

MW7P

SHEET 5 OF 5

Client:	MACARTHUR COAL
Project:	MIDDLEMOUNT COAL PROJECT
Borehole Location:	MW7P - MIDDLEMOUNT MINE
Project Number:	2117076B

PB Borehole No.:

Date Commenced: 21.07.2010

Date Completed: 28.07.2010

Recorded By: Malcolm Graham

Log Checked By:

Drill Model/Mounting: HYDROPOWER SCOUT
Borehole Diameter: 254mm to 140mm

Driller: E Schumacher
Driller Lic No: 3127
TOC (RL): 165 m AHD

Surface RL: 164 m AHD

Co-ords: E 669777 N 7472247 MGA94 Zone 55

Local Co-ords:

Borehole Information									Field Material Description				
1	2	3	4	5	6	7	8	9	10	11	12	13	
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL (m) AHD	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL, FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY CONSISTENCY	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			TWC - m								W		
					-38 202					SANDSTONE: (fine grained, gray, (consolid))			
					-40 204					END OF BOREHOLE AT 203.00 m			
					-42 206								
					-44 208								
					-46 210								
					-48 212								
					-50 214								
					-52 216								
					-54 218								
					-56 220								
					-58 222								
					-60 224								
					-62 226								
					-64 228								
					-66 230								
					-68 232								
					-70 234								
					-72 236								
					-74 238								
					-76 240								
					-78 242								
					-80 244								
					-82 246								
					-84 248								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW8FR

SHEET 2 OF 4

Client: **MACARTHUR COAL**
Project: **MIDDLEMOUNT COAL PROJECT**
Borehole Location: **MW8MR MIDDLEMOUNT MINE**
Project Number: **2117076B**

PB Borehole No.:

Date Commenced: **10.06.2010**Date Completed: **25.07.2010**Recorded By: **Malcolm Graham**Log Checked By: *UAR*

Drill Model/Mounting: **IRTH 60**
Borehole Diameter: **200mm to 114mm**

Driller: **S Baker**
Driller Lic No: **3046**
TOC (RL): **165 m AHD**

Surface RL: **164 m AHD**
Co-ords: **E 669941 N 7472277 MGA94 Zone 55**
Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			TOC 1 m									
				30.00						fine grained.	D	
				112	52							
				110	54							
				108	56							
				106	58							
				104	60							
				102	62							
				100	64							
				98	66							
				96	68							
				94	70							
				92	72					moist	M	
				90	74					dry	D	
				88	76							
				86	78					moist	M	
				84	80					SILTSTONE: grey, fresh, calcite alteration, dry.	D	
				82	82					SANDSTONE: fine grained, grey, fresh, calcite alteration.		
				80	84					very fine grained.		
				78	86					fine grained.		
				76	88					moist	M	
				74	90					very fine grained, dry	D	
				72	92					fine grained.		
				70	94					SHALE: dark grey to black, fresh, moist.	M	
				68	96					SANDSTONE: fine grained, dark grey, fresh, carbonaceous and calcite alteration, moist.		
				66	98					SHALE: dark grey to black, fresh, carbonaceous and calcite alteration, wet.	W	
				64	100					SILTSTONE: dark grey, fresh, carbonaceous, calcite alteration, dry.	D	

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW8FR

SHEET 3 OF 4

Client: MACARTHUR COAL PB Borehole No.: Date Commenced: 10.06.2010
Project: MIDDLEMOUNT COAL PROJECT Date Completed: 25.07.2010
Borehole Location: MW8MR MIDDLEMOUNT MINE Recorded By: Malcolm Graham
Project Number: 2117076B Log Checked By: *U&R*

Drill Model/Mounting: IRTM 60 Driller: S Baker Surface RL: 164 m AHD
Borehole Diameter: 200mm to 114mm Driller Lic No: 3046 Co-ords: E 669941 N 7472277 MGA94 Zone 55
TOC (RL): 165 m AHD Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			TOC 1m								VS FB VL J D S L	
RAB			50mm ID, Class 18 uPVC casing from 100 to 123.5m bgl	164	62 102					SANDSTONE: very fine grained, dark grey, fresh, calcite alteration, carbonaceous, wet.	W	
					60 104							
					58 106							
					56 108							
					54 110							
					52 112							
					50 114							
					48 116							
					46 118							
					44 120							
					42 122							
			50mm ID, Class 18 uPVC, 1.5mm sealed screen from 123.5 to 129.5m bgl		40 124							
					38 126							
					36 128							
			85mm ID, Class 18 uPVC casing from 129.5 to 147m bgl		34 130							
					32 132					SILTSTONE: dark grey, fresh, calcite alteration, wet.		
					30 134					SANDSTONE: very fine grained, dark grey, fresh, calcite alteration, wet.		
					28 136							
					26 138							
					24 140							
					22 142							
					20 144							
					18 146							
			50mm ID, Class 18 uPVC, 0.5mm sealed screen from 147 to 150.5m bgl, 0.3m uPVC casing		16 148							
This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.												

Airflow yield: 0.004 L/S

MW8FR

SHEET 4 OF 4

Client:	MACARTHUR COAL
Project:	MIDDLEMOUNT COAL PROJECT
Borehole Location:	MW8MR MIDDLEMOUNT MINE
Project Number:	2117076B

PB Borehole No.:

Date Commenced: 10.06.2010

Date Completed: 25.07.2010

Recorded By: Malcolm Graham

Log Checked By:

Drill Model/Mounting: IRTM 60
Borehole Diameter: 200mm to 114mm

Driller: S Baker
Driller Lic No: 3046
TOC (RL): 165 m AHD

Surface RL: 164 m AHD
Co-ords: E 66941 N 7472277 MGA94 Zone 55
Local Co-ords:

Borehole Information							Field Material Description						
1	2	3	4	5	6	7	8	9	10	11	12	13	
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RUM AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY CONSISTENCY	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			TOC 1m										
			Bentonite 151 to 153m bgl		12 m 152					SANDSTONE : very fine grained, dark grey, fresh, calcite alteration, wet. (continued)	W		
			Bentonite 153 to 189m bgl		131.00					SILTSTONE: grey, fresh, with calcite alteration, wet.			
					10 154					SANDSTONE: very fine grained, dark grey, fresh, wet.			114mm Diameter, 153 to 189m bgl
					8 156								
					6 158								
					4 160								
					2 162								
					0 164								
					-2 166								
					-4 168								
					-6 n 170					fine grained.			
					-8 n 172					very fine grained.			
					-10 n 174					fine grained.			
					-12 176					very fine grained.			
					-14 178					COAL: black, fresh, wet.			
					-16 180					TUFF: pale grey, fresh, wet.			
					-18 182					COAL: black, fresh, wet.			
					-20 n 184					TUFF: white, fresh, wet.			
					-22 186					COAL: black, fresh, wet and TUFF: white, fresh, wet.			Airlift yield: 0.07 L/S
					-24 188					COAL: black, fresh, wet.			
					-26 190					END OF BOREHOLE AT 189.00 m			
					-28 192								
					-30 194								
					-32 196								
					-34 198								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9A

SHEET 1 OF 2

Client: **MACARTHUR COAL** PB Borehole No.: **155 m AHD** Date Commenced: **05.07.2010**
Project: **MIDDLEMOUNT COAL PROJECT** Date Completed: **27.07.2010**
Borehole Location: **MW9A -MIDDLEMOUNT MINE** Recorded By: **Malcolm Graham**
Project Number: **2117076B** Log Checked By: *MSR*

Drill Model/Mounting: **IRTH 60** Driller: **S Baker** Surface RL: **155 m AHD**
Borehole Diameter: **143mm** Driller Lic No: **3046** Co-ords: **E 670246 N 7469610 MGA94 Zone 55**
TOC (RL): **157 m AHD** Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL (m) AHD	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY
			TOC 1 m								VS FB VL AD 100 50 25 0	
RB			Monument core with PVC cap. Correct 0 to 4.5m bgl (below ground level) 50mm ID, Class 12 uPVC casing, 0 to 10m bgl	154.200	2				CL	Silty CLAY: brown, dry, firm.	D	
				152.400	4				CL	CLAY: brown	M	
				150.600	6				SC	Clayey SAND: fine grained, pale brown, moist.	D	
				148.800	8				SP	SAND: fine grained, pale brown, dry.	M	
				147.000	10				SC	with clay, moist.	D	
				145.200	12				CL	CLAY: pale grey, moist, firm	M	
				143.400	14				SC	Sandy CLAY: brown, fine grained sand, moist.		
				141.600	16				CL	CLAY: grey, moist, firm		
				139.800	18				ML	and Clayey SAND: fine grained, orange, moist.		
				138.000	20				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				136.200	22				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				134.400	24				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				132.600	26				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				130.800	28				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				129.000	30				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				127.200	32				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				125.400	34				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				123.600	36				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				121.800	38				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				120.000	40				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				118.200	42				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				116.400	44				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				114.600	46				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				112.800	48				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				111.000	50				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				109.200	52				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				107.400	54				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				105.600	56				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				103.800	58				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				102.000	60				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				100.200	62				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				98.400	64				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				96.600	66				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				94.800	68				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				93.000	70				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				91.200	72				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				89.400	74				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				87.600	76				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				85.800	78				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				84.000	80				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				82.200	82				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				80.400	84				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				78.600	86				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				76.800	88				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				75.000	90				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				73.200	92				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				71.400	94				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				69.600	96				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				67.800	98				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				66.000	100				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				64.200	102				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				62.400	104				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				60.600	106				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				58.800	108				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				57.000	110				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				55.200	112				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				53.400	114				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				51.600	116				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				49.800	118				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				48.000	120				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				46.200	122				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				44.400	124				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				42.600	126				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				40.800	128				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				39.000	130				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				37.200	132				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				35.400	134				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				33.600	136				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				31.800	138				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				30.000	140				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				28.200	142				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				26.400	144				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				24.600	146				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				22.800	148				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				21.000	150				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				19.200	152				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				17.400	154				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				15.600	156				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				13.800	158				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				12.000	160				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				10.200	162				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				8.400	164				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				6.600	166				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				4.800	168				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				3.000	170				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				1.200	172				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-0.600	174				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-2.400	176				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-4.200	178				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-6.000	180				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-7.800	182				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-9.600	184				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-11.400	186				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-13.200	188				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-15.000	190				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-16.800	192				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-18.600	194				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-20.400	196				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-22.200	198				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-24.000	200				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-25.800	202				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-27.600	204				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-29.400	206				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-31.200	208				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-33.000	210				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-34.800	212				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-36.600	214				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-38.400	216				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-40.200	218				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-42.000	220				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-43.800	222				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-45.600	224				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-47.400	226				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-49.200	228				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-51.000	230				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-52.800	232				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-54.600	234				CL	CLAY: grey, orange and pink, firm, trace very fine grained pink sand, moist.		
				-56.400	236				CL	CLAY		



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9A

SHEET 2 OF 2

Client: MACARTHUR COAL
Project: MIDDLEMOUNT COAL PROJECT
Borehole Location: MW9A - MIDDLEMOUNT MINE
Project Number: 2117076B

FB Borehole No.:
Date Commenced: 05.07.2010
Date Completed: 27.07.2010
Recorded By: Malcolm Graham
Log Checked By: *WGR*

Drill Model/Mounting: IRTM 60
Borehole Diameter: 143mm

Driller: S Baker
Driller Lic No: 3046
TOC (RL): 157 m AHD

Surface RL: 156 m AHD
Co-ords: E 670246 N 7469610 MGA94 Zone 55
Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY / CONSISTENCY
RB			TOC 1 m							SILTSTONE: dark grey, slightly weathered, moist. (continued)	M	
				104	52					END OF BOREHOLE AT 52.00 m.		
				102	54							
				100	56							
				98	58							
				96	60							
				94	62							
				92	64							
				90	66							
				88	68							
				86	70							
				84	72							
				82	74							
				80	76							
				78	78							
				76	80							
				74	82							
				72	84							
				70	86							
				68	88							
				66	90							
				64	92							
				62	94							
				60	96							
				58	98							

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9M

SHEET 1 OF 3

Client: MACARTHUR COAL
Project: MIDDLEMOUNT COAL PROJECT
Borehole Location: MW9M - MIDDLEMOUNT MINE
Project Number: 2117076B

PB Borehole No.:

Date Commenced: 30.06.2010

Date Completed: 27.07.2010

Recorded By: Malcolm Graham

Log Checked By: *UAR*

Drill Model/Mounting: IRTM 60
Borehole Diameter: 200mm to 140mm

Driller: S Baker

Driller Lic No: 3046

TOC (RL): 157 m AHD

Surface RL: 156 m AHD

Co-ords: E 670244 N 7469619 MGA94 Zone 55

Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			TOC 1m									
RB			Aluminum cover with PVC cap. Concrete 0 to 5m bgl (above ground level). Steel ID. Class 12 JAWC coupling. 0 to 135m bgl.	154	2				CL	Silty CLAY: brown, dry, firm.	D	200mm Diameter, 0 to 51m bgl
				152	4				SL	CLAY: brown, dry, firm.		
				150	6				SC	Clayey SAND: medium grained, brown, moist.	M	
				148	8				CL/SC	CLAY: grey, moist, firm and Sandy CLAY: brown, fine grained sand, moist.		
				146	10				SC	Clayey SAND: fine to medium grained, grey and orange, moist.		
				144	12				CL/ML	CLAY: grey, moist, firm and Clayey SAND: fine grained, orange, moist.		
				142	14				CL	CLAY: pale grey, orange and pink, moist, firm, trace very fine grained pink sand.		
				140	16				CL/ML	CLAY: grey, pink and orange, moist, firm and SAND: very fine grained, pink, moist.		
				138	18							
				136	20							
				134	22							
				132	24							
				130	26							
				128	28							
				126	30							
				124	32							
				122	34				CL	CLAY: brown, moist, firm.		
				120	36				ML	SILT: yellow-brown, with fine grey clay, moist.		
				118	38					SANDSTONE: very fine grained, yellow-brown, extremely weathered, moist.		
				116	40							
				114	42							
				112	44					red, distinctly weathered.		
				110	46					CLAYSTONE: brown and orange, distinctly weathered, moist.		
				108	48					SILTSTONE: grey-brown, distinctly weathered, carbonaceous, moist.		
										SANDSTONE: very fine grained, grey, slightly weathered, moist.		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9M

SHEET 3 OF 3

Client: **MACARTHUR COAL**
Project: **MIDDLEMOUNT COAL PROJECT**
Borehole Location: **MW9M - MIDDLEMOUNT MINE**
Project Number: **2117076B**

PB Borehole No.:

Date Commenced: **30.06.2010**Date Completed: **27.07.2010**Recorded By: **Malcolm Graham**

Log Checked By:

Drill Method/Mounting: **IRTH 60**
Borehole Diameter: **200mm to 140mm**

Driller: **S Baker**
Driller Lic No: **3046**
TOC (RL): **157 m AHD**

Surface RL: **156 m AHD**
Co-ords: **E 670244 N 7469619 MGA94 Zone 55**
Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			TOC 1 m								VS FS VI L MO VS1 D VS2 H	
RAB				54m 402						SANDSTONE: very fine grained, dark grey, fresh, wet. (continued)	W	
				52m 104						SILTSTONE: dark grey, fresh, wet.		
				50m 406						SANDSTONE: very fine grained, dark grey, fresh, wet.		
				48m 408						SILTSTONE: dark grey, fresh, wet.		
				46m 110						SHALE: black, fresh, carbonaceous, wet.		
				44m 112						STONY COAL: fresh, carbonaceous, wet. (Roper Seam)		
				42m 114						SANDSTONE: fine to medium grained, pale grey, fresh, bands of carbonaceous, claystone and quartz veins, wet.		
				40m 416						SILTSTONE: dark grey, fresh, carbonaceous, wet.		
				38m 118						SANDSTONE: very fine grained, grey, fresh, wet.		
				36m 420						SILTSTONE: dark grey, fresh, carbonaceous, wet.		
				34m 122						SANDSTONE: very fine grained, grey, fresh, wet, and		
				32m 124						SILTSTONE: dark grey, fresh, carbonaceous, wet.		
				30m 126								Airlift yield: 0.014 L/S
				28m 128								
				26m 130								
				24m 132								
				22m 434						CLAYSTONE: black, fresh, carbonaceous, wet.		
				20m 136						COAL: black, fresh, wet. (Middlemount Seam)		
				18m 438						SILTSTONE: black, fresh, carbonaceous, wet.		
				16m 440						SANDSTONE: very fine grained, grey, fresh, wet.		
				14m 142								Airlift yield: 0.017 L/S
				12m 144						END OF BOREHOLE AT 144.00 m		
				10m 146								
				8m 148								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9P

SHEET 1 OF 5

Client: MACARTHUR COAL PB Borehole No.: Date Commenced: 25.07.2010
Project: MIDDLEMOUNT COAL PROJECT Date Completed: 28.07.2010
Borehole Location: MW9P - MIDDLEMOUNT MINE Recorded By: Malcolm Graham
Project Number: 21170768 Log Checked By: *MSR*

Drill Model/Mounting: HYDROPOWER SCOUT Driller: E Schumacher Surface RL: 156 m AHD
Borehole Diameter: 200mm to 140mm Driller Lic No: 3127 Co-ords: E 670251 N 7469592 MGA94 Zone 55
TOC (RL): 157 m AHD Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY
			TOC 1m								VS VL J MO ST DO H	
RB			Monument cover with PVC cap. Co-moist 0 to 5m light (below ground level) 83mm ID. Clear 18 L/PVC casing to 200m bgl	156	1.00				ML	Clayey SILT: brown, dry.	D	
				154	2				CL	Silty CLAY: brown and orange, moist, 5m.	M	
				152	4							
				150	6				SC	SAND: fine grained, orange, with clay, moist.		
				148	8					fine to medium grained, brown.		
				146	10					medium grained, orange.		
				144	12				CL	CLAY: grey and orange, moist, firm, with medium grained, orange sand.		
				142	14							
				140	16					pink, orange and grey, no sand.		
				138	18							
				136	20				CL SP	Sandy CLAY: pink and grey, moist, firm and SAND: fine, grained, pink, moist.		
				134	22							
				132	24							
				130	26				CL	CLAY: pink and grey, moist, firm.		
				128	28					orange and grey.		
				126	30				CL	Silty CLAY: grey, orange and dark brown, moist, firm.		
				124	32							
				122	34					SANDSTONE: very fine grained, yellow, extremely weathered, moist.		
				120	36					SILTSTONE: yellow, distinctly weathered, moist.		
				118	38					SANDSTONE: very fine grained, yellow and brown, extremely weathered, moist.		
				116	40					SILTSTONE: yellow, distinctly weathered, moist.		
				114	42					SANDSTONE: fine grained, grey, distinctly weathered, moist.		
				112	44					very fine grained.		
				110	46					brown, clayey in places.		
				108	48					SILTSTONE: grey and brown, slightly weathered, moist.		
										SANDSTONE: fine grained, grey, slightly weathered, moist.		
										CLAYSTONE: grey, slightly weathered, minor sil.		
										SILTSTONE: grey, slightly weathered, moist.		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9P

SHEET 2 OF 5

Client: MACARTHUR COAL
Project: MIDDLEMOUNT COAL PROJECT
Borehole Location: MW9P - MIDDLEMOUNT MINE
Project Number: 2117076B

PB Borehole No.:

Date Commenced: 25.07.2010

Date Completed: 28.07.2010

Recorded By: Malcolm Graham

Log Checked By:

Drill Model/Mounting: HYDROPOWER SCOUT
Borehole Diameter: 200mm to 140mm

Driller: E Schumacher
Driller Lic No: 3127
TOC (RL): 157 m AHD
Surface RL: 156 m AHD
Co-ords: E 670251 N 7469592 MGA94 Zone 55
Local Co-ords:

Borehole Information							Field Material Description						
1	2	3	4	5	6	7	8	9	10	11	12	13	
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			700 1m										
RAB				104	52					SILTSTONE: grey, slightly weathered, moist. (continued)	M		
				102	54								
				100	56					SANDSTONE: very fine grained, grey, slightly weathered, moist.			
				98	58								
				96	60								
				94	62								
				92	64					SILTSTONE: grey, fresh, moist.			
				90	66					SANDSTONE: very fine grained, grey, fresh, moist.			
				88	68					SILTSTONE: grey, fresh, moist.			
				86	70					SANDSTONE: grey, fresh, moist.			
				84	72					SILTSTONE: grey, fresh, moist.			
				82	74								
				80	76					SANDSTONE: very fine grained, grey, fresh, moist.			
				78	78					fine grained.			
				76	80								
				74	82								
				72	84								
				70	86								
				68	88								
				66	90					very fine grained.			
				64	92					SILTSTONE: dark grey, fresh, moist.			
				62	94					SANDSTONE: fine grained, grey, fresh, wet.	W		
				60	96					SILTSTONE: dark grey, wet.			
				58	98					SANDSTONE: very fine grained, dark grey, fresh, wet.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9P

SHEET 3 OF 5

Client: **MACARTHUR COAL** PB Borehole No.: **25.07.2010**
Project: **MIDDLEMOUNT COAL PROJECT** Date Completed: **28.07.2010**
Borehole Location: **MW9P - MIDDLEMOUNT MINE** Recorded By: **Malcolm Graham**
Project Number: **2117076B** Log Checked By: *WGR*
Drill Model/Mounting: **HYDROPOWER SCOUT** Driller: **E Schumacher** Surface RL: **156 m AHD**
Borehole Diameter: **200mm to 140mm** Driller Lic No: **3127** Co-ords: **E 670251 N 7469592 MGA94 Zone 55**
TOC (RL): **157 m AHD** Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			TOC 1 m							VS	VS	
RAB									SANDSTONE: very fine grained, dark grey, fresh, wet, (continued)	W		
				54	102							
				52	104				calcite veins			
				50	106				no calcite veins			
				48	108							
				46	110							
				44	112				SILTSTONE: grey, fresh, wet			
				42	114				SANDSTONE: very fine grained, grey, fresh, wet			
				40	116				SILTSTONE: grey, fresh, wet			
				38	118				SANDSTONE: very fine grained, grey, fresh, wet			
				36	120				SILTSTONE: dark grey, fresh, wet			
				34	122				SANDSTONE: very fine grained, grey, fresh, wet			
				32	124				fine grained			
				30	126				very fine grained			
				28	128							
				26	130							
				24	132				fine grained			
				22	134				very fine grained			Airlift yield: 0.03 L/S
				20	136							
				18	138				SILTSTONE: dark grey, fresh, carbonaceous, wet			
				16	140				Silty COAL: dark brown, fresh, wet, (Middlemount Seam)			
				14	142				COAL: black, fresh, wet, (Middlemount Seam)			
				12	144				SANDSTONE: very fine grained, brown, fresh, wet			
				10	146				fine grained, grey			Airlift yield: 0.03 L/S
				8	148				very fine grained, brown, carbonaceous			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9P

SHEET 4 OF 5

Client: MACARTHUR COAL
Project: MIDDLEMOUNT COAL PROJECT
Borehole Location: MW9P - MIDDLEMOUNT MINE
Project Number: 2117076B

PB Borehole No.:

Date Commenced: 25.07.2010

Date Completed: 28.07.2010

Recorded By: Malcolm Graham

Log Checked By: *UKR*

Drill Model/Mounting: HYDROPOWER SCOUT
Borehole Diameter: 200mm to 140mm

Driller: E Schumacher
Driller Lic No: 3127
TOC (RL): 157 m AHD

Surface RL: 156 m AHD
Co-ords: E 670251 N 7469592 MGA94 Zone 55
Local Co-ords:

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL (m) AHD	DEPTH (m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			10C 1m								RELATIVE DENSITY CONSISTENCY	
											VS VS ₁₀₀ VL VL ₁₀₀ VST VST ₁₀₀ VH	
RAB				156.00						fine grained, grey.	W	
				4m 152						very fine grained, bands of carbonaceous siltstone.		
				2 154						fine grained.		
				0m 156						brown		
				-2m 158						grey		
				-4m 160						brown		
				-6m 162						grey.		
				-8m 164						very fine grained.		
				-10m 166						fine grained.		
				-12m 168						very fine grained.		
				-14m 170						fine grained.		
				-16m 172						brown		
				-18m 174						grey		
				-20m 176						brown		
				-22m 178						caliche veins.		
				-24m 180								
				-26m 182						very fine grained, dark grey, no caliche veins.		
				-28m 184								
				-30m 186						fine grained.		
				-32m 188						SILTSTONE: dark grey, fresh, wet.		
				-34m 190						SANDSTONE: very fine grained, grey, fresh, caliche veins, wet.		
				-36m 192						SILTSTONE: dark grey, fresh, wet.		
				-38m 194								
				-40m 196								
				-42m 198						Silty COAL: dark brown, fresh, wet, (fences Seam)		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



GROUNDWATER BOREHOLE LOG

BOREHOLE NO.

MW9P

SHEET 5 OF 5

Client: **MACARTHUR COAL**
Project: **MIDDLEMOUNT COAL PROJECT**
Borehole Location: **MW9P - MIDDLEMOUNT MINE**
Project Number: **2117076B**

PB Borehole No.:

Date Commenced: **25.07.2010**Date Completed: **28.07.2010**Recorded By: **Malcolm Graham**

Log Checked By:

Drill Model/Mounting: **HYDROPOWER SCOUT**
Borehole Diameter: **200mm to 140mm**

Driller:

E SchumacherSurface RL: **156 m AHD**

Driller Lic No:

3127

Co-ords:

E 670251 N 7469592 MGA94 Zone 55TOC (RL): **157 m AHD**

Local Co-ords:

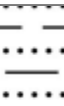
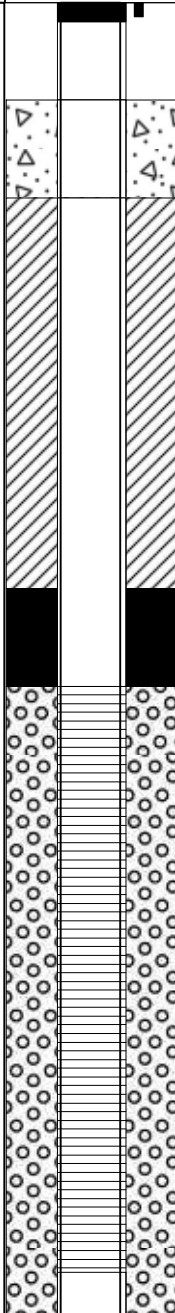
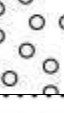
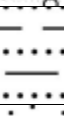
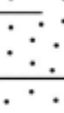
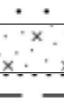
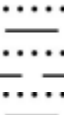
Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) AHD	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			TOC 1m									
			18mm ID, Class 18 uPVC, 0.5m long, 1m uPVC pump	-46	202					COAL: black, fresh, wet, non-very fine grained, white tuff (Fiscet Seam), (concrete)	W	
			Reinforced, 254 to 267m log	-48	204					SILTSTONE: dark brown, fresh, carbonaceous, wet, with very fine grained, white tuff.		Airfit yield: 0.15 L/S
			Reinforced, 207 to 210m log	-50	206					no tuff present.		
				-52	208					tuff present.		Airfit yield: 0.15 L/S
				-54	210					END OF BOREHOLE AT 210.00 m		
				-56	212							
				-58	214							
				-60	216							
				-62	218							
				-64	220							
				-66	222							
				-68	224							
				-70	226							
				-72	228							
				-74	230							
				-76	232							
				-78	234							
				-80	236							
				-82	238							
				-84	240							
				-86	242							
				-88	244							
				-90	246							
				-92	248							

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

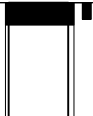


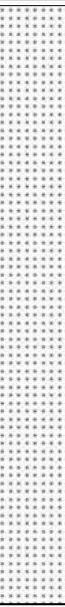
APPENDIX C

2014 / 2015 EXPLORATORY HOLE RECORDS

				Exploratory Hole Details					
				Hole No.	MW10A	Co-ordinate System	GDA94 Zone 55		
Project	Middlemount Coal - Monitoring Wells	Start Date	22/12/2014	Easting	669782.88				
Client	MCPL	Completion Date	22/12/2014	Northing	7475981.12				
Project No.	PGC1214004	Driller	L. Dahler	Ground Level	175.75mAHD				
		Supervisor	P. Rogers						
		Licence No.	Class 2 / 2517						
		Logged By	A. Horspool	Checked By	S. Flux				
		Page 1 of 1							
Drilling Method	R.L. (mAHD)	Depth (m)	Legend	Material Description	SPT (blows/300mm)	Sampling and Testing	Installation Details / Groundwater Levels		
Open Hole / Air Flush	175.75	0.00		CI: CLAY, intermediate plasticity, brown and reddish brown slightly sandy, trace gravel,dry				Monument	
	173.75	2.00		SP: SAND light grey and yellowish brown, dry				Bentonite Grout to 5.00m	
	171.75	4.00		GP: GRAVEL, fine and medium subrounded, dry					
	170.75	5.00		CI: CLAY, intermediate plasticity, brown and reddish brown slightly sandy, trace gravel,dry				5.00 to 6.00m: Bentonite Plug	
	169.75	6.00		SC: SAND, fine and medium grained, clayey to very clayey, reddish brown, dry					
	168.25	7.50		Silty SAND, fine to medium, fairly uniform, low plasticity					
	167.75	8.00		CI: CLAY, intermediate plasticity, grey and reddish brown slightly sandy, trace gravel,dry				Gravel Filter	
	163.75	12.00		MUDSTONE, mottled reddish brown and grey, extremely low strength, residual soil					
				Remarks					
Phi Ground Innovations Pty. Ltd. Ground Engineering Services 60 William Street, West End Queensland 4810 Tel: 0438985494 E-mail:enquiries@nqphigi.com.au Web: www.nqphigi.com.au				50mm Inner Diameter Class 18 PVC Screen and Casing. 1.20m Lockable Monument at ground level.					

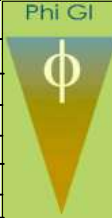
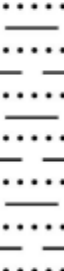
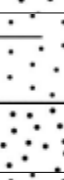
				Exploratory Hole Details					
				Hole No.	MW11A	Co-ordinate System	GDA94 Zone 55		
Project	Middlemount Coal - Monitoring Wells <th>Start Date</th> <td>25/03/2015<th>Easting</th><td>672355.00</td></td>	Start Date	25/03/2015 <th>Easting</th> <td>672355.00</td>	Easting	672355.00				
Client	MCPL	Completion Date	25/03/2015 <th>Northing</th> <td>7472275.10</td>	Northing	7472275.10				
Project No.	PGC1214004	Driller	L. Dahler	Ground Level	156.20mAHD				
		Supervisor	R. Goldsworthy						
		Licence No.	Class 2 / 2894						
		Logged By	A. Horspool	Checked By	S.Flux	Page 1 of 1			
Drilling Method	R.L. (mAHD)	Depth (m)	Legend	Material Description	SPT (blows/300mm)	Sampling and Testing	Installation Details / Groundwater Levels		
Continuous Flight Auger									
	156.2	0.00		SM: silty SAND, trace rootlets, dry. (TOPSOIL)				Monument	
	155.9	0.30		CI: CLAY, intermediate plasticity, stiff, brown and reddish brown slightly sandy, trace gravel,dry				0.00 to 1.00m: Concrete	
	154.2	2.00		CI:sandy CLAY, intermediate plasticity, brown and reddish brown, trace gravel,dry					
	151.7	4.50		CH: CLAY, high plasticity, brown and reddish brown slightly sandy, trace gravel,dry				1.00 to 7.70m: Bentonite Grout	
	149.2	7.00		CI: CLAY, intermediate plasticity, brown and reddish brown slightly sandy, trace gravel,dry					
	146.2	10.00		CI: CLAY, intermediate plasticity, brown and reddish brown mottled white, slightly sandy, trace gravel,dry				7.70 to 9.70m: Bentonite Seal	
	143.73	12.50		MUDSTONE, mottled reddish brown and grey, extremely low strength, residual soil				2mm Gravel Pack	
Phi Ground Innovations Pty. Ltd. Ground Engineering Services 60 William Street, West End Queensland 4810 Tel: 0438985494 E-mail:enquiries@nqphigi.com.au Web: www.nqphigi.com.au				Remarks 50mm Inner Diameter Class 18 PVC Screen and Casing. 1.20m Lockable Monument at ground level.					

