MSES species were detected and Inland Rail sections.

Target species	Sites eDNA Positive	Inland Rail Section
platypus	B2G17, B2G23, B2G21, B2G22 and B2G28	QLD/NSW border to Gowrie
Murray River cod	NS2QB12, NS2QB21, and NS2QB11	North Star to QLD/NSW border
	B2G11	QLD/NSW border to Gowrie
Mary River cod	No detections	-
silver perch	No detections	-
Australian lungfish	No detections	-
olive perchlet	H2C4A and H2C18A	Helidon to Calvert
	C2K1, C2K6, C2K7 and C2K5	Calvert to Kagaru
southern purple-spotted gudgeon	B2G37	QLD/NSW border to Gowrie
	H2C12A, H2C4A and H2C3	Helidon to Calvert

contents

1. INTRODUCTION 9
1.1 Background 9
1.2 Objectives and Scope 9
1.3 Location 10
1.3.1 Inland Rail Sections 10
1.3.2 Local Basins and Catchments 12
1.4 Flow and Rainfall 13
1.5 Legislation Relevent to Listed Species 15
2. METHODS 16
2.1 eDNA Survey 16
2.1.1 Site Selection 16
2.1.2 Sample Collection 18
2.1.3 Extraction and Sequencing 19
2.2 Conservation Significant Species Likelihood 21
3. TARGET SPECIES 22
4. RESULTS AND DISCUSSION 27
4.1 Habitat 27
4.2 Species Likelihood of Occurences 38
4.3 Species Detections 43
4.3.1 Target Species Detections 43
4.3.2 Community Fish Assemblages 45
4.3.3 Other Vertebrates 46
4.4 Habitat Improvements 55
5. CONCLUSION 63
6. REFERENCES 65

APPENDIX A. EDNA RESULTS
APPENDIX B. QA/QC

tables

Table 1-1 Sites where eDNA of MNES and MSES species were detected and Inland Rail sections. 5

Table 1-1 Stream flow gauges located within the study area and the sites to which the flow data is relevant. 13

Table 2-1 Basin, catchment, watercourse and inland rail section of each sample site 17

Table 2-2 Criteria used for assigning likelihood of occurrences relevant to threatened and special least concern species 21

Table 4-1 Habitat notes and imagery of each site throughout study area 28

Table 4-2 Number of sites with favourable and unfavourable habitat features for each target species for the study area for each species. . 40

Table 4-3 Likelihood of target species being present at sites based on habitat features present/absent at each site typically observed with target species. Likelihood classification defined in Table 2-2. Grey indicates sites within basins that are outside of the natural distribution of the species – the Mary River cod is found in the Mary River in the North East Coast Basin while the Murray River cod and silver perch are endemic to the Murray Darling River basin. Bold text indicates where species were confirmed or are suspected to occur and the habitat likelihood assessment result of the site. 41

Table 4-4 eDNA detection results for targeted threatened fish and platypus across all sites. 52

Table 4-5 Favourable micro and macrohabitat features observed at each site where species were detected and suggestions for long and short term improvements of habitat. 59

Table 6-1 Taxonomic diversity in water samples detected using 12S assay targeting vertebrates. Presence of the species at each site is indicated by the symbol *. Bolded species name indicates target species. Taxonomy was assigned as per NCBI and classifications were standardised according to the Global Biodiversity Information Facility (accessed January 2023). A dash is used where a classification category does not exist for that taxa, and blank cells indicate where taxa could not be resolved to a lower taxonomic level. Blue text indicates taxa that are not recorded from the study area according to GBIF. 74

Table 6-2 Taxonomic diversity in blank field samples detected using 12S assay targeting vertebrates. Presence of a species eDNA is indicated by the symbol *. Bolded species name indicates target species. Taxonomy was assigned as per NCBI and classifications were standardised according to the Global Biodiversity Information Facility (accessed January 2023). A dash is used where a classification category does not exist for that taxa, and blank cells indicate where taxa could

not be resolved to a lower taxonomic level. Blue text indicates taxa that are not recorded from the surveyed area according to GBIF. 84

Table 6-3 Macrohabitat and microhabitat sampled for eDNA at each site and factors that affected eDNA sampling..... 90

figures

Figure 1-1 Map of inland rail project with sections distinguished 11

Figure 1-2 Stream flow (average cumecs/day) from gauges throughout the study area from June-December 2022. Survey dates are indicated by orange bracket.. A. Macintyre River, B. Macintyre Brook, C. Western Creek at Kuss Road, D. North Condamine River at Pampas. E. Gowrie Creek at Oakey, F. Logan River at Yarrahappini 14

Figure 2-1 Map of study area with surveyed sites, inland rail sections, major watercourses and catchment areas indicated 20

Figure 4-1 Platypus positive eDNA locations across the study area 48

Figure 4-2 Murray River cod positive eDNA locations across the study area 49

Figure 4-3 Olive perchlet positive eDNA locations across the study area 50

Figure 4-4 Southern purple-spotted gudgeon positive eDNA locations across the study area..... 51

1. INTRODUCTION

1.1 BACKGROUND

The Inland Rail project is a 1,700 km rail freight project connecting Melbourne to Brisbane via regional Victoria, News South Wales and Queensland (Figure 1-1). The project is being delivered by the Australian Government through the Australian Rail Track Corporation (ARTC) in partnership with the private sector.

The Inland Rail project is divided into 13 sections. Construction began in 2018 however the alignment of some sections are yet to be finalised. Currently, the Parkes to Narromine section has been completed and the Narrabri to North Star section is under construction in NSW while the remaining 11 sections are awaiting construction commencement. Approximately 1,100 km of the Inland Rail will utilise existing rail and infrastructure which will be updated, while approximately 600 km of new track and corresponding infrastructure is to be constructed.

1.2 OBJECTIVES AND SCOPE

Of the 13 sections of Inland Rail, Hydrobiology was commissioned to conduct eDNA sampling across four of these sections – the North Star to NSW/QLD Boarder, NSW/QLD Border to Gowrie, Helidon to Calvert, and Calvert to Kagaru, covering approximately 307 km of the Inland Rail.

The primary scope of this work involves the use of eDNA survey techniques to build on the existing investigations and reporting undertaken for the following matters of national environmental significance (MNES) and state significance (MSES) aquatic species, including:

- MNES:

  - Murray River cod (*Maccullochella peelii*).
  - Australian lungfish (*Neoceratodus forsteri*).
  - Mary River cod (*Maccullochella mariensis*). We note that Mary River cod is unlikely to occur in the noted Project sections; however they have been included in the defined eDNA survey at the request of ARTC to investigate potential presence as a result of stocking outside their natural distribution.
  - Silver perch (*Bidyanus bidyanus*). Again, we note that silver perch is unlikely to occur in the noted Project sections; however they have been included in the defined eDNA survey at the request of ARTC to investigate potential presence as a result of stocking outside their natural distribution.
- MSES:
  - Threatened southern purple-spotted gudgeon (*Mogurnda adspersa*) in NSW.
  - Threatened olive perchlet (*Ambassis agassizii*) in NSW.
  - Platypus (*Ornithorhynchus anatinus*), special least concern in Queensland.

Threatened turtles were not included in the eDNA surveys as turtle detection via eDNA methods is considered limited (i.e. turtles do not shed DNA as efficiently as fish, therefore detection is typically low and could result in many false negatives), while the use of eDNA as a survey tool for invertebrates such as the Darling River snail is still in its infancy and was therefore excluded.

Based on the eDNA and habitat surveys, recommendations regarding habitat improvements were also provided.

1.3 LOCATION

The eDNA survey and site assessments were conducted from the Macintyre River near Goondiwindi to Ipswich and Toowoomba. Sites were surveyed across four sections of Inland rail, with sites sampled within the Border Rivers, Balonne-Condamine, Brisbane and Logan-Albert catchments.

1.3.1 INLAND RAIL SECTIONS

This included the North Star to NSW/QLD Border, NSW/QLD Border to Gowrie, Helidon to Calvert, and Calvert to Kagaru sections. Path details of each rail section are detailed below:

- The North Star to NSW/QLD border section of Inland Rail involves upgrading old and constructing new tracks across the Macintyre River, allowing for future connections to Goondiwindi and the broader region. It follows the existing track north from North Star before crossing Bruxner Way and the border to join the existing Queensland Rail line. Final alignment for this section is yet to be identified;
- The NSW/QLD border to Gowrie sections span from the NSW/Queensland border, near Yelarbon, to Gowrie Junction, north west of Toowoomba;
- The Helidon to Calvert section will involve the construction of new track connecting Helidon (east of Toowoomba) with Calvert (west of Ipswich). This section uses the existing rail corridor and the Department of Transport and Main Roads' Gowrie to Grandchester protected rail corridor, with possible refinements being considered within a defined study area; and
- Calvert to Kagaru section follows the protected Southern Freight Rail Corridor which links the West Moreton line near Calvert to the interstate rail line near Kagaru, north of Beaudesert.

Figure 1-1 Map of inland rail project with sections distinguished

1.3.2 LOCAL BASINS AND CATCHMENTS

The 28 sampled sites were spread across 4 catchments, located within the Murray-Darling and Northeast Coast basins. Within the Border Rivers, Balonne-Condamine, Brisbane and Logan-Albert catchments, a total of eleven, five, nine and three sites were sampled, respectively.

BORDER RIVERS CATCHMENT

The Border River catchment contains the Dumaresq, Macintyre and the Barwon Rivers, which straddle approximately 450 km of the NSW and QLD border (MDBA, 2022). These rivers rise on the western slopes of the Great Dividing Range and run westward, eventually merging to form the Barwon River on the floodplains upstream of the town of Mungindi. Upstream of Mungindi, water flows are heavily regulated (MDBA, 2022). Glenlyon Dam on Pike Creek, in the upper Dumaresq catchment, regulates 88% of inflows, and Pindari Dam on the Severn River (NSW) regulates 70% of inflows. On-farm ring tanks account for 40% of constructed storage capacity in the region.

The rivers and wetlands of the region provide refugia for many native fish species, whose range has contracted across the basin (MDBA, 2022). The nationally significant Morella watercourse, Boobera lagoon and Pungbougal lagoon are located on the Macintyre River floodplain and represent one of few permanent waterbodies within the Murray Darling Basin.

CONDAMINE-BALONNE CATCHMENT

The Condamine- Balonne Rivers catchment is one of the northmost and one of the largest catchments within the Murray-Darling basin (MDBA, 2021). Most of the catchment is contained within QLD, with only a small area (16%) present within NSW. The Maranoa and Condamine are the main rivers that flow through the catchment and rise in elevated country in Queensland. Approximately two thirds of the catchment is flat, floodplain country in a complex series of rivers and creeks joining and breaking away from the Balonne River throughout the floodplains. The floodplains and rivers provides habitat for a diverse range of animals and plant communities (MDBA, 2021).

LOGAN-ALBERT CATCHMENT

The Logan-Albert Rivers catchment represents approximately 3,800 km^2 of the North East Coast basin. The headwaters lie in the McPherson and Main Ranges on the NSW border (Resilient Rivers Initiative, 2017). The Logan River is approximately 180 km long and flows northward before discharging into the Ramsar wetlands in southern Moreton Bay. The Albert River joins the Logan River near Eagleby, approximately 10 km upstream of the Logan River mouth. The Albert River is approximately 163 km long and is tidal for 35 km.

The major land uses for the catchment include grazing native vegetation, residential and farm infrastructure and nature conservation. Large areas of remanent vegetation are found within the mid and upper catchment in the World Heritage Areas of the Border Ranges (Resilient Rivers Initiative, 2017). Waterways within the area were designated as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009. The upper catchment includes Mount Barney, Lamington, Main Range and Mount Chinghee national parks and is Heritage Listed as the Gondwana Rainforests of Australia. There are relatively large areas of mangrove forest lining the lower reaches and eucalypt vegetation across the mid and lower catchment (Resilient Rivers Initiative, 2017).

BRISBANE CATCHMENT

Like the Logan-Albert rivers basin, the Brisbane River basin is part of the North East Coast Drainage basin and covers an area of approximately 13,540 km^2 (CGQ, 2018). The main tributaries to the basin are the Lockyer, Bremer and Stanley rivers which all flow into the Brisbane River that discharges into Moreton Bay (I. Tibbetts et al., 2019). The headwaters of the Brisbane River are located in the Brisbane

Range about 25 km north-east of Nanango and 140 km from central Brisbane. The headwaters for the main tributaries, the Stanley, Lockyer and Bremmer rivers, are located along the Blackbutt range, the Great Dividing Range near Toowoomba and east of Cunningham's gap near Kalbar along the QLD/NSW border, respectively (CGQ, 2018).

1.4 FLOW AND RAINFALL

The eDNA and habitat assessments surveys conducted covered 28 sites that spanned 307 km along the Great Dividing Range. The climate of the western side of the range typically consists of high daytime summer temperatures and moderate winters and a wet season that typically falls during the summer months. Within the weeks prior to the survey, little rainfall (<15 mL) was recorded at Gatton, Inglewood, Millmerran, Laidley, Calvert and Kagaru (BOM, 2022). Pampas and Wellcamp received approximately 40 mL in the weeks leading up to the survey, while Goondiwindi recorded approximately 100 mL of rain in the weeks leading up to and during the survey, with 45 mL falling on the first day of the survey (BOM, 2022).

The inland rail route crosses a numerous major watercourses, including the Logan, Condamine, Macintyre and Bremer Rivers. Numerous stream flow gauges are in place throughout the study area and offer an indication on flow conditions during the survey. Table 1-1 displays the stream flow gauges from which data was extracted for the relevant survey sites. The data extracted from the gauges listed in Table 1-1 are shown in Figure 1-2. Across all areas, eDNA sampling occurred post high flow conditions, within multiple peak flows in the successive weeks and months prior to the survey.

Many of the fish species, including threatened species known to occur in the Study Area are potamodromous, meaning that they complete their lives wholly in freshwater but do undertake migrations. A number of species are diadromous or anadromous, meaning that they migrate between freshwater and saltwater to reproduce and vice versa, respectively. The spawning activity of fish species is usually highly related to flow regime. Meaning most species migrate from September to February during months of higher temperatures and rainfall with wet season conditions initiating migration and spawning. These periods are the peak movement times of fish and therefore their distributions are likely to be extended across the relative catchments. DSEWPC (2011), acknowledges the importance of timing surveys to coincide with migratory periods, as is the case for this survey.

Table 1-1 Stream flow gauges located within the study area and the sites to which the flow data is relevant.

Stream gauge	Relevant sites
416201A - Macintyre River at Goondiwindi	NS2QB12, NS2QB11, NS2QB21
416402C - Macintyre Brook at Inglewood	B2G11, B2G5, B2G10
143121A - Western Creek at Kuss Road	H2C18A, C2K4, C2K5, C2K3, C2K1
422347B - North Condamine River at Pampas	B2G28, B2G21, B2G22, B2G23
422332B - Gowrie Creek at Oakey	B2G37
145014A - Logan River at Yarrahappini	C2K7, C2K6, C2K2
No current running gauge stations nearby	NS2QB19, NS2QB5, NS2QB20 B2G16, B2G17 H2C12A, H2C3A, H2C4A, H2C17A

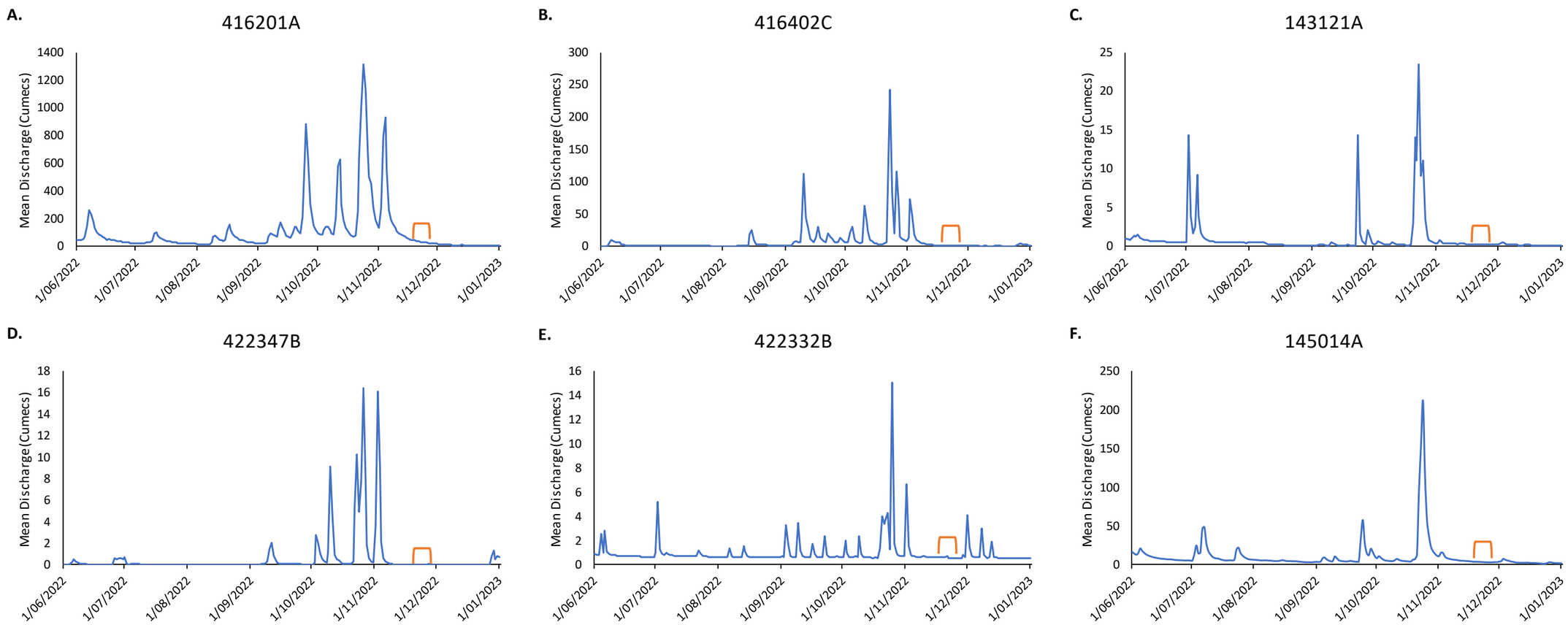


Figure 1-2 Stream flow (average cumecs/day) from gauges throughout the study area from June-December 2022. Survey dates are indicated by orange bracket. A. Macintyre River, B. Macintyre Brook, C. Western Creek at Kuss Road, D. North Condamine River at Pampas. E. Gowrie Creek at Oakey, F. Logan River at Yarrahappini

1.5 LEGISLATION RELEVENT TO LISTED SPECIES

Each of the seven target species is listed at a state and/or national level. The relevant listings and legislation for each species are detailed below.

Murray River cod:

- Vulnerable under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*;
- Endangered under *Flora and Fauna Guarantee Act 1988* (VIC); and
- Endangered in Action Plan for South Australian Freshwater Fishes (SA – non statutory listing).

Mary River cod:

- Endangered under the EPBC; and
- Not listed under *Nature Conservation Act 1992* but a no take species under *Fisheries Act 1994* (QLD)

Australian lungfish:

- Vulnerable under EPBC.

Silver perch:

- Critically endangered under EPBC:
- Endangered under *Nature Conservation Act 2014* (ACT);
- Vulnerable under *Fisheries Management Act 1994* (NSW);
- Endangered under *Flora and Fauna Guarantee Act 1988* (VIC); and
- Endangered in Action Plan for South Australian Freshwater Fishes (SA – non statutory listing)

Olive perchlet:

- Not listed under EPBC; and
- Western NSW population listed as an endangered population under the *Fisheries Management Act 1994* (NSW).

Southern purple-spotted gudgeon:

- Not listed under EPBC;
- Endangered under *Fisheries Management Act 1994* (NSW);
- Threatened under *Flora and Fauna Guarantee Act 1988* (VIC); and
- Endangered under *National Parks and Wildlife Act 1972* (SA).

Platypus:

- Not listed under EPBC;
- Special Least Concern under Nature Conservation (Wildlife) Regulation 2006 (QLD);
- Vulnerable under *Flora and Fauna Guarantee Act 1988* (VIC); and
- Endangered under *National Parks and Wildlife Act 1972* (SA).

2. METHODS

2.1 EDNA SURVEY

The use of eDNA for species detection has been found to be far more efficient than typical traditional methods for the detection of platypus (Lugg et al., 2018), threatened species of fish (Piggott, 2016) and is also a complimentary approach to traditional survey techniques (Golpour et al., 2022; Rourke et al., 2022). Regarding lungfish, in Hydrobiology's experience there are instances where eDNA detection has been less effective than traditional survey methods, though in other surveys lungfish have also been detected via eDNA and not captured via traditional survey techniques. At this stage the use of eDNA for understanding lungfish surveys is

2.1.1 SITE SELECTION

Sites were selected for sampling based on the previous works undertaken, which included:

- Habitat utilisation mapping defined in Future Freight (2020c, 2020f, 2020a, 2020d, 2020e, 2020b) – Areas noted where threatened species were likely or could possibly occur were selected for investigation; and
- Aquatic ecological survey undertaken by Ecological (2020) for the Border to Gowrie Project – Areas noted where threatened species were likely or could possibly occur were selected for investigation.

In addition to the above, Hydrobiology also selected sites for sampling based on internal expert knowledge regarding the discussed target species and habitat features identified from available aerial imagery relevant to these species.

Most sample points were along the alignment path; however some were moved due to lack of access and/or suitable habitat. Where sites could not be sampled directly along the Inland Rail alignment,

sites were moved nearby to accessible areas with suitable habitat within the same watercourse as the proposed point. Moved sites were either very close to the alignment path (approx. 100m) or were located further but were connected to the alignments path via permanent and non-impoundment watercourses. All sites selected were sampled and contained microhabitat relevant to at least one threatened species. During the field survey, two sites were moved from the proposed point due to lack of access and upstream closer to the alignment path and one was moved upstream due to a lack of free standing water at the original proposed point. The location of each test sites within the basin, catchment, watercourse and inland rail section are listed in Table 2-1 and displayed in Figure 2-1.