				Exploratory Hole Details					 Page 1 of 1	
				Hole No.	MW12A	Co-ordinate System	GDA94 Zone 55			
				Start Date	15/12/2014	Easting	671639.97			
Project	Middlemount Coal - Monitoring Wells	Completion Date	15/12/2014	Northing	7469852.68					
Client	MCPL	Driller	L. Dahler	Ground Level	158.28mAHD					
Project No.	PGC1214004	Supervisor	P. Rogers							
		Licence No.	Class 2 / 2517							
		Logged By	A. Horspool	Checked By	S. Flux					
Drilling Method	R.L. (mAHD)	Depth (m)	Legend	Material Description	SPT (blows/300mm)	Sampling and Testing	Installation Details / Groundwater Levels			
Open Hole / Air Flush							 Monument			
	158.28	0.00		SM: silty SAND, trace rootlets, dry. (TOPSOIL)			 0.00 to 1.00m: Concrete			
	157.98	0.30		SC: clayey SAND, low plasticity, reddish brown, dry			 1.00 to 5.00m: Bentonite Grout			
	156.78	1.50		CI: sandy CLAY, low plasticity, reddish brown, dry.						
	156.28	2.00		SC: fine and medium SAND with trace clay, yellowish brown, dry.						
	155.28	3.00		CI: CLAY intermediate plasticity, trace sand, dark brown, dry.						
	152.78	5.50		SP: fine SAND with some fine and medium platy gravel, dry			 5.00 to 6.00m: Seal			
	150.78	7.50		MUDSTONE, mottled reddish brown and grey, extremely low strength, residual soil			 2mm Gravel Pack			
Phi Ground Innovations Pty. Ltd. Ground Engineering Services 60 William Street, West End Queensland 4810 Tel: 0438985494 E-mail:enquiries@nqphigi.com.au Web: www.nqphigi.com.au				Remarks 50mm Inner Diameter Class 18 PVC Screen and Casing. 1.20m Lockable Monument at ground level.						

				Exploratory Hole Details					
Project		Middlemount Coal - Monitoring Wells		Hole No.	MW13A	Co-ordinate System	GDA94 Zone 55	Page 1 of 1	
Client		MCPL		Start Date	12/12/2014	Easting	669032.15		
Project No.		PGC1214004		Completion Date	12/12/2014	Northing	7468889.81		
				Driller	L. Dahler	Ground Level	162.79mAHD		
				Supervisor	P. Rogers				
				Licence No.	Class 2 / 2517				
				Logged By	A. Horspool	Checked By	S. Flux		
Drilling Method	R.L. (mAHD)	Depth (m)	Legend	Material Description	SPT (blows/300mm)	Sampling and Testing	Installation Details / Groundwater Levels		
Open Hole / Air Flush	162.79	0.00		SM: silty SAND, trace rootlets, dry. (TOPSOIL)			 Monument 0.00 to 1.00m: Concrete		
	161.79	1.00		CI: CLAY intermediate plasticity, trace sand, dark brown, dry.			 1.00 to 7.00m: Bentonite Grout		
	161.29	1.50		MUDSTONE, mottled reddish brown and grey, extremely low strength, residual soil					
	154.79	8.00		SANDSTONE, grey banded yellowish brown, very low strength, extremely to distinctly weathered			 7.00 to 8.00m: Seal  2mm Gravel Pack		

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Ground Engineering Services
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Web: www.nqphigi.com.au

Remarks
50mm Inner Diameter Class 18 PVC Screen and Casing. 1.20m Lockable Monument at ground level.

				Exploratory Hole Details					
				Hole No.	MW14A	Co-ordinate System	GDA94 Zone 55		
Project Middlemount Coal - Monitoring Wells		Start Date	14/12/2014	Easting	668175.46				
		Completion Date	14/12/2014	Northing	7469311.96				
Client MCPL		Driller	L. Dahler	Ground Level	159.65mAH				
Project No. PGC1214004		Supervisor	P. Rogers						
		Licence No.	Class 2 / 2517						
		Logged By	A. Horspool	Checked By	S. Flux	Page 1 of 1			
Drilling Method	R.L. (mAH)	Depth (m)	Legend	Material Description	SPT (blows/300mm)	Sampling and Testing	Installation Details / Groundwater Levels		
Open Hole / Air Flush								Monument	
	159.65	0.00		SM: silty SAND, fine and medium, reddish brown, dry				0.00 to 1.00m: Concrete	
	158.65	1.00		SM: silty SAND, fine and medium, light brown, dry.					
	158.15	1.50		CI: Sandy CLAY, intermediate plasticity, brown, dry.				0.00 to 1.00m: Concrete	
	154.65	5.00		SP: fine to coarse SAND, yellowish brown, dry.				5.00 to 6.00m: Seal	
	152.65	7.00		SC: Clayey SAND, fine to coarse, dark grey, moist.					
	151.65	8.00		SP: fine and medium SAND, yellowish brown, moist.					
	150.9	8.75		SC: very clayey SAND, fine to coarse, dark grey, moist.					
	149.9	9.75		MUDSTONE, mottled reddish brown and grey, extremely low strength, residual soil				GWL 8.50m	
								2mm Gravel Pack	

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Ground Engineering Services

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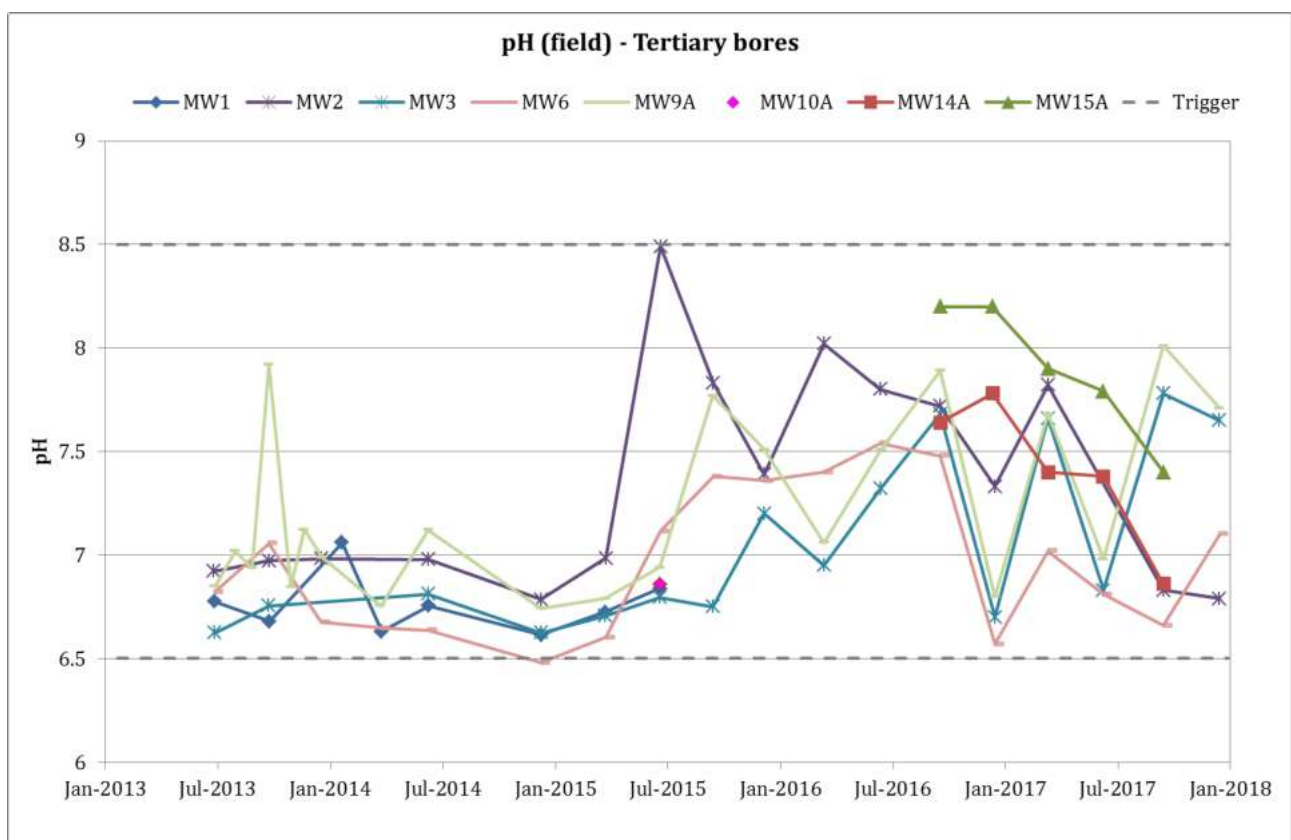
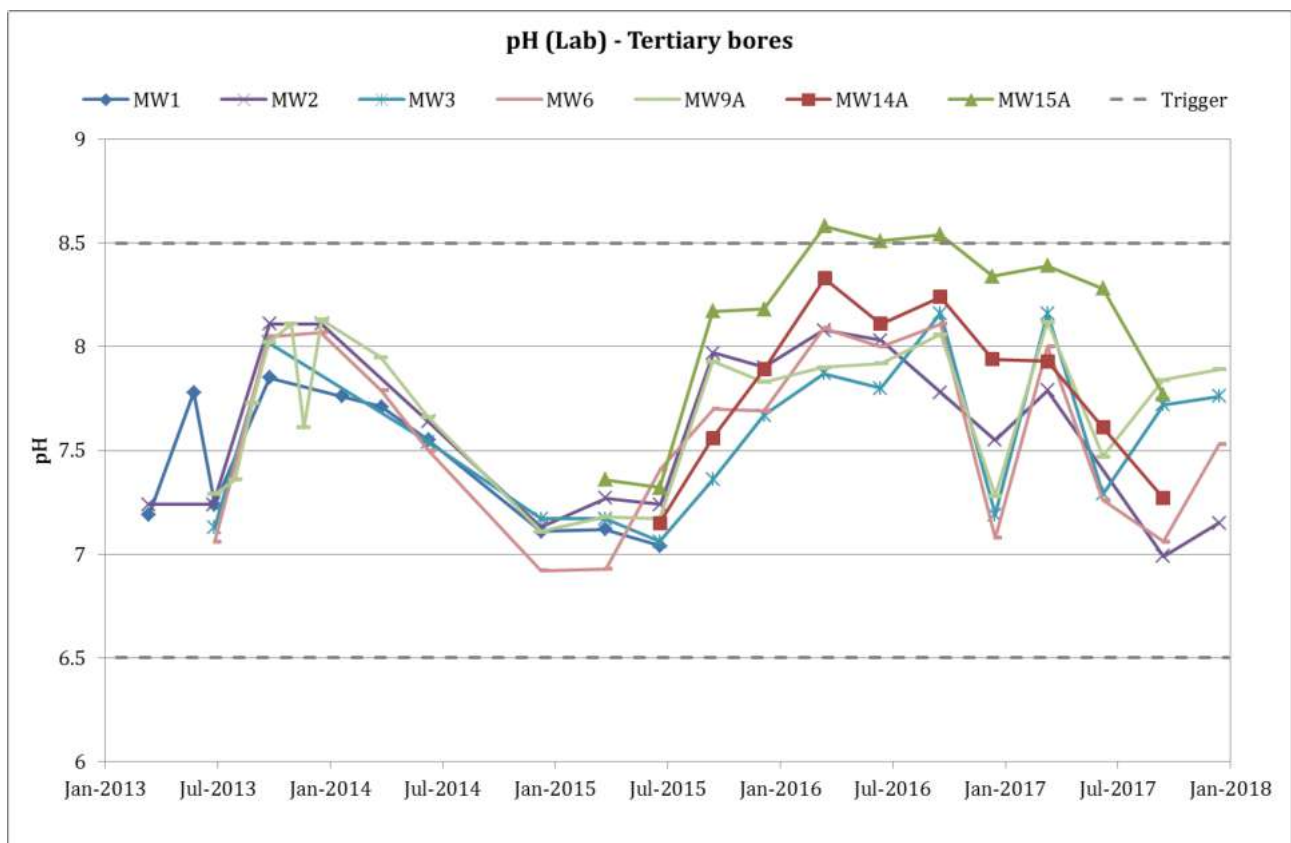
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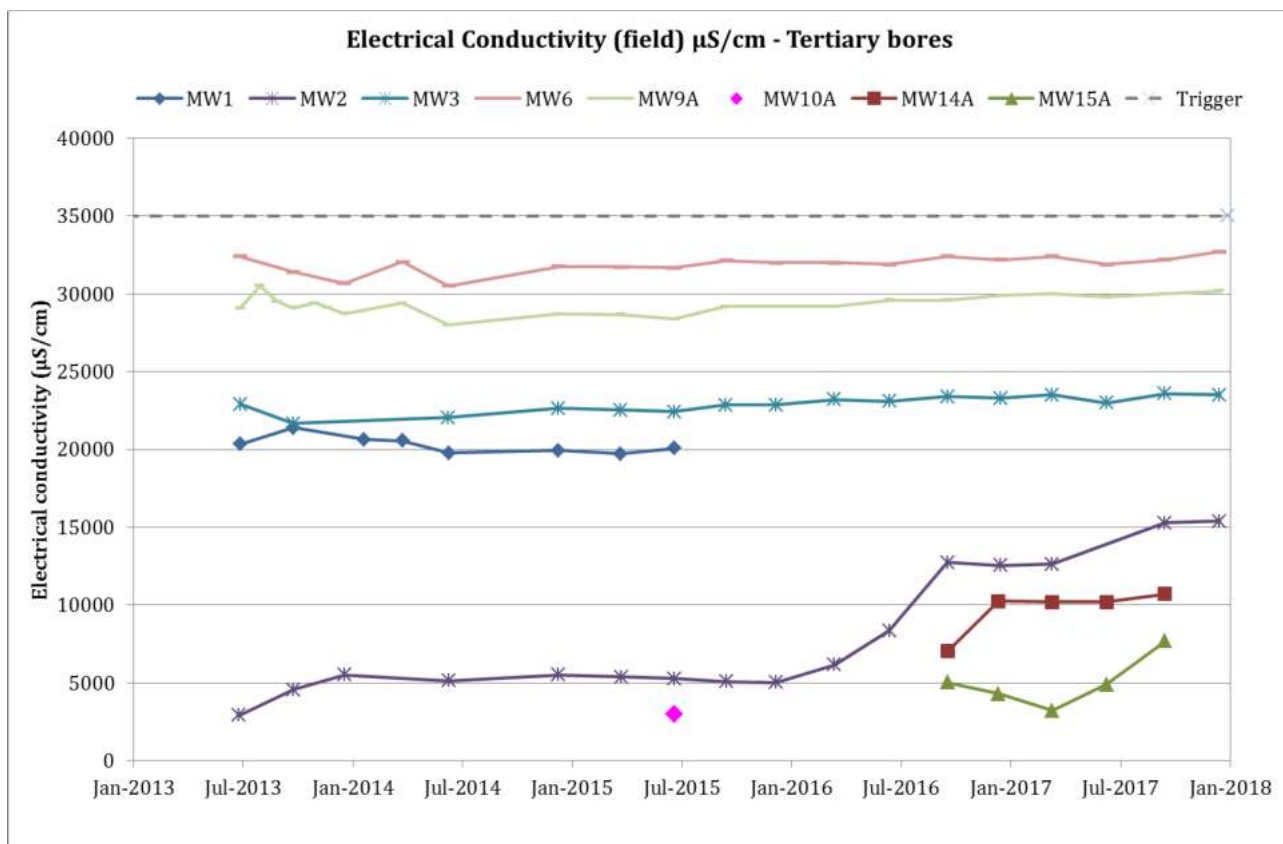
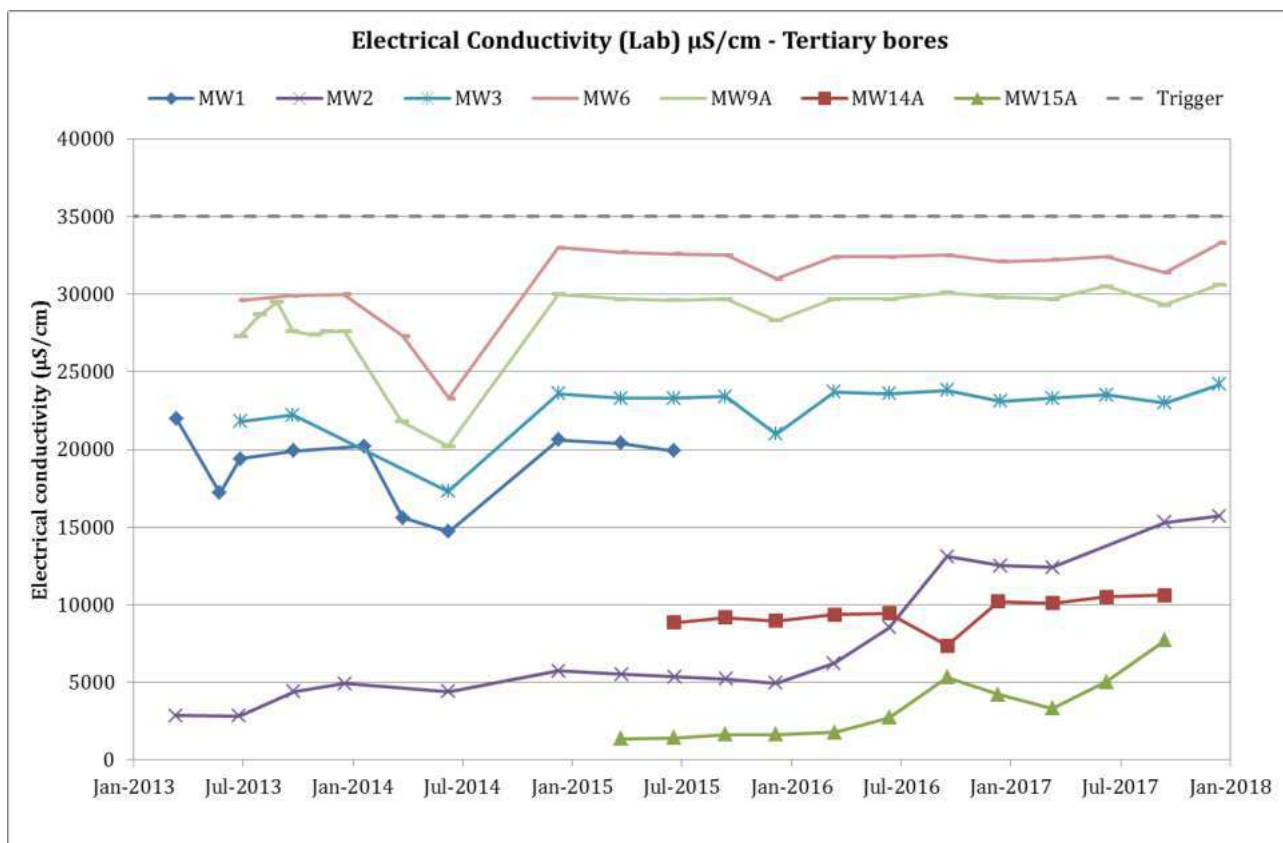
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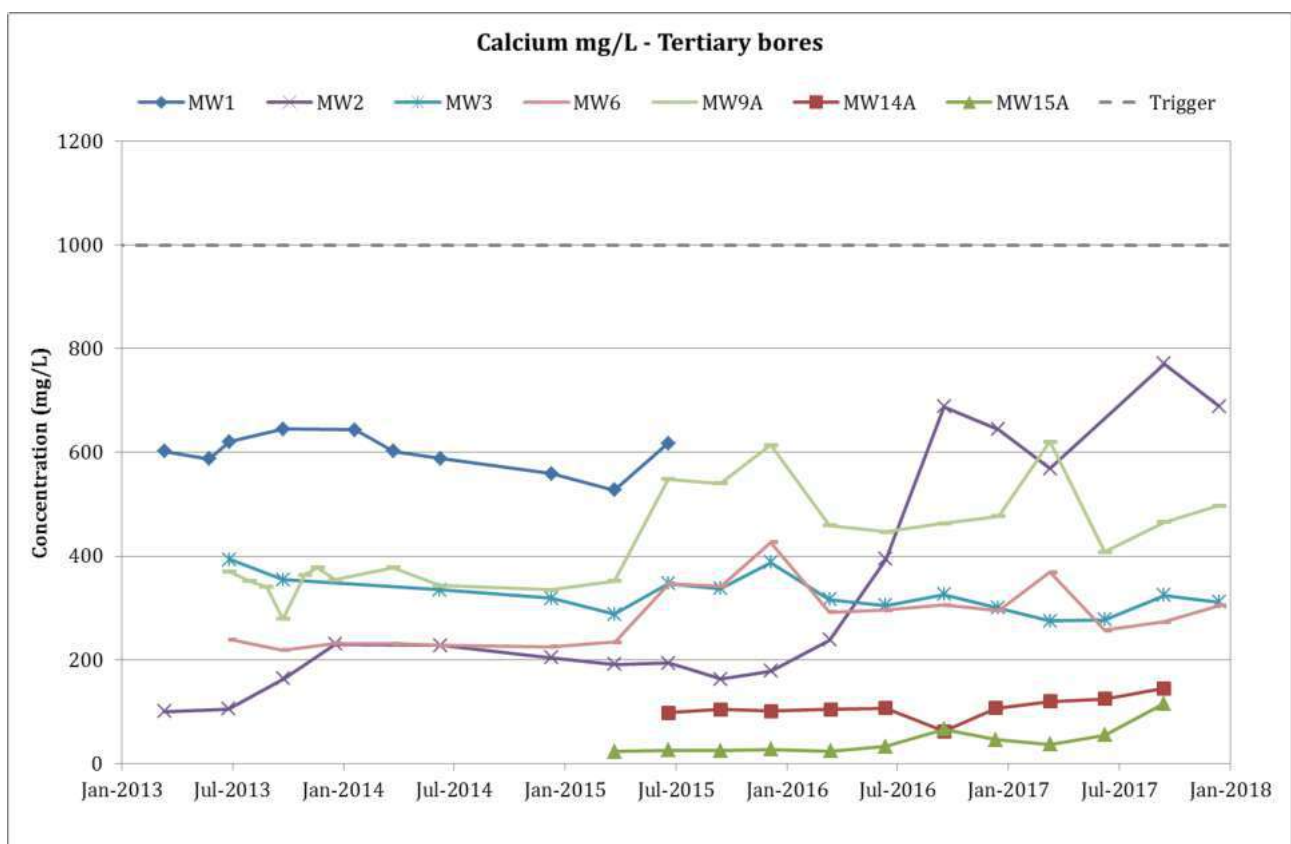
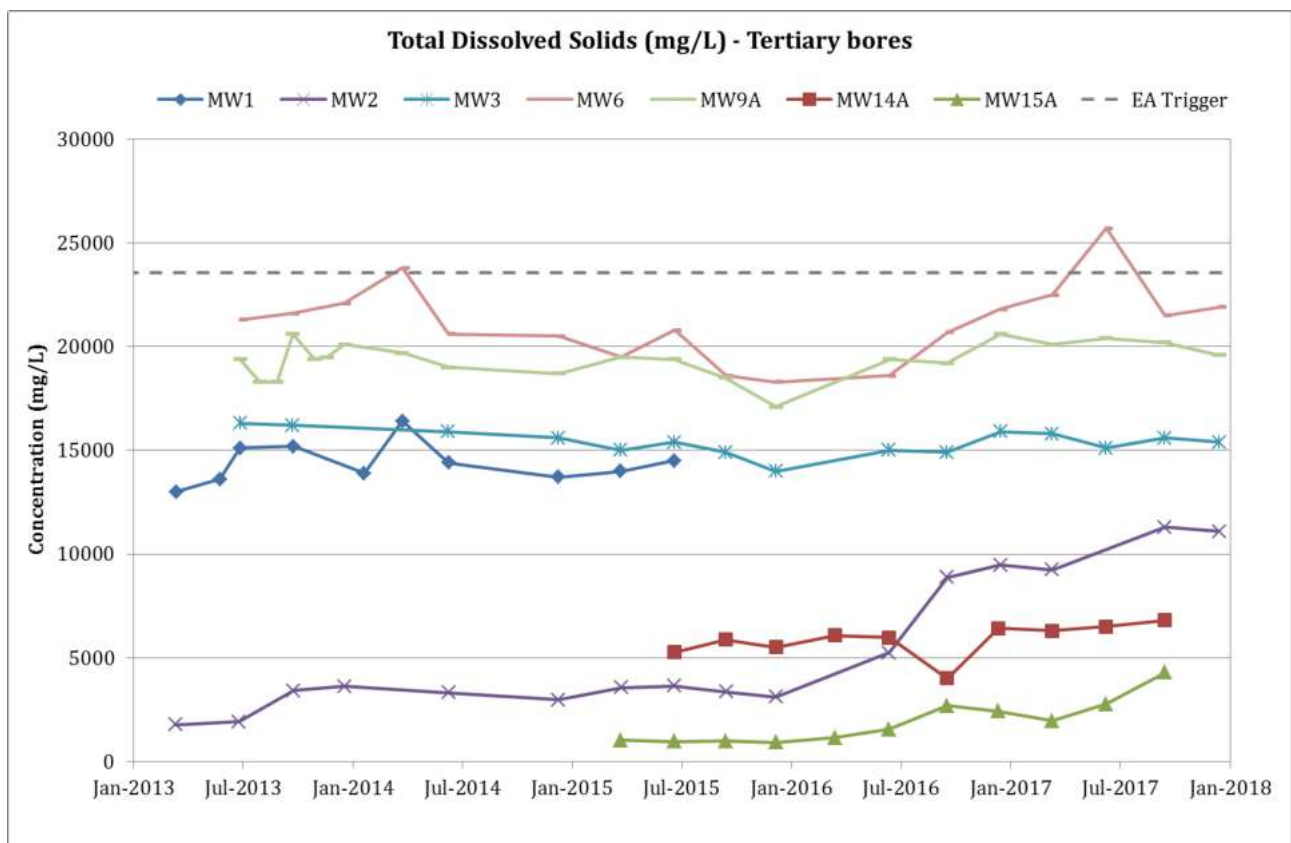
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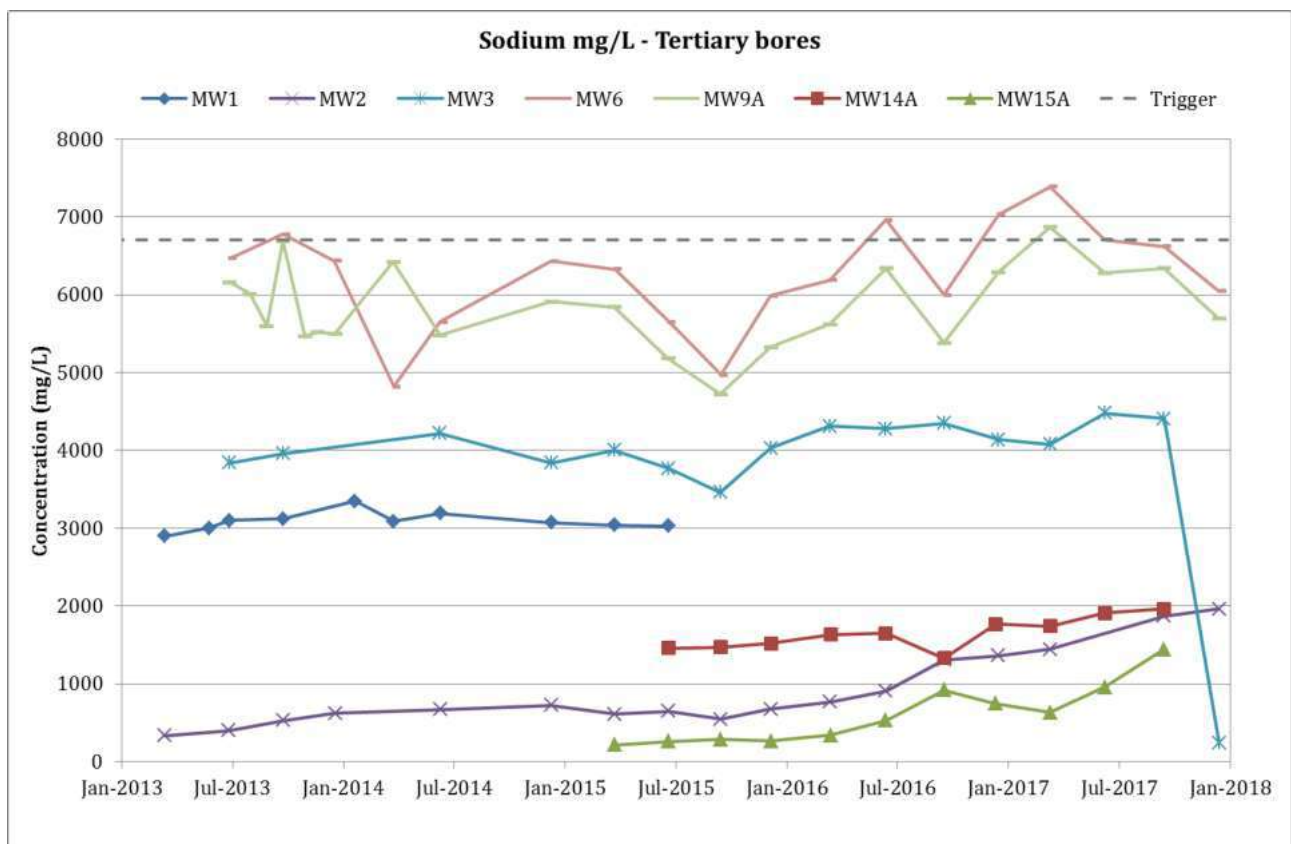
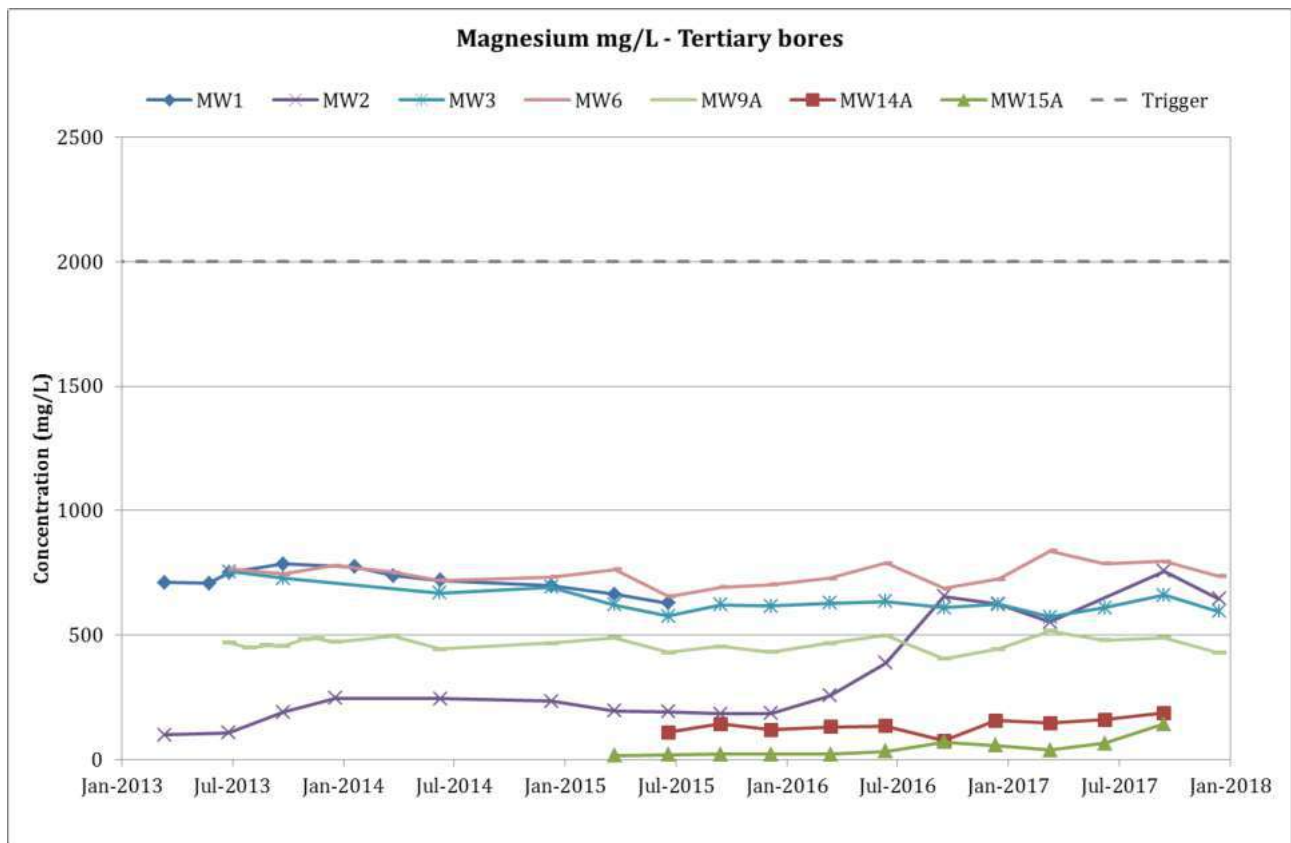
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ProjectMiddlemount Coal - Monitoring Wells				Start Date	15/12/2014	Easting	667795.96		
				Completion Date	15/12/2014	Northing	7469627.08		
ClientMCPL				Driller	L. Dahler	Ground Level	161.57mAHD		
				Supervisor	P. Rogers				
Project No.PGC1214004				Licence No.	Class 2 / 2517				
				Logged By	A. Horspool	Checked By	S. Flux		
Page 1 of 1									
Drilling Method	R.L. (mAHD)	Depth (m)	Legend	Material Description	SPT (blows/300mm)	Sampling and Testing	Installation Details / Groundwater Levels		
Open Hole / Air Flush								Monument	
	161.57	0.00		CH: CLAY with boulders, high plasticity, stiff, dry. FILL				0.00 to 1.00m: Concrete	
	160.57	1.00		SM: Silty SAND, fine and medium, with trace organic matter (TOPSOIL)					
	160.27	1.30		SM: Silty SAND, dark brown , dry.					
	159.77	1.80		CI: CLAY with trace cobbles, dark brown, very stiff, iontermediate plastcity, dry					
	158.87	2.70		CI: CLAY, dark brown, intermediate plasticity, very stiff, dry.				0.00 to 1.00m: Concrete	
	157.77	3.80		SW: SAND, fine to coarse, dry				5.00 to 6.00m: Seal	
	153.57	8.00		CI: Very sandy CLAY, intermediate plasticity, grey, moist.				GWL 7.20m	
							2mm Gravel Pack		
	150.57	11.00		MUDSTONE, mottled reddish brown and grey, extremely low strength, residual soil				Hole Collapsed	
Phi Ground Innovations Pty. Ltd. Ground Engineering Services 60 William Street, West End Queensland 4810 Tel: 0438985494 E-mail:enquiries@nqphigi.com.au Web: www.nqphigi.com.au				Remarks 50mm Inner Diameter Class 18 PVC Screen and Casing. 1.20m Lockable Monument at ground level.					