Table 2-1 Basin, catchment, watercourse and inland rail section of each sample site

Basin	Drainage Catchment	ARTC Section	Waterway	Site
Murray Darling	Border Rivers	NS2B North Star to Border	Unnamed Creek	NS2QB19
			Back Creek	NS2QB5
			Forest Creek	NS2QB20
			Macintyre River	NS2QB12
			Macintyre River	NS2QB21
			Macintyre River	NS2QB11
		B2G NSW/QLD Border to Gowrie	Macintyre Brook	B2G5
			Canning Creek	B2G11
			Pariagara Creek	B2G10
			Bringalily Creek	B2G16
			Bringalily Creek	BSG17
	Balonne-Condamine		Back Creek	B2G23
			Back Creek	B2G21
			Back Creek	B2G22
			Condamine River	B2G28
			Westbrook Creek	B2G37
North east coast	Brisbane	H2C Helidon to Calvert	Lockyer Creek	H2C12A
			Lockyer Creek	H2C4A
			Lockyer Creek	H2C3A
			Laidley Creek	H2C17A
			Western Creek	H2C18A
		C2K Calvert to Kagaru	Western Creek	C2K4

Basin	Drainage Catchment	ARTC Section	Waterway	Site
			Bremer River	C2K5
			Bremer River	C2K3
			Warrill Creek	C2K1
	Logan-Albert		Dugandan Creek	C2K6
			Woollaman Creek	C2K7
			Teviot Brook	C2K2

2.1.2 SAMPLE COLLECTION

eDNA samples were collected from the 20th-25th of November 2022, using a Smith-Root eDNA sampler with 5 µm Smith-Root self-preserving filters following Smith-Root protocol (Smith-Root, 2022). Three filters were processed at each site. The amount of water filtered averaged approximately 930 mL per site however varied between sites due to local factors such as present suspended solid concentrations which clogged the used filters. Overall the amount of material processed at each site ranged from 383-2533 mL. Samples were collected from areas of likely fish and platypus habitat (amongst snags, large woody debris (LWD), macrophytes, downstream of riffles and boulders, undercut banks, etc.). Filtration was undertaken on-site to reduce DNA degradation during transport of whole water samples (Yamanaka et al., 2016).

Clean sampling protocols were employed to minimise contamination between samples/ sites including new sampling equipment at each site, and taking care not to transfer soil, water or vegetation between sites. Filters were stored out of sunlight and at ambient temperature before being transported to the laboratory for processing. Quality control sampling was also undertaken in the form of blank samples. Three blank samples were processed with 1000 mL of clean water sampled per filter. Details regarding QA/QC measures implemented at each site including the result of blank samples are provided in Appendix B.

While eDNA samples were taken area of likely fish and platypus habitat, there are factors that must be taken into consideration when reviewing eDNA results, namely the rate of shedding and degradation and dispersal of eDNA. The rate of shedding can be influenced by an individual's species, size, age and maturity and by external factors such as temperature, pH and the presence of predators (Andruszkiewicz Allan et al., 2021). eDNA has successfully been used to determine distribution and/or presence of southern purple-spotted gudgeon, Murray River cod, Mary River cod, olive perchlet and platypus previously (Rourke et al., 2023; Stoessel et al., 2022; Wilkes Walburn et al., 2022; Yao et al., 2022). Studies on the effectiveness of eDNA to detect silver perch and Australian lungfish are not formerly published. Hydrobiology has previously conducted surveys within the Mary River basin and noted that the effectiveness of eDNA to detect lungfish varied, with some sites where lungfish were captured, eDNA results were negative; however eDNA also detected lungfish at sites where they were note captured via traditional survey techniques (Confidential client).

Once in the environment, DNA is broken down through processes such as UV exposure and microbial grazing, and is transported through advection, diffusion, mixing, settling and biological mechanisms (Andruszkiewicz Allan et al., 2021; Shogren et al., 2017). Overall fish DNA in the water column degrades rather quickly after the source species is removed, with variations between hours to weeks (Meng et al. 2022), though no formal investigations have been undertaken for the nominated target

species. It is expected that the species detected in this survey are likely recent occurrences for at least less than a month.

The amount of eDNA able to be transported and retained that can be recovered downstream of a source is highly variable and unpredictable (Shogren et al., 2017). No specific information relevant to the target species in terms of drift eDNA is available.

Fish DNA extraction, purification and quantification are detailed below. Laboratory analysis was undertaken at eDNA frontiers laboratory.

2.1.3 EXTRACTION AND SEQUENCING

DNA was extracted from each filter paper using a Qiagen DNeasy blood and tissue kit, following the eDNA frontiers lab's SOPs and detailed in Koziol et al., (2019), Stat et al., (2017), and Stat et al., (2019). Each sample was assigned an individual combination of index tags and amplified by PCR using 12S vertebrate metabarcoding primers and a species-specific qPCR assay targeting platypus. A metabarcoding library was generated and sequenced using the Illumina MiSeq. For qPCR analysis, samples were amplified using a specifically designed Ornithorhynchus anatinus assay (Lugg et al., 2018). Laboratory extraction and PCR controls were included to test for contamination for all tests.

Bioinformatic tools were used to analyse raw metabarcoding sequence data (Mousavi-Derazmahalleh et al., 2021) generated from the metabarcoding. The sequencing results were demultiplexed and trimmed using Obitools and quality filtered with Usearch v11 for sequencing errors (maxee=1) with a minimum length of 90 used. Sequences were then dereplicated and unique sequences were transformed into zero radius operational taxonomic units (ZOTUs) to provide sensitive taxonomic resolution (Usearch v11) (Edgar, 2018). ZOTUs, in contrast to OTUs, are a more exact sequence variant, clustering at 99% to improve taxonomic resolution. Generated ZOTUs were queried against the nucleotide database NCBI (GenBank) and assigned to the species level where possible. Taxonomic assignments were based on an in-house Python script which further filters the Blast results (evalue ≤1e-5, %identity ≥95, qCov =100, LULU minMatch =97%), combines them with the ZOTU table results and produces a table containing the taxonomic information available from Blast taxonomy database (accessed January 2023).

It is important to note that while sequences recovered are converted to the lowest possible taxon based on similarities and differences to a DNA database (NCBI's GenBank), this database, and the taxonomic framework that underpins it, may contain errors. Accordingly, the DNA taxon identifications should be interpreted as the best available assignment based on currently available information.

QA/QC details regarding extraction and sequencing are provided in Appendix B.

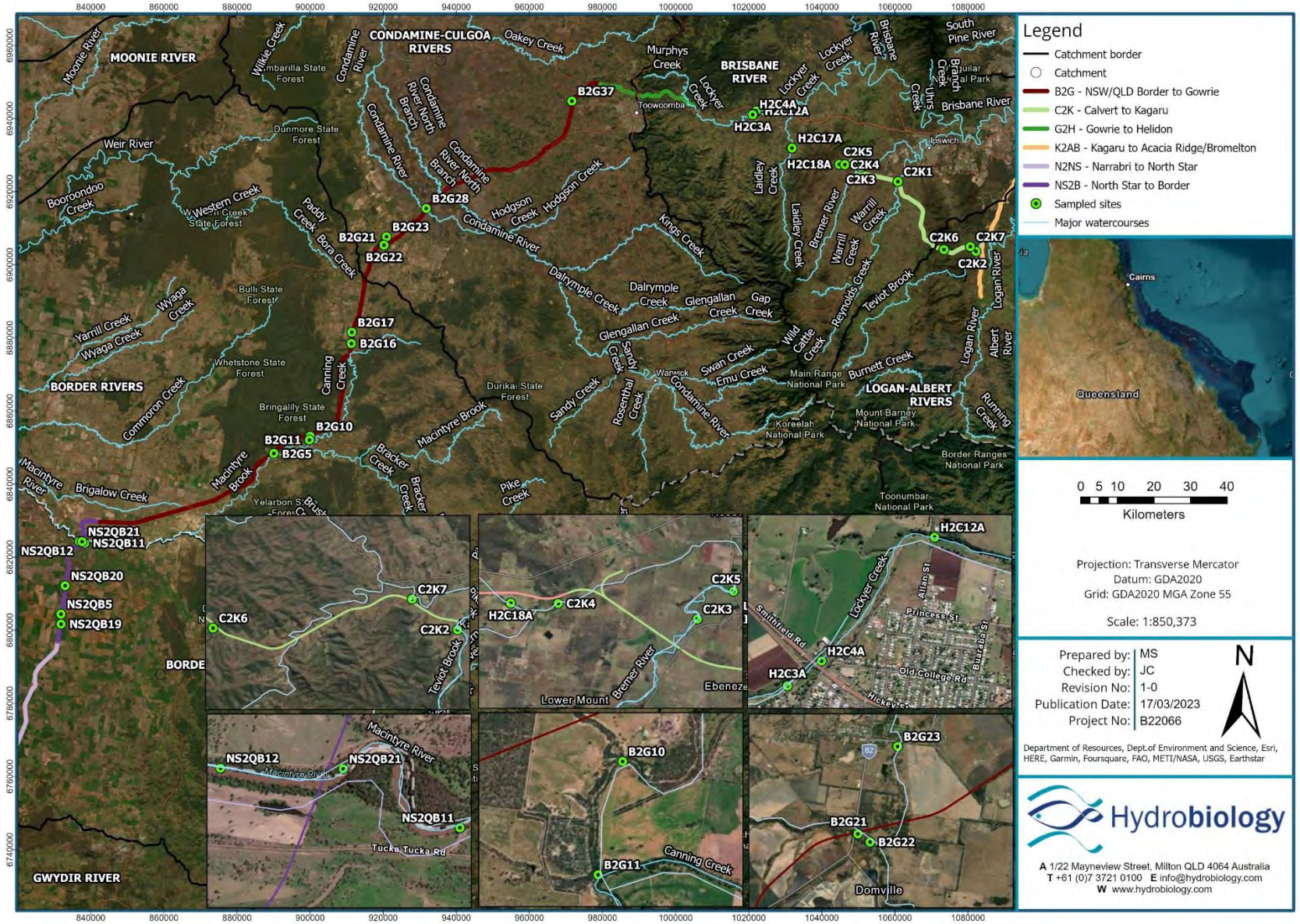


Figure 2-1 Map of study area with surveyed sites, inland rail sections, major watercourses and catchment areas indicated.

2.2 CONSERVATION SIGNIFICANT SPECIES LIKELIHOOD

At each site, habitat assessments were undertaken for each of the target species to classify the likelihood of any one species occurring at each site. The likelihood of species occurring was considered under three categories; (i) unlikely; (ii) possible; and (iii) likely. The criterion used to define each category is provided in Table 2-2. Occurrence records were taken from the Atlas of Living Australian (ALA) (2022).

Table 2-2 Criteria used for assigning likelihood of occurrences relevant to threatened and special least concern species

Likelihood of occurrence category	Criteria
Unlikely	No or very little suitable habitat present, or key habitat features absent.
Possible	Suitable species habitat present.
Likely	Suitable species habitat present and; A record occurs within 15 km in similar habitat.
Suspected	Positive eDNA results for the species were observed within 5 km at a different site.
Confirmed	Positive eDNA results returned for the species at the site.

3. TARGET SPECIES

MURRAY RIVER COD

Murray River cod are historically distributed throughout the Murray Darling Basin. Though their range remains the same, overfishing and habitat alteration has led to a drastic reduction of their numbers which has made them scarce throughout the range, particularly within headwaters (J. D. Koehn & Clunie, 2010). It is worth noting that the species remains an important fisheries species has been extensively stocked within the Border rivers and Condamine-Balonne River catchment (DAF, 2022).

Murray River cod of upland reaches reside in small, clear rocky streams and are usually associated with complex structures such as large snags, large rocks, woody debris, undercut banks and overhanging vegetation (J. D. Koehn & Clunie, 2010). This species spawns in early spring and eggs are laid on hard substrates such as wood, rock and clay surfaces. Although this species does not require migration for spawning, individuals have been known to undertake long-distance movements prior to spawning. Murray cod populations has declined throughout in the Murray-Darling basin since European settlement due to habitat loss and degradation, pollution, barriers to movement, flow regulation and fishing (J. D. Koehn & Clunie, 2010).

Murray River cod have been recorded along the Macintyre River, approximately 15 km downstream of site NS2QB11, within the Condamine River and Bora Creek near Millmerran, and within Macintyre Brook (ALA, 2022; Ecological, 2020). As mentioned above, Murray River cod have also been stocked throughout the Border and Condamine-Balonne rivers' catchments. Relevant stocking locations included the Inglewood town weir, located 4km upstream of B2G11 and 11km downstream of B2G5, and the Goondiwindi weir, approximately 25km upstream of NS2QB21 (DAF, 2022).

MARY RIVER COD

The historical range of the Mary River cod included the Mary, Brisbane-Stanley, Albert-Logan, and Coomera River systems, however the species has sharply declined and is now found naturally only within the Mary River and is listed as vulnerable under the EPBC (Australian Government, 2016; Simpson & Jackson, 1996). Current populations found outside of the Mary River catchment are either captive bred populations of are descendants of captive individuals (Australian Government, 2016). The Mary River is one of the fastest urban growth areas in Australia, and flow alteration, habitat degradation, introduced fishes and overfishing have contributed to the species decline through fragmenting populations and reducing the availability of spawning habitat and reproductive opportunities (Espinoza et al., 2020).

Critical habitat features for Mary River cod include deep pools within permanent water holes with access to shallower water and natural base flows to inundate riffles and facilitate movement between deep pools. Mary River cod movement is typically associated with the location of mates and spawning habitats, with the fish typically moving downstream during winter and upstream during spring (Australian Government, 2016). Knowledge on Mary River cod breeding habitat is limited as breeding has not been observed, however in captivity they are known to favour hollow pipes and large woody debris and have been shown to close association with logs and log jams in shallow littoral water and along banks with overhanging riparian vegetation during the breeding season (Espinoza et al., 2020; Simpson & Jackson, 1996). Outside of breeding season, Mary River cod still prefer complex habitats with undercut banks, LWD, deep pools and overhanging vegetation(Espinoza et al., 2020).

Natural Mary River cod populations are restricted to the Mary River catchment (ALA, 2022; Australian Government, 2016; Simpson & Jackson, 1996). Stocking has occurred within impoundments within the Brisbane river and Logan-Albert rivers catchments; however no stocking of Mary River cod had occurred within the study area (DAF, 2022).

SILVER PERCH

Silver perch are endemic to the Murray-Darling catchment and listed as critically endangered under the EPBC Act. This species occurs mainly in fast-flowing waters, particularly where there are rapids or races (McDowall, 1996). Silver perch undertake large migrations to spawning sites upstream during spring and summer, where spawning has been observed to occur over gravel or rock rubble substrate (McDowall, 1996). Populations of silver perch have declined sharply, and the species is now sparsely distributed across its former range. This decline is thought to be due to habitat loss and degradation, barriers to migration, egg mortality, spawning failures and pressures from non-native species (Bray & Thompson, 2021).

Silver perch are the second-most stocked species in Australia and hatchery-reared fingerlings have been stocked in the Murray-Darling basin, in impoundments east of the Great Dividing Range and north to the Fitzroy-Dawson catchment (Queensland Government, 2020). However, they have not been stocked within or near the study area (DAF, 2022). Silver perch have been recorded within the Macintyre River, approximately 60 km upstream of NS2QB12, in Back Creek in Millmerran approximately 5 km from B2G23, and within Spring Creek in Toowoomba (ALA, 2022).

AUSTRALIAN LUNGFISH

The Australian lungfish (*Neoceratodus forsteri*) is listed under the EPBC Act as vulnerable and a recovery plan has been drafted (DCCEEW, 2017). It is also a no-take species under the *Fisheries Act 1994.* The species was eligible for listing as vulnerable (DotE, 2014) as a result of past changes to its core habitat, limited geographic range and suspected poor recruitment. The recruitment of adult breeding population is suspected to be unsustainably low, and the populations is expected to

undergo a substantial decline over the next three generation. Its area of occupancy is estimated to be less than 2,000 km^2. Its natural distribution is assumed to be the Mary and Burnett systems with claims of being native to the Brisbane River with Pine River systems being subject to debate (Kemp, 2013; Wager, 1993). The species has also been translocated to several systems with populations persisting in the Condamine, Logan, Albert, and Coomera Rivers (Kemp, 2013).

The Australian lungfish requires clear or turbid, low-flow or still, vegetated, shallow pools to support spawning and feeding (Allen et al., 1989; Merrick & Schmida, 1984). Macrophytes are essential for reproduction with submerged or emergent variants providing nesting surfaces for egg laying and refuges for juveniles (Kemp, 2013). Adult lungfish favour submerged logs, dense banks of aquatic vegetation, or underwater caves formed by bed scouring under submerged logs. While lungfish can be found in both pools and riffles, their preferred habitats are pools of 3-10 m depth. In habitats such as these, they can often live in large groups (Kemp, 1986). All lungfish under 500 mm in length collected by Brooks and Kind (2002) were caught in dense macrophyte growth favoured for spawning, suggesting that juveniles prefer the same habitat and are probably slow to disperse after hatching. Juvenile lungfish are almost always found in dense macrophyte bed cover or similar in water of 500 mm depth or less.

Australian lungfish have been recorded within the Macintyre River, over 60 km from nearest site of NS2QB11, within the Condamine River near Millmerran, in Lockyer Creek within 500 m of H2C12A (record from 2003), in Mount Walker Creek approximately 4 km from C2K1, within the Logan River approximately 12 km downstream of C2K2 and along the Bremer River between C2K3 and C2K5, approximately 1.5 km from each site (ALA, 2022). Records from the Bremer River are from captures in 1992.

It is worth noting that the Bremer River was noted in Appendix K of the Calvert to Kagaru section of the EIS as “habitat critical for the survival of the species”. This is largely due to known records within proximity of the project. The lungfish was classified as being possible to occur within the study area however were not identified during targeted searches in 2016. Suitable habitat was identified within Purga Creek and Teviot Brook, however these areas are outside of the known distribution for Australian lungfish. Where the project intersects the Bremer River, habitat was not considered breeding or foraging habitat due to the lack of macrophytes and deep pools and the ephemeral nature of the section of river. The area was included within habitat mapping to ensure a conservative approach during the impact assessment, however the habitat should not be considered “habitat critical to the survival of the species”.

PLATYPUS

Platypus are listed as special least concern by the NCA (1992). Within Queensland, platypus are found along rivers east of the Great Dividing Range and in some western-flowing streams.

Platypuses inhabit a range of freshwater habitats including permanent freshwater streams and stream banks, shallow lakes, ephemeral streams and isolated pools, wetlands, and artificial water storages. Substrate composition is an important driver of platypus habitat quality with a substrate composition of pebbles, cobbles, gravel and other coarser rocks forming preferred habitats (T. R. Grant, 2004). Platypuses construct burrows above the water surface into the side of streambanks, generally preferring vegetation-consolidated banks of greater than 0.95 m in height (Brunt et al., 2018). Due to this, riparian vegetation is also known as a key platypus habitat driver with vegetation providing bank stability which is essential for platypus burrows (Serena et al., 2001a).

Platypus mating and nest building taking place in late winter to early spring, with egg laying occurring between July and November with young leaving their burrows in December to April (Grant, 2015).

Platypus have been observed within the Macintyre River approximately 18 km downstream of NS2QB11, the Macintyre Brook 3 km upstream of B2G11, Pine Creek at Millmerran, Lockyer Creek within 1 km of H2C3A and H2C4A, Lagoon Creek in Laidley and within the Bremmer River approximately 6km downstream of site C2K5 (ALA, 2022).

OLIVE PERCHLET

The olive perchlet is gazetted as endangered under the NSW *Fisheries Management Act 1994* (FMA). Historically, the olive perchlet range extends from north Queensland into NSW, Victoria and South Australia (SA) but has drastically reduced. It is now naturally extinct in SA, where it is present only as a single translocated population (DPI, 2013; MDBC, 2007). It was thought to be extinct in Victoria for 93 years, however a lone population was rediscovered in Mullaroo Creek in Victoria during 2022 (ALA, 2022; MDBC, 2023). Excluding the lone Victorian population, the current distribution range of the olive perchlet extends from north Queensland to northern NSW where they occur in coastal streams (eastern) and within Murray-Darling drainages (western). Eastern and western populations are treated as genetically distinct and the western population is listed as endangered within NSW(DPI, 2013). The western population of olive perchlet were once widespread throughout the Murray-Darling system but have suffered serious decline. The population is now found in limited sites in the Darling River drainage and an isolated population in the central Lachlan catchment (DPI, 2013; MDBC, 2007).

Olive perchlet typically inhabitant slow flowing or still environments with diverse microhabitat. They are known to inhabit rivers, creeks, ponds and swamps. During the day they are typically found in areas with overhanging vegetation, aquatic macrophyte beds, logs, dead branches and boulders, and will disperse to feed during the night (DPI, 2013; MDBC, 2007).

Threats for the western population of the olive perchlet include habitat loss and degradation, predation by invasive species, poor water management and spawning failures from cold water pollution (DPI, 2013).

SOUTHERN PURPLE-SPOTTED GUDGEON

The southern purple-spotted gudgeon is gazetted as endangered under the FMA. Historically, the southern purple-spotted gudgeon was known to persist within Queensland, NSW, Victoria and SA. The species is now threatened (regionally extinct) within Victoria, critically endangered within SA, endangered within NSW and is not listed within Queensland (DPI, 2017; Gomon & Bray, 2018).

The southern purple-spotted gudgeon inhabits coastal drainages from as far north as the Pascoe River in Queensland to the Clarence River in Northern NSW, which forms the Eastern NSW population, and throughout the Murray Darling Basin in NSW through to SA, which in NSW is referred to as the western population. The species was close to being extinct in SA prior to a captive breeding population and has been dwindling in NSW. As of 2017, the NSW Murray-Darling Basin population is confined to small remnant populations with limited gene flow between populations (DPI, 2017; Gomon & Bray, 2018). Few recent records exist in NSW of the Eastern population despite targeted surveys (ALA, 2022; DPI, 2017). Although the species is threatened in parts of its overall range, the southern purple-spotted gudgeon is common in coastal streams of central and southern Queensland (ALA, 2022; Gomon & Bray, 2018).

Southern purple-spotted gudgeon are a benthic species, typically found in a variety of habitats that include freshwater rivers, creeks and billabongs, preferring still or slow-flowing deeper waters with low turbidity. The fish often utilises aquatic and overhanging vegetation, leaf litter, rocks, snags and other woody debris (DPI, 2017; Gomon & Bray, 2018).

Threats to the species include predation by non-native fishes, habitat degradation and loss from anthropogenic activities and other fish species, water levels fluctuation due to drought and river regulation, thermal pollution and degraded water quality (DPI, 2017; Gomon & Bray, 2018).

4. RESULTS AND DISCUSSION

4.1 HABITAT

Site imagery and notes are displayed in Table 4-1. Across most sites, the available water was typically turbid, shallow in tributaries, deep in riverine sites and overall slow flowing. Macrohabitat was largely limited to pools and contained a mixture of microhabitat relative to small and large woody debris. Evidence of flood water was prevalent at most sites, evident in recently eroded banks and debris around structures and vegetation.

Table 4-1 Habitat notes and imagery of each site throughout study area.

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
Murray	NS2B North star to border	Unnamed Creek	NS2QB19	Isolated pools present under road and rail bridges and connected by a small channel. There is limited habitat available and present water was turbid. Signs of macropods and cattle activity.	
		Back Creek	NS2QB5	Limited habitat available, waterway likely an ephemeral creek with a small area of emergent macrophytes. Waterway sampled at road crossing/culvert. Riparian vegetation is heavily cleared around site, with signs of cattle activity. Limited water available is turbid.	
		Forest Creek	NS2QB20	Waterbody under road crossing with box culverts, flows through cattle paddocks. Casuarina trees present around the pool which is turbid with limited habitat. Tadpoles (suspected striped marsh frogs) and fish sites within pools.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
		Macintyre River	NS2QB12	Turbid pool within large channel impacted by cattle. Large tree trunk snags, marginal grasses and overhanging vegetation provide some habitat. Riparian vegetation is largely intact.	
		Macintyre River	NS2QB21	Run and pool habitat present, with visible movement of turbid water along surface. Pebble bar, backwater, large snags and overhanging vegetation are present, providing some habitat. Riparian vegetation is intact.	
		Macintyre River	NS2QB11	Riparian vegetation is continuous along left bank while semi-cleared and scattered along right bank. Eroded areas present along both banks. pebbled bars present on bends. Shed and pump infrastructure present on right bank, small accommodation setup present on left bank. Fisherman present during sampling, samples taken upstream.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
	B2G NSW/QLD border to Gowrie	Macintyre Brook	B2G5	Packed earth road crossing running through wetland site, water rich in tannins but not turbid. High coverage of duckweed along water surface, little open water remains. High coverage of emergent macrophytes along banks. Crop farming along right bank and livestock paddock on left banks with signs of cattle activity within the site.	
		Canning Creek	B2G11	Turbid series of large, sandy pools. heavy riparian clearing only on one bank, other largely intact. LWD and overhanging vegetation providing habitat. tributary inflow present.	
		Pariagara Creek	B2G10	River reduced to a series of large, turbid pools with a road crossing through site. Banks are largely undefined; however erosion is evident with sand deposition in stream. Banks and surrounding area are largely open as riparian vegetation has been heavily cleared. Large woody debris and emergent macrophytes providing some in stream habitat. LWD coverage limited instream, some along banks but unable to be sampled due to access. Mosquito fish observed at site.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
		Bringalily Creek	B2G16	Main channel contains limited SWD and LWD in form of fallen trees and associated debris. Backwater lined with emergent macrophytes, including *Ludwigia* sp., contains small woody debris (SWD) and LWD in the form of stags and fallen branches. Riparian vegetation heavily cleared with small pockets remaining. Water is very turbid. Site popular with water birds, with large amounts of droppings along banks. Cockatiels and Scaley-breasted lorikeets currently breeding in hollows of stags with backwater and there are large volumes of waterbird droppings along water's edge.	
		Bringalily Creek	BSG17	Turbid pools upstream of road crossing. Riparian vegetation heavily cleared along both banks, however no LWD within sample reach. Emergent sedges along banks.	
		Back Creek	B2G23	Riparian vegetation heavily cleared along both banks, which are shear and clearly eroded. Pools are deep, turbid and without any visible flow. Limited SWD present while LWD is in the form of fallen trees. site upstream of road crossing where LWD have been deposited during high flow events.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
		Back Creek	B2G21	Series of shallow, turbid pools present within degraded incised drainage channel with heavily eroded banks that have collapsed in some areas. SWD and LWD in the form of fallen trees and exposed roots. surrounding land heavily cleared, road access to coal mine adjacent to water way and sign of cattle activity throughout area. Site moved from original proposed point due to lack of access.	
		Back Creek	B2G22	Series of shallow pool within heavily incised and degraded drainage channel with collapsed banks. Vegetation heavily cleared throughout area. mine access road near site and signs of recent cattle activity. SWD and LWD in form of fallen trees and tree roots. upstream fence has large number of woody debris ensnared. fish bubbles visible. Site moved from original proposed point due to lack of access.	
		Condamine River	B2G28	Rail crossing over fast flowing river with large amount of LWD trapped along middle pylons. LWD forming barricade, redirecting high flow along ends of the rail crossing and to banks which have become heavily eroded and collapsed along most of the reach, exposing artificial stone placed around bridge abutments. Surrounding land heavily cleared for crops on both sides of the river. Site and rail crossing downstream of a stream confluence.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
North East Coast	H2C Helidon to Calvert	Westbrook Creek	B2G37	Shallow, flowing stream in small channel located within a broader channel. No woody debris present, however pebbled line stream bed. Surrounding area heavily cleared no exposed ground as dense groundcover throughout area, and no noticeable livestock activity - dog print noted along water's edge.	
		Lockyer Creek	H2C12A	Large channel with deep pool and low flowing run habitat passing under bridge. Riparian vegetation is isolated along the right bank, but nearly entirely cleared on the left bank. Woody debris is present within channel but downstream. Artificial boulders placed around bridge pylons for armouring provide good habitat. Fish bubbles seen within channel.	
		Lockyer Creek	H2C4A	Wide flowing channel passing under rail (upstream) and road bridges. Woody debris trapped around pillars of both bridges and geofabric (erosion sheet?) material wrapped around rail bridge pylons during floods. Some fish bubbles observed around road bridge pylons. Around bridges, bedrock along the banks is exposed. Mix of concrete, bedrock and artificially placed rocks within the stream. Buttresses from road gutters shoot into waterway however impact is limited as water hits exposed rock and concrete. Further downstream, natural cobbles (<25cm) form small bar around which is a natural riffle. Riparian zone is completely cleared for infrastructure and, along right bank downstream of road crossing, for agriculture. Cattle observed along banks and within waterway.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
		Lockyer Creek	H2C3A	Wide channel with broad banks. Left bank largely exposed sandstone bedrock. Somewhat eroded banks with grass cover vegetation. Left side cleared for road, housing and park, right bank for livestock. Upstream of rail and road bridges. SWD and LWD in form of fallen saplings and debris. Fish bubbles seen around debris. Several pairs of rainbow bee-eaters using hollows in right bank.	
		Laidley Creek	H2C17A	Well-formed channel below road bridge, artificial rocks armouring pylons form riffle zone across waterway. upstream banks heavily vegetated and surrounding land cleared for agriculture. Downstream, large section of bank has collapsed on bend. LWD and SWD from fallen trees and flood debris above and below water line. Downstream banks heavily vegetated with some LWD.	
		Western Creek	H2C18A	Large, deep pool in bend of creek bed. Banks well vegetated with mature trees, shrubs and grasses, however surrounding land completely cleared. Banks are somewhat eroded and steep, comprised of clay along right bank but exposed stone is visible along left banks. Macrophytes (Potamogeton sp.) and complex algae (charophytes) around water edge and some woody debris present in pool and streams. Fish, including mosquito fish, and turtle observed within pool.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
	C2K Calvert to Kagaru	Western Creek	C2K4	Creek running within larger, steeper channel which is enclosed by riparian overstory. Good riparian vegetation coverage along banks, most of the dominant vegetation are water associated plants eg Casuarina, Lomandra, Callistemon. Surrounding land largely cleared. Shrubs including lantana, climbers such as cat claw and grasses dominant. Undercut banks present within the stream, LWD and SWD provide habitat within the channel. No macrophytes present. Banks are very steep, channel is heavily incised and there are signs of erosion.	
		Bremer River	C2K5	Channel flows below road bridge, with abutments concreted and lined with blue stone. Banks are steep but shallow, and have isolated and scattered coverage of mature trees, and a largely bare understory as there is little groundcover. Upstream has high coverage from overhanging veg. Surrounding land is completely cleared for farming. Longnecked turtle and water dragons observed and potentially an eel observed at site.	
		Bremer River	C2K3	Macrophytic algae in stream, fish and fish bubbles sites. Large fish (possibly carp) sited. Relatively enclosed waterway with established riparian vegetation on both banks. Riparian vegetation largely dominated by callistemon which provide microhabitat in the form of LWD. Surrounding land entirely cleared for grazing livestock. Banks are steep along sections of reach. Property pumping water from river and bank has been lined in areas without riparian cover.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
		Warrill Creek	C2K1	Banks, particularly along bends, highly eroded with numerous collapses observed as well as undercut banks. some riparian cover remains along banks. LWD and SWD washed down during floods. Overhanging vegetation provided by callistemon trees, which are the dominant form of riparian vegetation. Feet of banks eroded, virtually no ground cover remining. Cattle and fresh pig scats along waterway. Turtles, water dragons, mullet and mosquito fish observed.	
		Dugandan Creek	C2K6	Series of isolated pools within much larger channel. Site upstream of spring confluence with another major (dry) channel. Sediment is very coarse sand, with banks showing signs of erosion with several section collapsed. Isolated pools remain but adjoining streambed is like quicksand and wet below the surface. Riparian vegetation is mainly intact, with Casuarina dominant in the canopy however some rainforest species also present. Lantana is dominant within the understory with some grasses and tobacco bush present. Persicaria present within pool. Little woody debris available, channel largely contains leaf litter debris from Casuarina. The channel would be susceptible to erosion during high flow events but currently dry through most of its reach. Cattle and pig tracks observed.	
		Woollaman Creek	C2K7	Well formed, relatively wide channel with the site downstream of a stream confluence. Right and left bank are predominantly sand, with large boulders an exposed bedrock along left bank. Riparian vegetation is comprised of casuarina, eucalyptus and bloodwoods with grassed understory and is largely intact, though cleared in surrounding farmland. Banks are eroded in some areas, and channel contains sand banks along the bends. LWD and Casuarina needles along stream bed. Fish (potentially young bass) and water dragons observed.	

Catchment	ARTC section	Waterway	Site	Habitat notes	Images
		Teviot Brook	C2K2	Site within an existing channel that has formed within a larger channel. Banks are comprised of sand and show signs or erosion, with remnants of silt fencing trapped within some eroded banks. Lower reaches have intact riparian vegetation which is largely comprised of Callistemon. in cleared area, patches of Persicaria and Schoenoplectus provide cover. left bank at site and upstream largely cleared. Site is upstream of two road crossings and downstream of cattle property. Cattle tracks and scats by water way upstream and flood debris caught on cattle fences and trees. Water very turbid.	

4.2 SPECIES LIKELIHOOD OF OCCURENCES

Habitat assessments were conducted at each site to determine the likelihood of platypus and MNES aquatic species Murray River cod, Australian lungfish and silver perch being present at each site based on preferred/required habitat features. Species specific habitat attributes present within each study region are detailed in the sections below (Table 4-2).

The below commentary discusses those sites where occurrences are likely based on available habitat, relevant to the platypus, Murray River cod, Mary River cod, Australian lungfish and silver perch. eDNA results are explored fully in Section 4.3.

Platypus

Platypus are likely to occur at one site – H2C4A. However favourable habitat for platypus exists at all sites within the H2C Helidon to Calvert except H2C3 and half the sites within the NS2B North star to border sections. Favourable habitat attributes present at most favourable sites include:

- Consolidated banks with vegetation;
- Large woody debris;
- Convex banks;
- Debris at water level;
- Permanent waterbody;
- Coarse rocky substrate;
- Deep pool/run habitat; and
- No impoundment of the stream.

Australian lungfish

Australian Lungfish is native to the North East Coast basin, therefore appearances of the species in the Murray Darling Basin is low. Though some sites contained favourable micro and macrohabitat for Australian lungfish, such as still or low flowing permanent water bodies, woody debris and undercut banks, there was a notable absence of submerged macrophyte beds at all the 28 surveyed sites. Macrophyte beds are key for Australian lungfish because they are used by the species for foraging and spawning, providing suitable habitat for the successful deposition of eggs and refuge for juveniles (Allen et al., 1989; Kemp, 2013; Merrick & Schmida, 1984). While a records exist near Rosewood within 15 km of sites C2K3 and C2K5, the lack of suitable habitat means that these sites were still classified as unlikely.

Along the study area, Lockyer Creek and Bremer River were listed as habitat critical for the survival of the species in Appendix K of the EIS report for the Calvert to Kagaru section due to historical records. Australian lungfish have been recorded in Lockyer Creek within 500 m of H2C12A, and along the Bremer River between C2K3 and C2K5, approximately 1.5 km from each site (ALA, 2022). During a targeted survey however no lungfish were found at the Bremer River and the habitat of the river where the project intersects it was described as representing no foraging or breeding habitat due to the lack of macrophytes, lack of deep pools and the ephemeral nature of the river at this section. The previous survey however did find favourable habitat within Purga Creek and Teviot Brook, however the sites were outside of the species known distribution.

During the eDNA survey, Bremer River, Lockyer River and Teviot Brook sites were all classified as unlikely due to the lack of macrophytes and other key features. No sites were located along Purga Creek.

Silver perch

Silver perch are endemic to the Murray-Darling basin however they are heavily stocked outside of this basin. All sites were assessed for suitable habitat; however sites within the Murray Darling Basin were inherently more likely to contain natural populations of silver perch.

Silver perch presence is known to be strongly correlated with high flowing streams, typically with rapid and races present. While favourable micro and macrohabitat attributes such as woody debris, rock substrate, deep pool/run habitat were present, particularly at sites within the H2C Helidon to Calvert and NS2B North star to border sections, high flow habitats were absent. As no rapids or races were evident at any surveyed site, all sites were classified as unlikely locations for this species. Furthermore, there are no records with 15 km of the surveyed sites.

Murray River cod

The Murray River cod is only found within the Murray Darling Basin, therefore likelihoods displayed in Table 4-3 was for sites within their respectively basin only. Favourable habitat suggests that Murray River cod are likely to be found at one site, N2QB4, though suitable habitat was found at six sites. Most, of the sites with favourable habitat include habitat attributes such as:

- Overhanging vegetation;
- Large snags;
- Other LWD;
- Large rocks;
- Deep pools; and
- No impoundment of the stream.

Mary River cod

The Mary River cod is naturally found only within the Mary River in the North East Coast basin and is stocked little elsewhere. Therefore all sites were assessed for suitable habitat however sites within the Murray Darling Basin were inherently unlikely to contain Mary River cod, regardless of habitat available. As no records exist near the sites, no site was classified as likely. Sites with possible habitat largely contained:

- Overhanging vegetation;
- Large snags or other LWD;
- Still/low flowing waters;
- Variety of shallow and deep pools; and;
- Lack of stream impoundment.

Intact riparian corridors were restricted to sites along the Macintyre River.

Table 4-2 Number of sites with favourable and unfavourable habitat features for each target species for the study area for each species.

Species	Found microhabitat	
	Favourable features	Unfavourable features
Australian lungfish	• Still/low flowing water with deep pool – 9/12 • Submerged macrophytes – 0/12 • LWD - 11/12 • Undercut banks - 2/12	• Impoundment of stream - 0/12 • Riparian clearing – 11/12
Silver perch	• Fast flowing water - 3/28 • Rapids and races present – 11/28 • Small woody debris – 24/28 • Gravel or rock rubble present - 15/28 • LWD – 24/28 • Deep pool/run habitat – 17/28	• Impoundment of stream – 2/28 • Riparian clearing - 24/28
Platypus	• Consolidated banks w. vegetation - 18/28 • LWD - 24/28 • Coarse rocky substrate (e.g. pebbles, cobbles and gravel) - 15/28 • Convex bank profile at water level – 28/28 • Debris at water level at bank - 24/28 • Permanent waterbody - 18/28 • Deep pool/run habitat – 17/28	• Impoundment of stream – 2/28 • Riparian clearing - 24/28
Murray River cod	• Overhanging vegetation - 7/16 • Large snags - 12/16 • Other LWD - 11/16 • Large rocks – 1/16 • Undercut banks – 0/16 • Deep pools - 8/16	• Impoundment of stream – 2/16 • Riparian clearing - 13/16
Mary River cod	• Overhanging vegetation – 17/28 • LWD - 24/28 • Undercut banks – 3/28 • Slow flowing pools - 24/28	• Impoundment of stream – 2/28 • Riparian clearing - 24/28

Table 4-3 Likelihood of target species being present at sites based on habitat features present/absent at each site typically observed with target species. Likelihood classification defined in Table 2-2. Grey indicates sites within basins that are outside of the natural distribution of the species – the Mary River cod is found in the Mary River in the North East Coast Basin while the Murray River cod and silver perch are endemic to the Murray Darling River basin. Bold text indicates where species were confirmed or are suspected to occur and the habitat likelihood assessment result of the site.

Catchment	ARTC section	Waterway	Site	Australian lungfish	Silver perch	Platypus	Murray River cod	Mary River cod
MURRAY DARLING	NS2B North star to border	Unnamed Creek	NS2QB19	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
		Back Creek	NS2QB5	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
		Forest Creek	NS2QB20	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
		Macintyre River	NS2QB12	Unlikely	Unlikely	Possible	**Possible & Confirmed**	Possible
		Macintyre River	NS2QB21	Unlikely	Unlikely	Possible	**Possible & Confirmed**	Possible
		Macintyre River	NS2QB11	Unlikely	Unlikely	Possible	**Likely & Confirmed**	Possible
	B2G NSW/QLD border to Gowrie	Macintyre Brook	B2G5	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
		Canning Creek	B2G11	Unlikely	Unlikely	Unlikely	**Possible & Confirmed**	Possible
		Pariagara Creek	B2G10	Unlikely	Unlikely	Unlikely	**Unlikely but Suspected**	Unlikely
		Bringalily Creek	B2G16	Unlikely	Unlikely	**Unlikely but Suspected**	Unlikely	Unlikely
		Bringalily Creek	BSG17	Unlikely	Unlikely	**Unlikely but Confirmed**	Unlikely	Unlikely
		Back Creek	B2G23	Unlikely	Unlikely	**Possible & Confirmed**	Possible	Possible
		Back Creek	B2G21	Unlikely	Unlikely	**Unlikely but Confirmed**	Unlikely	Unlikely
		Back Creek	B2G22	Unlikely	Unlikely	**Unlikely but Confirmed**	Unlikely	Unlikely
		Condamine River	B2G28	Unlikely	Unlikely	**Possible & Confirmed**	Possible	Unlikely
		Westbrook Creek	B2G37	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
NORTH EAST COAST	H2C Helidon to Calvert	Lockyer Creek	H2C12A	Unlikely	Unlikely	Possible	Unlikely	Unlikely
		Lockyer Creek	H2C4A	Unlikely	Unlikely	Likely	Unlikely	Unlikely
		Lockyer Creek	H2C3A	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
		Laidley Creek	H2C17A	Unlikely	Unlikely	Possible	Possible	Unlikely
		Western Creek	H2C18A	Unlikely	Unlikely	Possible	Unlikely	Possible

Catchment	ARTC section	Waterway	Site	Australian lungfish	Silver perch	Platypus	Murray River cod	Mary River cod
	C2K Calvert to Kagaru	Western Creek	C2K4	Unlikely	Unlikely	Possible	Possible	Possible
		Bremer River	C2K5	Unlikely	Unlikely	Unlikely	Unlikely	Possible
		Bremer River	C2K3	Unlikely	Unlikely	Unlikely	Possible	Possible
		Warrill Creek	C2K1	Unlikely	Unlikely	Possible	Possible	Possible
		Dugandan Creek	C2K6	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
		Woollaman Creek	C2K7	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
		Teviot Brook	C2K2	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

4.3 SPECIES DETECTIONS

Species specific detection using metabarcoding and quantitative PCR analysis (platypus only) returned a range of species throughout the study area. It is important to note that the natural range of some species does not occur within some of the assessed catchments. For example, the natural distribution of Murray River cod is within the Murray River basin but not easterly flowing catchments. Despite this, metabarcoding and eDNA for all species was conducted at every site regardless of individual species range. Presence/absence data of threatened species are displayed in Table 4-4. Results are explored below.

4.3.1 TARGET SPECIES DETECTIONS

Analysis of the eDNA found evidence of platypus, Murray River cod, olive perchlet and southern purple-spotted gudgeon across the surveyed area (Figure 4-1 to Figure 4-4 and Table 4-4), however Australian lungfish, Mary River cod and silver perch were notably absent.

MURRAY RIVER COD

Murray River cod were detected at a total of four sites across two sections of the inland rail. The species was detected at three sites within the North star to NSQ/QLD border section:

- NS2QB12;
- NS2QB21; and;
- NS2QB11.