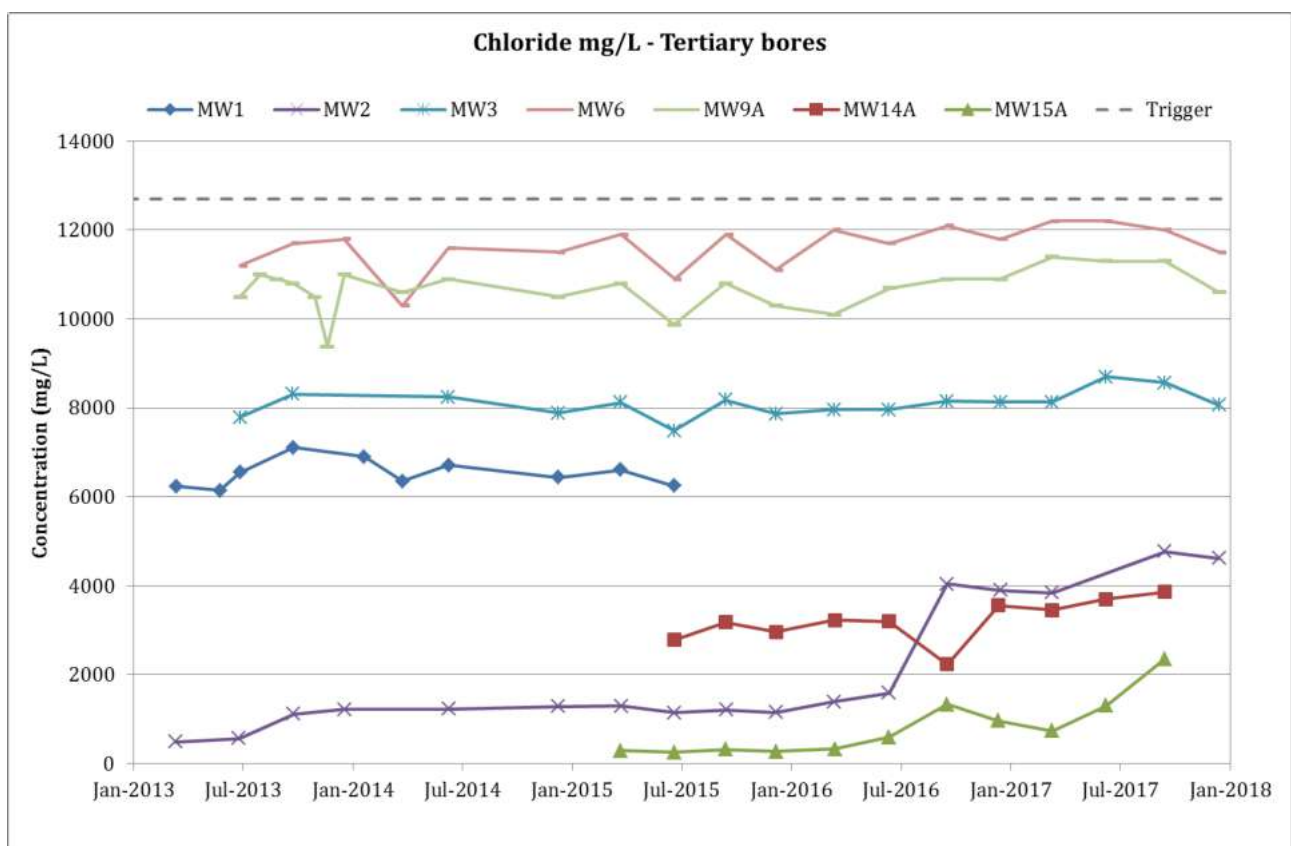
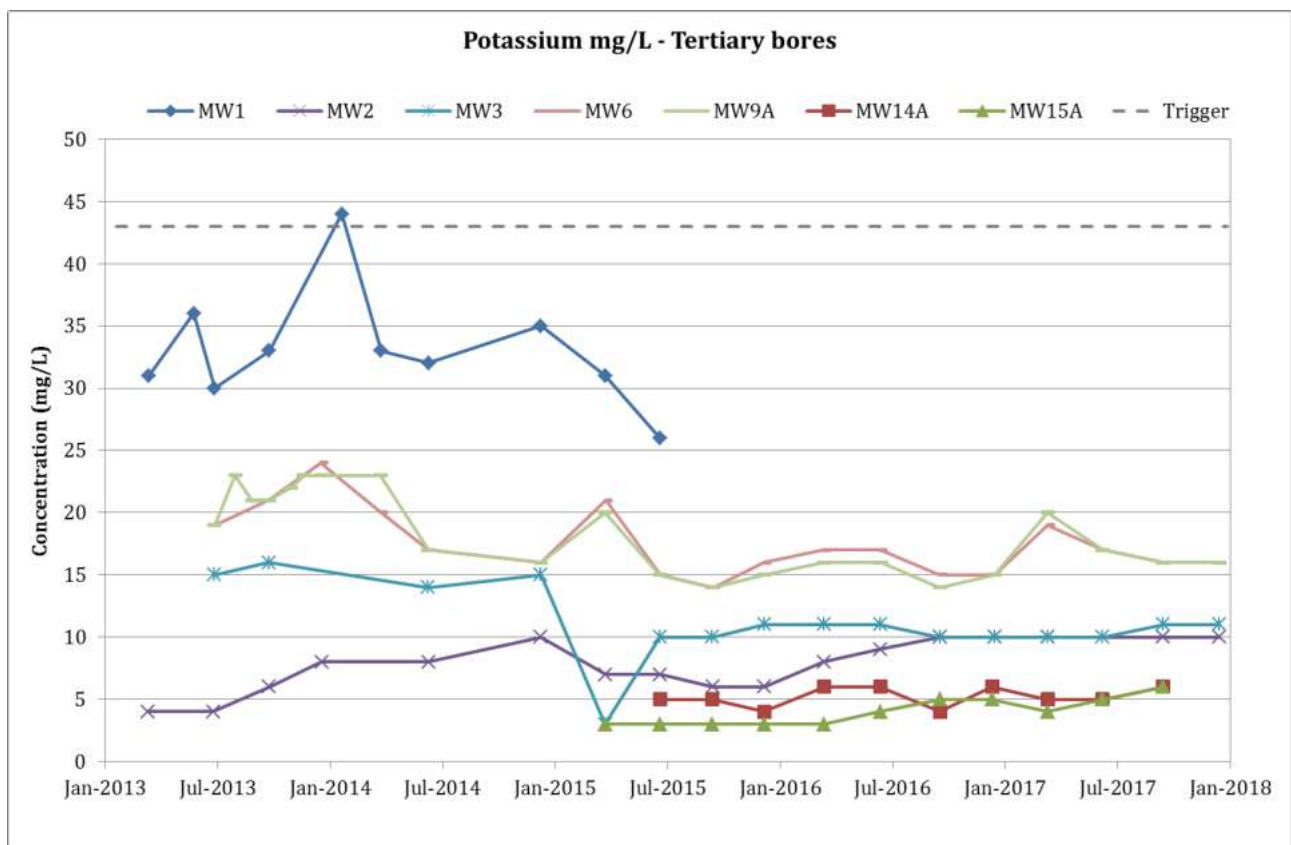
Appendix E **Tertiary and Permian water quality data**

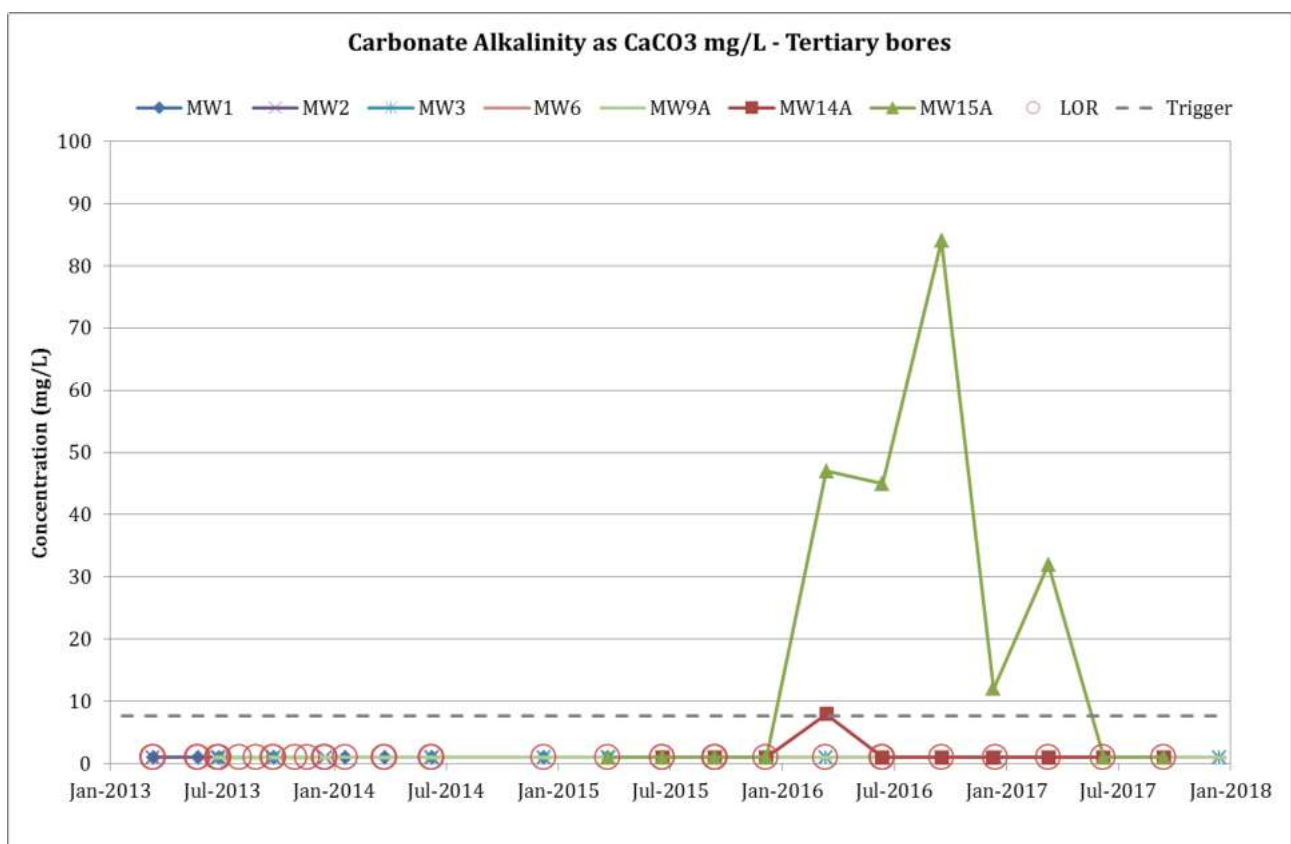
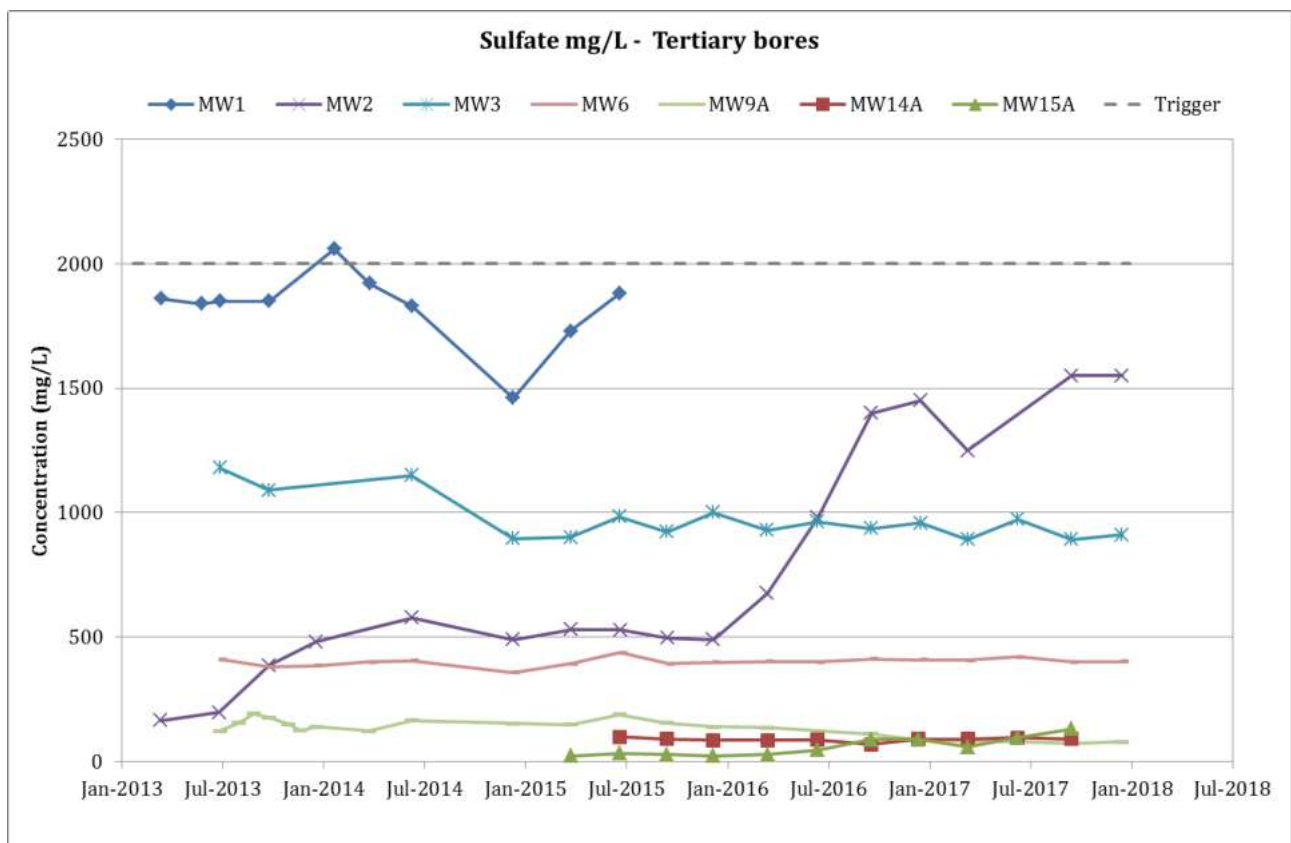


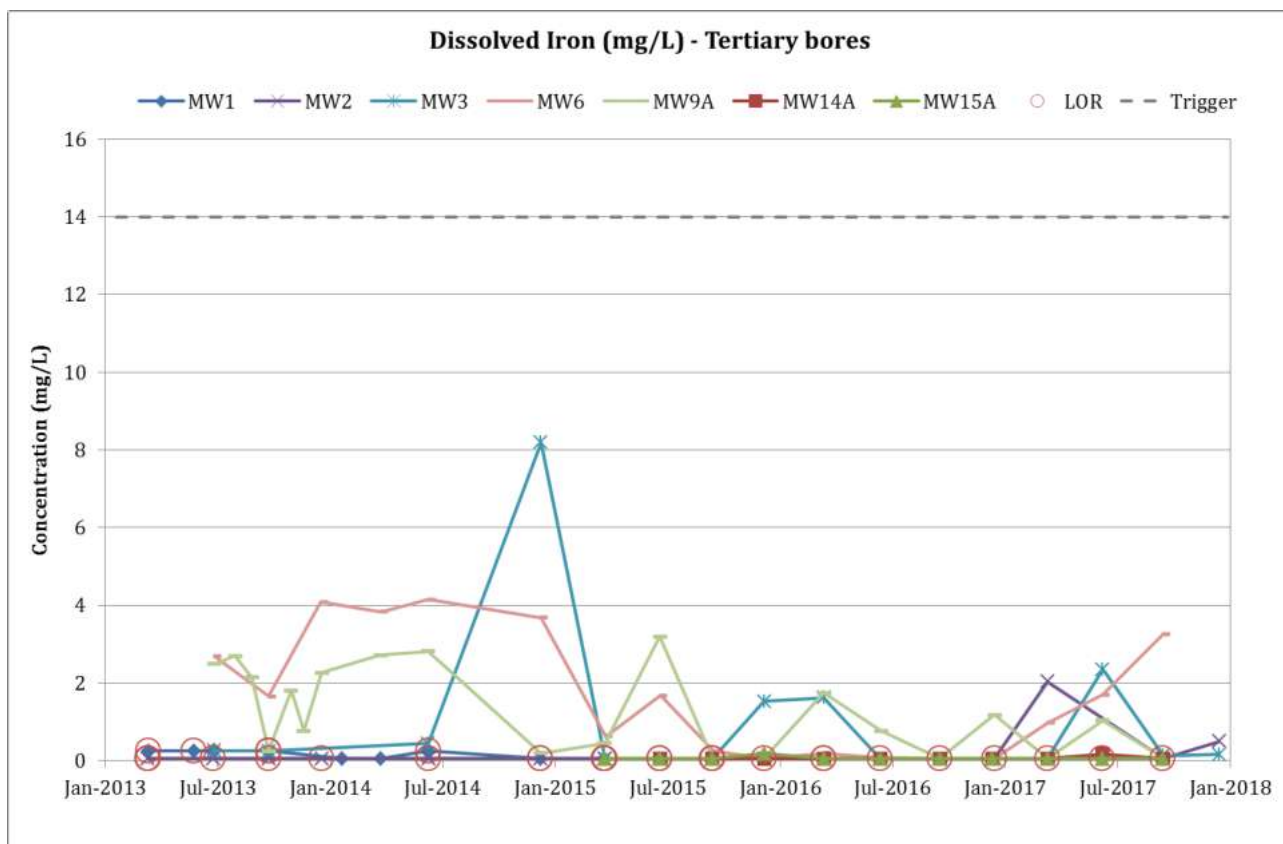
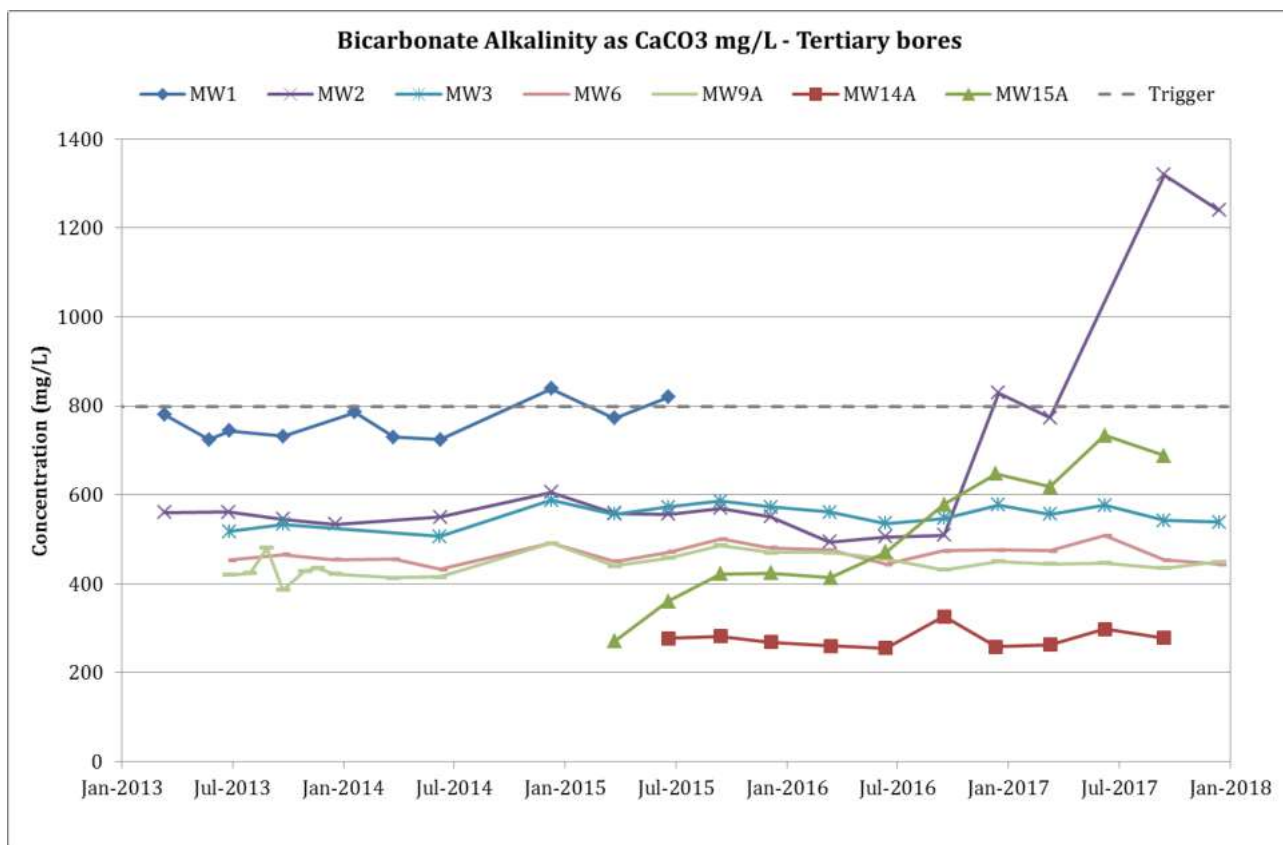


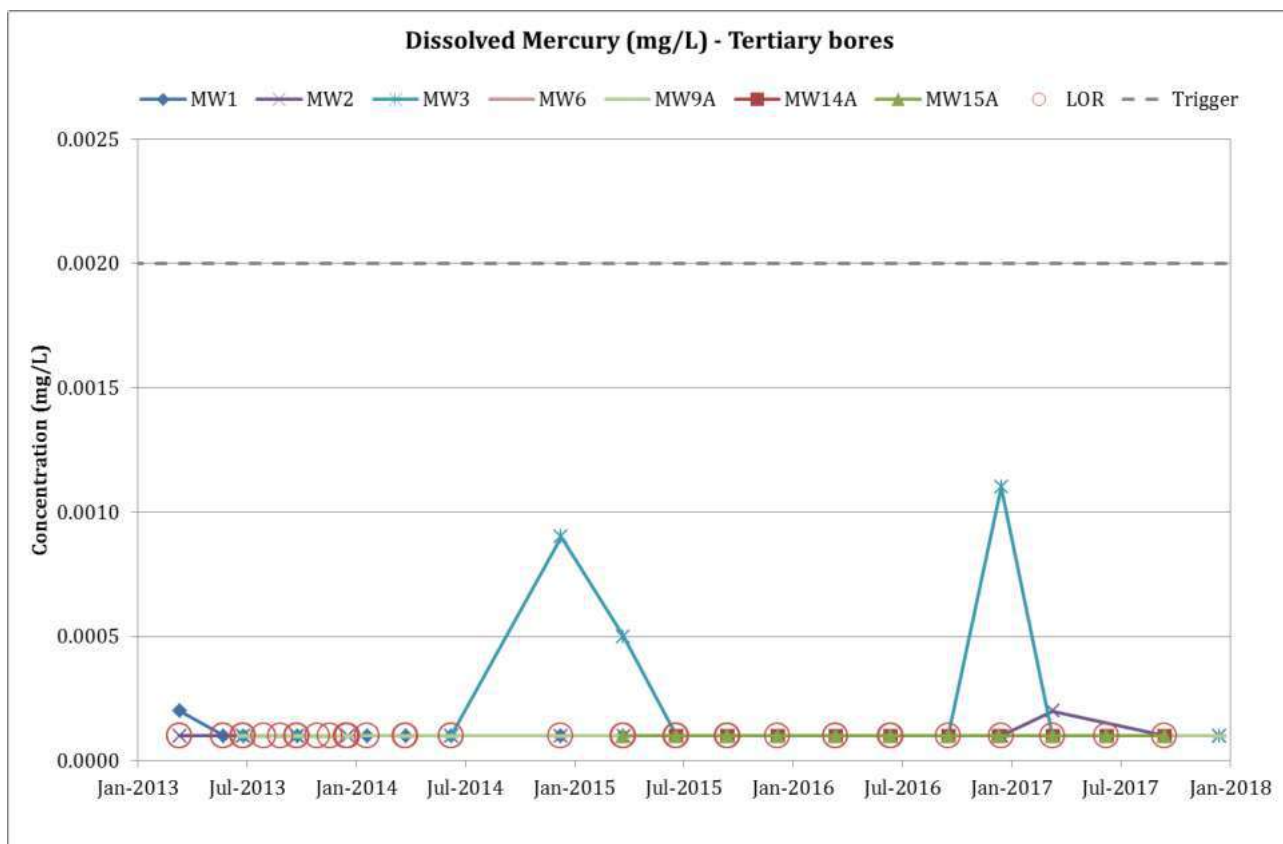
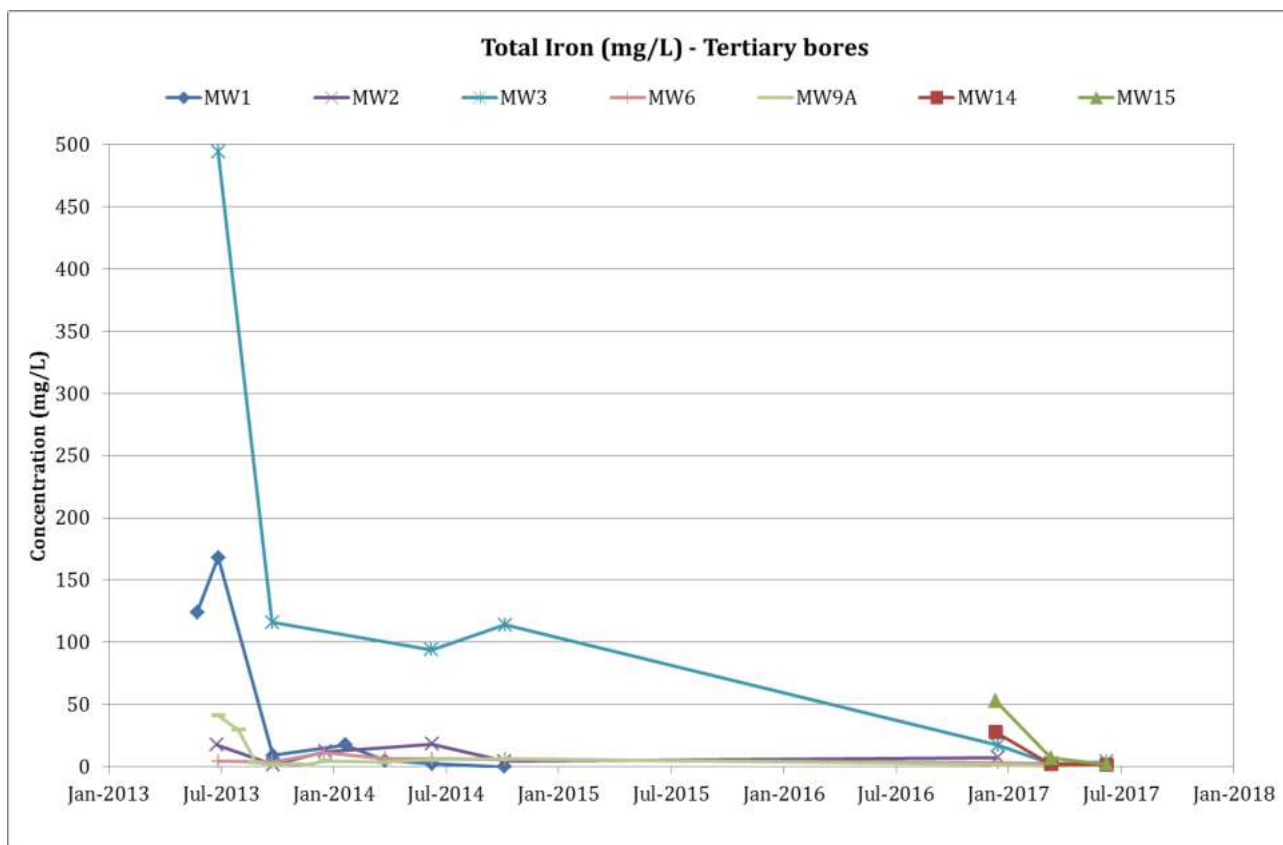


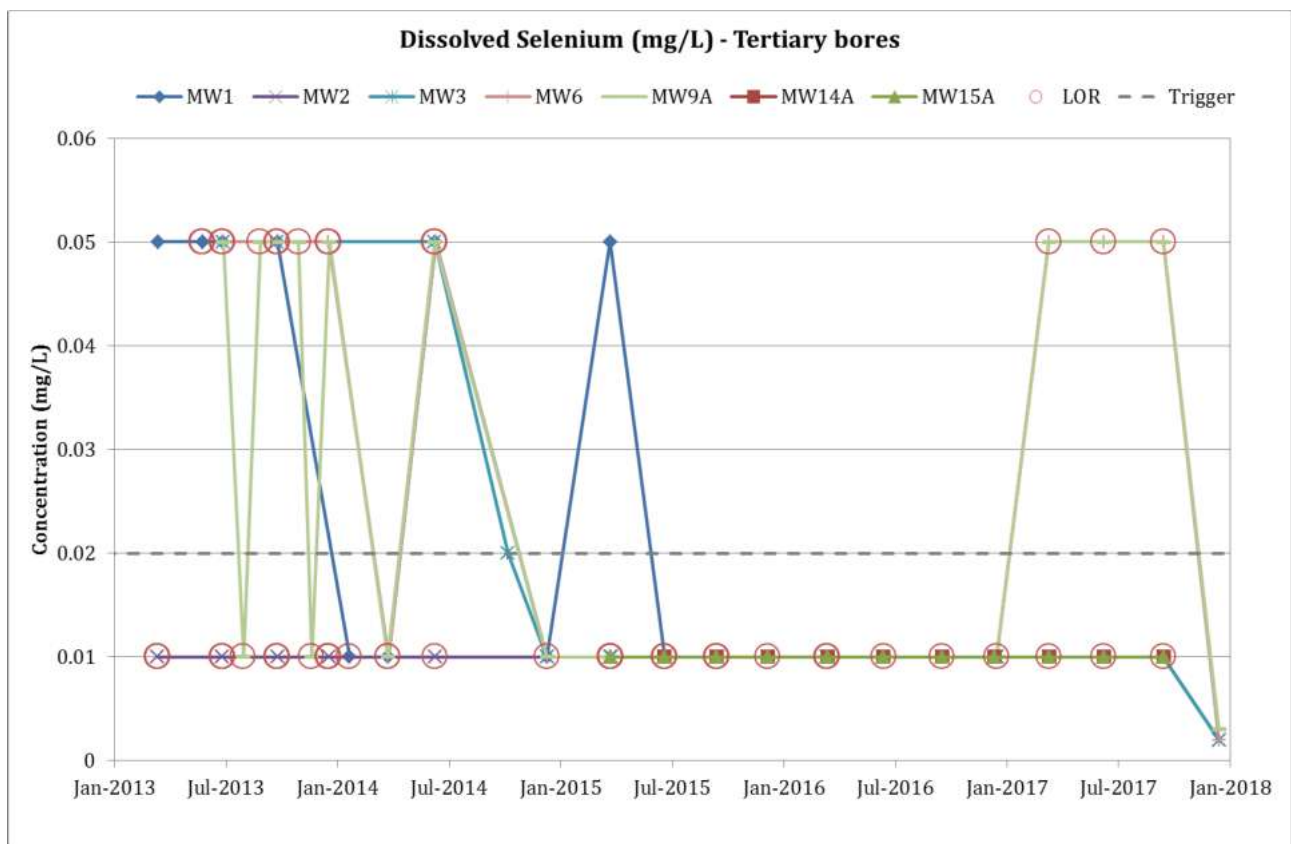
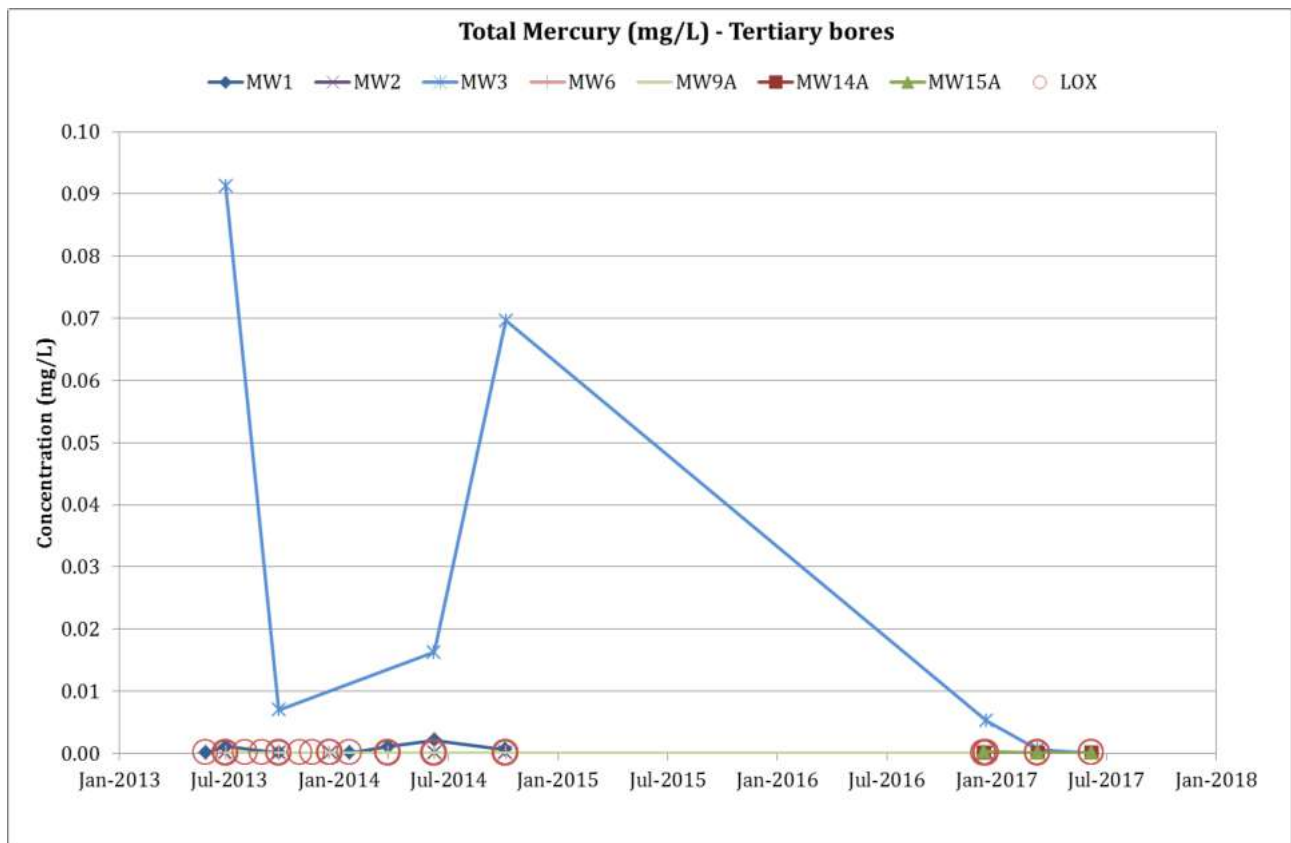


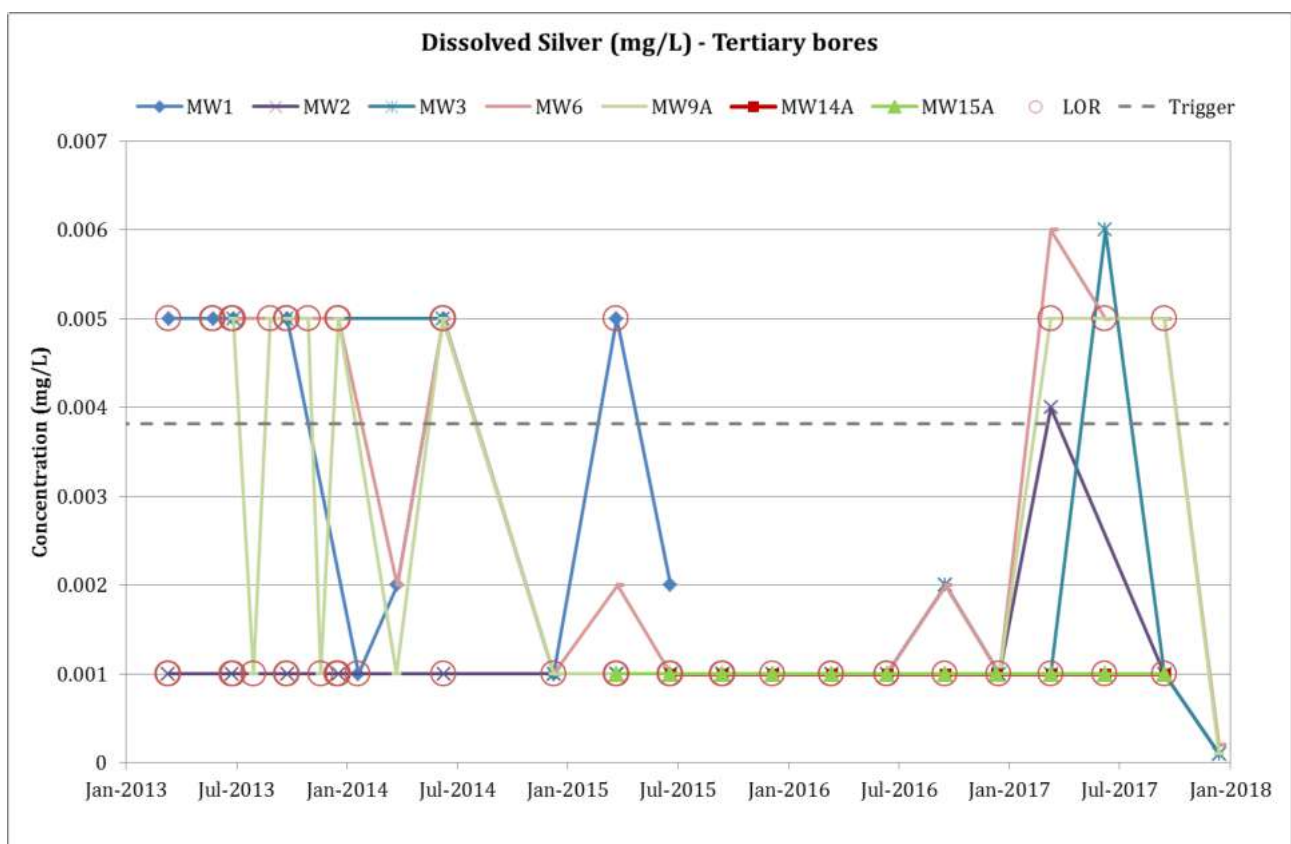
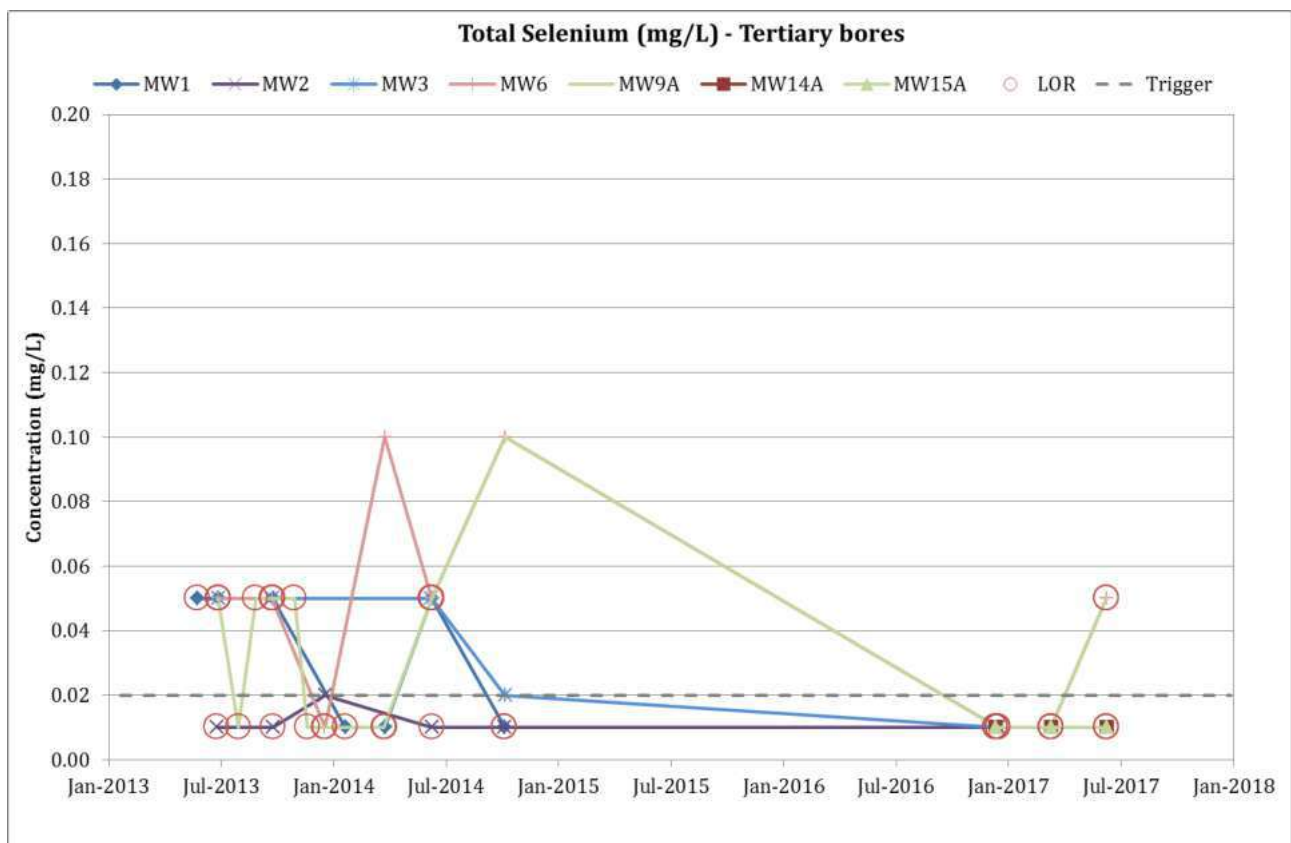


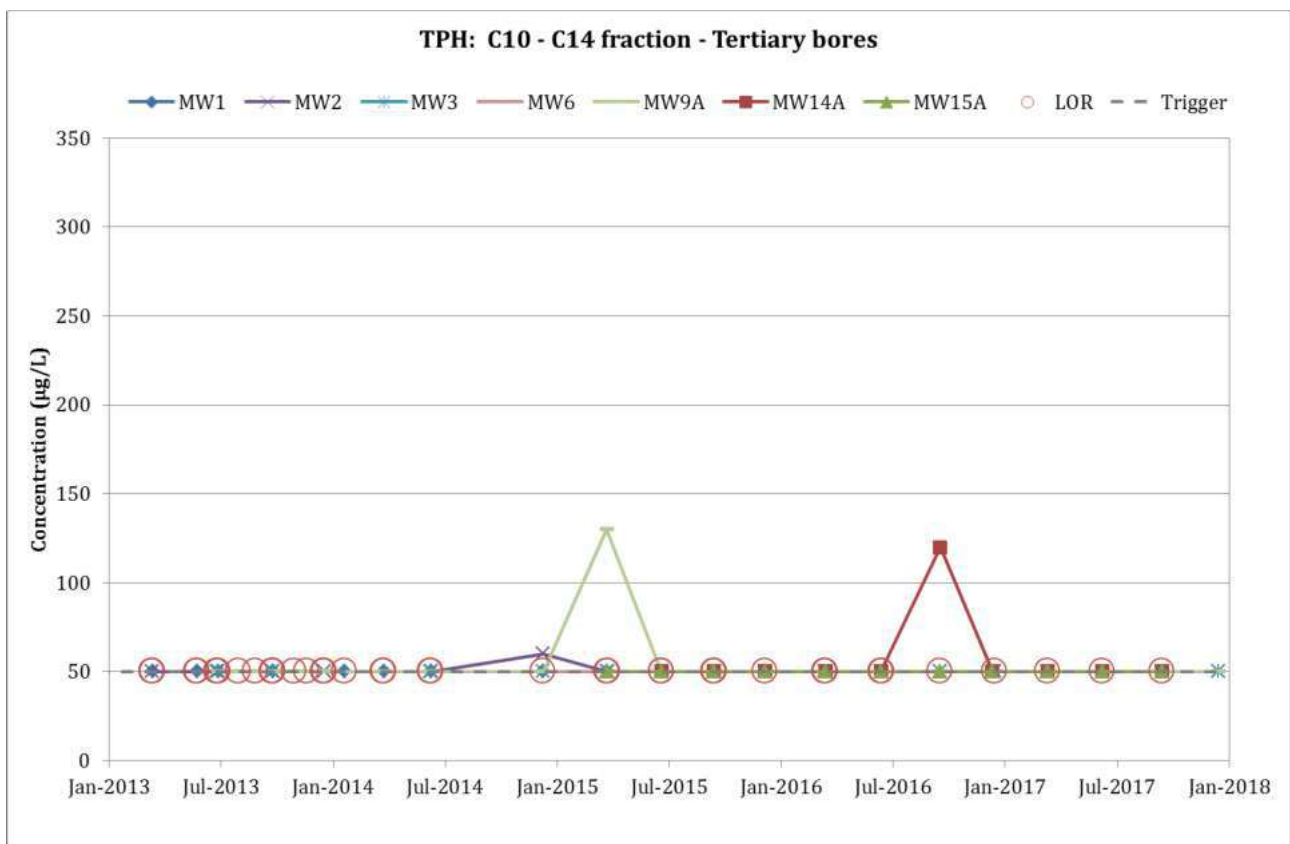
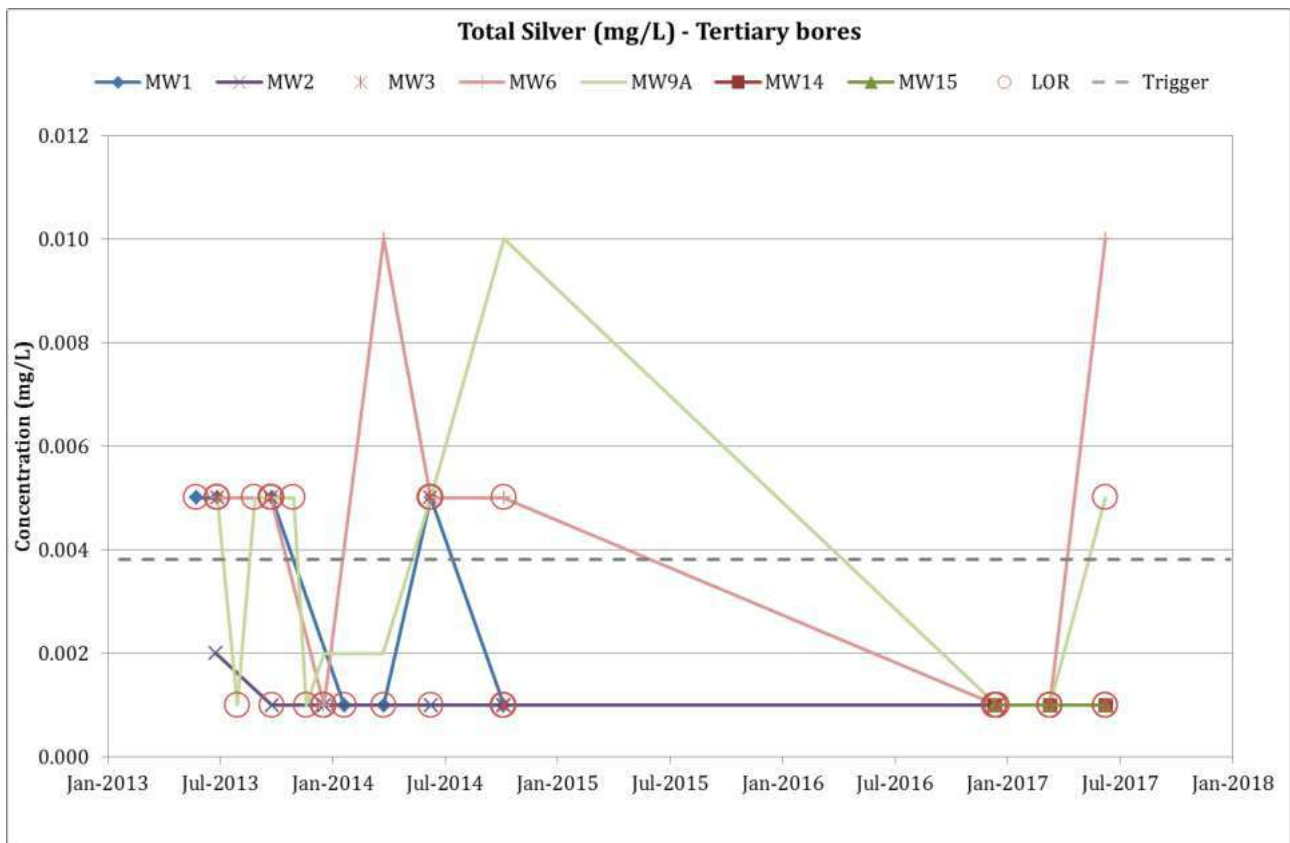


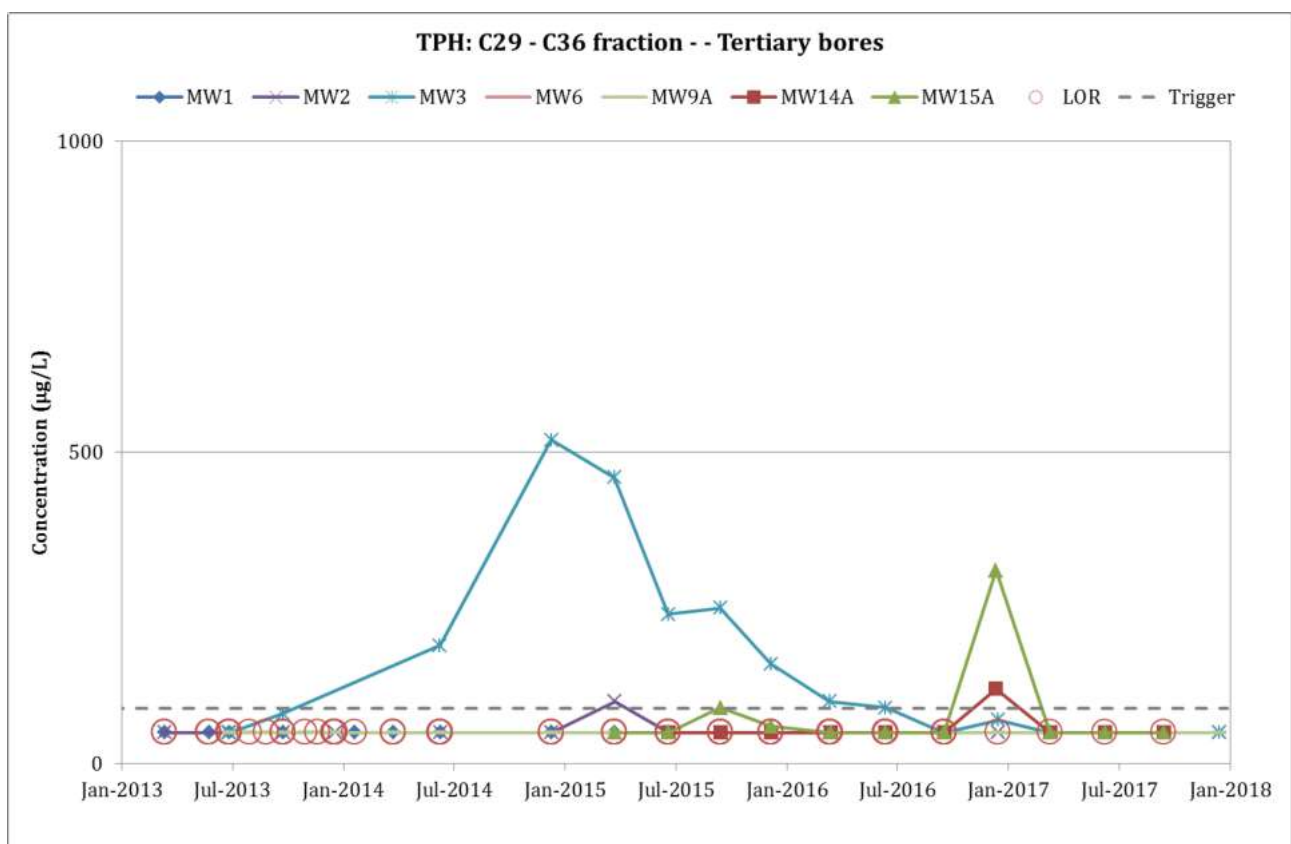
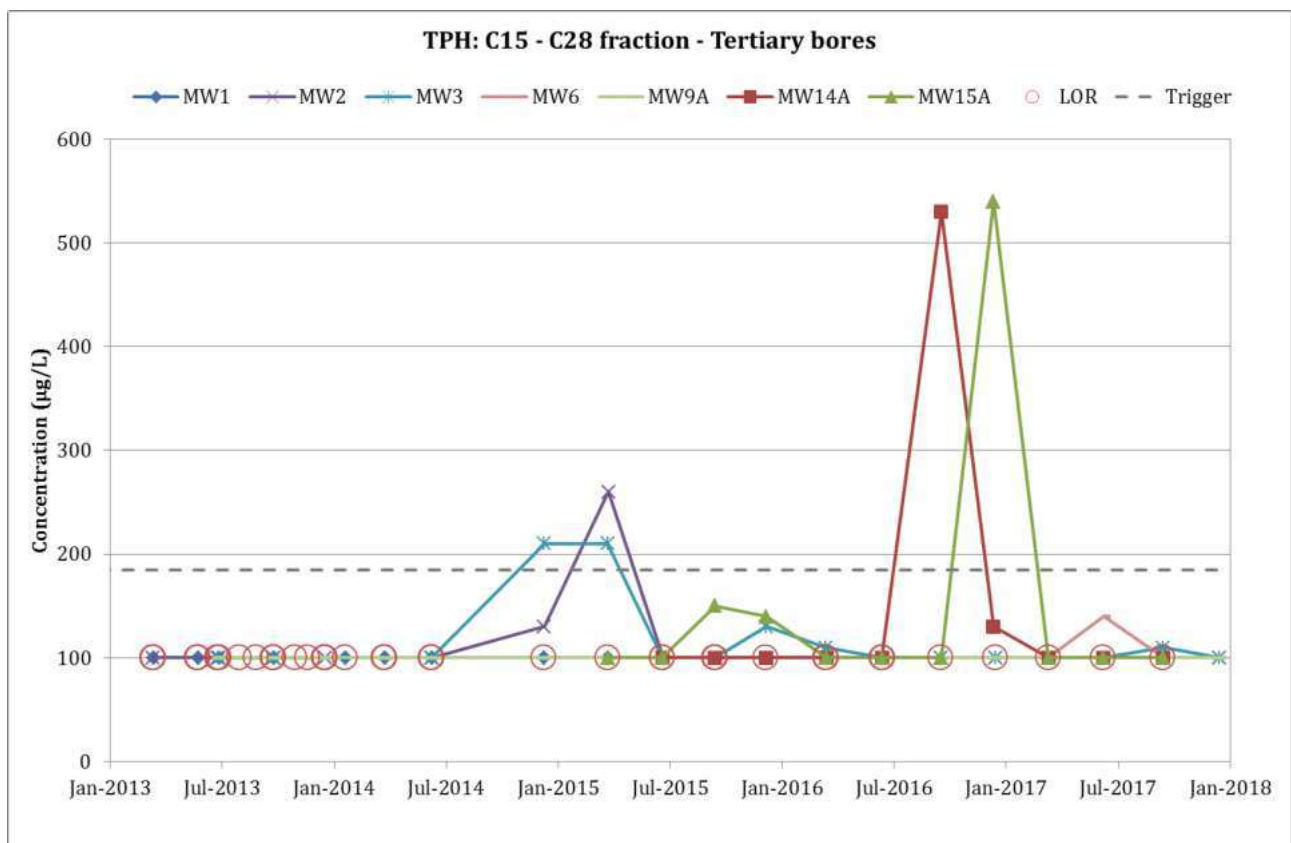


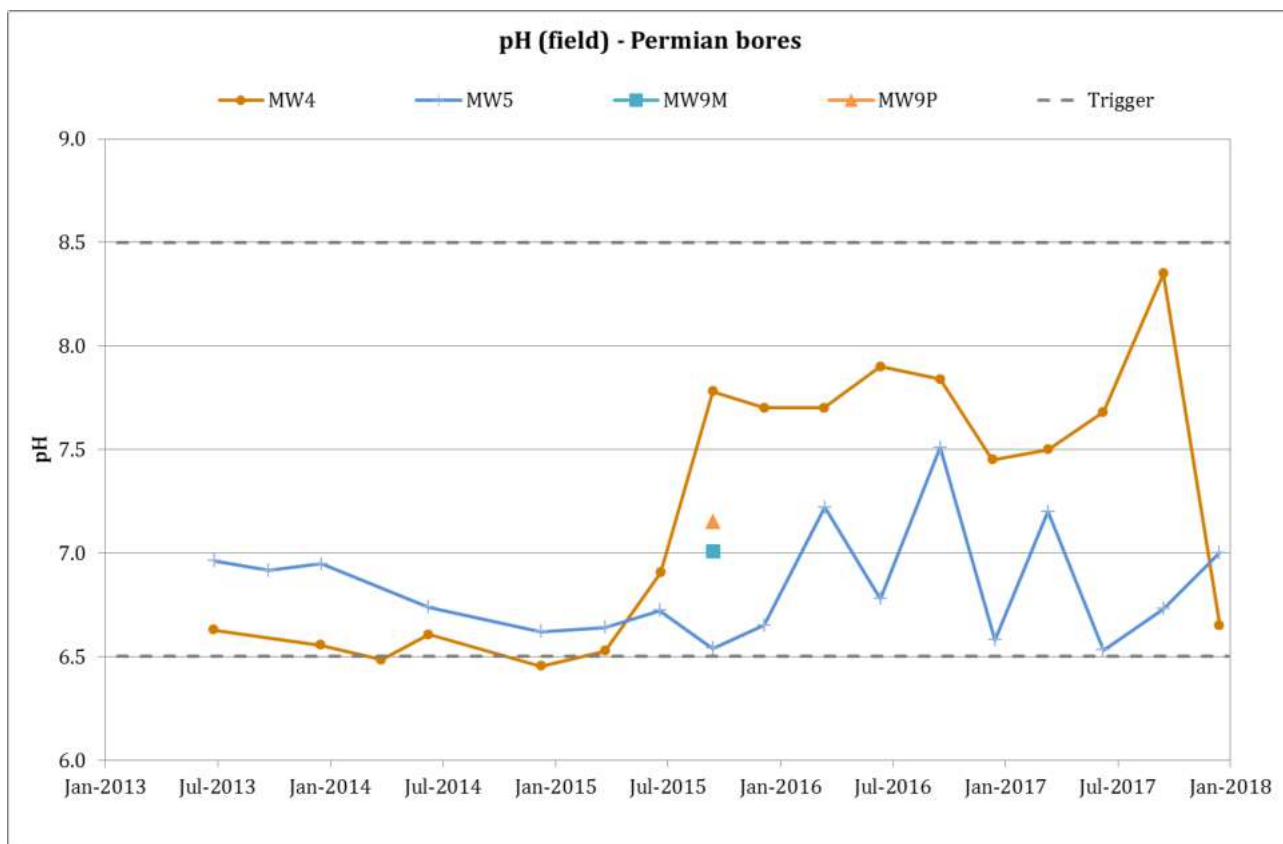
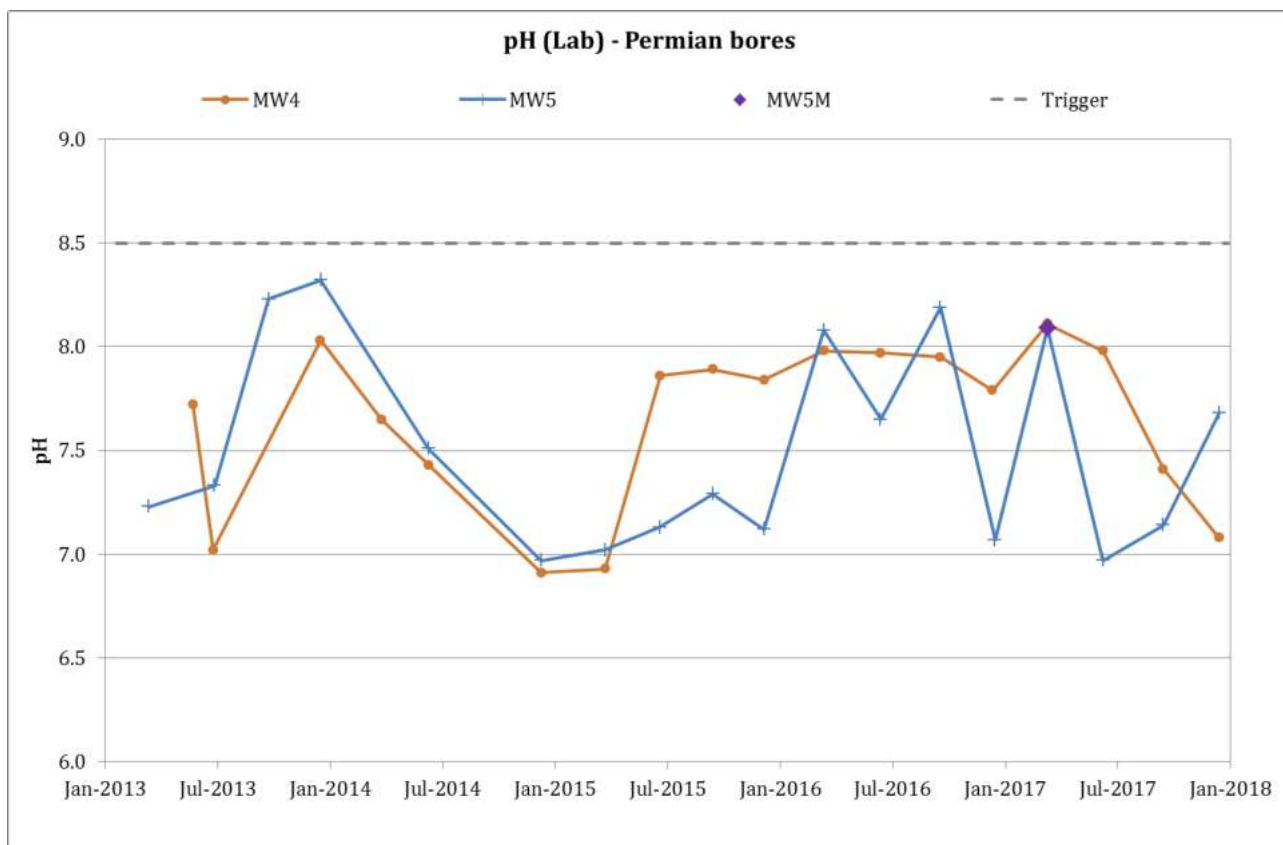