Murray River cod were also detected at one site within the NSW/QLD border to Gowrie section - B2G11.

Murray River cod are known to persist within the Murray Darling River basin and not the Northeast coast basin, therefore the absence of detections from sites within the Helidon to Calvert and Calvert to Kagaru sections is not unexpected. Sites NS2QB12, NS2QB21 and NS2QB11 were all located within an uninterrupted section of the Macintyre River prior to the junction of the Dumaresq and Macintyre Rivers. Site B2G11 sits along Canning Creek which, via the Macintyre Brook, is connected to the Dumaresq and Macintyre Rivers. B2G11 is also approximately 100 km upstream of other sites with positive Murray River cod detections.

While Murray River cod spend the majority of their life within a small area, often around a particular snag in favourable habitat, they will migrate up to 120 km (typically upstream) to spawn, typically when water levels are high. Following migration, adults will return to the area they occupied prior, often to the same snag. It is therefore possible that the Murray River cod DNA from the sites along the Macintyre River belong to the same population as the source of the DNA within site B2G11.

PLATYPUS

Platypus were detected at a total of five sites, all of which are within the B2G NSW/QLD border to Gowrie section. Platypus were detected at sites:

- B2G17;
- B2G23;
- B2G21;
- B2G22; and
- B2G28.

Site B2G28 is located within the Condamine River itself while B2G21, B2G22 and B2G23 are located in Back Creek, which is a tributary of the Condamine River. Individual home ranges of platypus are

typically <15 km, with male home ranges typically encapsulating numerous females' (Bino et al., 2019). However, young dispersing males have been known to travel more than 50 km in the Yarra River system and nearly 45 km in the Wimmera River system (Serena & Williams, 2013). Therefore it is suspected that the detection from Back Creek sites and those from the Condamine River are from individuals within the same population.

Platypus detection at site B2G17 was from Bringalily Creek which is a tributary of the Dumaresq River, where sightings have been recorded (ALA, 2022). The Bringalily Creek population is not expected to be from the same platypus population as that in the Condamine River and Back Creek. It is worth noting that platypus appear capable of migrating between adjacent river basins (Furlan et al., 2013). Genetic connectivity has been found between platypus in adjacent disconnected river systems within NSW, suggesting overland dispersal (Kolomyjec et al., 2009). However, it is unclear how often and over what distance platypus are able to successfully move between water bodies (Furlan et al., 2013). Platypus have been recorded travelling overland distances of 7-8 km (Furlan et al., 2013), however as B2G17 is at least 25 km (linear distance overland) from any other site tested that contained platypus DNA, overland dispersal between the two systems is unlikely.

OLIVE PERCHLET

Olive perchlet were detected at six sites through the Helidon to Calvert and the Calvert to Kagaru sections. Within the Helidon to Calvert section, olive perchlet were detected at sites:

- H2C4A; and
- H2C18A

Within the Calvert to Kagaru section detections occurred at sites:

- C2K1;
- C2K6;
- C2K7; and
- C2K5.

All detections were within Queensland in the vicinity of Undullah, Rosewood, Calvert or Gatton. The western population of olive perchlet is listed as endangered within NSW; however this species is not considered threatened in Queensland.

SOTHERN PURPLE-SPOTTED GUDGEON

Detections of Southern-purple spotted gudgeon occurred at a total of four sites. Three detections occurred within the Helidon to Calvert section:

- H2C12A;
- H2C4A; and
- H2C3.

One detection occurred within the NSW/QLD border to Gowrie section at B2G37.

These sites encompass Toowoomba and Gatton, Queensland, and there were no detections for any sites within NSW where the species is listed as endangered.

It is worth noting the detections returned do not separate an individual species of Mogurnda (genera of Southern-purple spotted gudgeon). Mogurnda DNA detected during the survey is expected to be that of *Mogurnda adspersa* (Southern-purple spotted gudgeon) due to distribution ranges of Mogurnda species (Atlas of Living Australia (ALA), 2022). Other Australian Mogurnda species are largely restricted to central northern Australia.

MARY RIVER COD

Mary River cod was not detected at any of the 28 visited sites. This is not unsurprising as all sites were outside of the Mary River basin (natural distribution) and there were no nearby records or known stocking of the species.

SILVER PERCH

There were no detections of eDNA for silver perch at any of the 28 visited sites. The lack of detections was unsurprising considering the endemic range of the species and the scarcity of historical records of natural or stocked populations. The absence of silver perch was largely attributed to the ephemeral nature of some sites and limited availability of high flow environments and absence of rapids and races.

Silver perch have been well studied under cultured conditions, however knowledge on their biology, environmental tolerances and habitat requirement in the wild are scarce (DPI, 2006). The species is known to have inhabited environments characterised by extremes in environmental flows, with periods of drought punctuated by major floods (Koster et al., 2021; NSW Department of Primary Industries (DPI), 2006). They have been known to occupy slow flowing and turbid water sources including lowland rivers of the west and north of the Murray-Darling Basin, floodplains, lakes and reservoirs . However, they have been noted by anglers and researches to show a more general preference for high flow environments where rapids and races are present and within open sections of the river (Clunie & Koehn, 2001; DoE, 2013; DPI, 2006).

AUSTRALIAN LUNGFISH

As with the silver perch and Mary River cod, there were no detections of Australian lungfish at any of the 28 visited sites. Australian lungfish are known to occur within the Northeast coast catchments, but not the Murray Darling River basin, therefore the absence of lungfish in the North star to QLD/NSW border and QLD/NSW border to Gowrie sections is not unexpected.

The absence of Australian lungfish within the Northeast coast basin sites was also unsurprising due to a lack of key habitat feature. For the Australian Lungfish, the complete absence of submerged macrophyte beds (i.e. largely shallow pool habitat present), which limits breeding and foraging habitat.

As mentioned earlier, previous surveys conducted by Hydrobiology targeting Australian lungfish have noted that the effectiveness of eDNA to detect lungfish varied – at some sites where lungfish were electrofished eDNA results were negative however eDNA also detected lungfish at sites where electrofishing was unsuccessful.

4.3.2 COMMUNITY FISH ASSEMBLAGES

FISH

A total of 15 families comprising 28 species of fish were detected throughout the surveyed area (Appendix A). Most were species native to Australia, although eastern mosquito fish and Eurasian carp were present at all bar 10 and five sites, respectively. Western carp gudgeon and Eurasian carp were the most widely distributed species, absent from four and five sites, respectively.

The Brisbane River catchment was the most diverse, containing 24 species across the nine sites, three of which were found in no other catchment. The most diverse site within the Brisbane River catchment, Bremer River site C2K5, recorded 15 species of fish. The Logan-Albert Rivers catchment was the next most diverse, with 17 fish species detected across three sites, one of which was unique to the catchment. The most diverse site was C2K2, located within Teviot Brook, with 16 individual fish species, making this site the most diverse for fish across the study area. Border Rivers and the

Balonne-Condamine Rivers catchments were comparatively less diverse, with 13 species across 11 sites and 11 species across 5 sites recorded, respectively, and no unique species in either catchment.

4.3.3 OTHER VERTEBRATES

While not the target of this investigation, metabarcoding of vertebrate DNA detected a number of other vertebrate species. These results provide a preliminary analysis of other species at each site; however this is not comprehensive as their habitats were not targeted nor were other vertebrate species targeted beyond fish and platypus. Therefore, these detections are considered incidental.

FROGS

Four families of amphibian were represented encompassing five species throughout the surveyed area, including the Wallum rocketfrog (*Litoria freycineti*) (Appendix A).

The wallum rocketfrog is of particular note as it is listed as vulnerable in Queensland under the NCA and, was detected within Queensland at site B2G10. Wallum rocket frogs are largely confined to the coastal lowlands and sand islands of southeast Queensland and NSW. They typically inhabit coastal wet heath where it can be found around sedge swamps, freshwater lakes and drainage lines on low nutrient soils. The wallum rocketfrog has also been recorded a considerable distance from water in eucalypt forest near wet heath habitat (Hines et al., 2004; Meyer, 2012; Meyer et al., 2006). Their detection during this survey is out of their typically distribution range, however it is worth noting that historical records (from 1978-2004) exist in other similarly unlikely locations that are outside of their usual distribution. Unusual records includes towns such as Armidale, Tenterfield, Bonalbo, Kyogle and Bundarra in NSW and Fernvale in Queensland. While the record should not be discounted, further investigation is required.

REPTILES

The Macquarie River turtle, saw-shelled turtle and *Chelodina* sp., all from the Chelidae family, were detected at a total of two, five and 10 sites across the study area, respectively (Appendix A). None of these species are listed as threatened in NSW and Queensland.

BIRDS

A total of 27 bird species along the project extent were detected, representing 18 families (Appendix A). Most birds throughout the area were common, though there were a few species of interest or note:

- Sacred kingfisher (New Zealand subspecies) are found throughout most of Australia except central Western Australia (WA) and suitable habitat was observed throughout much of the study area for this species. However, the New Zealand subspecies, *vagans*, was detected at B2G16. This subspecies has not been historically recorded in Australia. This subspecies detection is likely an error allocation in the Global database likely due to missing or unsuitable reference sequences for local taxa.
- Red junglefowl is native to South East Asia but are kept for poultry in Australia. Detection during this survey is expected to be from farmed or escaped animals. Detections for this species were returned at sites B2G28, H2C17, C2K5 and C2K2.
- Princess parrots (*Polytelis alexandrae*) are listed as vulnerable federally, and in the Northern Territory, SA and WA. Extent occurrences vary greatly between years, with the species not being recorded for considerable amounts of time followed by years with abundant records (DCCEEW, 2023). This nomadic species are typically found within interior Australia, but large numbers estimated to 25,000 birds are held within private aviaries in Australia alone (DCCEEW, 2023). Records exist within Queensland (ALA, 2022). It is possible that these are wild princess parrots that have traversed

outside of their normal range, however it is more likely that they are birds that have escaped aviaries. Princess parrot eDNA was detected at site B2G10 only.

- Western corellas (*Cacatua pastinator*) are typically known to occur within the Wheat Belt and formerly around Perth, WA. Isolated records exist within NSW and Queensland; however most records are either not recent or based on human observation (ALA, 2022). Western corella detections occurred at site B2G10. B2G10 also contained princess parrot DNA, another species which, as detailed above, is typically found within western and central Australia. As with princess parrots, western corella are sometimes kept as aviary pets and are able to interbreed with other corella species found along the eastern coast of Australia. As with princess parrots, it is possible that the eDNA was from wild birds that have traversed outside of their normal range, however given that two typically Western Australian species were both identified at the same site, it is more likely that the eDNA is from captive individuals.

MAMMALS

A total of 16 mammal species, representing nine families were detected throughout the surveyed area (Appendix A). Of these 16 species, six were livestock species (i.e. cattle, sheep, deer, pigs). This data may prove useful to understand causes of habitat degradation and determine appropriate management measures regarding their access where threatened species have been detected.

The remaining mammals were comprised of three bats, four marsupials and three rodents, which included the Lakeland Downs mouse. This species is of note because genetically distinct populations are typically found within the dry savanna of northern Australia (ALA, 2022), therefore their detection represents a potential range expansion.

Of the three bat species eDNA was assigned to, one species is not known to occur within Australia. The monando fruit bat (*Boneia bidens*) is native to Indonesia and no known records exist within Australia. The assignation of eDNA to species not known to occur within the study area is most likely due to missing or unsuitable reference sequences for local taxa. No other bat species from this genus are known in Australia, however the family to which the genus belongs, Pteropodidae, is represented by other genera in Australia, such as the *Pteropus* genus, to which one of the other detected species, the little red flying-fox (*Pteropus scapulatus)*, belongs.

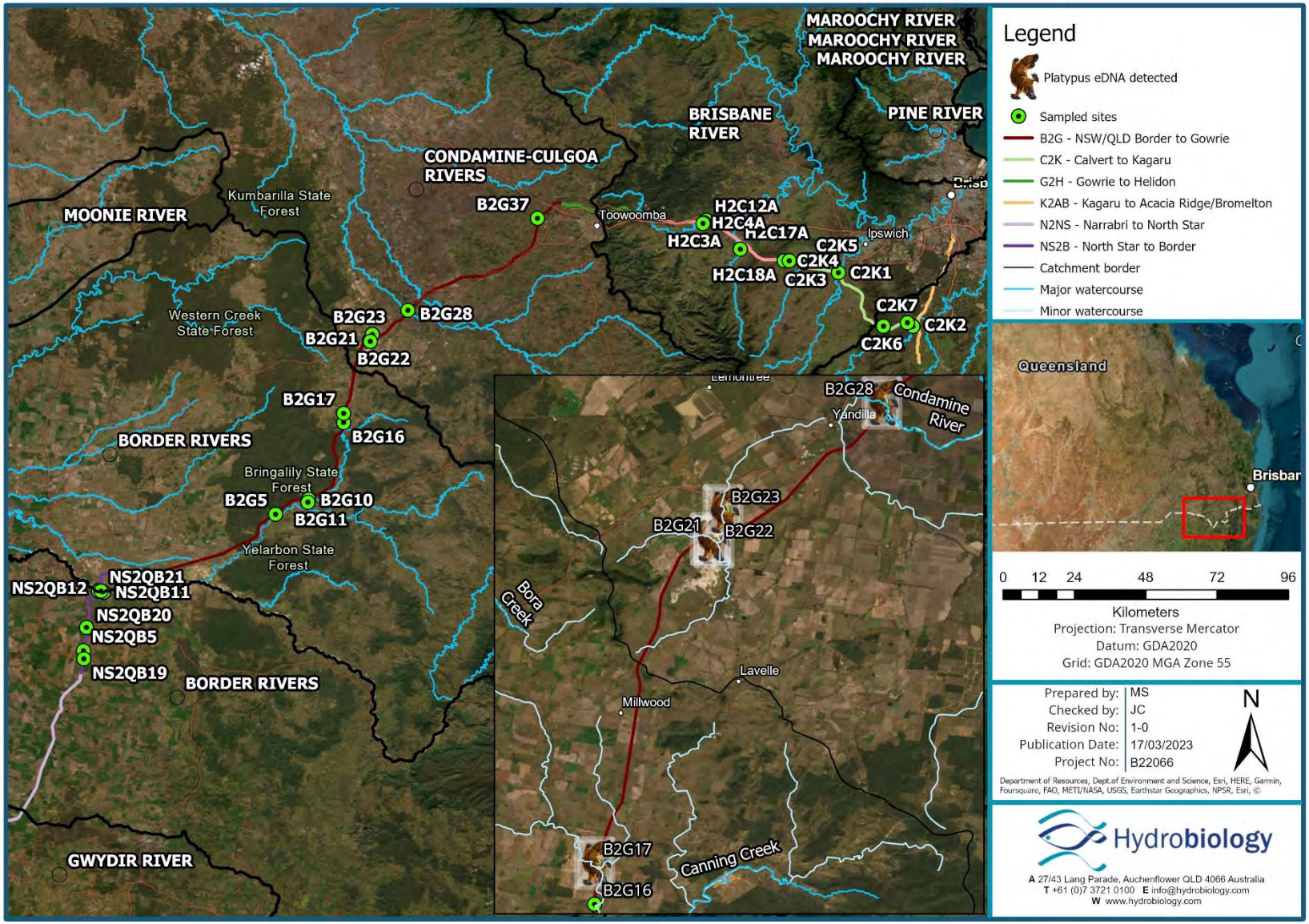


Figure 4-1 Platypus positive eDNA locations across the study area.

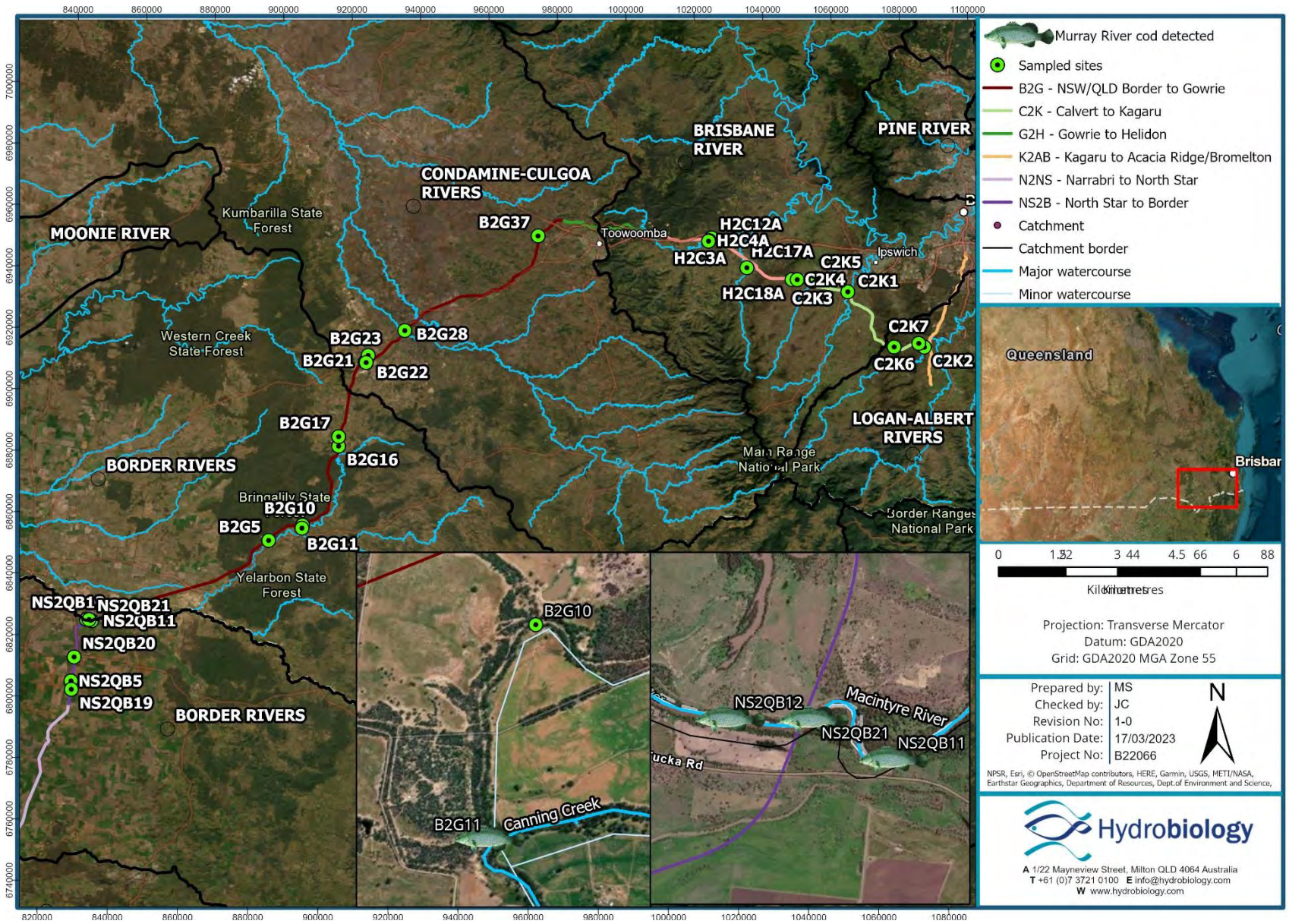


Figure 4-2 Murray River cod positive eDNA locations across the study area.

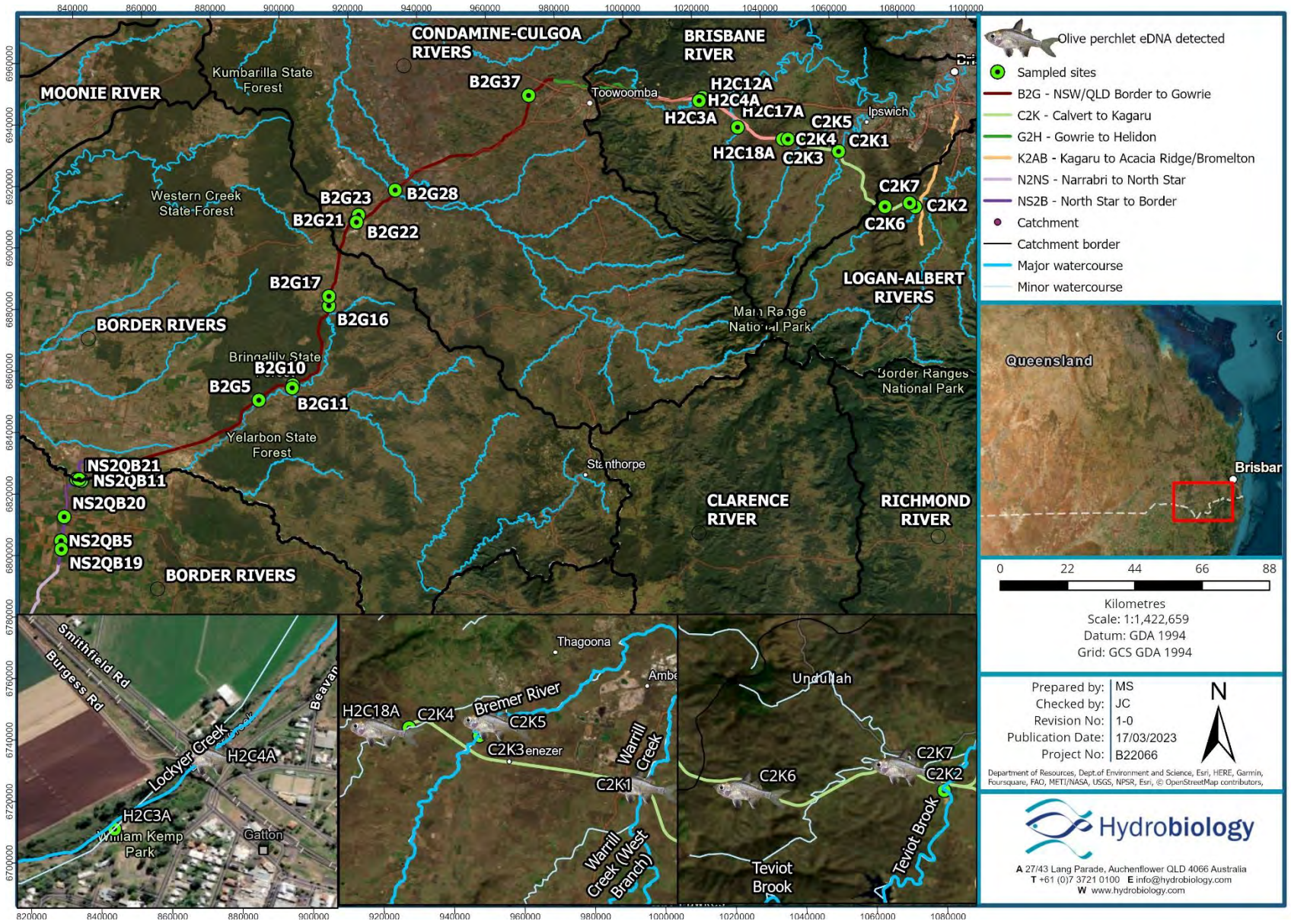


Figure 4-3 Olive perchlet positive eDNA locations across the study area.