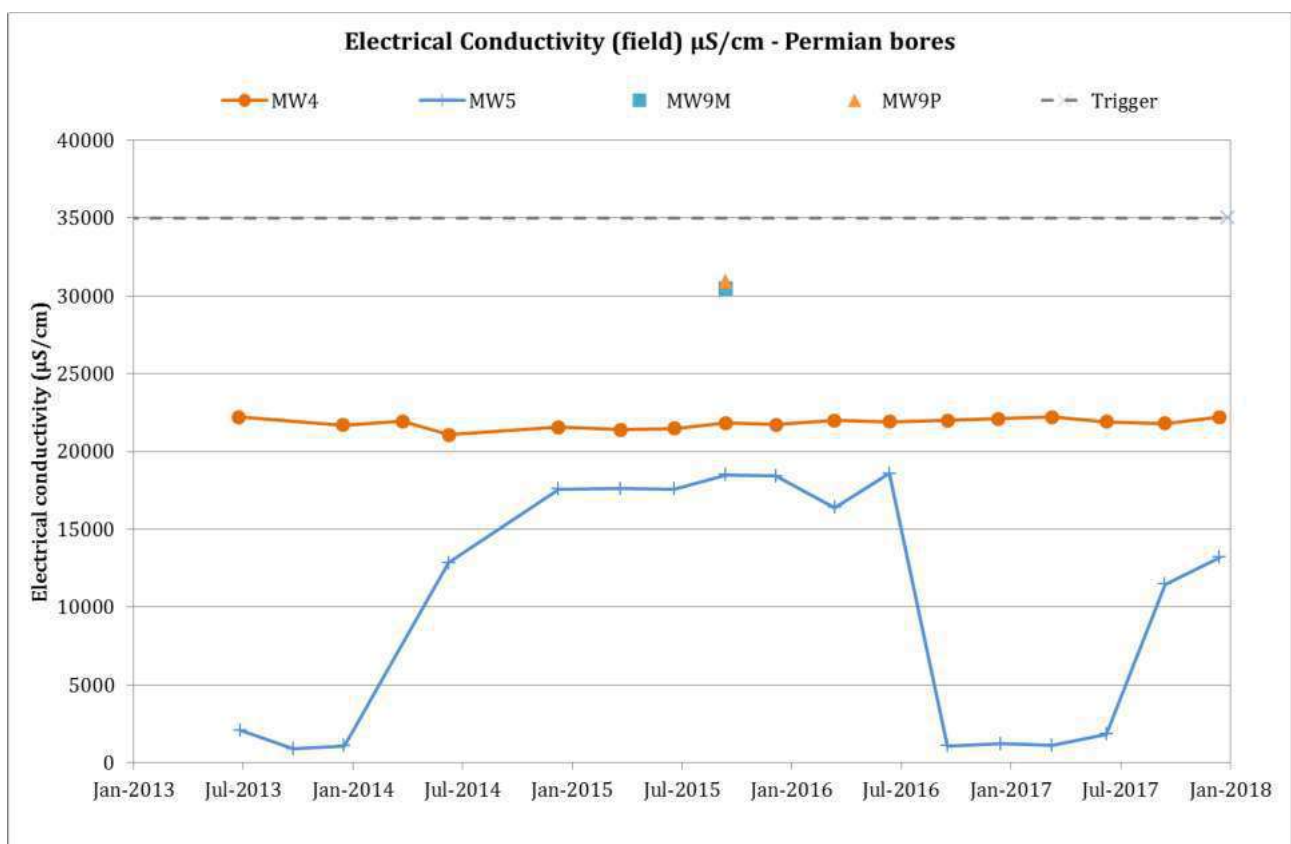
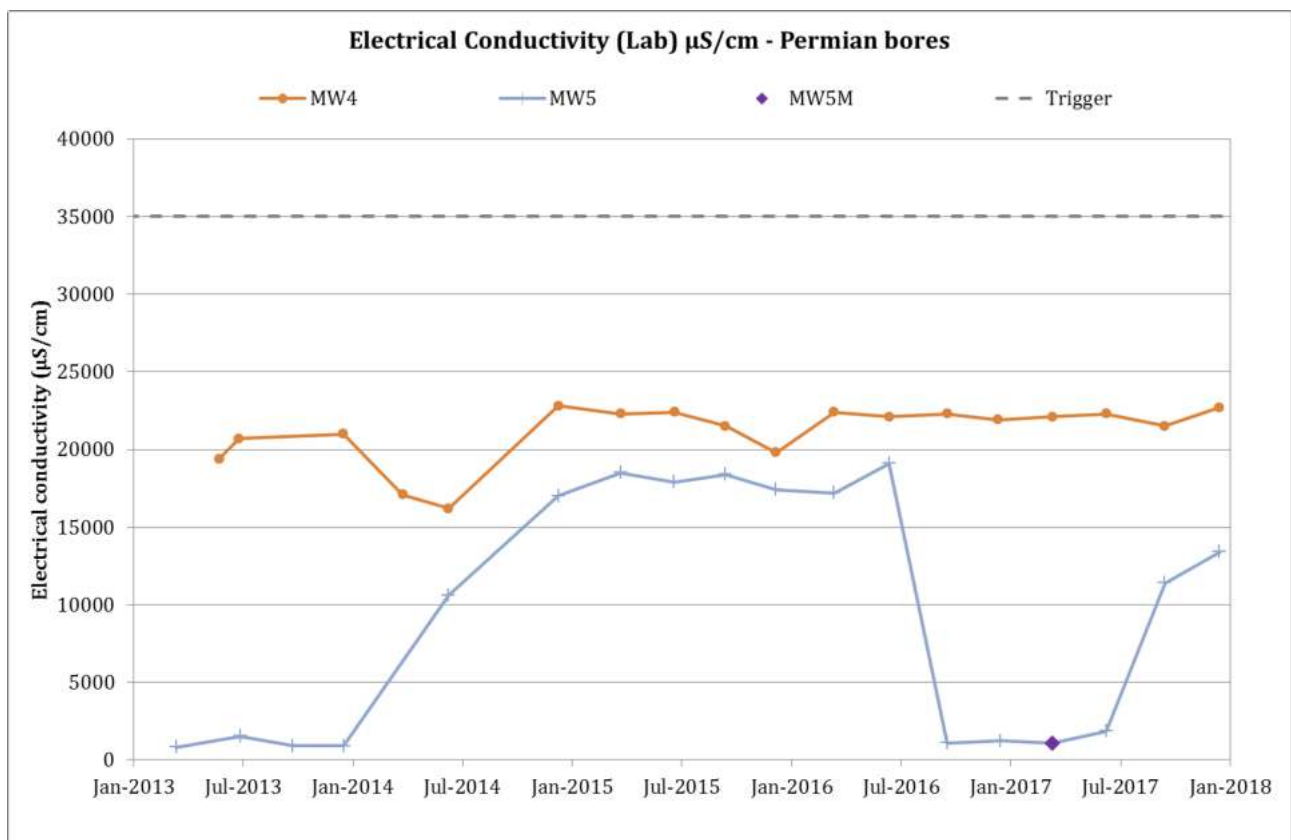


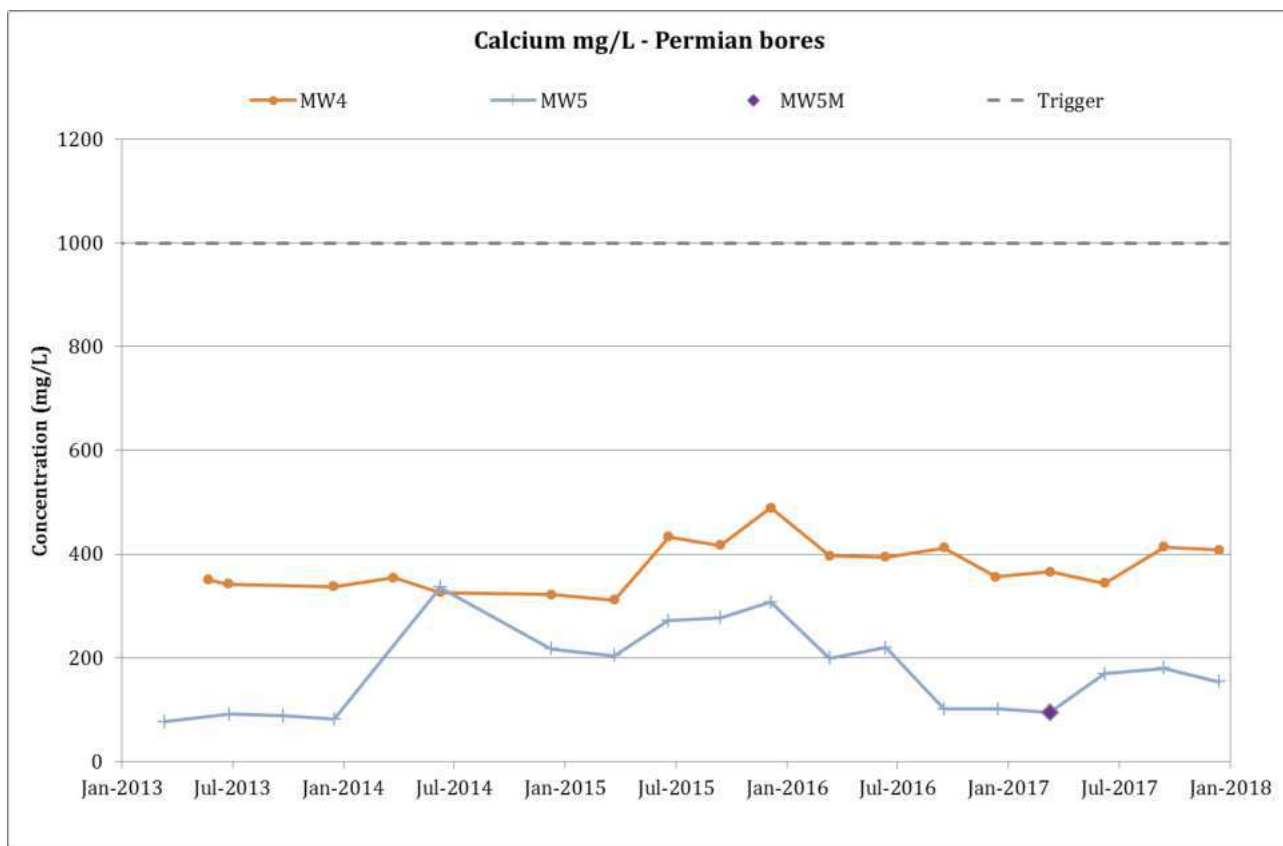
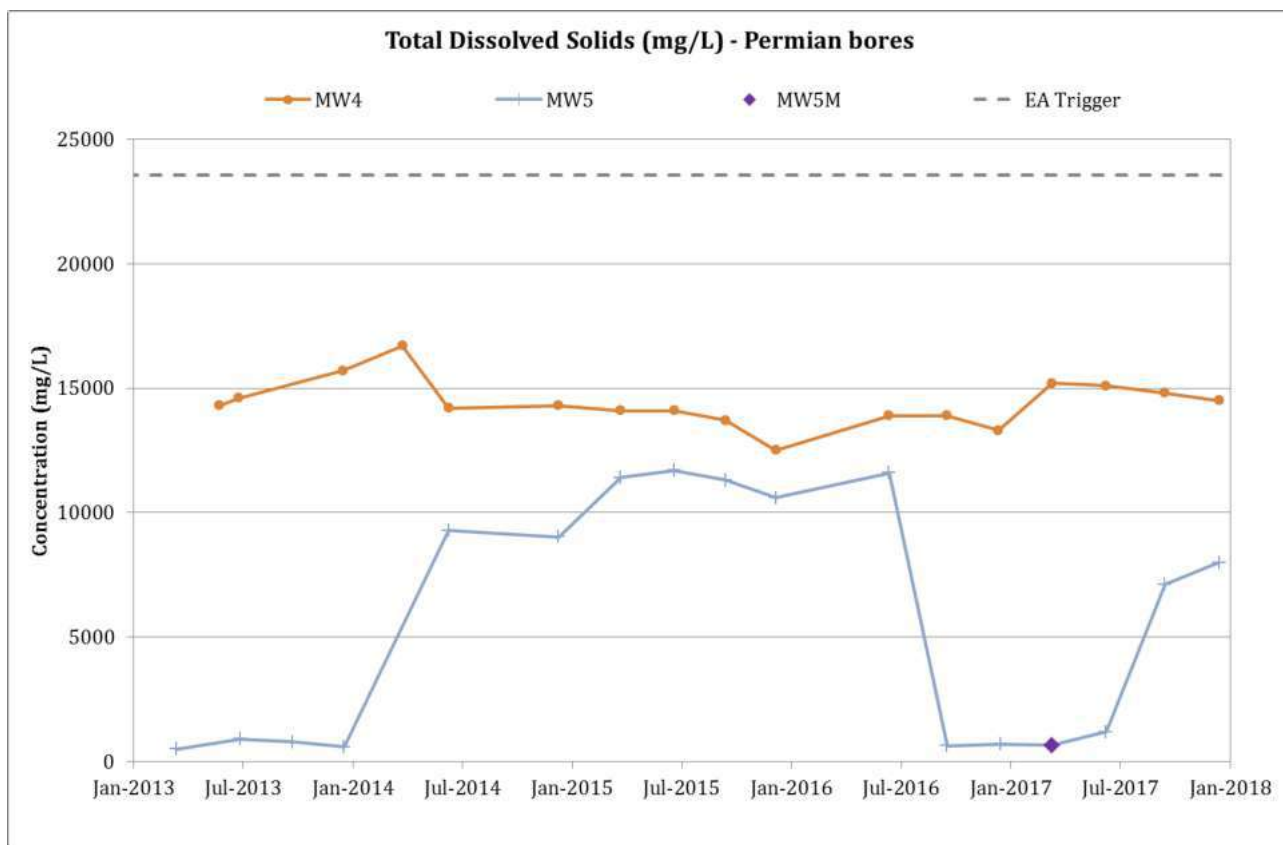


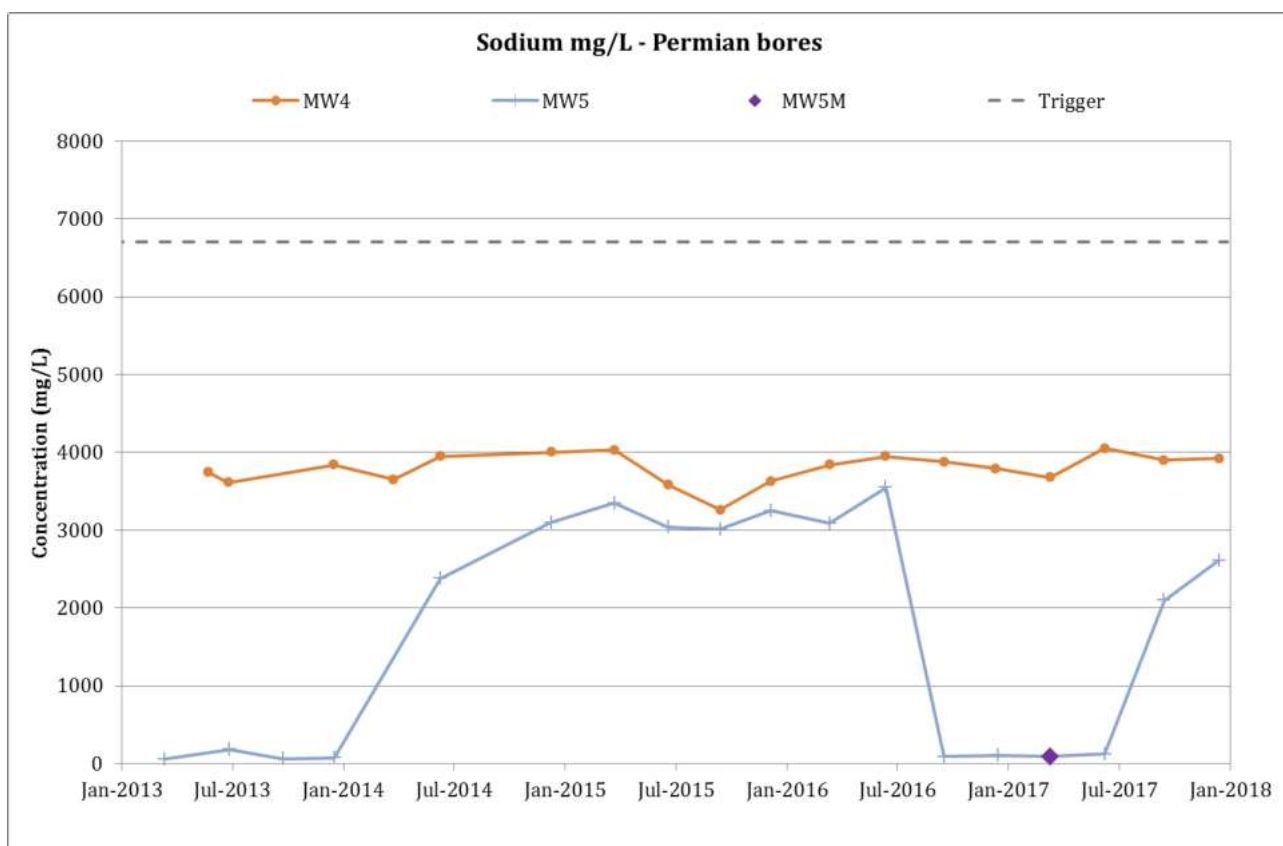
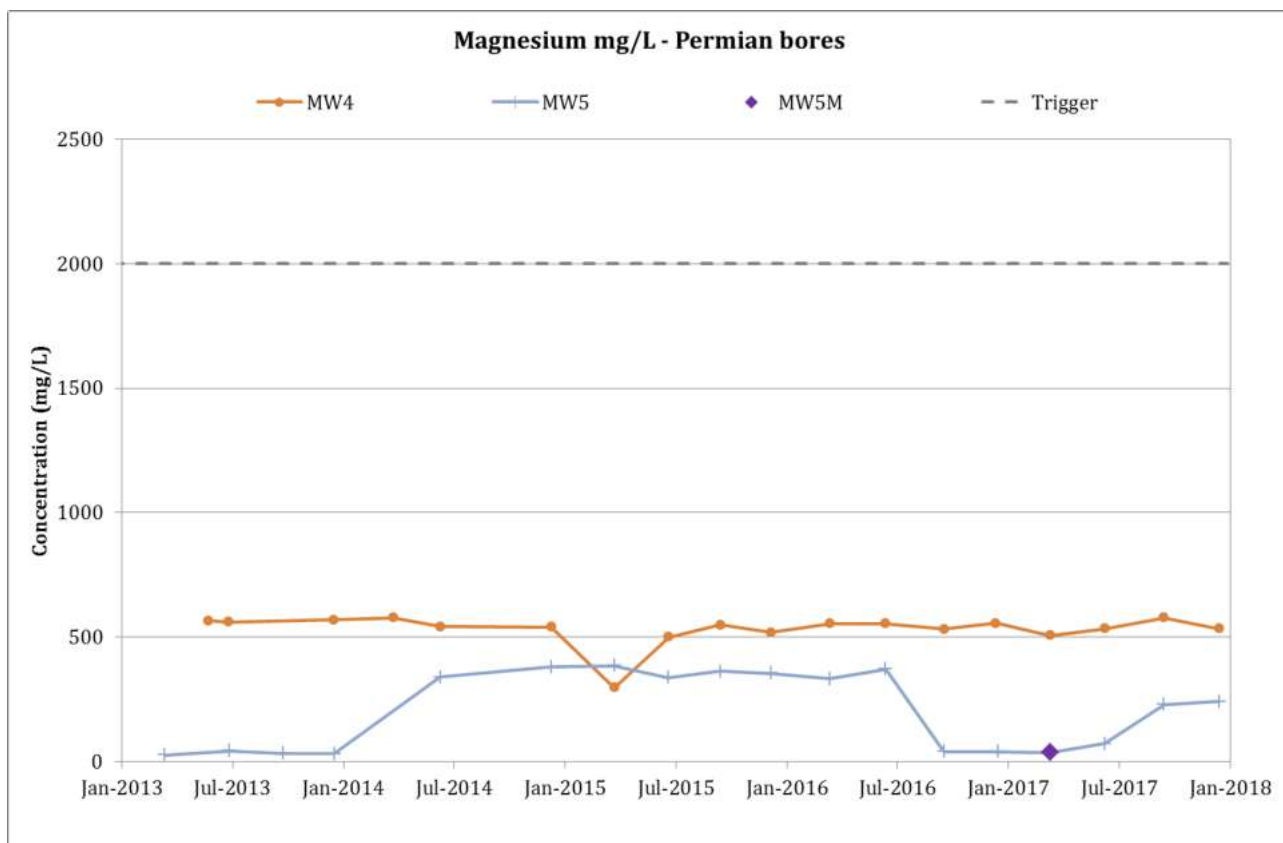


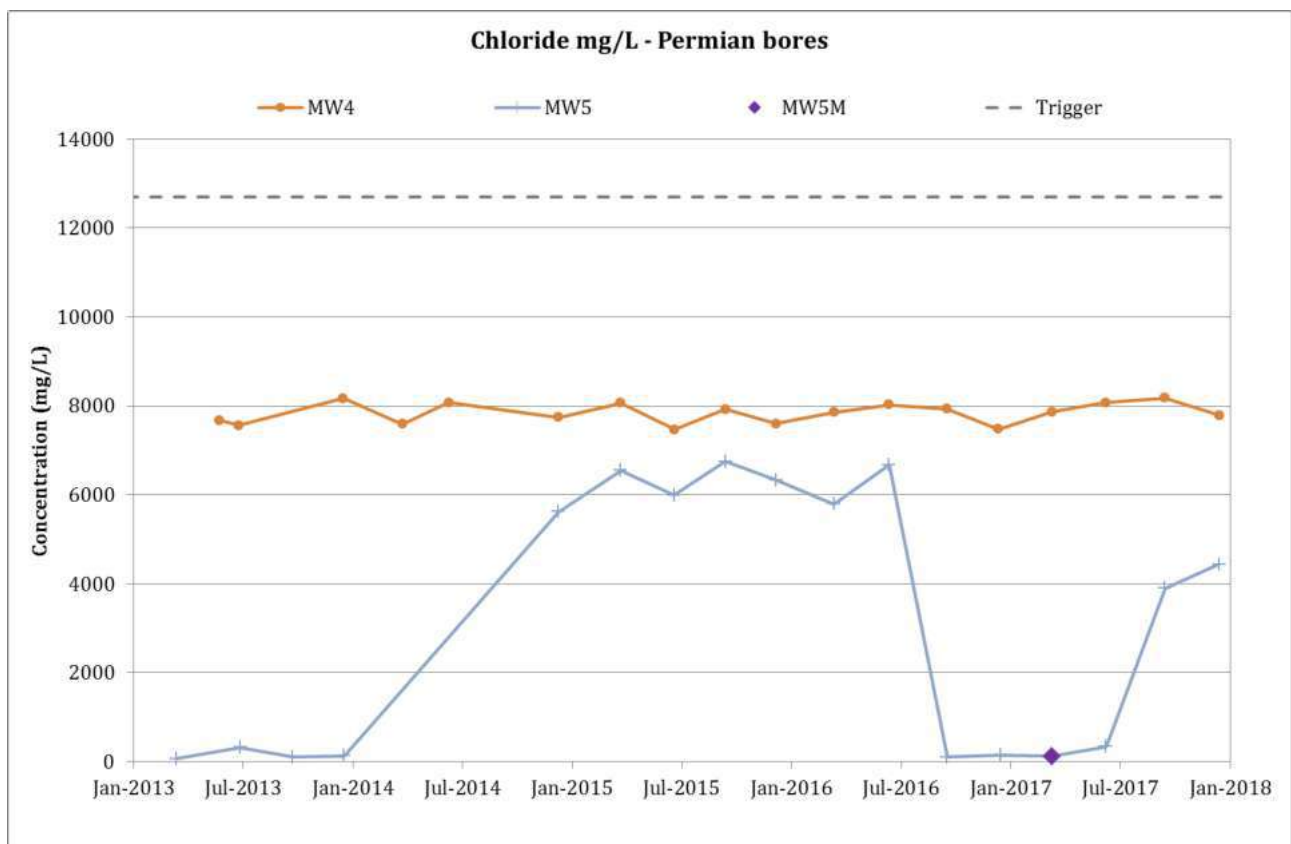
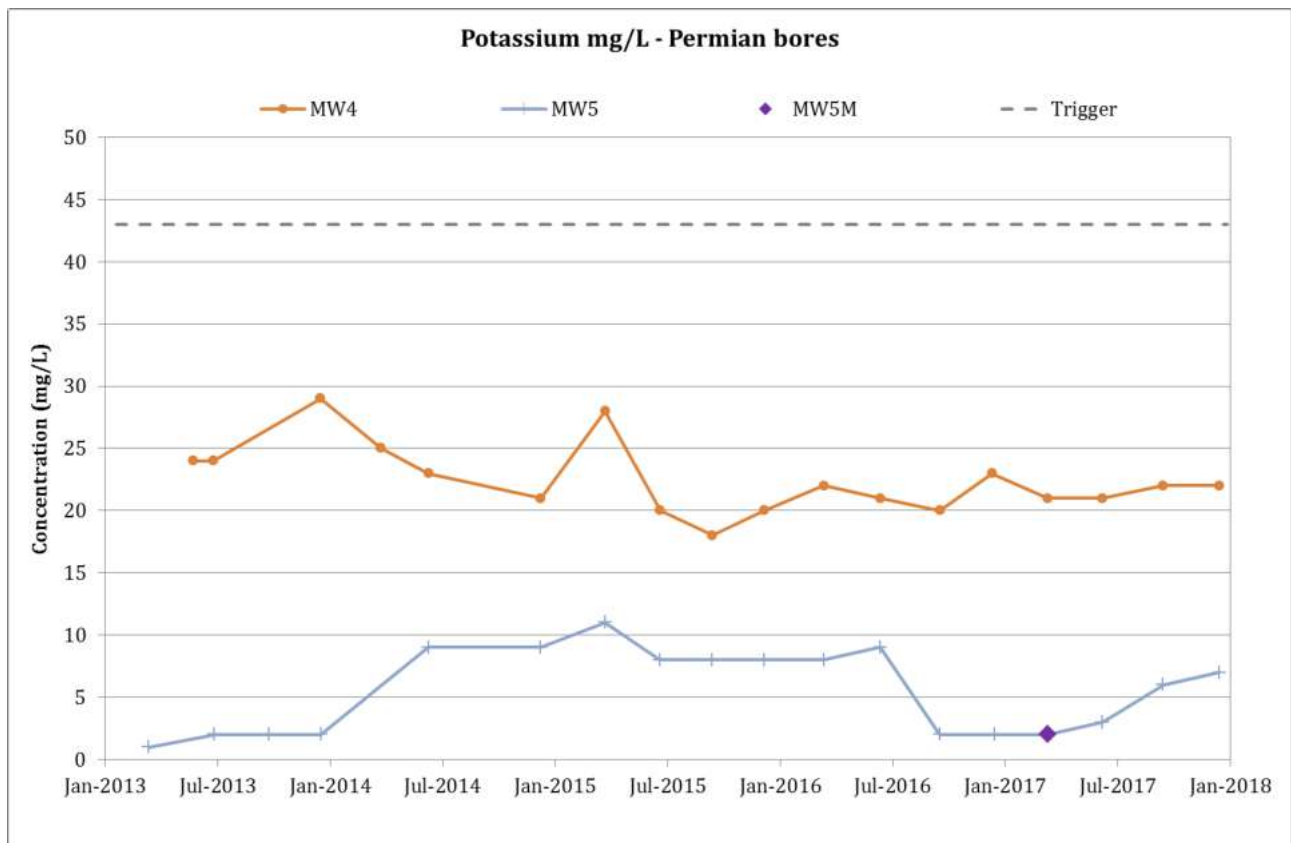


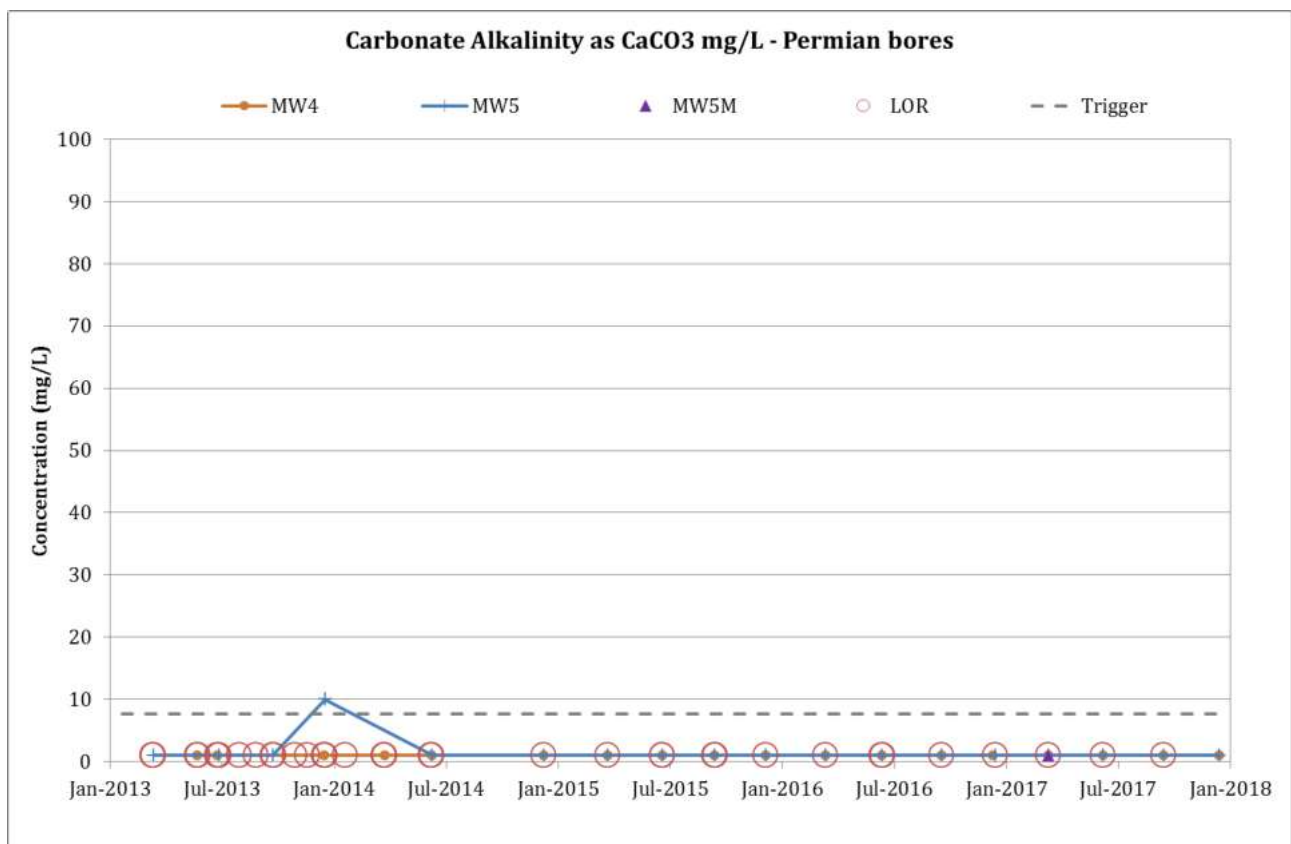
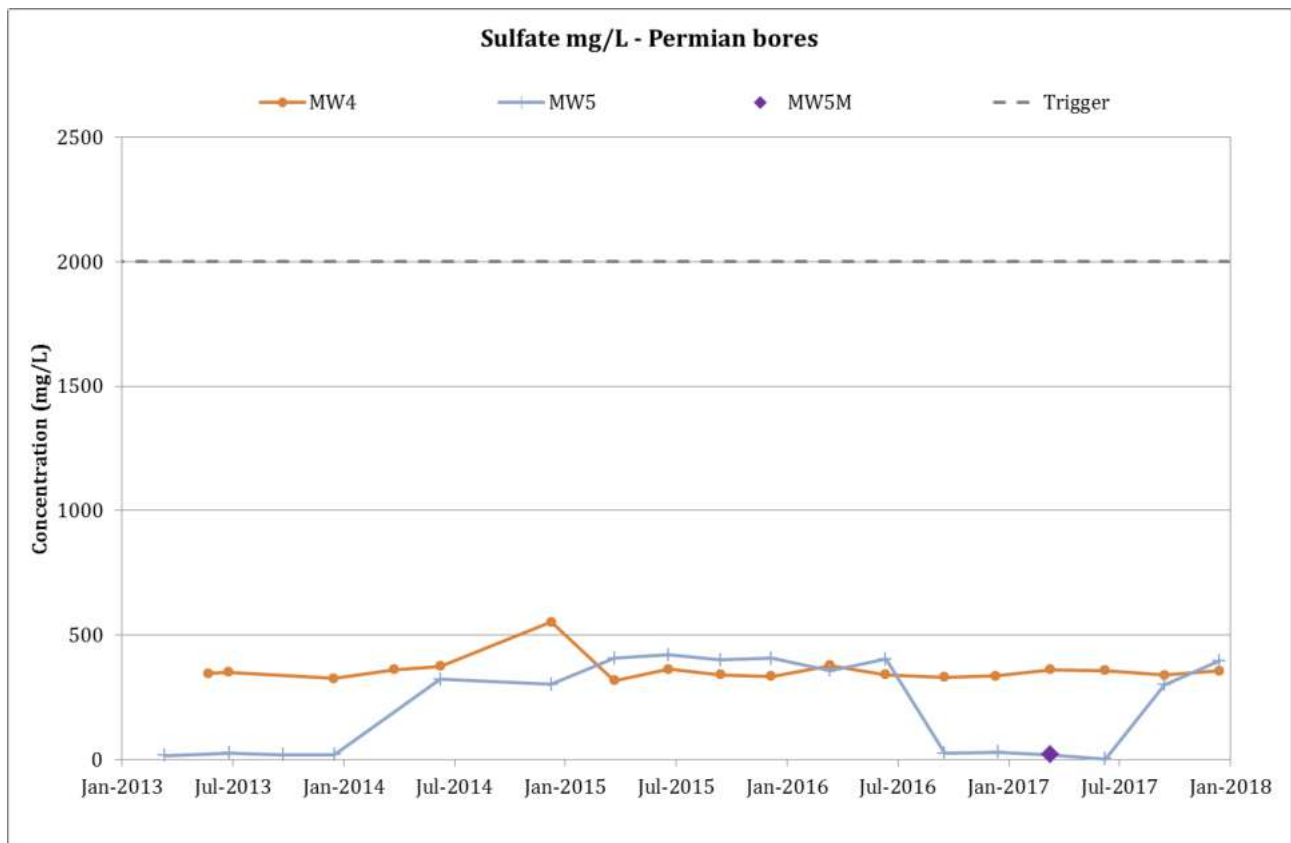


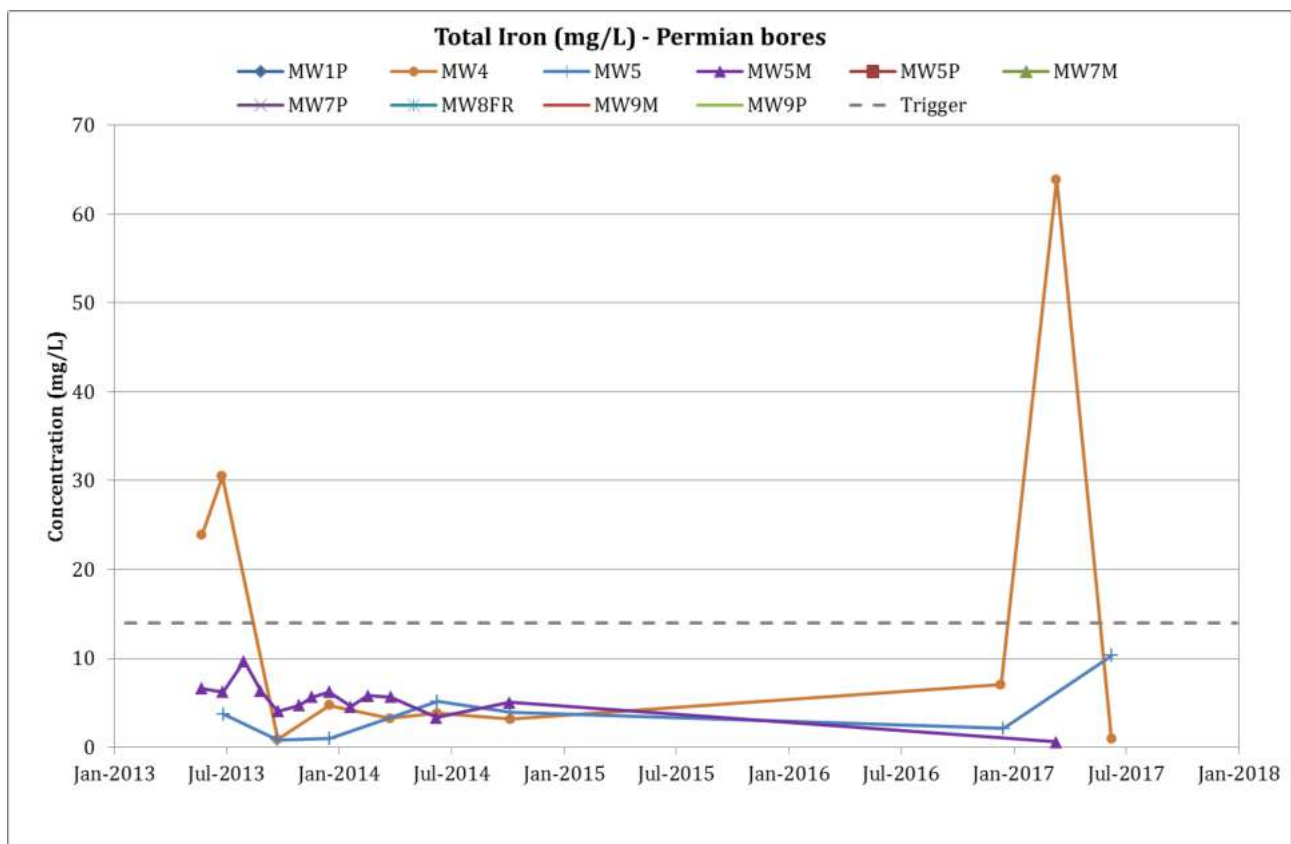
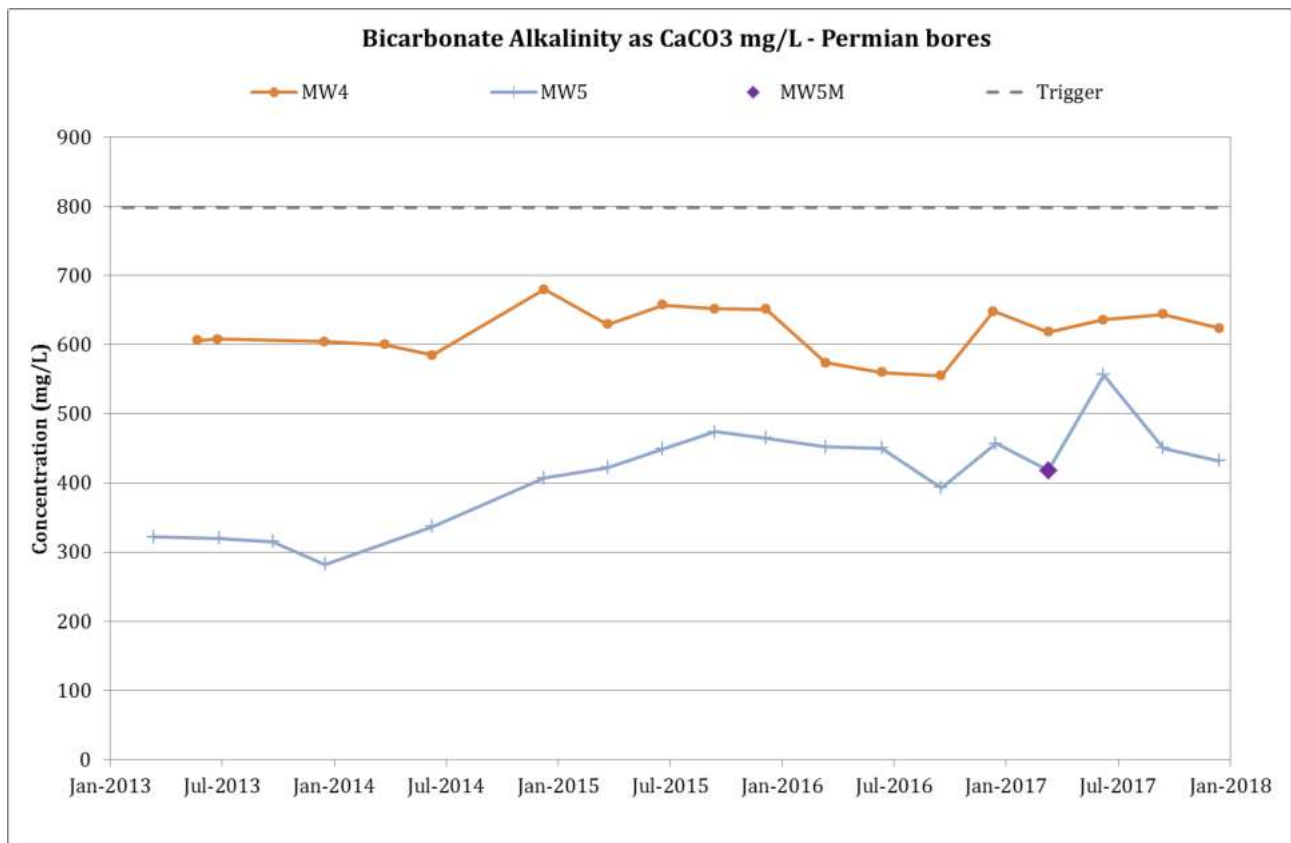


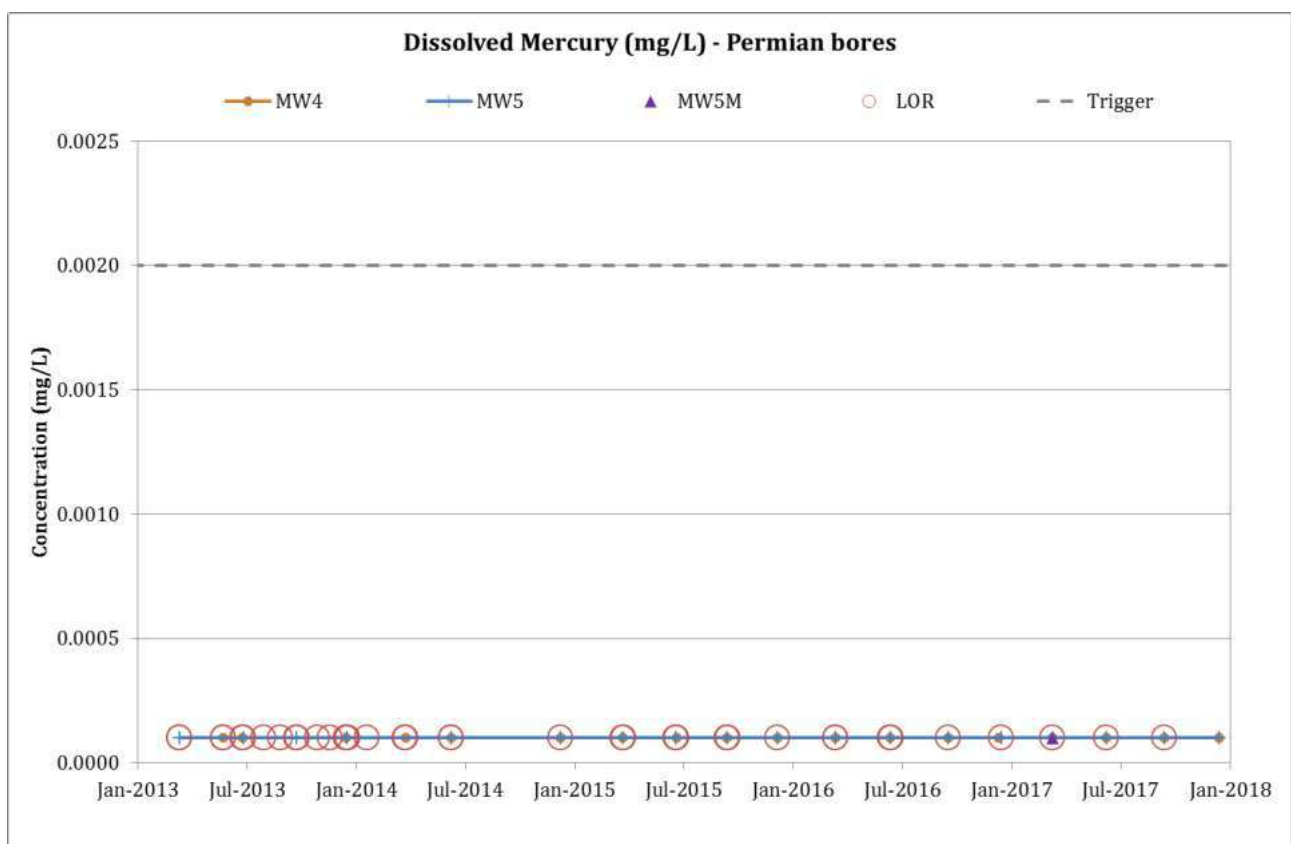
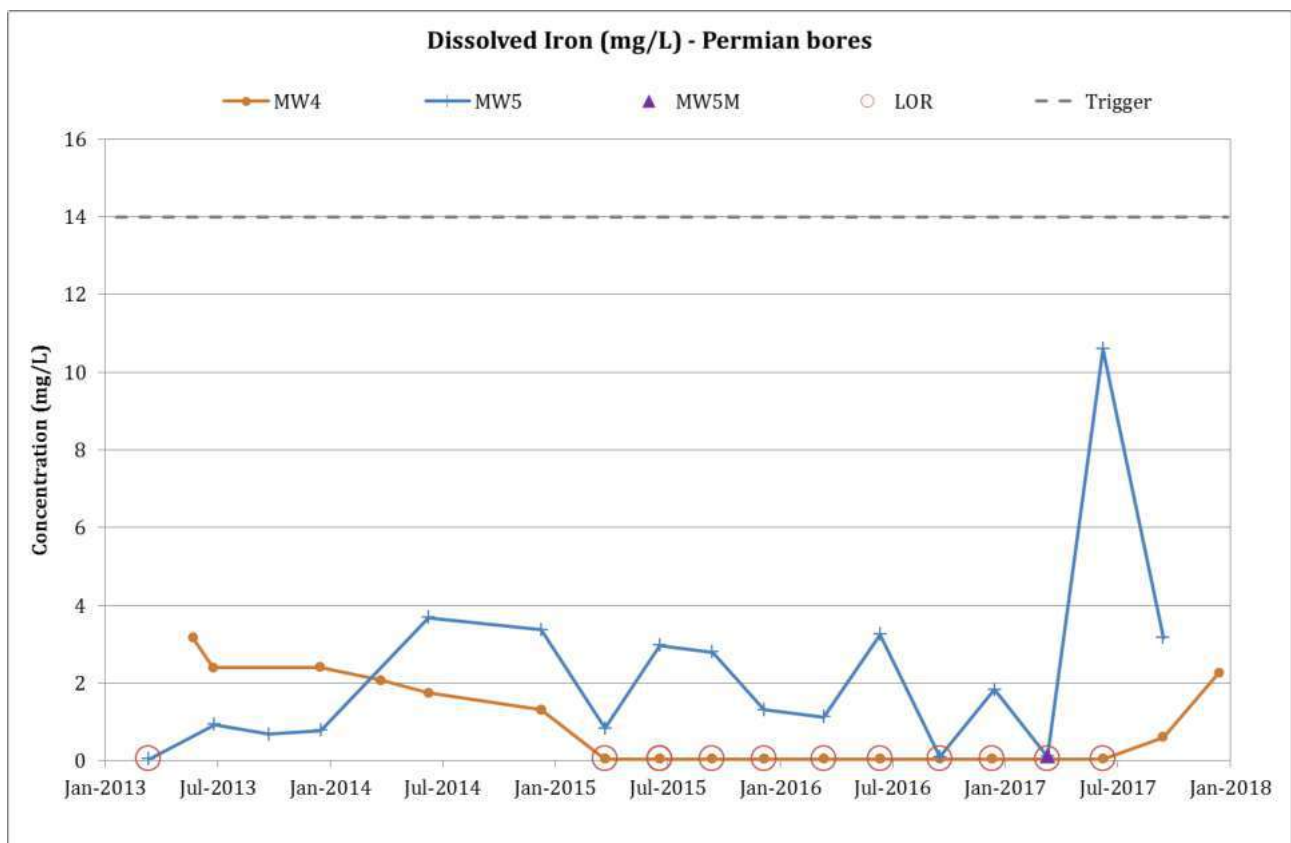


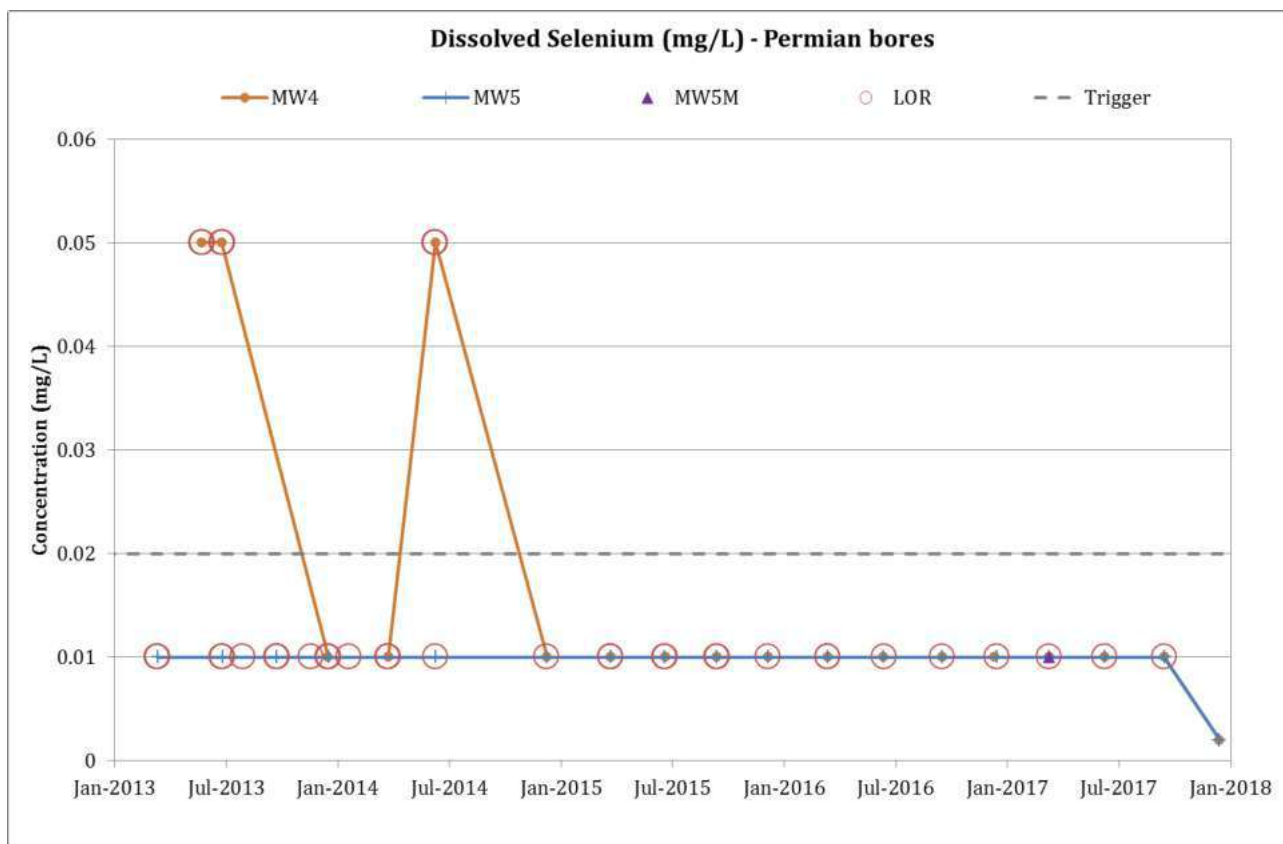
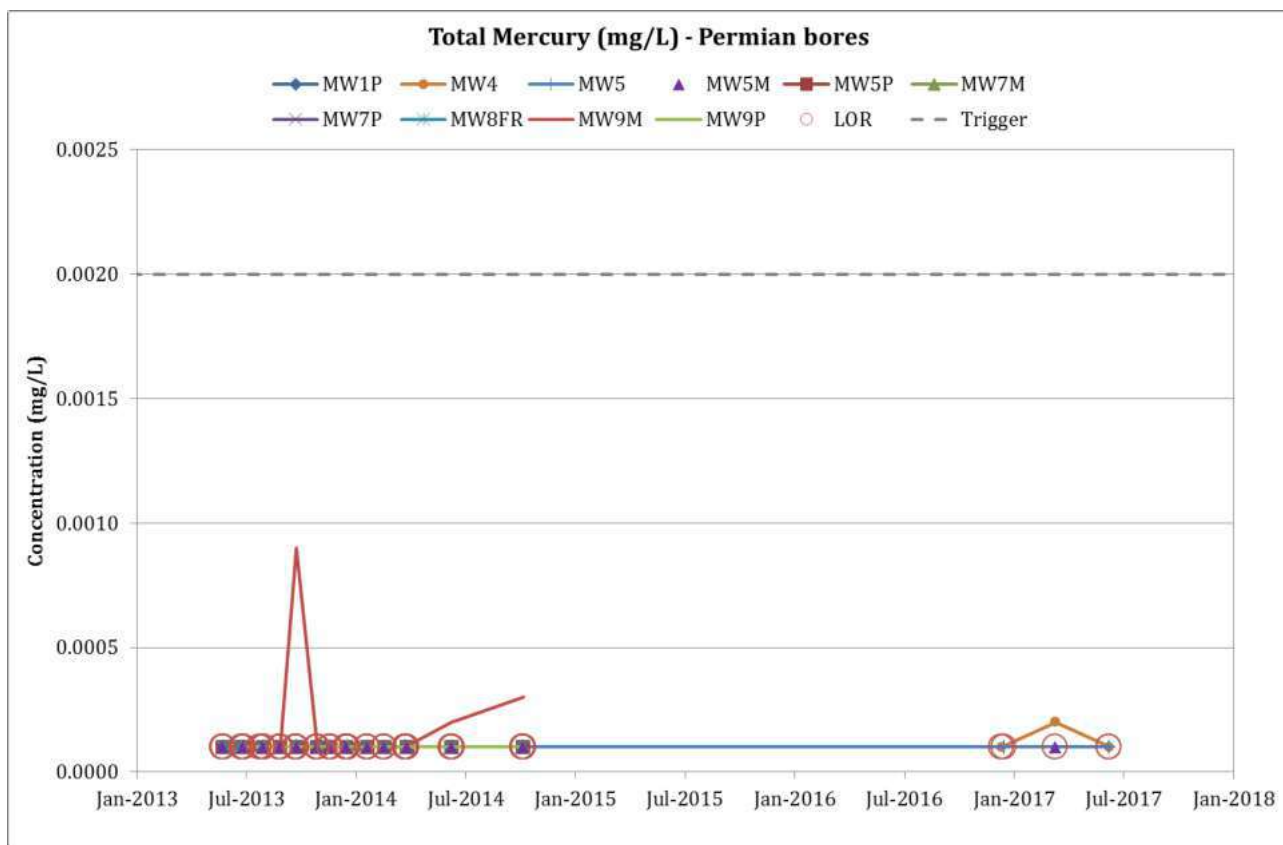


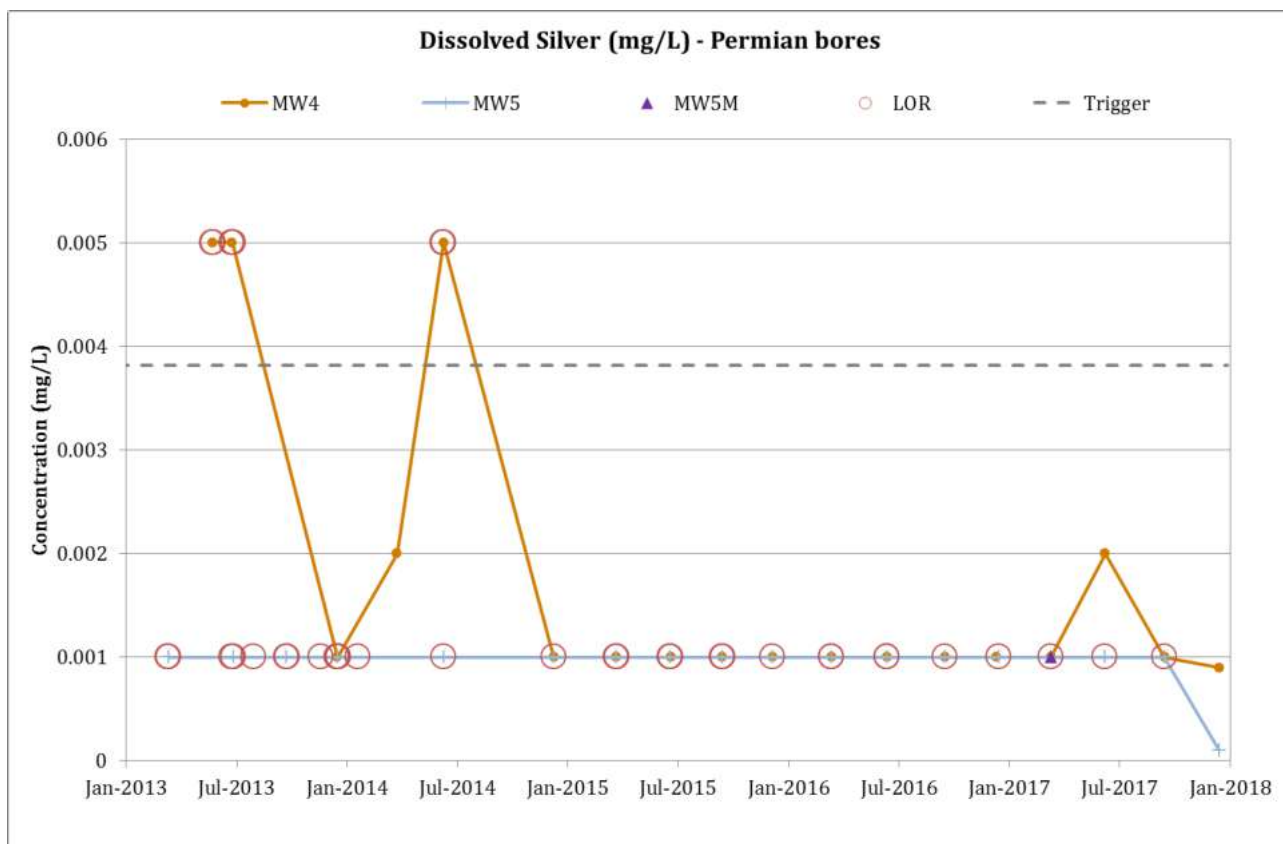
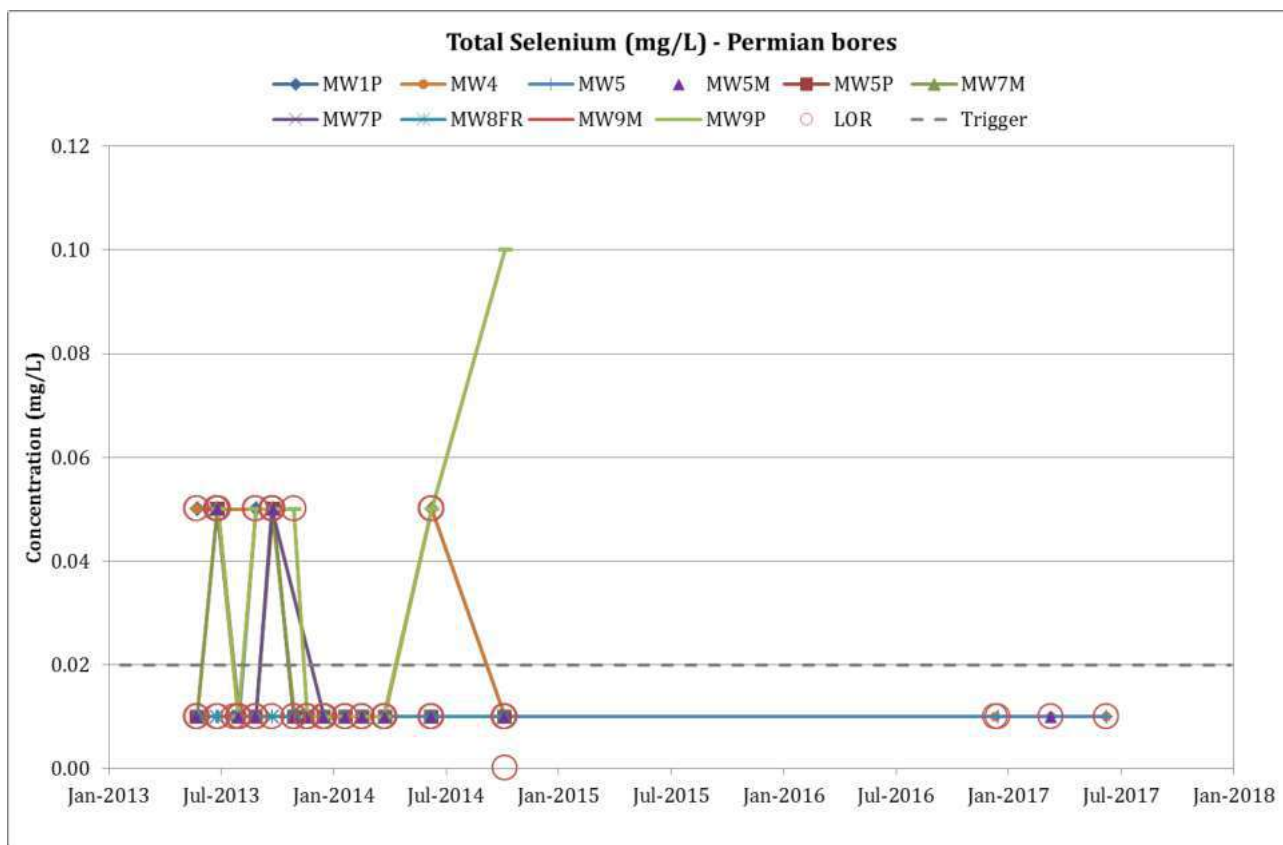