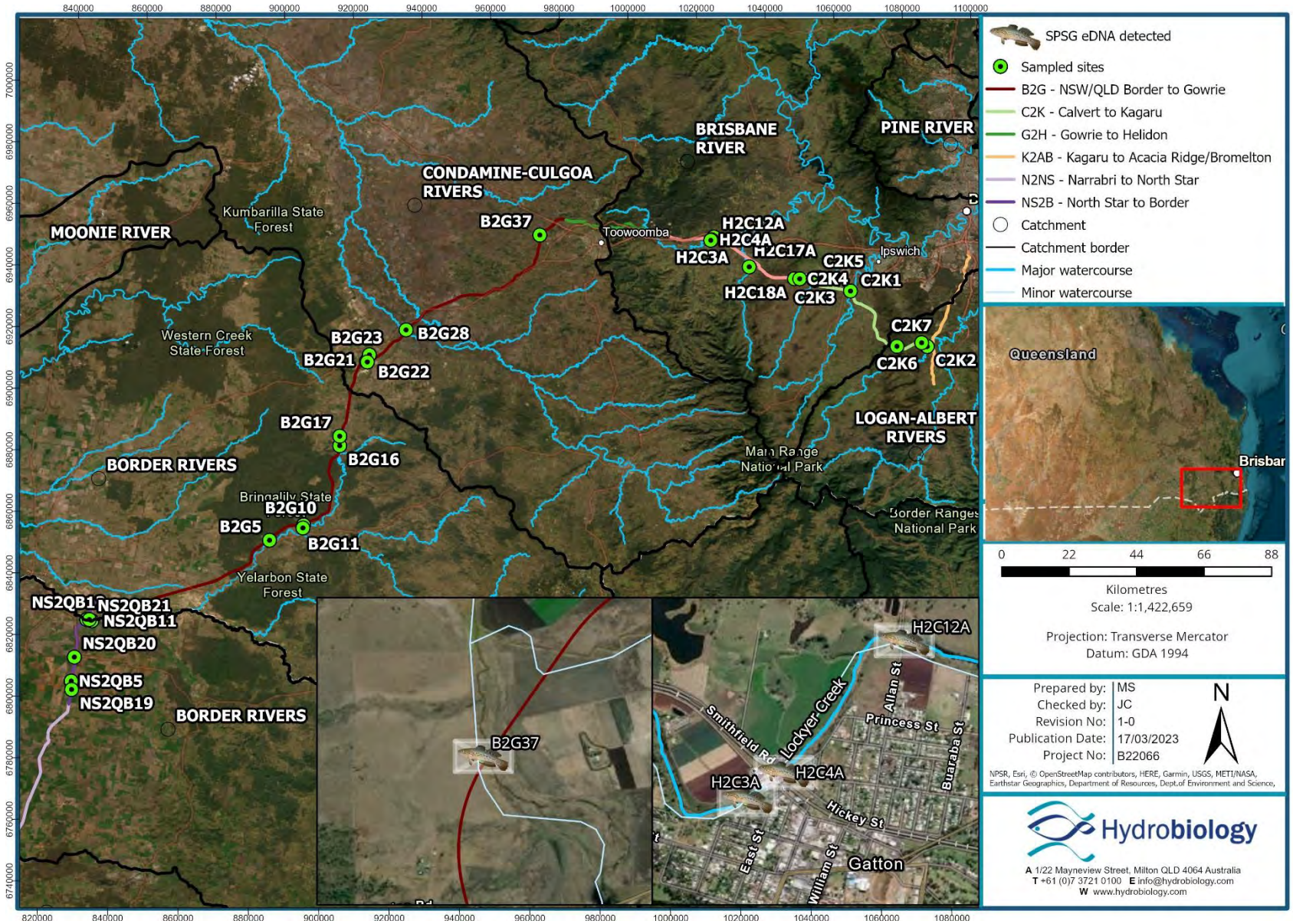


Figure 4-4 Southern purple-spotted gudgeon positive eDNA locations across the study area.

Table 4-4 eDNA detection results for targeted threatened fish and platypus across all sites.

Catchment	ARTC section	Waterway	Site	Australian lungfish	Silver perch	Platypus	Murray River cod	Mary River cod	Olive perchlet	Southern purple-spotted gudgeon
Murray Darling	NS2B North star to border	Unnamed Creek	NS2QB19	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Back Creek	NS2QB5	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Forest Creek	NS2QB20	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Macintyre River	NS2QB12	Negative	Negative	Negative	Positive	Negative	Negative	Negative
		Macintyre River	NS2QB21	Negative	Negative	Negative	Positive	Negative	Negative	Negative
		Macintyre River	NS2QB11	Negative	Negative	Negative	Positive	Negative	Negative	Negative
	B2G NSW/QLD border to Gowrie	Macintyre Brook	B2G5	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Canning Creek	B2G11	Negative	Negative	Negative	Positive	Negative	Negative	Negative
		Pariagara Creek	B2G10	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Bringalily Creek	B2G16	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Bringalily Creek	BSG17	Negative	Negative	Positive	Negative	Negative	Negative	Negative
		Back Creek	B2G23	Negative	Negative	Positive	Negative	Negative	Negative	Negative

Catchment	ARTC section	Waterway	Site	Australian lungfish	Silver perch	Platypus	Murray River cod	Mary River cod	Olive perchlet	Southern purple-spotted gudgeon
		Back Creek	B2G21	Negative	Negative	Positive	Negative	Negative	Negative	Negative
		Back Creek	B2G22	Negative	Negative	Positive	Negative	Negative	Negative	Negative
		Condamine River	B2G28	Negative	Negative	Positive	Negative	Negative	Negative	Negative
		Westbrook Creek	B2G37	Negative	Negative	Negative	Negative	Negative	Negative	Positive
North east coast	H2C Helidon to Calvert	Lockyer Creek	H2C12A	Negative	Negative	Negative	Negative	Negative	Negative	Positive
		Lockyer Creek	H2C4A	Negative	Negative	Negative	Negative	Negative	Positive	Positive
		Lockyer Creek	H2C3A	Negative	Negative	Negative	Negative	Negative	Negative	Positive
		Laidley Creek	H2C17A	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Western Creek	H2C18A	Negative	Negative	Negative	Negative	Negative	Positive	Negative
	C2K Calvert to Kagaru	Western Creek	C2K4	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Bremer River	C2K5	Negative	Negative	Negative	Negative	Negative	Positive	Negative
		Bremer River	C2K3	Negative	Negative	Negative	Negative	Negative	Negative	Negative

Catchment	ARTC section	Waterway	Site	Australian lungfish	Silver perch	Platypus	Murray River cod	Mary River cod	Olive perchlet	Southern purple-spotted gudgeon
		Warrill Creek	C2K1	Negative	Negative	Negative	Negative	Negative	Positive	Negative
		Dugandan Creek	C2K6	Negative	Negative	Negative	Negative	Negative	Positive	Negative
		Woollaman Creek	C2K7	Negative	Negative	Negative	Negative	Negative	Positive	Negative
		Teviot Brook	C2K2	Negative	Negative	Negative	Negative	Negative	Negative	Negative

4.4 HABITAT IMPROVEMENTS

Sites varied greatly across the study area and improvements could be made to increase habitat suitability for target species. Habitat improvements for each site where target species were detected, suspected or likely to occur are detailed in Table 4-5 and explored below. Suggestion for habitat improvements were made for Murray River cod and platypus. All other target species were not detected or, as is the case of olive perchlett and southern purple-spotted gudgeon, were not listed as threatened in the state in which they were detected. Overall, there was a focus on the re-establishment and/or regeneration of riparian and stream vegetation, which in-time will improve habitat complexity (i.e. regulation of water quality, input of debris, etc.) and erosion control.

MURRAY RIVER COD

Murray River cod are known to favour deep, slow flowing turbid waterbodies, preferably with boulders, undercut banks, overhanging vegetation and large woody debris. During the breeding season, eggs are deposited on clay beds, rocks, logs and other hard substrates in shallow and warm water (Allen et al., 1989; DCCEEW, 2022; J. Koehn & Clunie, 2010b). During the habitat likelihood assessments, habitat was largely limited at most sites. Habitat degradation has been listed alongside poor management of waterways, overfishing and regulation of water flows as major causes for the species decline (DCCEEW, 2022; J. Koehn & Clunie, 2010).

HABITAT COMPLEXITY

Throughout the study area, habitat complexity was typically low, due to absence of large boulders or rocky habitat, undercut banks and, within the Border to Gowrie section sites, the somewhat limited amount of LWD. Loss of habitat complexity has been a problem for many freshwater species in Australia, including Murray River cod, and various strategies have been adopted to increase habitat complexity, including the addition LWD and structures that mimic its properties.

The removal of LWD through de-snagging of rivers and clearing of riparian vegetation has reduced habitat complexity throughout the Murray River cod's distribution (Kalatzis & Baker, 2010; J. Koehn & Clunie, 2010a; J. D. Koehn, 2004). LWD naturally forms from complex root structures along the banks and from riparian vegetation and flood debris. It provides surfaces for egg deposition, predator protection for small-bodied individuals, areas of reduced flow and foraging/hunting grounds (J. Koehn & Clunie, 2010a, 2010b). One of the first programs to highlight the connection between LWD and the fish found that fish occupancy increased with the density of LWD in the Murray River (Nicol et al., 2004). Since then, numerous projects have incorporated natural 'snag stacks' and manmade 'fish hotels'. One of the largest restoration and monitoring projects began in 2006 and restored 4,450 snags to the Murray River between Lake Mulwala and Lake Hume (J. P. Lyon et al., 2019; J. Lyon & Tonkin, 2014). After seven years of monitoring, a three-fold increase in the local Murray River cod population was observed within the re-snagged area, largely due to immigration of fish to the restored stretch of the river (J. P. Lyon et al., 2019; J. Lyon & Tonkin, 2014). The project demonstrated the benefits of large-scale river rehabilitation, however smaller localised programs can also deliver benefits to fish populations . Re-snagging, the addition of 'fish hotels' and pipes within the Dewfish Demonstration Reach (DDR) in the Condamine catchment saw Murray River cod return to and/or or increase in numbers in Oaky and Myall Creek (Hydrobiology, 2016). Part of the DDRs success is a result of the diversity in microhabitats offered (Hutchison et al., 2013).

In addition to LWD, undercut banks, rocky habitat and/or large boulders have been seen to further improve habitat complexity for Murray River Cod, however were notably scarce across the study area. Undercut banks are important for Murray River cod and other species as they provide instream cover and breeding habitat. "Lunkers" are artificial habitat constructed from wood and rock placed against

the edge of stream to replicate undercut banks while improving stream bed stability (NRCS, 2007). Their introduction to some streams in the USA where they were designed showed considerable improvement to trout numbers (Brown, 2001). Within Australia, they have been used in projects such as the DDR in the Condamine catchment, in the rehabilitation of Mullinmur Billabong, and as part of habitat enhancement works along the Goulburn, Delatite, Rubicon and Acheron Rivers (DCEEW, 2021; Douglas & Abery, 2009; Hydrobiology, 2016). Within these projects, they have been associated with increases in the recruitment and overall population of several species, including large bodied fish (DCEEW, 2021; Douglas & Abery, 2009; Hydrobiology, 2016). Their effectiveness for Murray River cod is expected to be improved if used in conjunction with rocky habitat such as rock boulder piles or rocky reefs, as this would reduce the distance between spawning and nursery habitat for the species (Hutchison et al., 2013). Rocky structures are used as refugia, nursey areas and staging posts for fish and Murray River cod have been shown to favour complex rocky habitat over macrophytes, bare substrate and SWD near the streambank (Hutchison et al., 2013). While habitat complexity can be improved through re-snagging, boulder seeding and the addition of structures such as cod pipes, fish hotels and lunkers, these techniques are immediate and/or short-term strategies. For the best results, these strategies should be used while long-term actions, namely restoration of the riparian corridors with indigenous species, come to fruition (Hutchison et al., 2013).

RIPARAIN VEGETATION AND BANK STABILITY

Intact riparian corridors and vegetation needs to be established along Murray River cod habitat for a range of reasons, including bank stability and erosion control. Riparian vegetation provides temperature control and shade, complex habitat through root structures and a continual supply of snags, transfer of energy from the terrestrial environment into aquatic food webs, bank stability and erosion control (Arthington, 2009; Pusey & Arthington, 2003). Increased fine sediment loads can impair Murray River cod through filling of undulations and holes the fish frequent as well as the smothering of spawning habitats (J. D. Koehn, 2004), oxygen depletion of the stream bed and a loss of food items as smothering of interstitial particles removes macroinvertebrate habitat (Leitner et al., 2021). Riparian vegetation is highly effective at binding stream banks and controlling erosion, however can be hindered by ungulates and in areas where banks are steep, eroded and/or tall.

Along the Macintyre River, in which Murray River cod were detected at sites N2SQB12, N2SQB21 and N2SQB11, stream banks at bends were steep, tall and showed signs rotational failure (bank collapse or slumping). These sites also contained eDNA from goats, pigs and cattle. Short term improvements would involve the removal or exclusion of ungulates from the area. Larger scale works and appropriate management actions to address bank stability and erosion within heavily eroded sections of the river would require hydraulic and geomorphological assessments. Stabilising of these banks and consequent erosion control would rely on processes such as reprofiling of the banks (may require removing and/or adding sediment) and the installation of rock groynes into the river while the bank itself and the top of the bank was being revegetated. Lunkers could also be incorporated into this work to stabilise the banks while providing valuable undercut bank habitat for Murray River cod. This approach would allow riparian vegetation to establish and feasibly stabilise the bank while rock groynes attract sediment and eventually disintegrate naturally into the river. For the best results, riparian vegetation should be dominated by native, if not indigenous, species with an effort to eradicate and prevent weed species.

Re-establishing or regeneration of riparian vegetation should focus on the inclusion of native, if not indigenous, species and removal of noxious or invasive weeds. Non-native and/or invasive species can rapidly invade disturbed sites. Once established, non-native species compete with native plants for space, nutrients and sunlight and rarely provide the food or habitat required by native fauna (Department of the Environment and Heritage (DEH), 2004). For example, native species, such as species of Eucalyptus, Acacia, and Melaleuca, have sclerophyllous leaves, which may persist for

months or years before completely breaking down, therefore ensures a continuous food resource for stream organisms (DES, 2013).

PLATYPUS

Platypus tend to occur in areas that have stable banks for burrowing, intact streamside vegetation, aquatic invertebrates for food, complex aquatic habitats (including woody structures), and reliable water flows. However, platypus are known to persist in areas where some of these aforementioned features are absent, often in degraded agricultural settings (Bino et al., 2019; Bryant, 1993; Rohweder, 1992; Serena et al., 2001b), such as that seen at sites B2G21 and B2G22. During the habitat likelihood assessment, there was an absence of coarse rocky substrate or intact riparian vegetation at virtually all sites. At some sites, permanency of the waterbody was questionable and deep pool/run habitat was absent, while at others features such as consolidated banks with vegetation, LWD or debris at water level on the bank were not present.

HABITAT COMPLEXITY

Platypus density in an area is thought to be constrained by food availability, assuming that there is sufficient surface water (Serena & Williams, 2010). The presence of suitable foraging habitat is a key indicator for platypus presence, particularly when combined with suitable nesting and breeding habitat (Rohweder, 1992; Serena & Williams, 2010). Key foraging habitat for platypus is typically comprised of coarse bed substrate, undercut banks and LWD (T. Grant, 2004; Rohweder, 1992; Serena et al., 2001b). Within the study area, undercut banks and coarse bed substrate were notably absent from virtually all sites, including those where platypus were detected, however LWD was more prevalent.

Platypus have shown preference for complex habitats, with undercut banks, LWD and coarse substrates for foraging. Favourable substrates include gravel, pebbles, cobbles, large rocks and coarse particulate organic matter, while consolidated clay, willow tree roots and fine silt are negatively correlated with foraging activity (T. Grant, 2004; Rohweder, 1992; Serena et al., 2001b). As mentioned earlier, siltation can impair waterways through clogging of interparticle spaces which, subsequently, reduces the diversity and abundances of platypus' main food source – macroinvertebrates (Duan et al., 2008; Leitner et al., 2021). Similarly, macroinvertebrates are also common amongst woody debris, where some fauna will graze on the wood itself, while other graze on the biofilm or other macroinvertebrate species (J. Koehn et al., 2000). As a result, woody debris is often used as foraging habitat by platypus and LWD coverage is positively correlated with platypus activity. Even in habitats where LWD is limited, addition of woody debris has been seen to rapidly increase macroinvertebrate densities and consequently increase platypus foraging activity at sites where wood was deposited (Coleman, 2022). In addition to complex substrate and LWD, Serena et al (2001b) found that foraging activity by platypus was also positively correlated the coverage provided by undercut banks. As with LWD and coarse substrate, increased macroinvertebrate densities have been observed in undercut bank habitats, ergo represent a foraging environment for platypus (Rhodes & Hubert, 1991; Serena et al., 2001b). However, undercut banks are also used by platypus for burrows (Serena et al., 1998a).

STABLE EARTH BANKS

Stable earthen river and creek beds are essential for platypus for the construction of nesting and resting burrows (Serena et al., 2001b). Burrows can be very long reaching up to 55 m, however most platypus burrows typically reach 10 m in length, and are typically found along undercut or convex banks often associated with overhanging vegetation and established riparian vegetation. Burrow use and construction is positively correlated with the coverage of overhanging and riparian vegetation, through largely to be a result of the bank stabilisation the plants offer.

RIPARIAN VEGETATION

For reasons mentioned detailed above, riparian vegetation is important for waterways and the fauna that inhabit them. For platypus, riparian vegetation is particularly important as it provides woody debris, prevents erosion that would foul foraging habitat and stabilises the banks that their burrows are constructed in. The amount of overhanging vegetation has also been found to be positively linked to burrow usage (Serena & Williams, 2010). Overhanging vegetation provides protection for their burrows and provide in-stream organic material (Bryant, 1993; Rohweder, 1992; Serena et al., 2001b). Overhanging vegetation is expected to protect platypus burrows by obscuring their burrows from predators, reducing damage caused to the burrows by erosion and act as screen for light and noise from the surrounding environment (Bethge, 2002; Serena et al., 1998b). Overhanging vegetation and the detritus it deposits also provides an additional foraging habitat for platypus (Selena and Williams 2010).

Species present within riparian vegetation has been shown to correlate to platypus activity. Platypus activity is positively correlated with the number of medium and large Eucalyptus, Acacia and Populus trees growing along the bank and negatively correlated with the number of medium and large exotic trees (Serena et al., 2001b).

POLLUTION

Pollution, from debris or changes in water quality, can have indirect and direct impact platypus populations, particularly around populated, agricultural and industrial areas (Munday et al., 2002). Indirect impacts of pollution would include changes to macroinvertebrate communities through: sedimentation and clogging of interstitial spaces; elevated concentrations of organic compounds such as nitrogen and phosphorus leading to algal blooms; and; elevated concentrations of metals from industry and vehicles including cadmium, zinc and lead which are toxic to many macroinvertebrates (Kownacki & Szarek-Gwiazda, 2022; Leitner et al., 2021; Richmond et al., 2018). Given the surrounding land uses where platypus were detected metal contamination is not expected to be an impacting process in the study area.

Litter and debris can represent significant problem for platypus. Platypus can become trapped by instream structures such as pipes and culverts and become ensnared in other forms of debris (Bino et al., 2019; Serena & Williams, 2010). Their specialised feet are unable to remove litter trapped against their bodies, with repercussions of wounds and legions to drowning (DoELWP, 2016). They can become hooked by and tangled within discarded fishing hooks and lines, and become ensnared by plastic and rubber loops, such as those found in tamper proof seals, hair bands, bracelets, cable ties, caning jar rings etc. (Bino et al., 2019; Serena et al., 1998b; Serena & Williams, 2010). In a study on platypus populations around Melbourne, 40% of captured individuals had plastic or rubber loops around the animals head and/or body (Serena et al., 1998b; Serena & Williams, 2010).

Table 4-5 Favourable micro and macrohabitat features observed at each site where species were detected and suggestions for long and short term improvements of habitat.