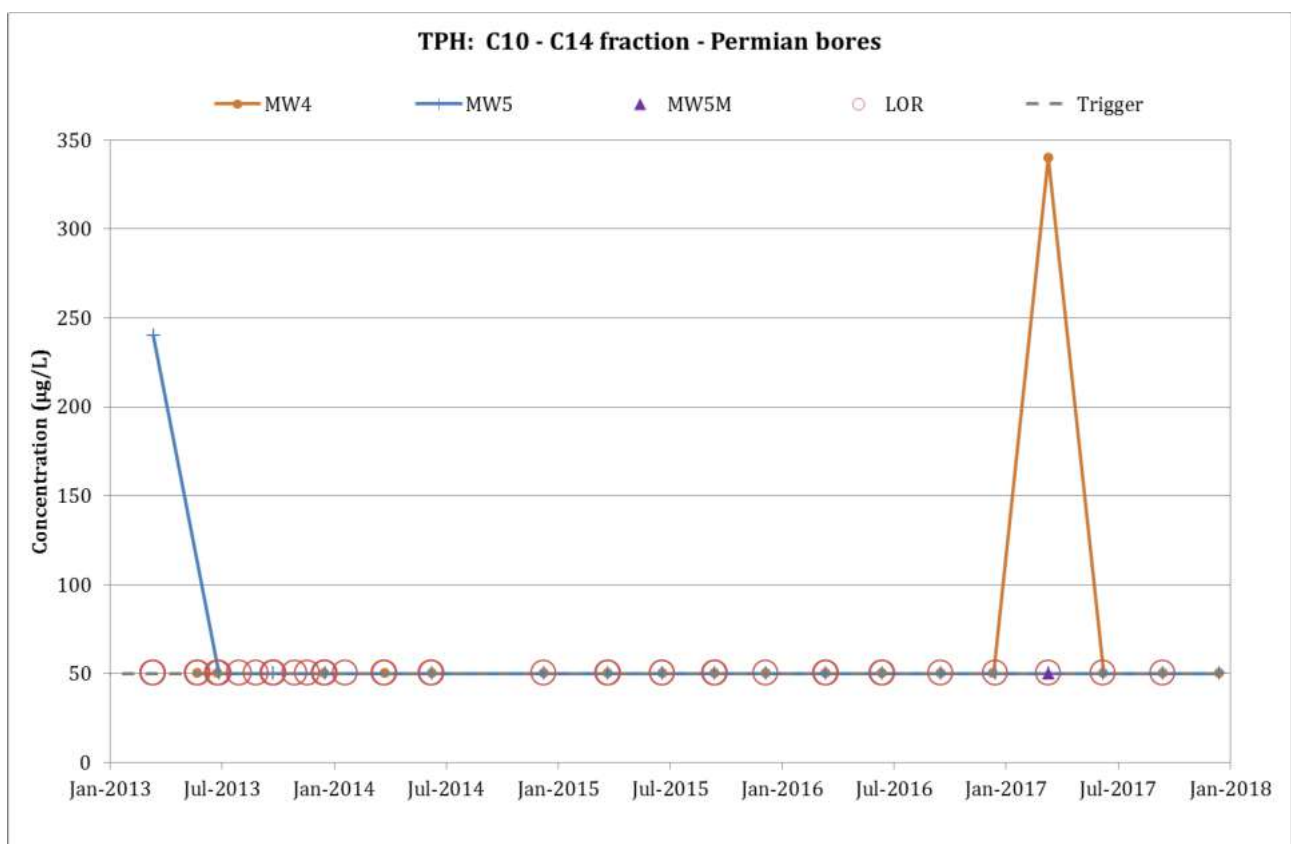
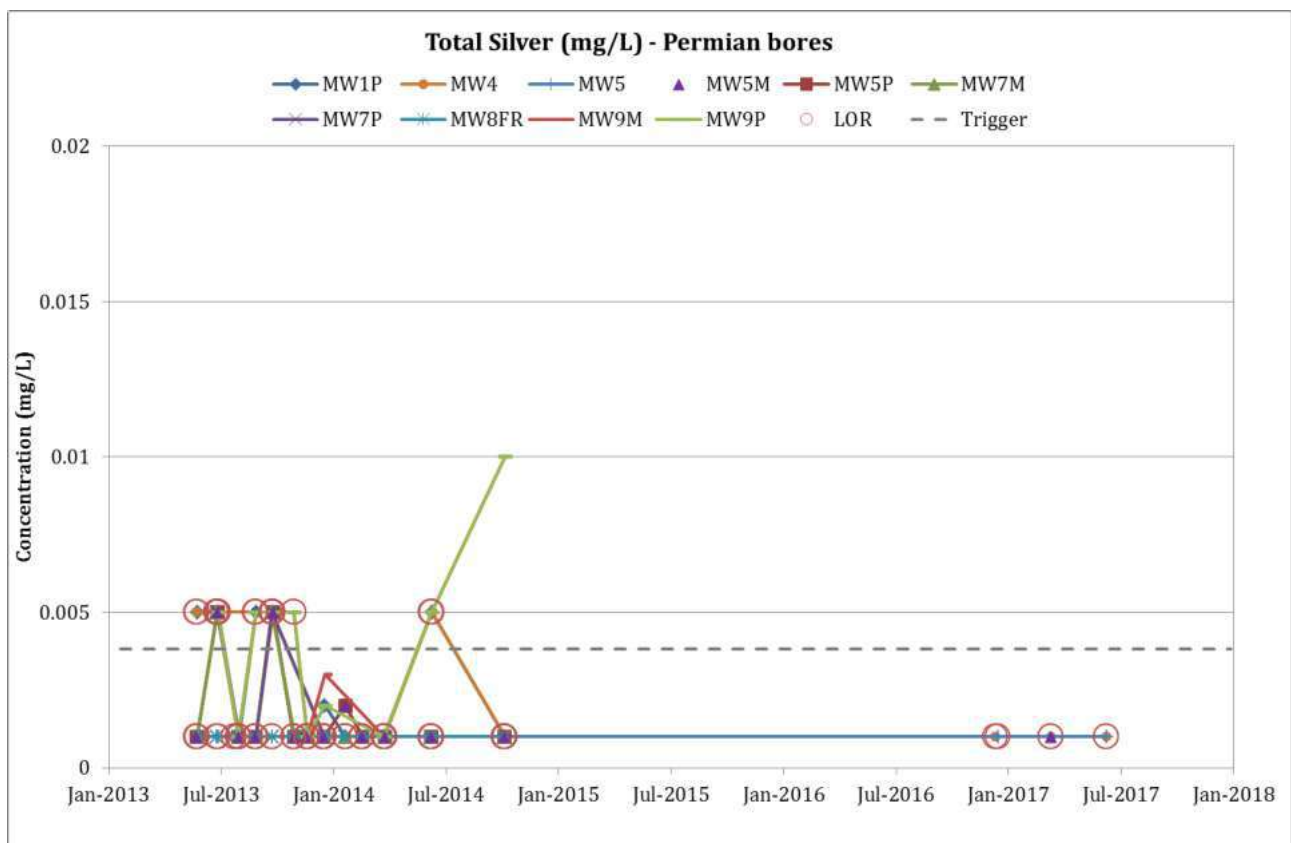


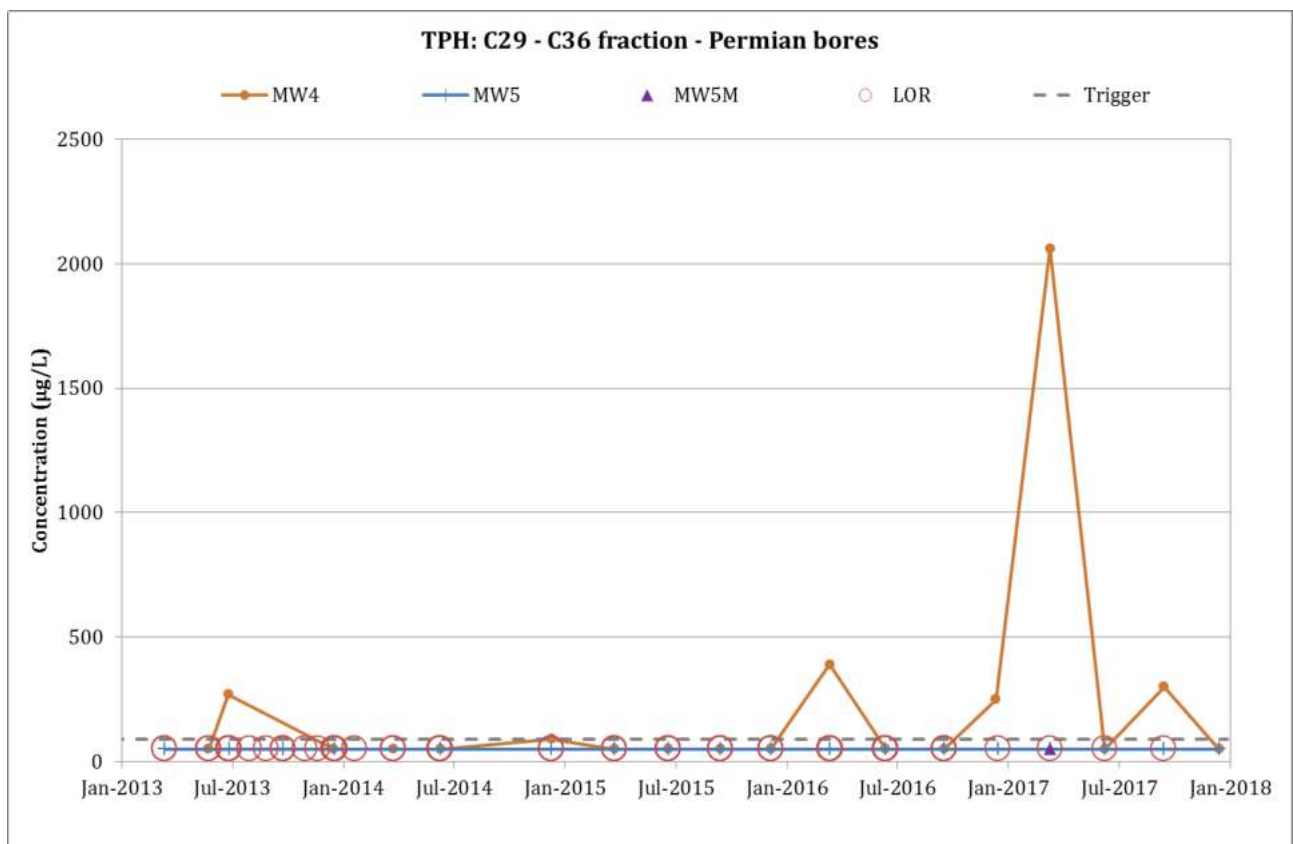
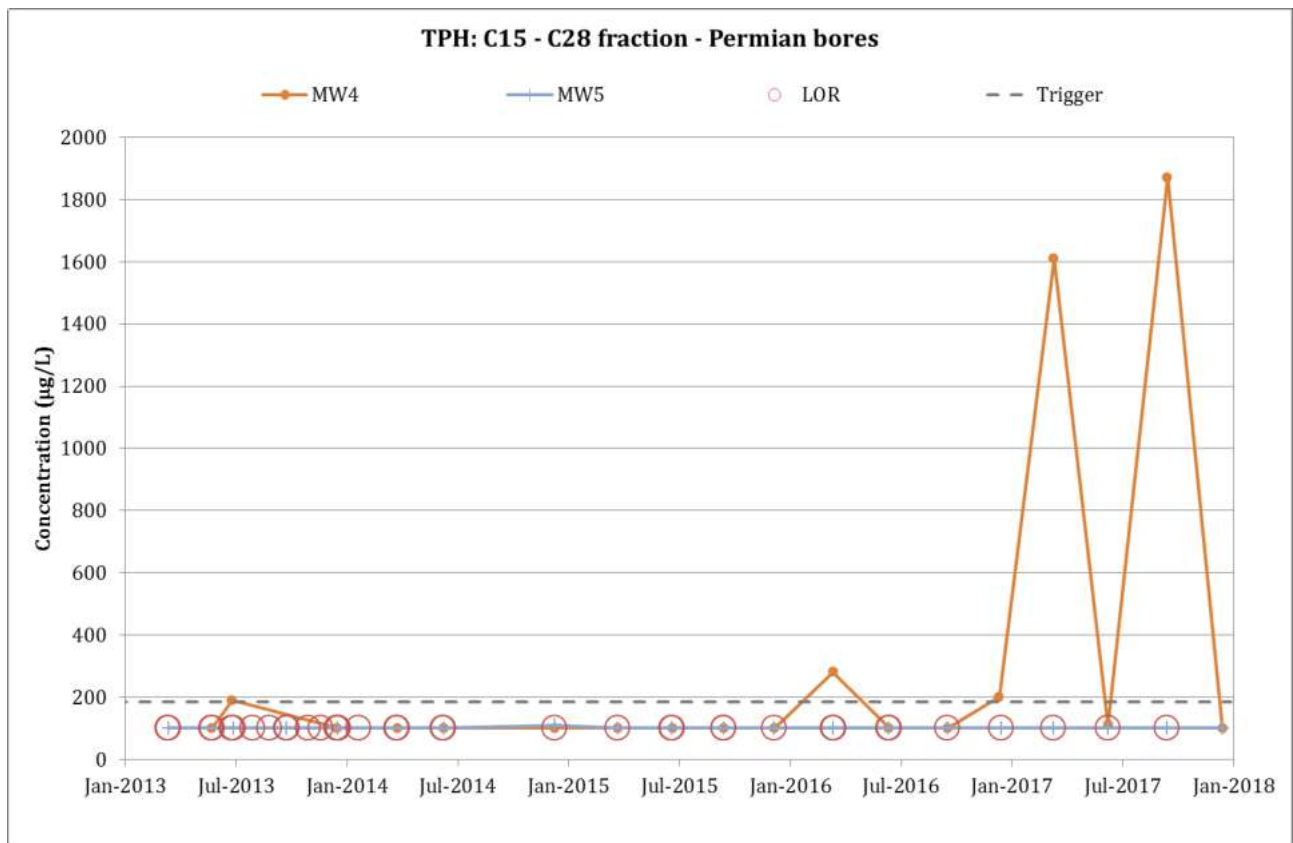












Appendix F Numerical model report

Middlemount Western Extension Project

Numerical Modelling Report

F1 Introduction and objectives

Numerical modelling was undertaken to assess the impact of the proposed Middlemount Western Extension Project (the Project) on the groundwater regime. The objectives of the modelling were to estimate with a high level of confidence:

1. potential mine inflows for water licencing; and
2. potential drawdown impacts on the surrounding environment due to mining.

This has been achieved by:

- simulating groundwater flow within the Quaternary, Tertiary, and Permian strata;
- calibrating the model under steady state and transient conditions;
- predicting future mine inflows and surrounding drawdown under the current hydrogeological conditions;
- predicting the volumetric take of groundwater, changes in regional groundwater levels and impacts on private bore water levels due to the Project and cumulatively;
- undertaking uncertainty analysis to capture range of predictions within the uncertainty in model parameters; and
- assessing the rate of groundwater recovery and long term impacts occurring on cessation of mining.

F1.1 Model confidence level classification

A high level of confidence in model predictions is required for the Project. Barnett *et al.*, (2012) developed a system to classify the confidence-level for groundwater models. Models are classified as either Class 1, Class 2 or Class 3 in order of increasing confidence. Several factors are considered in determining the model confidence-level:

- available data;
- calibration procedures;
- consistency between calibration and predictive analysis; and
- level of stresses.

A Class 3 model is often referred to as an aquifer simulator, in that it encapsulates a very detailed and well understood conceptualisation. Despite the use of all available data for the model inputs, it is difficult to obtain all of the Class 3 descriptors, and an appropriate and achievable level is somewhere between an aquifer simulator and an impact model. Barnett *et al.*, (2012) consistently suggest “*it is not expected that any individual model will have all the defining characteristics of Class 1, 2 or 3 models*”.

Comparison against the performance indicators for individual model classes are presented in Table F 1.1.

Table F 1.1 Model classification – model performance indicators

Class	Data	Calibration	Prediction	Quantitative Indicators
1 (Simple)	× Not much	× Not possible	✓ Timeframe >> Calibration	× Timeframe > 10x
	✓ Sparse coverage	× Large error statistic	× Long stress periods	✓ Stresses < 5x
	✓ No metered usage	× Inadequate data spread	× Poor/no validation	× Mass balance > 1% (or one-off 5%)
	× Low resolution	× Targets incompatible with model purpose.	× Transient prediction but steady-state calibration	~ Properties < > field values
	× Poor aquifer geometry			× No review by Hydro/Modeller
2 (Impact Assessment)	✓ Some	× Partial performance	✓ Timeframe > Calibration	× Time frame = 3-10x
	✓ Ok coverage	× Some long term trends wrong.	× Long stress periods	✓ Stresses = 2-5x
	~ Some usage data/ low volumes	✓ Short term record.	✓ Ok validation	✓ Mass balance <1%
	~ Baseflow estimates. Some K & S measurements	✓ Weak seasonal match.	✓ Transient calibration and prediction	✓ Some properties < > field values. Review by Hydrogeologist
	✓ Some high resolution topographic DEM &/or some aquifer geometry	× No use of targets compatible with model purpose (heads & fluxes)	✓ New stresses not in calibration	× Some coarse discretisation in key areas of grid or at key times
3 (Complex Simulator)	✓ Lots, with good coverage.	✓ Good performance stats	× Timeframe ~ calibration	✓ Timeframe < 3x
	× Good metered usage info.	✓ Most long term trends matched	~ Similar stress periods	× Stresses < 2x
	~ Local climate data	× Most seasonal matches ok.	✓ Good validation	✓ Mass balance < 0.5%
	~ Kh, Kv & Sy measurements from range of tests	✓ Present day data targets	✓ Calibration & prediction consistent (transient or steady state).	~ Properties ~field measurements
	~ High resolution DEM all areas.	✓ Head & Flux targets used to constrain calibration	~ Similar stresses to those in calibration.	✓ No coarse discretisation in key areas (grid or time)
	✓ Good aquifer geometry.			✓ Review by experienced Modeller

This shows the Western Extension Project groundwater model is classified between a Class 2 and Class 3 model. That is, the model classification identifies:

- 4 out 18 (22%) performance indicators align with a Class 1 model;
- 12 out 22 (60%) performance indicators align with a Class 2 model; and
- 11 out 21 (52%) performance indicators align with a Class 3 model.

The above indicates the groundwater model has been developed to be suitable for predicting groundwater responses to changes in applied stress or hydrological conditions, and the evaluation and management of potential impacts.

F2 Model background

F2.1 Previous modelling for Middlemount Coal Mine

A groundwater model was developed as part of the groundwater component of the Environmental Impact Assessment for Stage 2 of the Middlemount Mine in 2010 (PB, 2010). The model was constructed using MODFLOW SURFACT and comprised eight layers as shown in Table F 2.1. In MODFLOW SURFACT the model layers have to be continuous across the model domain. The spatial extent of the model was approximately 38.8 km x 30 km, using a uniform grid of 100 m x 100 m cells.

The impact of geological structures, especially faulting, within the Project area was not considered in the 2010 modelling due to limited data being available on their hydrogeological characteristics. The model was calibrated to steady state conditions. Transient calibration was not conducted as there was no suitable time series dataset at the time for calibration. A sensitivity analysis was conducted on all model parameters and showed that the model was sensitive to several parameters. The resulting uncertainties in model predictions were considered to be acceptable although several recommendations were made for future model improvements.

With the level of information available at the time the model was given a complexity rating of low-medium according to the MDBC (2000) modelling guidelines.

Table F 2.1 2010 model layering

Layer	Hydrogeological unit
1	Tertiary
2	Weathered zone
3	Aquitard #1
4	Middlemount Coal Seams
3 - 5	Aquitard #2
6	Pisces Coal Seams
3 - 7	Fort Cooper Coal Measures
3 - 8	Fort Cooper Coal Measures/Fair Hill Formation

F2.2 Other nearby sites

There are a number of other mine sites in the vicinity of the Middlemount Coal Mine. The nearest mines include Lake Lindsay, Oak Park, German Creek, German Creek East, Foxleigh and Foxleigh Plains, and Norwich Park. Of these, German Creek East, Lake Lindsay and Oak Park are the only mines that target coal from the same Rangal Coal Measures sub-basin as Middlemount Coal Mine. Mining at German Creek East mine ceased in 2007 and the voids are now used as mine water storage facilities, which will effectively mask the northwards propagation of any impacts from Lake Lindsay and Oak Park mines. On this basis, the only nearby mine operations considered most likely to have a cumulative interaction with the Project will include German Creek East and Foxleigh mines.

The Bowen Gas Project (Arrow Energy, 2012b) identifies coal seam gas (CSG) production commencing in the Rangal Coal Measures approximately 7 km to the north of the Project in 2034 and within the Project area in the Moranbah Coal Measures in 2039. Groundwater drawdown from CSG production is predicted to extend within the Rangal Coal Measures into the northern portion of the model domain approximately 4.5 km from the Project.

However, detail of this drawdown is only provided for the end of CSG production in 2072 (Arrow Energy, 2012). Groundwater drawdown from the CSG production in the Moranbah Coal Measures is not predicted to extend vertically upwards into the overlying Rangal Coal Measures. Therefore, the only CSG production considered likely to have any cumulative interaction with the Project would be that within the Rangal Coal Measures north of the Project.

F2.3 Conceptual model

The conceptual model of the groundwater systems at Middlemount Coal Mine and Western Extension Project assumes the following key processes for water movement:

Inflow:

- recharge from rainfall infiltration (deep drainage);
- recharge from streamflow; and
- up-gradient inflow from surrounding strata.

Outflow:

- groundwater extraction from the existing mine operations;
- evapotranspiration;
- baseflow to surface drainages; and
- down-gradient outflow to surrounding strata.

The conceptual groundwater model for the Middlemount Coal Mine and Western Extension Project is presented in Section 6 of the main report. This graphically presents and illustrates the main hydrogeological processes and mechanisms within the Middlemount Coal Mine, including recharge, flow directions, discharge, and anthropogenic activities (i.e. mine dewatering).

The geology surrounding the Middlemount Coal Mine comprises a relatively thin cover of Quaternary and Tertiary sediments overlying Permian coal measures which dip to the east. The main groundwater bearing units at the Middlemount Coal Mine are the Tertiary (Duarina Formation) aquifer, and the Rangal Coal Measures coal seams. The Quaternary alluvium is limited in extent.

Where saturated, recharge to the Quaternary alluvium can occur via direct rainfall on to the alluvium, and seepage through the stream bed, when the creeks are flowing.

Recharge of the Tertiary aquifer occurs by direct infiltration of rainfall, via slow leakage through the overlying Tertiary clay aquitard. Ephemeral watercourses such as Roper Creek would also contribute a proportion of recharge into the Tertiary aquifer through infiltration during periods of stream flow. Recharge of the Permian coal measures occurs in areas where the coal seams sub-crop beneath the Tertiary cover.

The regional water table within the Tertiary aquifer is a subdued reflection of topography with a general flow towards the southeast. The exception to this is immediately around the mine where groundwater levels will have declined due to localised depressurisation resulting from mining.

The depth to groundwater within the Tertiary sediments in excess of 10 mbgl, indicates Roper Creek to be a losing stream with limited to nil potential for a baseflow contribution from the Tertiary aquifer. This correlates with the extended periods of zero flow observed within Roper Creek. Similarly, groundwater uptake by terrestrial vegetation from the Tertiary aquifer and loss through evapotranspiration is also considered unlikely, with the take of any water by vegetation most likely to be from soil moisture within the unsaturated zone.

The coal measures form confined groundwater systems and they sub-crop beneath the Tertiary aquifers. The direction of groundwater flow for the Permian coal measures is influenced by the local geomorphology and structural geology (i.e. faults), and around the mine where groundwater levels have declined as a result of depressurisation from mining.

The presence of the Jellinbah Fault has been considered in the conceptual model. It is assumed that vertical displacement along the fault alignment has resulted in the Rangal Coal Measures coal seams being truncated against lower permeability Fort Cooper Coal Measures/Burngrove Formation interburden. That is groundwater flow / movement to the east across the Jellinbah Fault is not halted, rather it is slowed as a result of the lower permeability Fort Cooper Coal Measures/Burngrove Formation interburden sediments.

F3 Model software

F3.1 Code selection

The industry standard in groundwater modelling is MODFLOW. This software is freely available from the United States Geological Survey (USGS). The base MODFLOW code is a finite difference model that relies on an orthogonal model grid of rows and columns (and layers) of model cells.

The USGS have released their new version called MODFLOW-USG (USG) that allows for the model to have an unstructured grid. This allows for model cell refinement within specific areas of the model without requiring extended refinement to the edge of the model. This creates the opportunity to reduce the number of model cells in each model layer. Another key advantage of USG is the fact that model layers can be truncated where they cease to exist (such as sub-cropping geological units), and the model maintains its connections for layers above and below where the model layer has ceased. USG can also simulate unsaturated flow. The USG code is particularly effective when the model grid is made up of Voronoi (polygon) cells, which has been implemented for the Middlemount numerical model.

F3.1.1 Pre and post processing

In-house FORTRAN and Python codes have also been used to process the raw data into the model input file formats, as well as extracting the model results from the binary model output files. QGIS and Surfer software were also used to implement the layer interpolation and visualise the modelling outcomes.

F4 Model design

The model grid domain was designed to account for the current and future likely drawdown attributable to the Project. The model boundaries are sufficiently distant to the area of interest, such that there is no undue influence on the model predictions from the boundary assumptions. Where necessary, natural hydrogeological boundaries such as geological units and regional catchment boundaries, have been adopted in the model.

The model cell dimensions have been optimised to replicate the historical and future mining progressions and associated groundwater level responses. Grid spacing across the model domain is variable, with refinement around the mine site and locations of groundwater level observations. The model cell size becomes larger away from these key areas. The model domain was discretised into 19,412 cells per layer, and a total of 108,554 cells for the whole model. Layers 4 to 17 pinch out where these layers sub-crop beneath the weathered zone, or are truncated by the Jellinbah Fault. Cell sizes range from 100 m by 100 m within the mining area and up to 700 m by 700 m outside the Project area (Figure F 4.1).

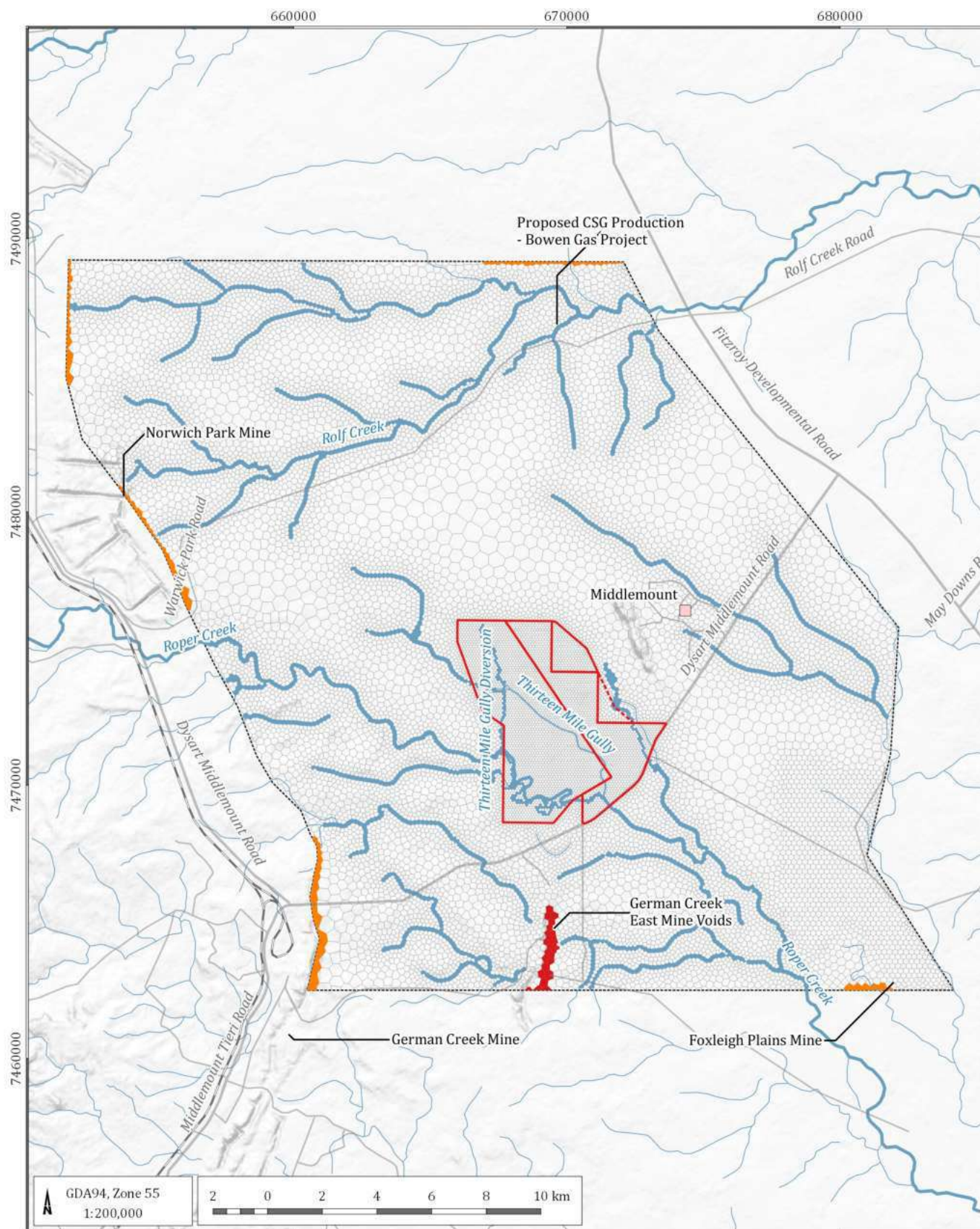
The model extents have been revised from the Stage 2 EIS model due to the following considerations:

- the drawdown observed from the current approved coal operations;
- cumulative impacts given the proximity of the Project to the nearest operational mines which include Lake Lindsay, Oak Park, German Creek, German Creek East, Foxleigh, Foxleigh Plains, and Norwich Park;
- inclusion of the areas targeted for the bore census for the Project; and
- adequacy to capture the predicted drawdown attributable to the Project.

The current model extent is shown by the dashed line in Figure F 4.1.

The vertical discretisation of the model is described by the geological layers. Geological surfaces have been developed for the Middlemount Coal mining area from the mine geology model, and have been extrapolated across the entire proposed numerical model extent from interpretation of the regional geological mapping and layering for the Bowen Gas Project (Arrow Energy, 2012). The model layering is similar to the 2010 numerical model, and includes the Quaternary alluvium as a separate layer to represent recharge from ephemeral surface water flows and rainfall in these areas.

The hydraulic properties of the model are based on the initial parameters established for the 2010 groundwater model (Parsons Brinkerhoff, 2010). These initial parameters were based on available field data, which includes site permeability tests conducted at bores on site. The parameters have been calibrated for a better fit to the available data. In addition, the range of parameters used for the Bowen Gas Project (Arrow Energy, 2012), were used as a reference to set the valid ranges of the model calibration.



LEGEND

- | | |
|---|---|
| Populated place | General Head Boundary |
| Mining Lease boundary (ML) | River package |
| Mining Lease Application boundary (MLA) | Drain package |
| Active model outline | |
| Model grid | |
| Road | |
| Watercourse | |
| Drainage feature | |
| Rail | |

Middlemount Coal Mine Western Extension Project (G1840D)

Extent of the modelling domain - model grid



DATE
06/04/2018

FIGURE No:
F 4.1

F4.1 Time discretisation – stress periods

The time discretisation adopted for the calibration and prediction periods incorporated a variable time step ranging between 30 days and 365 days.

F4.2 Boundary conditions

Areal recharge from rainfall infiltration has been estimated as a percentage of rainfall and applied across the model domain. Evapotranspiration has not been applied in the model due to the depth of water below the ground surface. However, an evaporation boundary condition was applied over the mine voids footprint for the void recovery analyses. The pan evaporation rate was used for the voids to simulate the take of water from an open surface water body.

The surface drainages are represented by the RIV package. The focus of representing Roper Creek in the model is to capture its potential interaction with the underlying groundwater regime. Due to the creek predominantly being a losing stream, the key feature requiring simulation is recharge from the creek to the water table during flow events. The water table is generally located well below the creek bed, and as such, baseflow is assessed to not occur, meaning there is no need to route the baseflow downstream.

The western model boundary has been established coincident with the generally north-south extents of the German Creek and Norwich Park open cut mine voids. Review of aerial imagery provided through Queensland Globe (DNRME, 2017) shows these mine voids are no longer operational mines and are used for either water storage or tailings disposal. Similarly, the model southern boundary intersects the German Creek East Mine voids. Mining is understood to have commenced operations in 1991 and ceased mining around 2007, with the mine voids subsequently used as mine water storage facilities, which includes provision of process water to Middlemount Coal Mine. For the purposes of assessment, it has been assumed (based on advice from Middlemount Coal Mine) that the void water level in the German Creek East Mine voids is maintained coincident with the base of Tertiary in these pits. This being the case, the German Creek and Norwich Park open cut mine voids are represented as drains using the Drain package. Similarly, the German Creek East Mine voids are initially represented as drains between 1991 and 2005 (during mining), and then by the General Head Boundary (GHB) between 2005 to 2037 (when used for mine water storage). In both instances, a reference level was set to the base of the Tertiary layer for the southern and western model extents.

The south-eastern corner of the model boundary is located at the northern extents of the Foxleigh Mine. The Drain package has been applied to model cells along this boundary where the mine exists. The levels for the Drain cells were set at the base of the Rangal Coal Measures to represent depressurisation from this mine operation, beyond which groundwater drawdown from the Project would not be able to propagate.

The northern boundary is situated sufficient distant from drawdown predicted from the Project and is simulated as a no flow boundary for model calibration.

However, inclusion of CSG production commencing in the Rangal Coal Measures approximately 7 km to the north of the Project in 2034 is represented as drains along the eastern end of the northern model boundary from 2034 to 2037 prediction simulation. The levels for the Drain cells were set 30 m above the base of the Leichhardt and Vermont Seams within the Rangal Coal Measures to represent depressurisation from this activity. The drain conductance was set to 100 m²/day.

The model's eastern boundary is approximately 10 km east of the Project, and extends northwest from the south-eastern model corner boundary until it intersects the model's northern boundary. The model's eastern extents are assumed to be a no-flow boundary. The no-flow status of the model extent is considered appropriate as this part of the model is sufficiently distant to the area of interest for the Project, that being the Middlemount Extension area and the existing Middlemount mining area.

Mine progression is extrapolated from the mine plan data provided by Middlemount Coal Mine and implemented into the model using DRN cells.

Pumping from private bores is limited in both location and volume. Groundwater data has been sourced from the NRM groundwater database and bore census for the Project. The NRM database does not include pumping data and the bore census identified that usage of groundwater is limited to an as-required basis if an emergency water supply during dry conditions is needed. As no actual pumping details were determined from the bore census or the NRM database, abstraction from the active bores identified within the model domain is not represented within the groundwater model.

F4.3 Initial conditions

A steady state model was created to represent pre-mining groundwater levels at Middlemount Mine. This has formed the starting heads for a simulation representing mine development in surrounding mines from 1974 to the end of 2010. The final predicted water levels from that model run become the starting heads for the historical transient simulation covering the period from 2011 to present.

F4.4 Hydraulic parameters

The fieldwork completed for the monitoring bores at the site has provided measurements of hydraulic parameters within the different hydrogeological units. Where available, these values were compared to published values for the same strata both regionally and for nearby areas.