Site and Likelihood	Favourable micro and macrohabitat characteristics	Improvements
Platypus		
B2G16 (Suspected)	• Large woody debris • Convex banks • Debris at water level • Permanent water body • Deep pool/run habitat • No impoundment of stream	Short term • Introduction of coarse substrate using gravel beds • Removal and/or exclusion of cattle • Increase amount of LWD • Artificial undercut bank habitat created through the installation of lunkers Long term • Consolidated banks with vegetation • Re-establish riparian vegetation • Removal of exotics and replaced with native eucalyptus, acacia or populus tree species
B2G17 (Confirmed)	• Consolidated banks with vegetation • Convex bank profiles at water level • Deep pool/run habitat • No impoundment of the stream.	Short term • Removal and/or exclusion of cattle • Introduction of gravel beds and other coarse substrate • Artificial undercut bank habitat created through the installation of lunkers • Install LWD within the mainstream • Addition of SWD/LWD along stream banks • Establish overhanging plants on stream bed • Artificial undercut bank habitat created through the installation of lunkers Long term • Re-establish riparian vegetation • Removal of exotics and replaced with native eucalyptus, acacia or populus tree species
B2G23 (Confirmed)	• Consolidated banks with vegetation • Large woody debris • Convex bank profiles at water level • Debris at water level • Permanent water bodies • Deep pool/run habitat • No impoundment of the stream.	Short term • Introduce coarse rocky substrate • Removal and/or exclusion of cattle and goats • Increase amount of LWD • Artificial undercut bank habitat created through the installation of lunkers Long term • Re-establish riparian vegetation • Removal of any willow trees and replaced with native eucalyptus, acacia or populus tree species

Site and Likelihood	Favourable micro and macrohabitat characteristics	Improvements
B2G21 and B2G22 (Confirmed)	• Consolidated banks with vegetation • Large woody debris • Sections of convex bank profiles at water level • Debris at water level • No impoundment of the stream.	Short term • Temporary sedimentation protection • Coarse substrate through instruction of gravel beds • Removal and/or exclusion of cattle • Increase amount of LWD • Vegetate along the river bank and between pools with shrubs and other plants that will overhang the water and provide cover for platypus during movement between isolated pools • Artificial undercut bank habitat created through the installation of lunkers • Identify nearby permanent water holes nearby that will serve as drought refugia. Improve habitat characteristics in these areas • Removal of barbed wire fencing through stream Long term • Establish suitable habitat between creeks and permanent waterbodies with riparian vegetation, stable banks and microhabitat • Re-establish riparian vegetation to provide cover and bank stability • Consider reprofiling and vegetation banks to reduce chance of collapse • Establish connection to permanent waterbody with suitable habitat • Establish water monitoring program at these sites due to proximity to Millmerran township and Commodore coal mine and power station • Removal of any willow trees and replaced with native eucalyptus, acacia or populus tree species
B2G28 (Confirmed)	• Consolidated banks with vegetation • Large woody debris • Coarse rocky substrate • Convex bank profiles at water level • Debris at water level • Permanent water bodies • Deep pool/run habitat • No impoundment of the stream.	Short term • Increase volume of coarse rocky substrate • Removal and/or exclusion of cattle and pigs • A large mass of LWD was deposited against rail bridge pilons during eDNA survey. LWD should not be removed from the system but instead redistributed downstream of the rail crossing • Vegetate along the river bank with shrubs and other plants that will overhang the water • Artificial undercut bank habitat created through the installation of lunkers Long term • Re-establish riparian vegetation • Removal of any willow trees and replaced with native eucalyptus, acacia or populus tree species • Reprofiling of eroded banks and establishing erosion control for high flow (flood) events
Murray River cod		

Site and Likelihood	Favourable micro and macrohabitat characteristics	Improvements
NS2QB12 (Confirmed)	• Overhanging vegetation • Large snags • Other LWD • Deep pools • No impoundment of stream • Intact riparian corridor	Short term • Artificial undercut bank habitat created through the installation of lunkers • Increase habitat complexity through fish hotel installation, cod pipes and boulder seeding • Removal and exclusion of cattle from the streambed Long term • Establish intact riparian veg in areas in cleared areas along the top of the bank and on the bank itself • Reprofiling and stabilisation of bends within the Macintyre River prone to erosion
NS2QB21 (Confirmed)	• Overhanging vegetation • Large snags • Other LWD • Deep pools • No impoundment of stream • Intact riparian corridor	Short term • Artificial undercut bank habitat created through the installation of lunkers • Increase habitat complexity through fish hotel installation, cod pipes and boulder seeding • Removal and exclusion of goats and cattle from the riparian zone and main channel Long term • Establish intact riparian veg in areas where it is clear along the top of the bank and on the bank itself • Reprofiling and stabilisation of bends within the Macintyre River prone to erosion
NS2QB11 (Confirmed)	• Overhanging vegetation • Large snags • Other LWD • Deep pools • No impoundment of stream	Short term • Artificial undercut bank habitat created through the installation of lunkers • Increase habitat complexity through fish hotel installation, cod pipes and boulder placement • Removal and exclusion of pigs and cattle from the riparian zone and main channel Long term • Establish intact riparian veg in areas where it is clear along the top of the bank and on the bank itself • Reprofiling and stabilisation of bends within the Macintyre River prone to erosion
B2G11 (Confirmed)	• Overhanging vegetation • Large snags • Other LWD • Deep pools • No impoundment of stream	Short term • Artificial undercut bank habitat created through the installation of lunkers • Increase habitat complexity through additional LWD, fish hotel installation, cod pipes and boulder placement • Removal and exclusion of cattle from the riparian zone and main channel Long term • Re-establish riparian corridors comprised of native, if not indigenous plant species

Site and Likelihood	Favourable micro and macrohabitat characteristics	Improvements
B2G10 (Suspected)	• Overhanging vegetation • Large snags • Other LWD • Deep pools	Short term • Artificial undercut bank habitat created through the installation of lunkers • Increase habitat complexity through additional LWD, fish hotel installation, cod pipes and boulder placement • Removal and exclusion of cattle from the riparian zone and main channel Long term • Re-establish riparian corridors comprised of native, if not indigenous plant species • Removal of waterway barrier at road crossing to improve connectivity

5. CONCLUSION

Overall most sites within the study area consisted of pool and run habitat within heavily eroded channels which showed signs of flood damage and partial, if not total, riparian clearing. Microhabitat within the sites typically consisted of small and large woody debris and detritus.

Positive eDNA results were returned for the following species:

- Olive perchlet - found at a total of six sites through the Helidon to Calvert and the Calvert to Kagaru sections of Inland Rail. The species was found within Lockyer, Western and Warrill creeks and the Bremer River within the Brisbane River catchment and within Dugandan and Woollaman creeks in the Logan-Albert catchment within Queensland. No detections occurred in NSW where the species is threatened;
- Southern purple-spotted gudgeon – found at a total of four sites across the Helidon to Calvert and NSW/QLD Border to Gowrie sections. eDNA was found at three sites within Lockyer Creek in the Brisbane Rivers catchment and once within Westbrook Creek in the Balonne-Condamine Rivers catchment. No detections occurred in NSW, where the species is threatened;
- Platypus - found at five sites within the QLD/NSW border to Gowrie section in the Condamine River, Bringalily Creek and Back Creek. eDNA suspected to be from at least two populations; and
- Murray River cod – detected three times within the Macintyre River in the North Star to Border section and once in Canning Creek within the NSW/QLD border to Gowrie section.

eDNA for silver perch, Mary River cod and Australian lungfish were not detected at any sites. This was largely attributed to the distance of sites from their endemic ranges of (Mary River for Mary River cod and Murray Darling basin for silver perch) and/or lack of suitable habitat (rapids and races for silver

perch, lack of macrophytes for lungfish). We note that eDNA detection of lungfish can be problematic. In our experience surveys targeting Australian lungfish have noted that the effectiveness of eDNA to detect lungfish varied. At some sites where lungfish were electrofished, eDNA results were negative however eDNA also detected lungfish at sites where electrofishing was unsuccessful. The noted historical records 500 m from H2C12A (record from 2003) and 1.5 km from C2K3 and C2K5 (record from 1992), could be investigated further via traditional fish sampling techniques such as electrofishing, etc; however we note that these records are outdated and habitat characteristics including critical macrophyte habitat were absent at these sites.

Habitat likelihood assessments were conducted for the MNES species and the platypus. The lack of high flow rapids and races (silver perch preferred habitat) and the absence of macrophyte beds (foraging and spawning habitat for lungfish) throughout the surveyed area meant no sites were deemed as potential locations for the silver perch or Australian lungfish. However, for platypus and Murray River cod, a total of 11 and six sites, respectively were deemed as possible or likely locations for each species. A total of 10 sites contained suitable habitat for Mary River cod; however given the sites were outside their natural ranges and that fact that there were no eDNA detection or historical records for this species, they are considered unlikely to occur in the study area. Despite stocking efforts for a number of these species, it has been shown that such efforts do not result in improvements in natural populations.

In addition to identifying Murray River cod and platypus eDNA at multiple sites, the eDNA survey also identified DNA belonging to a range of mammals, birds, reptiles and other fish. Of these, several species were of note – particularly the wallum rocket frog and the Lakeland's plains mouse. While eDNA can be prone to misidentifying hybrid species, these eDNA results could represent a range expansion of these species.

A range of site specific long and short term habitat improvements have been suggested for platypus and Murray River cod – the only target species detected in areas where they are protected under legislation. Generally, habitat suitability improvements rely upon the increase of habitat complexity for breeding and foraging sites through the addition of natural and artificial structures, improvement of bank stability, exclusion of livestock and the regeneration and/or re-establishment of riparian vegetation.

6. REFERENCES

Allen, G. R., Midgley, S. H., & Allen, M. (1989). *Freshwater Fishes of Australia* (J. Knight & W. Bulgin, Eds.). TFH Publications.

Andruszkiewicz Allan, E., Zhang, W. G., C. Lavery, A., & F. Govindarajan, A. (2021). Environmental DNA shedding and decay rates from diverse animal forms and thermal regimes. *Environmental DNA*, *3*(2), 492–514. https://doi.org/https://doi.org/10.1002/edn3.141

Arthington, A. H. (2009). Australian lungfish, Neoceratodus forsteri, threatened by a new dam. *Environmental Biology of Fishes*, *84*(2), 211–221. https://doi.org/10.1007/s10641-008-9414-y

Atlas of Living Australia (ALA). (2022). *Occurrence Records*. https://biocache.ala.org.au/search#tab_simpleSearch

Australian Government. (2016). Mary River Threatened Aquatic Species Recovery Plan. *Commonwealth of Australia 2016*.

Bethge, P. (2002). *Energetics and foraging behaviour of the Platypus Ornithorhynchus anatinus*.

Bino, G., Kingsford, R. T., Archer, M., Connolly, J. H., Day, J., Dias, K., Goldney, D., Gongora, J., Grant, T., & Griffiths, J. (2019). The platypus: evolutionary history, biology, and an uncertain future. *Journal of Mammalogy*, *100*(2), 308–327.

Bray, D. J., & Thompson, V. J. (2021). Silver Perch, Bidyanus bidyanus (Mitchell 1838). *Fishes of Australia*. https://fishesofaustralia.net.au/home/species/689#moreinfo

Brooks, S., & Kind, P. (2002). *Ecology and demography of the Queensland lungfish (Neoceratodus forsteri) in the Burnett River, Queensland with reference to the impacts of Walla Weir and future water*

infrastructure development. Department of Primary Industries, Queensland Agency for Food and Fibre Sciences.

Brown, P. (2001). A review of fish habitat rehabilitation projects in Minnesota and Wisconsin, USA. Scientific Exchange Program Travel Report, Marine and Freshwater Resources Institute. *Natural Resources and Environment*, *41*.

Brunt, T., Adams-Hosking, C., & Murray, P. (2018). Prime real estate for the platypus (Ornithorhynchus anatinus): Habitat requirements in a peri-urban environment. *Queensland Naturalist*, *56*(4/5/6), 25–39. https://search.informit.org/doi/10.3316/informit.155013392713552

Bryant, A. G. (1993). An evaluation of the habitat characteristics of pools used by platypus (Ornithorhynchus anatinus) in the upper Macquarie River system, New South Wales. *Honours Thesis, Charles Sturt University, Bathurst, New South Wales, Australia*.

Bureau Of Meteorology (BOM). (2022). *Climate data online*. http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=033062

Centre for the Government of Queensland (CGQ). (2018). *Brisbane River System*. https://queenslandplaces.com.au/brisbane-river-system

Clunie, P., & Koehn, J. (2001). *Silver Perch — A Resource Document. Volume 2*. Murray Darling Basin Commission, Canberra. http://www.dse.vic.gov.au/__data/assets/pdf_file/0019/112483/SilverPerchResourceDocument2001.pdf

Coleman, R. (2022). Ecological and physical responses to large woody debris reintroduction in the Little Yarra River, Victoria, Australia. *Monash University. Master's Thesis.*

Curtis, A. N., Tiemann, J. S., Douglass, S. A., Davis, M. A., & Larson, E. R. (2021). High stream flows dilute environmental DNA (eDNA) concentrations and reduce detectability. *Diversity and Distributions*, *27*(10), 1918–1931. https://doi.org/https://doi.org/10.1111/ddi.13196

Department of Agriculture and Fisheries (DAF). (2022). Freshwater stocking records – 2009 to 2018. *Open Data Portal*.

Department of Climate Change Energy the Environment and Water (DCCEEW). (2017). Draft National Recovery Plan for the Australian lungfish (Neoceratodus forsteri). *Commonwealth of Australia*, 1–59.

Department of Climate Change Energy the Environment and Water (DCCEEW). (2022). Maccullochella peelii — Murray Cod. *Species Profile and Threats Database*.

Department of Climate Change Energy the Environment and Water (DCCEEW). (2023). Polytelis alexandrae — Princess Parrot, Alexandra's Parrot. *Species Profile and Threats Database (SPRAT)*.

Department of Climate Change Energy the Environment and Water (DCEEW). (2021). *Native fish making a comeback: Mullinmur Billabongs gets a makeover*. Commonwealth Environmental Water Office.

Department of Environment and Science (DES). (2013). Riparian vegetation. *WetlandInfo*.

Department of Primary Industries (DPI). (2013). Olive Perchlet (western population) - Ambassis agassizii. *Primefact*, *176*(2). https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/635876/PUB12-10-Primefact-176-Western-Olive-Perchlet-Ambassis-agassizii.pdf

Department of Primary Industries (DPI). (2017). Southern Purple Spotted Gudgeon – Mogurnda adspersa. *Primefact*, *1275*(2).

https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635290/Primefact-1275-Southern-Purple-Spotted-Gudgeon-Mogurnda-adspersa.pdf

Department of the Environment and Heritage (DEH). (2004). Invasive species in Australia. *Weeds of National Significance and the Alert List for Environmental Weeds*.

Department of the Environment (DoE). (2013). *Conservation Advice Bidyanus bidyanus (silver perch)*. Canberra: Department of the Environment. http://www.environment.gov.au/biodiversity/threatened/species/pubs/76155-conservation-advice.pdf

Department of the Environment (DotE). (2014). *Approved Conservation Advice for Neoceratodus forsteri (Australian lungfish).* . Canberra: Department of the Environment. http://www.environment.gov.au/biodiversity/threatened/species/pubs/67620-conservation-advice.pdf. In effect under the EPBC Act from 11-Apr-2014.

Department of Sustainability, Environment, Water, Population and Communities. (2011). *Survey guidelines for Australia's threatened fish. EPBC Act survey guidelines 6.4* . EPBC Act policy statement. Canberra, ACT: DSEWPAC. Retrieved from http://www.environment.gov.au/

Douglas, J., & Abery, N. (2009). Response of brown trout to willow management and habitat improvements in the Rubicon River. *Fisheries Revenue Allocation Committee*.

Duan, X., Wang, Z., & Tian, S. (2008). Effect of streambed substrate on macroinvertebrate biodiversity. *Frontiers of Environmental Science & Engineering in China*, *2*, 122–128. https://doi.org/10.1007/s11783-008-0023-y

Ecological. (2020). Inland Rail (Border to Gowrie Project). Appendix K: Aquatic Ecological Technical Report. *Prepared for Freight Joint Venture.*

Espinoza, T., Burke, C., Carpenter-Bundhoo, L., Marshall, S., Roberts, D., & Kennard, M. (2020). Fine-scale acoustic telemetry in a riverine environment: movement and habitat use of the endangered Mary River cod (Maccullochella mariensis). *Endangered Species Research*, *42*, 125–131. https://doi.org/10.3354/esr01046

Furlan, E. M., Griffiths, J., Gust, N., Handasyde, K. A., Grant, T. R., Gruber, B., & Weeks, A. R. (2013). Dispersal patterns and population structuring among platypuses, Ornithorhynchus anatinus, throughout south-eastern Australia. *Conservation Genetics*, *14*, 837–853.

Future Freight. (2020a). *Biodiversity Technical Report Parts 1 to 6. Inland Rail – North star to NSW/Queensland Border Environmental Impact Statement*.

Future Freight. (2020b). *MNES technical Report. Parts 1 to 4. Inland Rail – Border to Gowrie Environmental Impact Statement*.

Future Freight. (2020c). *MNES technical Report. Parts 1 to 4. Inland Rail – Calvert to Kagaru Environmental Impact Statement*.

Future Freight. (2020d). *MNES technical Report. Parts 1 to 4. Inland Rail – Helidon to Calvert Environmental Impact Statement*.

Future Freight. (2020e). *Terrestrial and Aquatic Ecology Technical Report Parts 1 to 2. Inland Rail –Helidon to Calvert*.

Future Freight. (2020f). *Terrestrial and Aquatic Ecology Technical Report Parts 1 to 4. Inland Rail –Calvert to Kagaru Environmental Impact Statement*.

Golpour, A., Šmejkal, M., Čech, M., dos Santos, R. A., Souza, A. T., Jůza, T., Martínez, C., Bartoň, D., Vašek, M., Draštík, V., Kolařík, T., Kočvara, L., Říha, M., Peterka, J., & Blabolil, P. (2022). Similarities

and Differences in Fish Community Composition Accessed by Electrofishing, Gill Netting, Seining, Trawling, and Water eDNA Metabarcoding in Temperate Reservoirs. *Frontiers in Ecology and Evolution*, *10*. https://www.frontiersin.org/articles/10.3389/fevo.2022.913279

Gomon, M. F., & Bray, D. J. (2018). Mogurnda adspersa. *Fishes of Australia*. https://fishesofaustralia.net.au/home/species/4148

Grant, T. (2004). Depth and substrate selection by platypuses, Ornithorhynchus anatinus, in the lower Hastings River, New South Wales. *Proceedings of the Linnean Society of New South Wales*, *125*, 235–241.

Grant, T. R. (2004). Captures, Capture Mortality, Age and Sex Ratios of Platypuses, Ornithorhynchus anatinus, during Studies over 30 Years in the Upper Shoalhaven River in New South Wales. *Proceedings of the Linnean Society of New South Wales*, *125*, 217–226. https://search.informit.org/doi/10.3316/informit.041787475555173

Hines, H., Hero, J.-M., Meyer, E., & Newell, D. (2004). Litoria freycineti. *IUCN 2011. IUCN Red List of Threatened Species*, *2011.2*. https://www.iucnredlist.org/

Hutchison, M., Norris, A., Nixon, D., & Chilcott, K. (2013). Habitat preferences of small bodied native fish: Final Report Feb 2013. *Department of Agriculture, Fisheries and Forestry.* .

Hydrobiology. (2016). Dewfish Demonstration Reach Monitoring and Evaluation Report. *Prepared by Hydrobiology Pty Ltd for Condamine Alliance*.

Kalatzis, A., & Baker, L. (2010). Murray cod. *Recreational Fishers' Education Project*.

Kemp, A. (1986). The biology of the Australian Lungfish, Neoceratodus forsteri (Krefft, 1870). *Journal of Morphology*, *Supplement 1:* 181–198.

Kemp, A. (2013). Abnormal development in embryos and hatchlings of the Australian lungfish, *Neoceratodus forsteri*, from two reservoirs in south-east Queensland. *Australian Journal of Zoology*, *62*(1), 63–79. https://doi.org/10.1071/ZO13038

Koehn, J., & Clunie, P. (2010a). Background and Implementation Information for the National Recovery Plan for the Murray Cod Maccullochella peelii peelii. *Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Victoria*.

Koehn, J., & Clunie, P. (2010b). National Recovery Plan for the Murray Cod Maccullochella peelii peelii. *Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Victoria*.

Koehn, J. D. (2004). Threats to Murray cod. *Arthur Rylah Institute for Environmental Research Department of Sustainability and Environment*.

Koehn, J. D., & Clunie, P. (2010). National recovery plan for the Murray Cod Maccullochella peelii peelii. *National Murray Cod Recovery Team, Department of Sustainability and Environment, Melbourne*.

Koehn, J., Nicol, S., & Lieschke, J. (2000). Resnagging the Murray River. *RipRap*, *16*, 9.

Kolomyjec, S. H., Chong, J. Y. T., Blair, D., Gongora, J., Grant, T. R., Johnson, C. N., & Moran, C. (2009). Population genetics of the platypus (Ornithorhynchus anatinus): a fine-scale look at adjacent river systems. *Australian Journal of Zoology*, *57*(4), 225–234.

Koster, W. M., Stuart, I., Tonkin, Z., Dawson, D., & Fanson, B. (2021). Environmental influences on migration patterns and pathways of a threatened potamodromous fish in a regulated lowland river network. *Ecohydrology*, *14*(2), e2260. https://doi.org/https://doi.org/10.1002/eco.2260

Kownacki, A., & Szarek-Gwiazda, E. (2022). The Impact of Pollution on Diversity and Density of Benthic Macroinvertebrates in Mountain and Upland Rivers. *Waters*, *14*, 1349.

Koziol, A., Stat, M., Simpson, T., Jarman, S., DiBattista, J. D., Harvey, E. S., Marnane, M., McDonald, J., & Bunce, M. (2019). Environmental DNA metabarcoding studies are critically affected by substrate selection. *Molecular Ecology Resources*, *19*(2), 366–376.

Leitner, P., Graf, W., & Hauer, C. (2021). Ecological assessment of high sediment loads based on macroinvertebrate communities in the Bohemian Massif in Austria – A sensitivity analysis. *Limnologica*, 125941. https://doi.org/https://doi.org/10.1016/j.limno.2021.125941

Lugg, W. H., Griffiths, J., van Rooyen, A. R., Weeks, A. R., & Tingley, R. (2018). Optimal survey designs for environmental DNA sampling. *Methods in Ecology and Evolution*, *9*(4), 1049–1059. https://doi.org/https://doi.org/10.1111/2041-210X.12951

Lyon, J. P., Bird, T. J., Kearns, J., Nicol, S., Tonkin, Z., Todd, C. R., O'Mahony, J., Hackett, G., Raymond, S., Lieschke, J., Kitchingman, A., & Bradshaw, C. J. A. (2019). Increased population size of fish in a lowland river following restoration of structural habitat. *Ecological Applications*, *29*(4), e01882. https://doi.org/https://doi.org/10.1002/eap.1882

Lyon, J., & Tonkin, Z. (2014). The Murray River Resnagging Experiment . *The State of Victoria Department of Environment and Primary Industries Melbourne*.

McDowall, R. M. (1996). *Freshwater Fishes of South-eastern Australia*. Reed. https://books.google.com.au/books?id=kEwWAQAAIAAJ

Meng Yao, Shan Zhang, Qi Lu, Xiaoyu Chen, Si-Yu Zhang, Yueqiao Kong, Jindong Zhao. (2022). Fishing for fish. Environmental DNA: Ecological applications, methodological considerations, survey designs, and ways forward. Molecular Ecology. 31(20): 5125-5418.

Merrick, J. R., & Schmida, G. E. (1984). *Australian freshwater fishes*. JR Merrick.

Meyer, E. (2012). Wallum rocketfrog, Litoria freycineti. In L. Curtis, A. Dennis, K. McDonald, P. Kyne, & S. Debus (Eds.), *Queensland's Threatened Animals* (pp. 152–153). CSIRO Publishing.

Meyer, E., Hero, J.-M., Shoo, L., & Lewis, B. (2006). National recovery plan for the wallum sedgefrog and other wallum-dependent frog species. *Report to Department of the Environment and Water Resources, Canberra. Queensland Parks and Wildlife Service: Brisbane*.

Mousavi-Derazmahalleh, M., Stott, A., Lines, R., Peverley, G., Nester, G., Simpson, T., Zawierta, M., De La Pierre, M., Bunce, M., & Christophersen, C. T. (2021). eDNAFlow, an automated, reproducible and scalable workflow for analysis of environmental DNA sequences exploiting Nextflow and Singularity. *Molecular Ecology Resources*, *21*(5), 1697–1704. https://doi.org/https://doi.org/10.1111/1755-0998.13356

Munday, B. L., Stewart, N. J., & Södergren, A. (2002). Accumulation of persistent organic pollutants in Tasmanian platypus (Ornithorhynchus anatinus). *Environmental Pollution*, *120*(2), 233–237. https://doi.org/https://doi.org/10.1016/S0269-7491(02)00143-4

Murray Darling Basin Authority (MDBA). (2021). *Condamine–Balonne*.

Murray Darling Basin Authority (MDBA). (2022). *Border rivers*. https://www.mdba.gov.au/water-management/catchments/border-rivers

Murray-Darling Basin Commission (MDBC). (2023). Olive perchlet (Agassiz's glassfish, Glass perchlet, Western chanda perch). *Fishes of the Murray-Darling Basin*. https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2203_factsheet_native_olive_perchlet.pdf

Natural Resources Conservation Service (NRCS). (2007). Stream Habitat Enhancement Using LUNKERS. In *Part 654 National Engineering Handbook*. United States Department of Agriculture (USDA).

Nicol, S. J., Lieschke, J. A., Lyon, J. P., & Hughes, V. (2004). Restoring structural woody habitat in the River Murray. *Rivers*, *10*.

NSW Department of Primary Industries (DPI). (2006). Silver Perch Bidyanus bidyanus NSW Recovery Plan. *Threatened Species Recovery Planning Program*.

Piggott, M. (2016). Evaluating the effects of laboratory protocols on eDNA detection probability for an endangered freshwater fish. *Ecology and Evolution*, *6*. https://doi.org/10.1002/ece3.2083

Pusey, B. J., & Arthington, A. H. (2003). Importance of the riparian zone to the conservation and management of freshwater fish: a review. *Marine and Freshwater Research*, *54*(1), 1–16.

Queensland Government. (2020). *Policy for fish stocking in Queensland*.

Resilient Rivers Initiative. (2017). Logan-Albert Catchment Action Plan 2017 – 2020. *Resilient Rivers Regional Strategy (2015-2025)*.

Rhodes, H. A., & Hubert, W. A. (1991). Submerged undercut banks as macroinvertebrate habitat in a subalpine meadow stream. *Hydrobiologia*, *213*(2), 149–153. https://doi.org/10.1007/BF00015001

Richmond, E. K., Rosi, E. J., Walters, D. M., Fick, J., Hamilton, S. K., Brodin, T., Sundelin, A., & Grace, M. R. (2018). A diverse suite of pharmaceuticals contaminates stream and riparian food webs. *Nature Communications*, *9*(1), 4491. https://doi.org/10.1038/s41467-018-06822-w

Rohweder, D. (1992). Management of Platypus in the Richmond River Catchment, Northern New South Wales. *PhD Thesis, University of New England-Northern Rivers*.

Rourke, M. L., Fowler, A. M., Hughes, J. M., Broadhurst, M. K., DiBattista, J. D., Fielder, S., Wilkes Walburn, J., & Furlan, E. M. (2022). Environmental DNA (eDNA) as a tool for assessing fish biomass: A review of approaches and future considerations for resource surveys. *Environmental DNA*, *4*(1), 9–33. https://doi.org/https://doi.org/10.1002/edn3.185

Rourke, M. L., Walburn, J. W., Broadhurst, M. K., Fowler, A. M., Hughes, J. M., Fielder, D. S., DiBattista, J. D., & Furlan, E. M. (2023). Poor utility of environmental DNA for estimating the biomass of a threatened freshwater teleost; but clear direction for future candidate assessments. *Fisheries Research*, *258*, 106545. https://doi.org/https://doi.org/10.1016/j.fishres.2022.106545

Serena, M., Thomas, J., Williams, G., & Officer, R. (1998a). Use of stream and river habitats by the platypus, Ornithorhynchus anatinus, in an urban fringe environment. *Australian Journal of Zoology - AUST J ZOOL*, *46*. https://doi.org/10.1071/ZO98034

Serena, M., Thomas, J., Williams, G., & Officer, R. (1998b). Use of stream and river habitats by the platypus, Ornithorhynchus anatinus, in an urban fringe environment. *Australian Journal of Zoology - AUST J ZOOL*, *46*. https://doi.org/10.1071/ZO98034

Serena, M., & Williams, G. A. (2010). Conserving PLATYPUS and Water-Rats INFORMATION and GUIDELINES. *Australian Platypus Conservancy*.

Serena, M., & Williams, G. A. (2013). Movements and cumulative range size of the platypus (Ornithorhynchus anatinus) inferred from mark–recapture studies. *Australian Journal of Zoology*, *60*(5), 352–359.

Serena, M., Worley, M., Swinnerton, M., & Williams, G. (2001a). Effect of food availability and habitat on the distribution of platypus (Ornithorhynchus anatinus) foraging activity. *Australian Journal of Zoology*, *49*, 263–277. https://doi.org/10.1071/ZO00089

Serena, M., Worley, M., Swinnerton, M., & Williams, G. A. (2001b). Effect of food availability and habitat on the distribution of platypus (<emph type="2">Ornithorhynchus anatinus</emph>) foraging activity. *Australian Journal of Zoology*, *49*(3), 263–277. https://doi.org/10.1071/ZO00089

Shogren, A. J., Tank, J. L., Andruszkiewicz, E., Olds, B., Mahon, A. R., Jerde, C. L., & Bolster, D. (2017). Controls on eDNA movement in streams: Transport, Retention, and Resuspension. *Scientific Reports*, *7*(1), 5065. https://doi.org/10.1038/s41598-017-05223-1

Simpson, P., & Jackson, P. (1996). THE MARY RIVER COD RESEARCH AND RECOVERY PLAN . *Prepared For Endangered Species Program ENVIRONMENT AUSTRALIA*.

Stat, M., Huggett, M. J., Bernasconi, R., DiBattista, J. D., Berry, T. E., Newman, S. J., Harvey, E. S., & Bunce, M. (2017). Ecosystem biomonitoring with eDNA: metabarcoding across the tree of life in a tropical marine environment. *Scientific Reports*, *7*(1), 12240. https://doi.org/10.1038/s41598-017-12501-5

Stat, M., John, J., DiBattista, J. D., Newman, S. J., Bunce, M., & Harvey, E. S. (2019). Combined use of eDNA metabarcoding and video surveillance for the assessment of fish biodiversity. *Conservation Biology*, *33*(1), 196–205. https://doi.org/https://doi.org/10.1111/cobi.13183

State Library of South Australia. (2010). The dwindling river: Problems with introduced species. *SA Memory. South Australia Past and Present, for the Future*. https://www.samemory.sa.gov.au/site/page.cfm?u=1374

Stoessel, D. J., Raadik, T. A., Adams, M., Shelley, J., Hately, T. A., Iervasi, D., Rose, R., Russell, A., & Murphy, N. (2022). Status of Southern Purple-spotted Gudgeon (Mogurnda adspersa) in the Kerang region, Victoria. *Arthur Rylah Institute for Environmental Research - Technical Report Series*, *343*.

The State of Victoria Department of Environment Land Water and Planning (DoELWP). (2016). *Managing willows in Victoria*.

Tibbetts, I., Rothlisburh, P., Neil, D., Homburg, T., & Brewer, D. (2019). History and Change in Moreton Bay. In I. R. Tibbetts, P. C. Rothlisberg, D. T. Neil, T. A. Homburg, D. T. Brewer, A. H. Arthington, & The Moreton Bay Foundation Limited (Eds.), *Moreton Bay Quandamooka & Catchment: Past, present, and future*. The Moreton Bay Foundation.

Wager, R. (1993). The distribution and conservation status of Queensland freshwater fishes. *Queensland Department of Primary Industries Information Series*, *No Q193001.*

Wilkes Walburn, J., Rourke, M. L., Furlan, E., DiBattista, J. D., Broadhurst, M. K., Fowler, A. M., Hughes, J. M., & Fielder, S. (2022). Robust environmental DNA assay development and validation: A case study with two vulnerable Australian fish. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *32*(7), 1225–1231. https://doi.org/https://doi.org/10.1002/aqc.3809

Yamanaka, H., Motozawa, H., Tsuji, S., Miyazawa, R. C., Takahara, T., & Minamoto, T. (2016). On-site filtration of water samples for environmental DNA analysis to avoid DNA degradation during transportation. *Ecological Research*, *31*(6), 963–967. https://doi.org/https://doi.org/10.1007/s11284-016-1400-9

Yao, M., Zhang, S., Lu, Q., Chen, X., Zhang, S.-Y., Kong, Y., & Zhao, J. (2022). Fishing for fish environmental DNA: Ecological applications, methodological considerations, surveying designs, and ways forward. *Molecular Ecology*, *31*(20), 5132–5164. https://doi.org/https://doi.org/10.1111/mec.16659

APPENDIX A. EDNA RESULTS

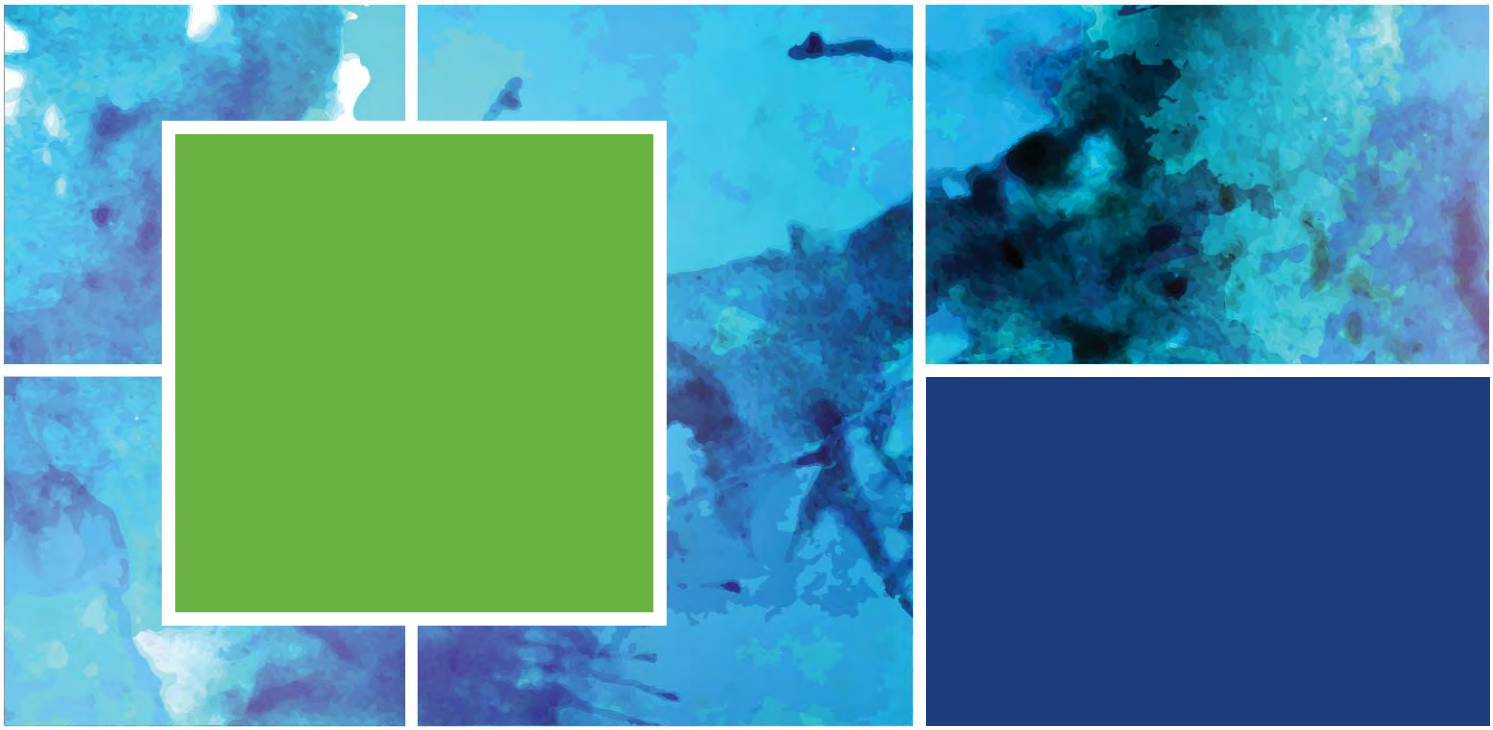


Table 6-1 Taxonomic diversity in water samples detected using 12S assay targeting vertebrates. Presence of the species at each site is indicated by the symbol *. Bolded species name indicates target species. Taxonomy was assigned as per NCBI and classifications were standardised according to the Global Biodiversity Information Facility (accessed January 2023). A dash is used where a classification category does not exist for that taxa, and blank cells indicate where taxa could not be resolved to a lower taxonomic level. Blue text indicates taxa that are not recorded from the study area according to GBIF.

Class	Family	Genus	Species	Common name	NS2QB19	NS2QB5	NS2QB20	NS2QB12	NS2QB21	NS2QB11	B2G5	B2G11	B5G10	B2G16	B2G17	B2G23	B2G21	B2G22	B2G28	B2G37	H2C12A	H2C4A	H2C3	H2C17	H2C18A	C2K4	C2K5	C2K3	C2K1	C2K6	C2K7	C2K2
Actinopterygii	Anguillidae	Anguilla		Freshwater eels																				*	*	*	*	*	*	*	*	*
	Atherinidae	Craterocephalus	*Craterocephalus marjoriae*	Marjorie's hardyhead																*	*	*	*										
			Craterocephalus stercusmuscarum	Fly-specked hardyhead																	*	*											
	Clupeidae	Nematalosa	*Nematalosa erebi*	Bony bream	*	*		*	*			*	*	*	*	*			*	*							*					
	Cyprinidae			Carp	*	*	*					*	*	*	*				*	*	*	*	*		*		*	*				
		Cyprinus	*Cyprinus carpio*	Eurasian carp	*	*	*	*	*	*		*	*	*	*	*		*	*	*	*				*	*	*	*	*	*	*	*
	Poeciliidae	Gambusia		Mosquito fish	*	*	*	*			*	*	*			*	*	*		*	*	*			*	*	*		*			*
		Xiphophorus		Tooth-carps																						*							
			Xiphophorus maculatus	Southern platyfish																						*		*					
	Mugilidae	Mugil	*Mugil cephalus*	Flathead grey mullet																								*	*		*	*
	Retropinnidae	Retropinna	*Retropinna semoni*	Australian smelt				*	*			*			*				*	*							*		*		*	*
	Ambassidae	Ambassis	*Ambassis agassizii*	**Olive perchlet**																		*			*		*		*	*	*	
	Cichlidae			Cichlid																												*
	Eleotridae	Gobiomorphus	*Gobiomorphus australis*	Striped gudgeon																						*	*	*	*	*	*	*
		Hypseleotris		Carp gudgeon				*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Hypseleotris klunzingeri	Western carp gudgeon				*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Hypseleotris sp. 'Lake's carp gudgeon'	Lake's carp gudgeon				*	*	*		*	*	*	*	*	*	*			*	*	*	*	*	*	*	*		*	*
			Hypseleotris sp. 'Midgley's carp gudgeon'	Midgley's carp gudgeon				*	*	*		*	*	*		*		*	*	*	*	*	*		*	*	*	*	*		*	*

Class	Family	Genus	Species	Common name	NS2QB19	NS2QB5	NS2QB20	NS2QB12	NS2QB21	NS2QB11	B2G5	B2G11	BSG10	B2G16	B2G17	B2G23	B2G21	B2G22	B2G28	B2G37	H2C12A	H2C4A	H2C3	H2C17	H2C18A	C2K4	C2K5	C2K3	C2K1	C2K6	C2K7	C2K2
		Mogurnda		**Purple spotted gudgeon**																*	*	*	*										
		Philypnodon	*Philypnodon grandiceps*	Flathead gudgeon																							*	*		*	*	*
			Philypnodon macrostomus	dwarf flathead gudgeon																							*	*				
	Percichthyidae	Maccullochella	***Maccullochella peelii***	**Murray River cod**				*	*	*		*																				
		Macquaria	*Macquaria ambigua*	Golden perch				*	*	*		*			*	*			*	*												
			Macquaria novemaculeata	Australian bass																									*			*
	Terapontidae			Grunters								*	*	*	*	*	*	*	*	*	*	*	*	*	*						*	*
	Tetrarogidae	Notesthes	*Notesthes robusta*	Bullrout																									*			*
	Plotosidae	Tandanus	*Tandanus tandanus*	Eel-tailed catfish					*	*		*			*					*		*	*	*	*	*	*	*	*			*
Amphibia	Bufonidae	Rhinella	*Rhinella marina*	Cane toad																		*	*		*						*	
	Limnodynastidae	Limnodynastes	*Limnodynastes salmini*	Salmon-striped frog	*																											
	Myobatrachidae	Mixophyes	*Mixophyes fasciolatus*	Great barred frog																										*		
	Pelodryadidae	Litoria	*Litoria freycineti*	Wallum rocket frog									*																			
			Litoria peronii	Peron's tree frog							*		*																			

Class	Family	Genus	Species	Common name	NS2QB19	NS2QB5	NS2QB20	NS2QB12	NS2QB21	NS2QB11	B2G5	B2G11	BSG10	B2G16	B2G17	B2G23	B2G21	B2G22	B2G28	B2G37	H2C12A	H2C4A	H2C3	H2C17	H2C18A	C2K4	C2K5	C2K3	C2K1	C2K6	C2K7	C2K2
Aves	Anatidae	Anas		Dabbling ducks				*		*	*							*	*			*	*	*		*						
			Anas platyrhynchos	Mallard				*			*		*			*		*	*	*		*	*	*	*	*		*	*		*	
		Chenonetta	*Chenonetta jubata*	Australian wood duck										*	*	*		*	*						*	*	*	*				
		Dendrocygna	*Dendrocygna eytoni*	Plumed whistling duck																		*										
	Dromaiidae	Dromaius	*Dromaius novaehollandiae*	Emu															*													
	Columbidae	Geopelia	*Geopelia cuneata*	Diamond dove																					*							
		Ocyphaps	*Ocyphaps lophotes*	Crested pigeon															*													
	Alcedinidae	Dacelo	*Dacelo novaeguineae*	Laughing kookaburra																				*		*			*			
		Todiramphus	*Todiramphus sanctus vagans*	Sacred Kingfisher										*																		

Class	Family	Genus	Species	Common name	NS2QB19	NS2QB5	NS2QB20	NS2QB12	NS2QB21	NS2QB11	B2G5	B2G11	BSG10	B2G16	B2G17	B2G23	B2G21	B2G22	B2G28	B2G37	H2C12A	H2C4A	H2C3	H2C17	H2C18A	C2K4	C2K5	C2K3	C2K1	C2K6	C2K7	C2K2
	Coraciidae	Eurystomus	*Eurystomus orientalis*	Oriental dollarbird														*													
	Phasianidae	Gallus	*Gallus gallus*	Red junglefowl															*					*			*					*
	Rallidae	Gallinula	*Gallinula chloropus*	Common moorhen												*				*	*											
				Passerine														*														
	Artamidae	Gymnorhina	*Gymnorhina tibicen*	Australian magpie														*														
	Corcoracidae	Struthidea	*Struthidea cinerea*	Apostlebird														*														
	Corvidae	Corvus		Crows											*		*															
	Meliphagidae	Philemon		Friarbird									*																			
	Monarchidae	Grallina	*Grallina cyanoleuca*	Magpie-lark							*		*																			

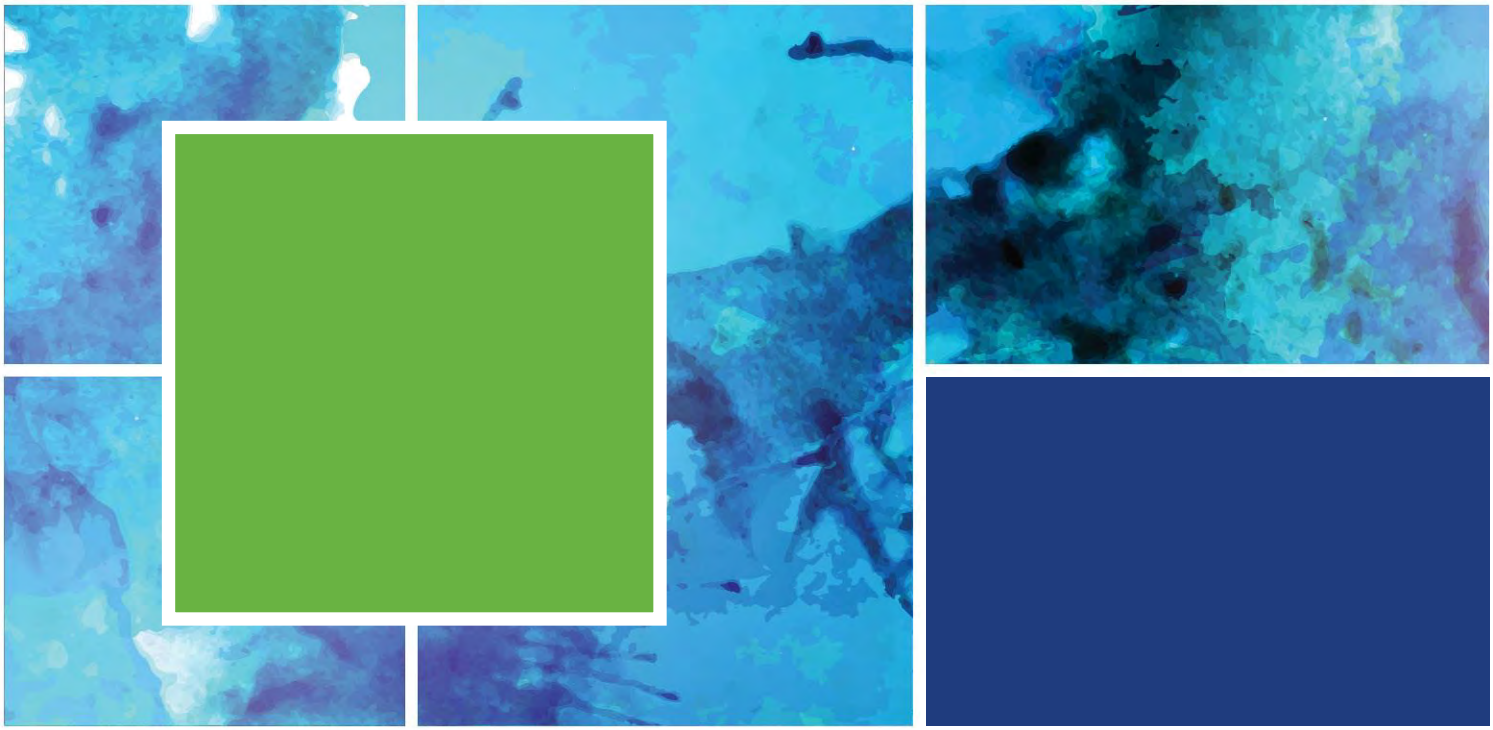
Class	Family	Genus	Species	Common name	NS2QB19	NS2QB5	NS2QB20	NS2QB12	NS2QB21	NS2QB11	B2G5	B2G11	BSG10	B2G16	B2G17	B2G23	B2G21	B2G22	B2G28	B2G37	H2C12A	H2C4A	H2C3	H2C17	H2C18A	C2K4	C2K5	C2K3	C2K1	C2K6	C2K7	C2K2
	Ardeidae	Bubulcus	*Bubulcus ibis*	Cattle egret																*												
		Egretta		Egret			*									*																
	Phalacrocoracidae	Phalacrocorax	*Phalacrocorax sulcirostris*	Little black cormorant									*						*													
			Phalacrocorax varius	Australian pied cormorant															*													
	Threskiornithidae	Threskiornis	*Threskiornis aethiopicus*	African sacred ibis												*						*	*									
	Cacatuidae	Cacatua		Cockatoo												*	*		*											*		
			Cacatua galerita	Sulphur-crested cockatoo															*													
			Cacatua pastinator	Western corella									*																			
	Psittacidae	Polytelis	*Polytelis alexandrae*	Princess parrot									*																			

Class	Family	Genus	Species	Common name	NS2QB19	NS2QB5	NS2QB20	NS2QB12	NS2QB21	NS2QB11	B2G5	B2G11	BSG10	B2G16	B2G17	B2G23	B2G21	B2G22	B2G28	B2G37	H2C12A	H2C4A	H2C3	H2C17	H2C18A	C2K4	C2K5	C2K3	C2K1	C2K6	C2K7	C2K2
Mammalia	Bovidae	Bos		Cow	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Bos taurus	Domesticated cattle						*																*						
		Capra	*Capra hircus*	Goat	*	*		*								*						*					*					
		Ovis		Sheep	*	*																*					*					
	Cervidae	Cervus	*Cervus elaphus*	Red deer						*																						*
	Suidae	Sus	*Sus scrofa*	Wild boar						*									*	*	*								*			
	Molossidae	Mormopterus	*Mormopterus planiceps*	South-eastern freetail bat				*																								
	Pteropodidae	Boneia	*Boneia bidens*	Manado fruit bat	*					*																						
		Pteropus	*Pteropus scapulatus*	Little red flying fox																				*								

Class	Family	Genus	Species	Common name	NS2QB19	NS2QB5	NS2QB20	NS2QB12	NS2QB21	NS2QB11	B2G5	B2G11	BSG10	B2G16	B2G17	B2G23	B2G21	B2G22	B2G28	B2G37	H2C12A	H2C4A	H2C3	H2C17	H2C18A	C2K4	C2K5	C2K3	C2K1	C2K6	C2K7	C2K2
	Macropodidae	Macropus	*Macropus giganteus*	Eastern grey kangaroo																												*
	Petauridae	Petaurus	*Petaurus breviceps*	Sugar glider								*																				
	Phalangeridae	Trichosurus	*Trichosurus caninus*	Short-eared possum																				*		*						
			Trichosurus vulpecula	Common brushtail possum	*	*		*	*	*	*	*	*	*	*	*	*	*	*							*	*	*	*		*	*
	Muridae	Leggadina	*Leggadina lakedownensis*	Lakeland Downs mouse									*																			
		Mus	*Mus musculus*	House mouse					*																							
		Rattus	*Rattus rattus*	Black rat							*																					
Reptilia	Chelidae	Chelodina		Snake-necked turtles		*							*			*	*	*			*				*		*	*				
		Emydura	*Emydura macquarii*	Macquarie River Turtle																										*		*

Class	Family	Genus	Species	Common name	NS2QB19	NS2QB5	NS2QB20	NS2QB12	NS2QB21	NS2QB11	B2G5	B2G11	BSG10	B2G16	B2G17	B2G23	B2G21	B2G22	B2G28	B2G37	H2C12A	H2C4A	H2C3	H2C17	H2C18A	C2K4	C2K5	C2K3	C2K1	C2K6	C2K7	C2K2
		Myuchelys	*Myuchelys latisternum*	Saw-shelled turtle																					*	*	*			*		*

APPENDIX B. QA/QC



EDNA FIELD SURVEY

Specific QA/QC procedures implemented during eDNA sampling included:

- Prior to sampling taking place, the equipment that would be in contact with the eDNA filter (tubing) was disinfected within a 10% bleach solution.
- The 'clean-hands' – 'dirty-hands' sampling techniques was used for all water sampling. This involved one person to take the sample (primary sampler – 'clean hands') only handling the eDNA filters after the seal on the sterile zip-locked foil bag that contained the filter had been opened by the other person (secondary sampler – 'dirty hands').
- Powder-less nitrite gloves (double gloved) were used when collecting eDNA samples. Care was taken not to touch the inside surfaces of the filter bag or expose the filter to the atmosphere for extended periods of time.
- Samples were taken in areas of free-standing water and sediment was avoided to prevent clogging of eDNA filter with fine sediment.
- At sites where canoes were necessary to access the sampling location, downstream location were sampled first to prevent contamination by the canoe itself. Similarly, samples were taken upstream of any observed fishing or water discharge.
- A total of 3 samples were taken at each site in areas of suitable microhabitat to ensure best detection of eDNA present at the site. Macrohabitats samples and potential factors affected eDNA sampling are detailed in Table 6-3.
- For QA/QC purposes the QC field blank sample was collected to quantify potential contamination during sampling using clean water. All blank samples returned no fish DNA (Table 6-2).

EDNA LAB ANALYSIS

SAMPLE STORAGE

Filter membranes were transported ambiently to eDNA frontiers laboratories where they were stored at -20°C until scheduled for DNA extraction.

PCR ANALYSIS

Result criteria for PCR analysis:

- Positive: Indication of exponential amplification with a C_T average of <40;
- Possible: Indication of exponential amplification with a C_T average of <40, but fewer than two replicates within a single dilution amplified; and
- Negative: Lack of amplification, C_T average 40 and above.

eDNA Frontiers noted that because this assay is designed to be species-specific, positive amplification should be indicative of a positive detection of the target species, *Ornithorhynchus anatinus.*

METABARCODING

A wide range of taxa were detected in the water samples using a vertebrate metabarcoding assay Contamination attributable to Homo sapiens and Canis lupus familiaris were removed from the dataset. Although detections of cow, sheep, goat, pig, deer, and chicken are possibly due to environmental contamination, these were left in the dataset as they could potentially be true detections from nearby locations. Laboratory extraction controls were all negative, and the positive control amplified successfully.

Table 6-2 Taxonomic diversity in blank field samples detected using 12S assay targeting vertebrates. Presence of a species eDNA is indicated by the symbol *. Bolded species name indicates target species. Taxonomy was assigned as per NCBI and classifications were standardised according to the Global Biodiversity Information Facility (accessed January 2023). A dash is used where a classification category does not exist for that taxa, and blank cells indicate where taxa could not be resolved to a lower taxonomic level. Blue text indicates taxa that are not recorded from the surveyed area according to GBIF.

Class	Order	Family	Genus	Species	Common name	Blank 1	Blank 2	Blank 3
Actinopterygii	Anguilliformes	Anguillidae	Anguilla		Freshwater eels			
	Atheriniformes	Atherinidae	Craterocephalus	*Craterocephalus marjoriae*	Marjorie's hardyhead			
				Craterocephalus stercusmuscarum	Fly-specked hardyhead			
	Clupeiformes	Clupeidae	Nematalosa	*Nematalosa erebi*	Bony bream			
	Cypriniformes	Cyprinidae			Carp			
			Cyprinus	*Cyprinus carpio*	Eurasian carp			
	Cyprinodontiformes	Poeciliidae	Gambusia		Mosquito fish			
			Xiphophorus		Tooth-carps			
				Xiphophorus maculatus	Southern platyfish			
	Mugiliformes	Mugilidae	Mugil	*Mugil cephalus*	Flathead grey mullet			
	Osmeriformes	Retropinnidae	Retropinna	*Retropinna semoni*	Australian smelt			
	Perciformes	Ambassidae	Ambassis	*Ambassis agassizii*	Olive perchlet			
		Cichlidae			Cichlid			
		Eleotridae	Gobiomorphus	*Gobiomorphus australis*	Striped gudgeon			

Class	Order	Family	Genus	Species	Common name	Blank 1	Blank 2	Blank 3
			Hypseleotris		Carp gudgeon			
				Hypseleotris klunzingeri	Western carp gudgeon			
				Hypseleotris sp. 'Lake's carp gudgeon'	Lake's carp gudgeon			
				Hypseleotris sp. 'Midgley's carp gudgeon'	Midgley's carp gudgeon			
			Mogurnda		Purple spotted gudgeon			
			Philypnodon	*Philypnodon grandiceps*	Flathead gudgeon			
				Philypnodon macrostomus	Dwarf flathead gudgeon			
		Percichthyidae	Maccullochella	*Maccullochella peelii*	Murray River cod			
			Macquaria	*Macquaria ambigua*	Golden perch			
				Macquaria novemaculeata	Australian bass			
		Terapontidae			Grunters			
	Salmoniformes	Salmonidae	Salmo	*Salmo salar*	Atlantic salmon			
	Scorpaeniformes	Tetrarogidae	Notesthes	*Notesthes robusta*	Bullrout			
	Siluriformes	Plotosidae	Tandanus	*Tandanus tandanus*	Eel-tailed catfish			
Amphibi	Anura	Bufonidae	Rhinella	*Rhinella marina*	Cane toad			

Class	Order	Family	Genus	Species	Common name	Blank 1	Blank 2	Blank 3
		Limnodynastidae	Limnodynastes	*Limnodynastes salmini*	Salmon-striped frog			
		Myobatrachidae	Mixophyes	*Mixophyes fasciolatus*	Great barred frog			
		Pelodryadidae	Litoria	*Litoria freycineti*	Wallum rocket frog			
				Litoria peronii	Peron's tree frog			
Aves	Anseriformes	Anatidae	Anas		Dabbling ducks			
				Anas platyrhynchos	Mallard			
			Chenonetta	*Chenonetta jubata*	Australian wood duck			
			Dendrocygna	*Dendrocygna eytoni*	Plumed whistling duck			
	Casuariiformes	Dromaiidae	Dromaius	*Dromaius novaehollandiae*	Emu			
	Columbiformes	Columbidae	Geopelia	*Geopelia cuneata*	Diamond dove			
			Ocyphaps	*Ocyphaps lophotes*	Crested pigeon			
	Coraciiformes	Alcedinidae	Dacelo	*Dacelo novaeguineae*	Laughing kookaburra			
			Todiramphus	*Todiramphus sanctus vagans*	Sacred Kingfisher			

Class	Order	Family	Genus	Species	Common name	Blank 1	Blank 2	Blank 3
		Coraciidae	Eurystomus	*Eurystomus orientalis*	Oriental dollarbird			
	Galliformes	Phasianidae	Gallus	*Gallus gallus*	Red junglefowl			
	Gruiformes	Rallidae	Gallinula	*Gallinula chloropus*	Common moorhen			
	Passeriformes				Passerine			
		Artamidae	Gymnorhina	*Gymnorhina tibicen*	Australian magpie			
		Corcoracidae	Struthidea	*Struthidea cinerea*	Apostlebird			
		Corvidae	Corvus		Crows			
		Meliphagidae	Philemon		Friarbird			
		Monarchidae	Grallina	*Grallina cyanoleuca*	Magpie-lark			
	Pelecaniformes	Ardeidae	Bubulcus	*Bubulcus ibis*	Cattle egret			
			Egretta		Egret			
		Phalacrocoracidae	Phalacrocorax	*Phalacrocorax sulcirostris*	Little black cormorant			
				Phalacrocorax varius	Australian pied cormorant			

Class	Order	Family	Genus	Species	Common name	Blank 1	Blank 2	Blank 3
		Threskiornithidae	Threskiornis	*Threskiornis aethiopicus*	African sacred ibis			
	Psittaciformes	Cacatuidae	Cacatua		Cockatoo			
				Cacatua galerita	Sulphur-crested cockatoo			
				Cacatua pastinator	Western corella			
		Psittacidae	Polytelis	*Polytelis alexandrae*	Princess parrot			
Mammalia	Artiodactyla	Bovidae	Bos		Cow			
				Bos taurus	Domesticated cattle			
			Capra	*Capra hircus*	Goat			
			Ovis		Sheep			
		Cervidae	Cervus	*Cervus elaphus*	Red deer			
		Suidae	Sus	*Sus scrofa*	Wild boar			
	Chiroptera	Molossidae	Mormopterus	*Mormopterus planiceps*	South-eastern freetail bat			
		Pteropodidae	Boneia	*Boneia bidens*	Manado fruit bat			
			Pteropus	*Pteropus scapulatus*	Little red flying fox			

Class	Order	Family	Genus	Species	Common name	Blank 1	Blank 2	Blank 3
	Diprotodontia	Macropodidae	Macropus	*Macropus giganteus*	Eastern grey kangaroo			
		Petauridae	Petaurus	*Petaurus breviceps*	Sugar glider			
		Phalangeridae	Trichosurus	*Trichosurus caninus*	Short-eared possum			
				Trichosurus vulpecula	Common brushtail possum			
	Rodentia	Muridae	Leggadina	*Leggadina lakedownensis*	Lakeland Downs mouse			
			Mus	*Mus musculus*	House mouse			
			Rattus	*Rattus rattus*	Black rat			
Reptilia	Testudines	Chelidae	Chelodina		Snake-necked turtles			
			Emydura	*Emydura macquarii*	Macquarie River Turtle			
			Myuchelys	*Myuchelys latisternum*	Saw-shelled turtle			

Table 6-3 Macrohabitat and microhabitat sampled for eDNA at each site and factors that affected eDNA sampling.

Catchment	ARTC section	Waterway	Site	Macrohabitat sampled					Microhabitat sampled					Factors affecting eDNA sampling			
				Riffle	Run	Deep pool	Shallow pool	Cascade	Undercut banks	LWD	SWD	Backwaters	Macrophytes	Depth (m)	Slipperiness/ bogginess	Suspended material	Flow
Murray Darling	NS2B North star to border	Unnamed Creek	NS2QB19	×	×	×	✓	×	×	✓	×	×	✓	1	û	Turbid	û
		Back Creek	NS2QB5	×	×	×	✓	×	×	✓	✓	×	×	0.5	û	û	û
		Forest Creek	NS2QB20	×	×	×	✓	×	×	×	×	×	×	0.2	û	Turbid	û
		Macintyre River	NS2QB12	×	×	✓	×	×	×	✓	✓	×	×	>2	û	Turbid	Low flow
		Macintyre River	NS2QB21	×	✓	✓	×	×	×	✓	✓	×	×	>2	û	Turbid	Low flow
		Macintyre River	NS2QB11	×	✓	✓	×	×	×	✓	✓	×	×	>2	û	Turbid	Low flow
	B2G NSW/QLD border to Gowrie	Macintyre Brook	B2G5	×	×	×	✓	×	×	✓	✓	×	✓	<0.5	û	û	û
		Canning Creek	B2G11	×	×	✓	×	×	×	✓	✓	×	×	1.5	û	Turbid	û
		Pariagara Creek	B2G10	×	×	×	✓	×	×	×	✓	×	×	0.3	✓	Turbid and tannin rich	û
		Bringalily Creek	B2G16	×	×	×	✓	×	×	✓	×	✓	✓	-	û	Very turbid	û
		Bringalily Creek	BSG17	×	×	✓	×	×	×	×	×	×	✓	2	û	Turbid	û
		Back Creek	B2G23	×	×	✓	×	×	×	✓	×	×	×	-	û	Very turbid	No flow
		Back Creek	B2G21	×	×	×	✓	×	×	×	×	×	×	0.5	û	Very turbid	No flow
		Back Creek	B2G22	×	×	×	✓	×	×	✓	✓	×	×	0.5	û	Very turbid	No flow
		Condamine River	B2G28	✓	✓	×	✓	×	×	✓	×	×	×	-	û	û	No flow
		Westbrook Creek	B2G37	×	✓	×	×	×	×	×	×	×	✓	1	Boggy soft sand and clay	Turbid	Moderate flow
North East Coast	H2C Helidon to Calvert	Lockyer Creek	H2C12A	×	✓	✓	×	×	×	×	✓	×	×	>2	û	û	Low, visible flow
		Lockyer Creek	H2C4A	×	✓	✓	×	×	×	✓	✓	×	×	>1.5m	û	û	Low, visible flow

Catchment	ARTC section	Waterway	Site	Macrohabitat sampled					Microhabitat sampled					Factors affecting eDNA sampling			
				Riffle	Run	Deep pool	Shallow pool	Cascade	Undercut banks	LWD	SWD	Backwaters	Macrophytes	Depth (m)	Slipperiness/ bogginess	Suspended material	Flow
		Lockyer Creek	H2C3A	×	✓	✓	×	×	×	×	×	×	×	>3m	û	û	Low flow
		Laidley Creek	H2C17A	✓	✓	×	×	×	×	×	✓	×	×	>2	û	û	Moderate flow below bridge
		Western Creek	H2C18A	×	×	✓	×	×	×	×	×	×	✓	>2	Slippery clay and sand edges	Turbid	Low flow
	C2K Calvert to Kagaru	Western Creek	C2K4	×	✓	×	×	×	×	✓	✓	×	×	>1m, bed highly variable	Steep clay banks slippery when wet	Turbid	Low flow
		Bremer River	C2K5	×	×	✓	×	×	×	✓	✓	×	×	3m	Clay banks slippery when wet	Very turbid	No flow
		Bremer River	C2K3	×	×	✓	×	×	×	✓	×	×	×	1.5m, bed highly variable	Clay banks slippery when wet	Very turbid	No flow
		Warrill Creek	C2K1	×	×	✓	×	×	×	✓	×	×	×	>1m	Banks black clay, slippery and boggy when wet	Very turbid	Low flow
		Dugandan Creek	C2K6	×	×	×	✓	×	×	✓	×	×	✓	0.5	Very boggy sand banks	×	No flow
		Woollaman Creek	C2K7	×	×	✓	×	×	×	✓	×	×	×	<1.5m	Soft sand	Turbid	Low flow
		Teviot Brook	C2K2	×	✓	×	×	×	×	✓	✓	×	✓	0.5m	Soft sand	Very turbid	Low flow