Storage properties have not been determined on site as these are typically obtained from a pumping test with observation bores, which has not been performed for this site. As such, storage parameters have been adapted from the previous study undertaken for the Stage 2 EIS model and the CSG production for the Bowen Gas Project (Arrow Energy, 2012). Where required, estimates for hydraulic parameters have also been sourced from text book references and nearby projects to guide the parameter range for the calibration of different hydrogeological units. Table F 4.1 shows the layer details as well as the hydraulic property values assigned to each layer.

Layers 1 to 3 occur stratigraphically above the geology displaced by the Jellinbah Fault and as such are not assessed to be impacted by this fault, and are therefore consistent across the model domain. However, layers 4 to 17 includes replicated layers to represent strata (i.e Rangel Coal Measures and Fort Cooper Coal Measures) displaced east and west of the Jellinbah Fault northwest-southeast strike alignment.

Table F 4.1 Summary of groundwater model parameters

Layer	Layer name	Hydraulic conductivity (K m/day)			Specific storage (m ⁻¹)	Specific yield
		Horizontal (Kh)	Vertical (Kv)	Depth dependency		
Model Domain						
1	Alluvium	0.75	6.37E-02	No	6.40E-05	2.00E-02
2	Tertiary	0.75	5.47E-02	No	1.76E-05	2.00E-02
3	Weathered Zone (Rangal Coal Measures)	0.1	1.30E-02	No	5.00E-05	1.00E-02
Permian Geology West of Jellinbah Fault						
4	Rangal Coal Measures – overburden	1.00E-04	2.10E-05	No	1.00E-06	1.00E-02
5	Rangal Coal Measures – Middlemount coal seam	0.22 to 1.00E-05 [#]	1.48E-01	Yes	1.00E-06	1.00E-02
6	Rangal Coal Measures – interburden	6.03E-06	3.24E-08	No	1.00E-06	1.00E-02
7	Rangal Coal Measures – Permian Pisces coal seam	0.09 to 1.00E-05 [#]	1.29E-01	Yes	1.00E-06	1.00E-02
8	Rangal Coal Measures – strata underlying Pisces coal seam	5.43E-05	4.18E-06	No	1.00E-06	1.00E-02
9	Fort Cooper Coal Measures – Burngrove Formation	7.20E-05	6.48E-05	No	8.42E-05	1.00E-02
10	Fort Cooper Coal Measures – Fair Hill Formation	3.59E-04	2.06E-05	No	8.21E-05	1.00E-02
Permian Geology East of Jellinbah Fault						
11	Rewan Formation	1.00E-04	2.10E-05	No	1.00E-06	1.00E-02
12	Rangal Coal Measures – Leichhardt coal seam	0.18 to 1.00E-05 [#]	1.48E-01	Yes	1.00E-06	1.00E-02
13	Rangal Coal Measures – interburden	6.03E-06	3.24E-08	No	1.00E-06	1.00E-02
14	Rangal Coal Measures – Vermont coal seam	0.06 to 1.00E-05 [#]	1.29E-01	Yes	1.00E-06	1.00E-02
15	Rangal Coal Measures – strata underlying the Vermont coal seam	5.43E-05	4.18E-06	No	1.00E-06	1.00E-02
16	Fort Cooper Coal Measures – Burngrove Formation	7.20E-05	6.48E-05	No	8.42E-05	1.00E-02
17	Fort Cooper Coal Measures – Fair Hill Formation	3.59E-04	2.06E-05	No	8.21E-05	1.00E-02

Note: # Range of horizontal hydraulic conductivity (Kh) values based on the depth dependence equations used for each coal seam (refer Section F4.4.1).

It is acknowledged that whilst heterogeneity exists within the geological units, there is not enough data to support fully defining this in the model layers. The Jellinbah Fault is the main structural feature within the model domain, and is represented by offsetting the Rangal Coal Measures against the underlying Fort Cooper Coal Measures where this geology strata has been vertically displaced east of the Middelmount Mine area. Whilst there is likely to be other minor faults within the model domain, the nature of these faults is unknown and therefore have not been incorporated into the groundwater model to slow or halt groundwater flow / movement. This approach in conjunction with the available model inputs, has necessitated simplifications to the numerical model that are considered to create conservative predictions of the impacts from groundwater depressurisation. This simplified conceptualisation and representation of the groundwater model is presented in the cross section in Figure F 4.2.

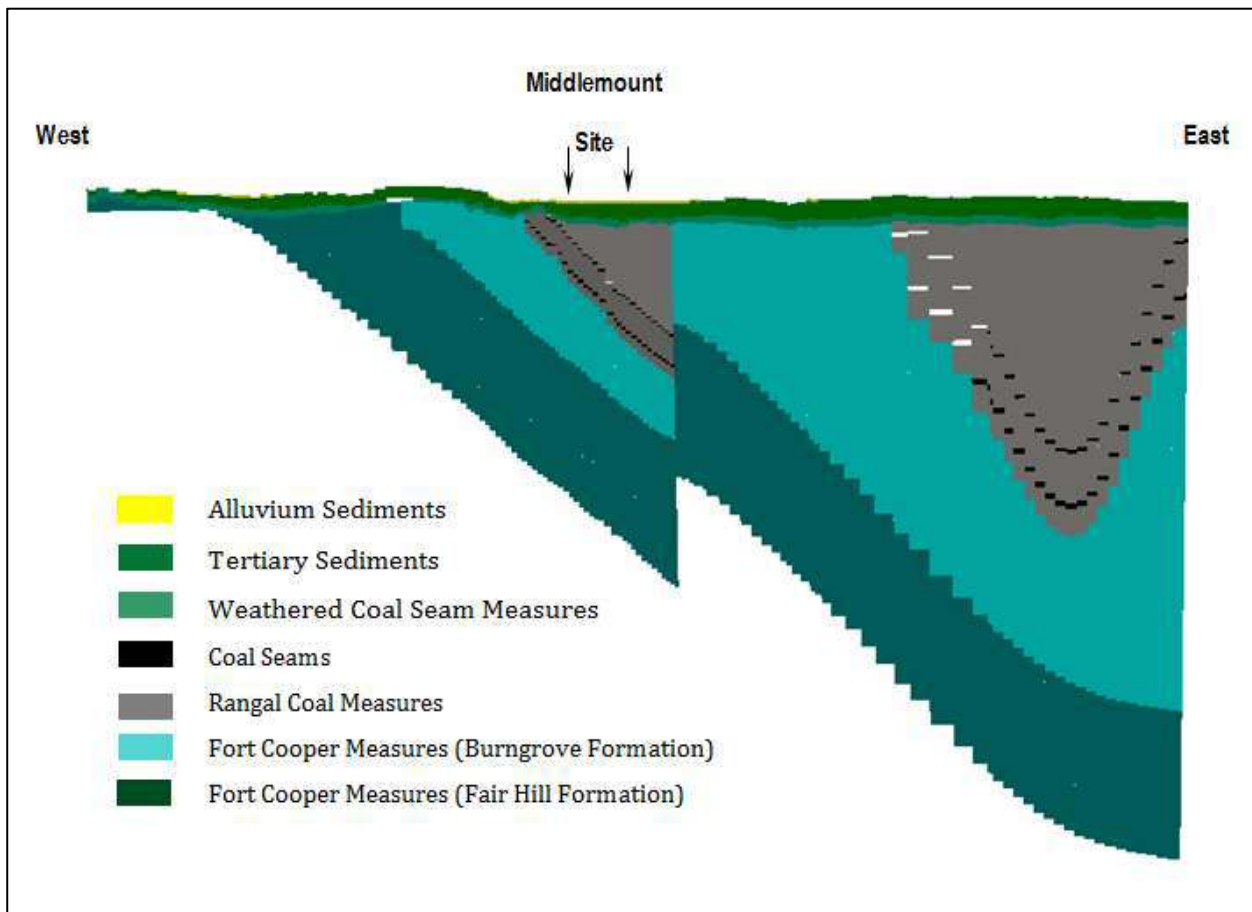


Figure F 4.2 Section through groundwater model showing layer design

Hence, the numerical model provides for a lateral, horizontal hydraulic connection across the Jellinbah Fault where different layers are juxtaposed on the eastern and western sides of the fault plane as represented in Figure F 4.2 and summarised in (Table F 4.2) below. This was achieved using the Algomesh software to hydraulically connect model cells (nodes) within the different model layers positioned on either side of the Jellinbah Fault.

Table F 4.2 Model layer horizontal hydraulic connection as shown east and west of the Jellinbah Fault in Figure F 4.2

Model Layer (Geology) West of Jellinbah Fault	Model Layer (Geology) East of Jellinbah Fault
Rangal Coal Measures – overburden – layer 4	Fort Cooper Coal Measures – Burngrove Formation – layer 16
Rangal Coal Measures – Middlemount coal seam – layer 5	Fort Cooper Coal Measures – Fair Hill Formation – layer 16 or 17
Rangal Coal Measures – interburden – layer 6	Fort Cooper Coal Measures – Fair Hill Formation – layer 16 or 17
Rangal Coal Measures – Permian Pisces coal seam – layer 7	Fort Cooper Coal Measures – Fair Hill Formation – layer 16 or 17
Rangal Coal Measures – strata underlying Pisces coal seam – layer 8	Fort Cooper Coal Measures – Fair Hill Formation – layer 16 or 17
Fort Cooper Coal Measures – Burngrove Formation – layer 9	Fort Cooper Coal Measures – Fair Hill Formation – layer 16 or 17
Fort Cooper Coal Measures – Fair Hill Formation – layer 10	Fort Cooper Coal Measures – Fair Hill Formation – layer 17

F4.4.1 Depth dependence of hydraulic conductivity in coal seam

It is known that seam permeability typically reduces with depth within the Bowen Basin (Arrow Energy, 2012). The decrease occurs as increased pressure from the overlying strata closes up cleats in the coal and mineral precipitates seal fractures.

The model simulates a reduced (horizontal) hydraulic conductivity (K_h) of each coal seam with depth according to the following relationship:

- *Middlemount and Leichhardt seam* $K_h = 0.3731 \times e^{(-0.021 \times \text{depth})}$
- *Pisces and Vermont seam* $K_h = 0.1504 \times e^{(-0.021 \times \text{depth})}$

The above relationship was obtained using the available coal permeability measurements from the Middlemount Mine. This results in an order of magnitude reduction in the hydraulic conductivity over 110 m depth. The lower bound of coal seam horizontal conductivity was capped to two orders of magnitude lower than the upper bound value.

F4.5 Timing – proposed mining run

The model was run in three stages: the pre-mining starts from January 1974 to December 2010, followed by a transient lead-in period from January 2011 to December 2017, and then the prediction simulation of the proposed extension from January 2018 up to December 2037. The lead-in period was used to compare the model performance with observed field data (i.e. model calibration).

F4.6 Timing – post-mining

The post-mining conditions were simulated using a steady state model. The stabilised water levels for each void, obtained from the WRM void water level recovery (hydrological) modelling, were used to define the head in the voids, from which the steady state model defines the long term residual impacts from the Project. The Drain cells representing the Foxleigh Mine and CSG production were turned off, and the Drain cells along the model's western boundary representing German Creek Mine and Norwich Park open cut mines were changed to General Head Boundary cells coincident with the base of the Tertiary cover.

F4.7 Mine drainage

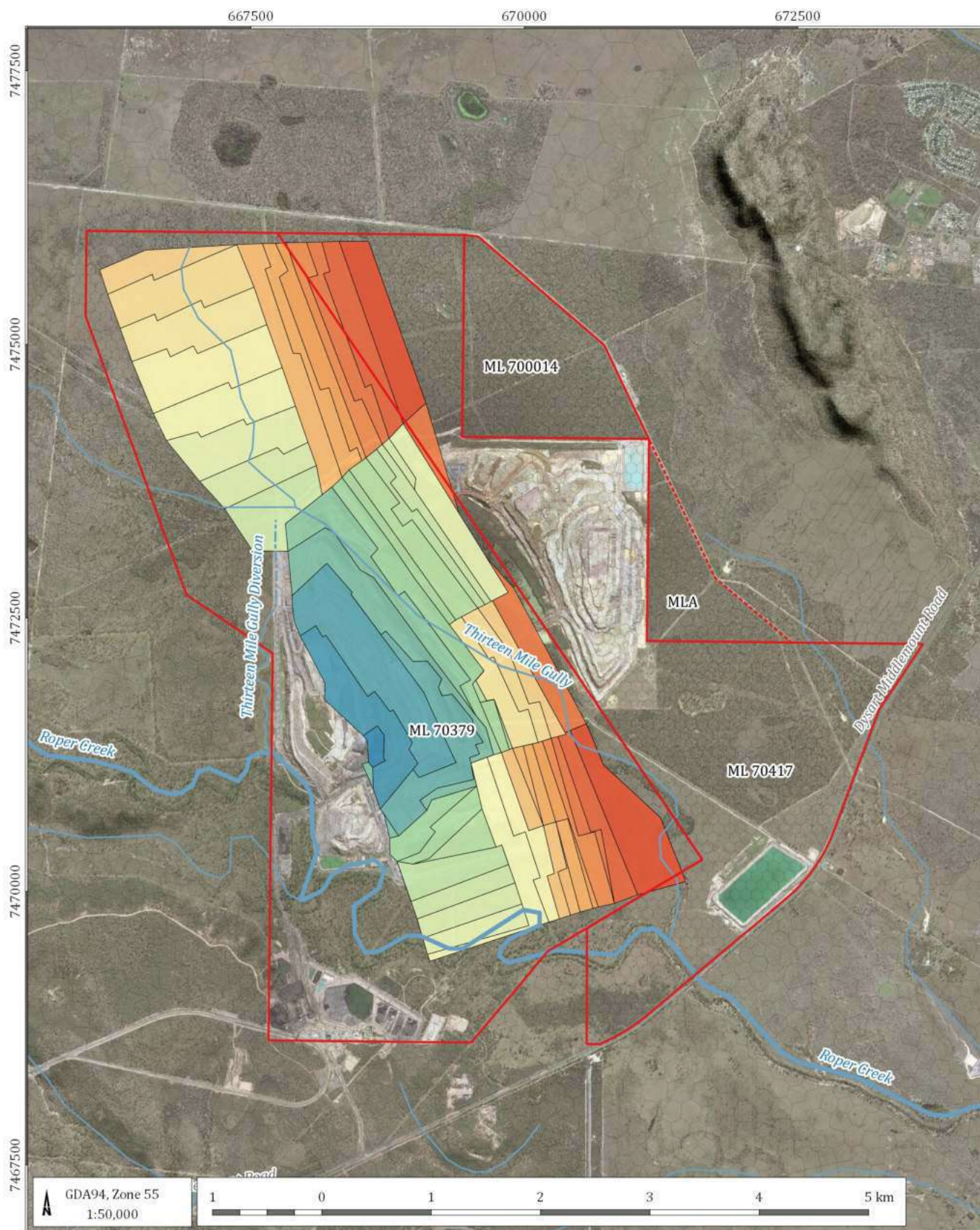
During the predictive run, a drain boundary condition (DRN) was used to simulate the effect of mine operations. A nominally high drain conductance of 100 m²/day was applied to the drain cells and the elevation of the base of the modelled layer was used as the drain level. The drain cells were moved within the mine footprint in line with the proposed mine plan progression, simulating water removal from the active block for that particular stress period. The drain cell progression for both approved and proposed mining plans is presented in Figure F 4.3

At the completion of mining, drain cells were removed representing mining at Middlemount Coal Mine and the model simulated post-mining conditions.

F4.8 Recharge

Recharge to the groundwater system occurs through diffuse rainfall recharge across the land surface, leakage from surface water flows (i.e. perennial streams) and overland flow, as there are no specific bedrock outcrop areas that would form recharge zones within the model domain (PB, 2010). This is assumed to be via the Quaternary alluvium, Tertiary sediments, or weathered profile. These recharge mechanisms were condensed in a single package for the model using the recharge package (RCH) for MODFLOW-USG, and were applied to the uppermost layer.

For the steady-state modelling, a value of 0.06 mm/year has been adopted for recharge. This represents the proportion of rainfall that seeps through the predominantly clayey Tertiary and regolith surficial layers and becomes deep drainage to the water table.



LEGEND

- Mining Lease boundary (ML)
- Mining Lease Application boundary (MLA)
- Road
- Watercourse
- Drainage feature

Mine Progression (Year)

2011	2020	2029
2012	2021	2030
2013	2022	2031
2014	2023	2032
2015	2024	2033
2016	2025	2034
2017	2026	2035
2018	2027	2036
2019	2028	2037

Middlemount Coal Mine Western Extension Project
(G1840D)

Proposed continued operations project mine plan



DATE
11/04/2018

FIGURE No:
F 4.3

F4.9 Water budget

Table F 4.3 shows the average rates of water transfer (flow into and out of the model) over the transient lead-in period (2011 to 2017). Table F 4.4 shows the average flow rates across model boundaries for the prediction period of 2018 to 2037.

Table F 4.3 Model budgets – transient lead-in period

Parameter	Average water transfer - 2011 – 2017 (ML/day)	
	Input	Output
Rainfall recharge	0.10	--
Drains	--	2.06
River	--	0.06
General head boundary	0.12	0.08

Table F 4.4 Model budgets – Prediction

Parameter	Average water transfer - 2018– 2037 (ML/day)	
	Input	Output
Rainfall recharge	0.10	--
Drains	--	2.28
River	--	0.06
General head boundary	0.12	0.09

Groundwater recharge during the transient and prediction periods is on average 0.1 ML/day. Mining is simulated via the DRN package with an average extraction rate of 2.06 ML/day for the calibration period. As mining progress to the deeper coal seams, the average rate of dewatering increases slightly to 2.28 ML/day (see Table F 4.4).

The mass balance error is a parameter used to quantify the quality of the internal numerical solution of the simulation, defined as the difference between the model inflows and outflows at the completion of calibration model run. The mass balance of the simulation was generally less than 0.5% indicating that the model was numerically stable and achieved an accurate numerical solution.

F5 Model calibration and verification

The groundwater model calibration was verified for the transient run (2011 to 2017) using available groundwater level data, including results of the 2017 bore census. The model was calibrated by adjusting aquifer hydraulic properties and recharge parameters to achieve the best match between the observed and simulated water levels. The modelled hydrographs were then compared to the observed water levels as well as modelled heads in previous report (PB, 2010).

F5.1 Calibration heads

The transient model simulated water levels at 26 site monitoring bores (MW1-18). The majority of monitoring bores are located within the footprint of the proposed mine and will be eventually destroyed as the mining progresses. Additional groundwater level data sourced from the Department of Natural Resources and Mines (DNRM) groundwater database identified that most DNRM registered bores were dry and only three bores (i.e. RN158617, RN158619 and RN158621) included water level data located further from the Project that was able to be used.

Figure F 5.1 presents the observed and simulated groundwater levels graphically as a scattergram. The calibration hydrographs for the site monitoring bores and regional registered bores are shown in Appendix F1, which present the calibration data in context with the overall predicted drawdown for each bore.

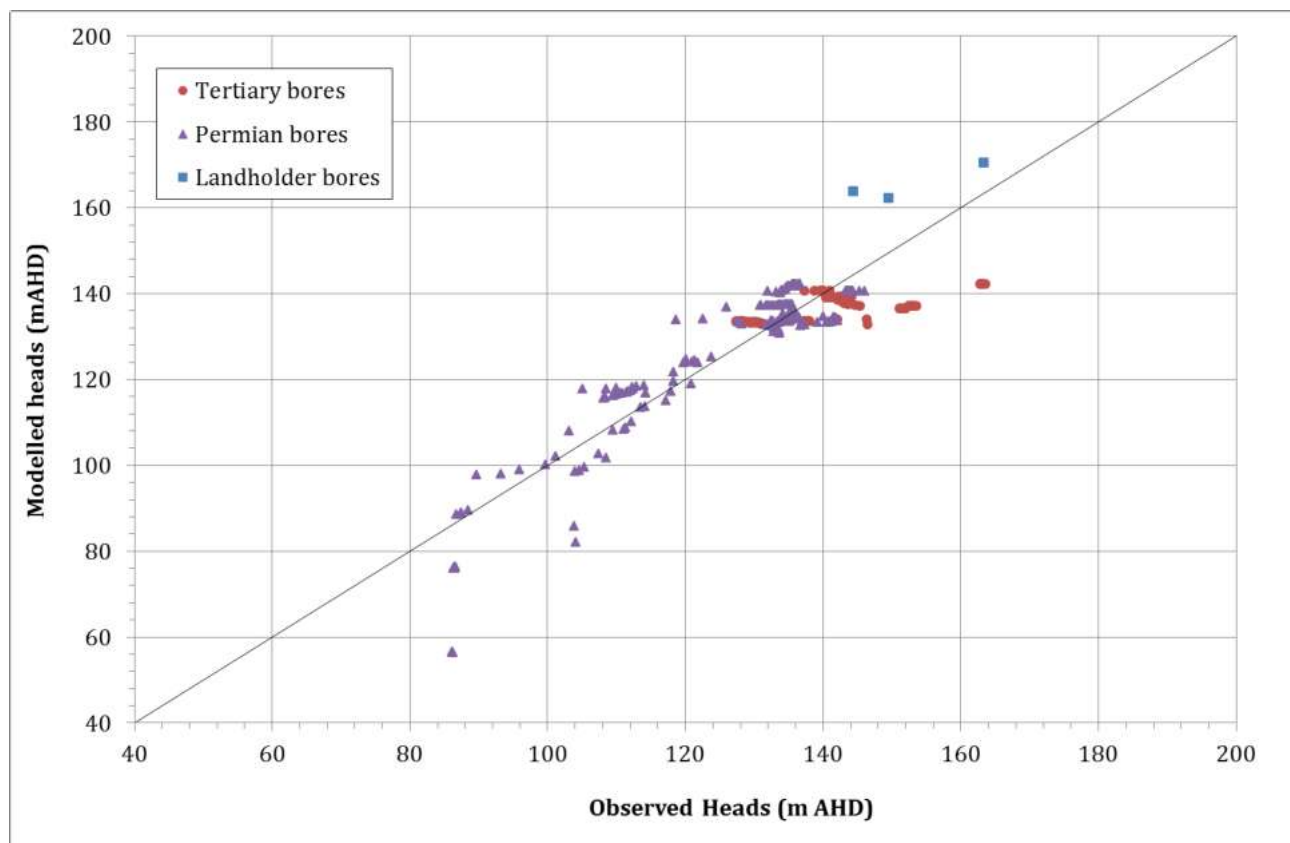


Figure F 5.1 Transient calibration – modelled vs observed groundwater levels

The root mean square (RMS) error calculated for the calibrated model was 6.69 m. The total measured head change across the model domain was 77.55 m, resulting in a scaled RMS (SRMS) of 8.6%. A lower SRMS would most likely be achieved through inclusion of heterogeneity to the aquifer parameters. However, the number and distribution of currently available observations would not support a calibrated parameter set that would also limit parameter non-uniqueness. That is, whilst it may be possible to find a set of parameter values that were able to match the observations almost perfectly, the required heterogeneity this creates would remove the model's predictive potential due to parameter non-uniqueness. The other critical aspect of the calibration is that all of the observation data is close to the mine and appears to have responded to historical mining. Incorporation of the historical mine progression has required it to be simplified to allow it to fit in with the model discretisation and transient progression, which in turn has impacted on the ability of the model to perfectly match the water level responses.

The calibration hydrographs for the site monitoring bores are shown in Appendix F1, which presents the calibration data in context with the overall predicted drawdown for each monitoring bore. These show a reasonably good match between the predicted and observed groundwater levels and trends with exception to bore MW01, where the predicted drawdown response did not replicate the observed rise in groundwater levels between 2013 and 2015 (when this bore was mined out and destroyed). This monitoring bore was located near the confluence of Drainage lines 1 and 2, in an area where surface water periodically ponds along the western side of the open cut pit. This interaction between surface water and groundwater (at a local scale) is not represented in the groundwater model as the creeks are ephemeral and the groundwater table is located generally below the creek bed (refer Section F4.2).

A combination of manual and automated calibration using PEST (Doherty, 2010) was undertaken to determine optimal hydraulic parameters and recharge rates to replicate observed groundwater level data. The software made iterative adjustments to the parameter set within pre-defined bounds to reduce the residual difference between the predicted results and the observed data. PEST adjusted the following properties in the model to achieve the steady-state and transient calibrations:

- horizontal and vertical hydraulic conductivity;
- recharge rate to each recharge zone; and
- storage parameters (specific yield and specific storage).

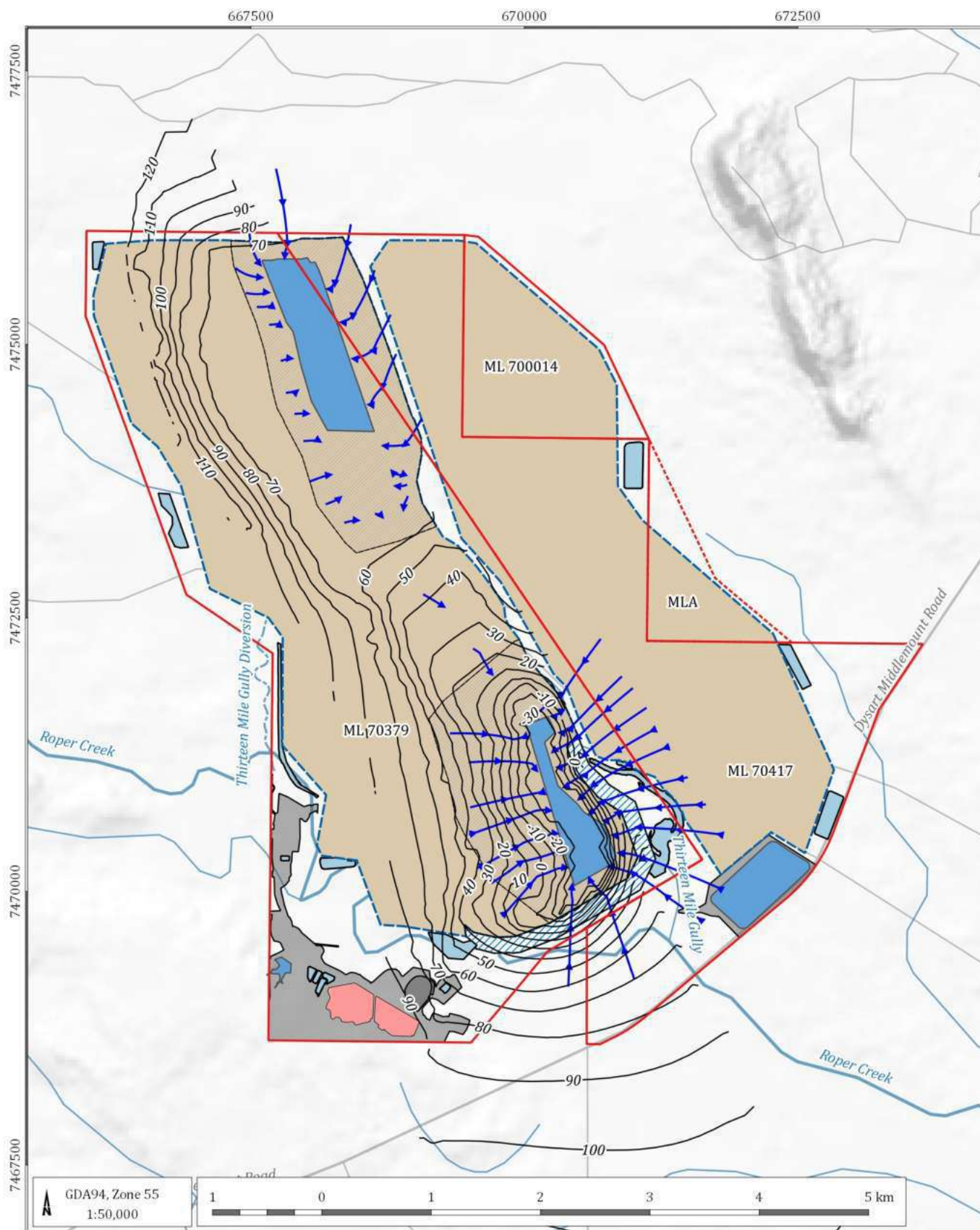
The manual process was used following initial automatic calibration given the relatively limited data available and the better judgement provided by the groundwater modeller's experience, which provides for a better assessment of observation trends and the overall behaviour of the system.

The Australian Modelling Guidelines (Barnett *et al*, 2012) suggest a SRMS of 10% or lower constitute a reasonably well calibrated model. This model meets this criterion. Additionally, the generally good match between the predicted and observed groundwater levels and trends suggests an acceptable model calibration. More widespread observation data around the model domain which could support the simulation of non-homogeneous hydraulic parameters would be necessary for a better match of the observed data while still retaining the prediction capacity.

F6 Groundwater fate modelling

Particle tracking was used to identify the likely travel paths of water particles surrounding the North and South Voids post closure for the Project. Points were placed around the two void lake footprints and back simulated over a 50,000 year period to simulate the path line a water particle would travel based on the gradients surrounding the final voids.

This analysis shows the particles positioned surrounding each void essentially track backwards radially away from each void (see Figure F 6.1), regardless of the length of the particle tracking timeframe. That is, the mine voids remain groundwater sinks in perpetuity post mining, with seepage draining from with the surrounding aquifers towards the two mine voids. No particles of water within the mine voids migrate away from the Project area.



LEGEND

- | | |
|---|---|
| Mining Lease boundary (ML) | Final Void |
| Mining Lease Application boundary (MLA) | Spoil/Waste Dumps |
| Road | Infrastructure Extent |
| → Particle trace | Tailings Storage Facility |
| — Watercourse | Sediment Dam |
| — Drainage feature | Water Management Dam |

Middlemount Coal Mine Western Extension Project
(G1840D)

Particle tracking-Steady state



DATE
11/04/2018

FIGURE No:
F 6.1

F7 Uncertainty analysis

Groundwater models represent complex environmental systems and processes in a simplified manner. This means that predictions from groundwater models, likely so many other environmental models are inherently uncertain. The preceding sections highlight uncertainties in model inputs and the necessary simplifications within models to represent natural systems. National modelling guidelines encourage the acknowledgement of uncertainty and suggest methods to formulate predictions in which uncertainties are minimised. Barnett *et al* (2012) recommend uncertainty in model predictions can be quantified using linear or non-linear methods. The sections below describe the methodology and results of the uncertainty analysis.

F7.1 Methodology

A pseudo Null-space Monte Carlo uncertainty analysis was undertaken to quantify the magnitude of uncertainty in the future impacts predicted by the model. This type of analysis produces probability distributions for predictive impacts by assessing a composite likelihood of an impact occurring by assessing and ranking the predictions from hundreds of model 'realizations'. Each model realisation is informed by the observation dataset by using the relationship between the observations statistics to perturbations of each parameter in the groundwater model. The approach is described as a 'pseudo' Null-space Monte Carlo simply because this model did not utilise a 'highly parameterised inversion' approach, whereby pilot points are used extensively across the model as to not introduce artificial sensitivity (and consequently 'certainty') to small changes to homogenous aquifer units. To compensate, 'posterior' or post-calibration parameter ranges were informed by the Jacobian matrix, but were manually inspected and adjusted where posterior ranges appeared artificially constrained.

F7.2 Parameter generation

To undertake this type of analysis it is necessary to firstly quantify the parameter variability based on our prior knowledge about parameters. This requires specifying a distribution and range for each parameter, which is referred to as the "prior uncertainty range". Table F 7.1 to Table F 7.5 shows the 'prior' range explored for the Project. Each parameter is assumed to be log-normally distributed around the optimum value derived from calibration, and spreads gradually over the upper and lower bounds. The next step is to constrain the prior uncertainty range using information from the calibration matrix. This is achieved using Predunc7 utility from calibration and uncertainty software PEST (Doherty, 2010). In summary, PEST (Predunc7 utility) uses the prior parameter distribution and parameter sensitivities and provides a constrained parameter range which is known as "posterior uncertainty range". Appendix F2 presents the prior and posterior parameter distributions and ranges.

Table F 7.1 Prior uncertainty range - Horizontal hydraulic conductivity

Model layer	Lithology	Horizontal hydraulic K m/day (lower)	Horizontal hydraulic K m/day (optimum)	Horizontal hydraulic K m/day (upper)
1	Alluvium	0.01	0.75	10
2	Tertiary	0.001	0.75	5
3	Weathered Zone (Rangal Coal Measures)	0.001	0.1	1
4, 11	Rangal Coal Measures – overburden Rewan Formation	1.00E-6	1.00E-04	1.00E-03
5, 12	Rangal Coal Measures – Middlemount coal seam Leichhardt coal seam	1.00E-2	0.37	5
6, 13	Rangal Coal Measures – interburden	1.00E-07	6.03E-06	1.00E-04
7, 14	Rangal Coal Measures – Pisces coal seam Vermont coal seam	1.00E-02	0.15	5
8, 15	Rangal Coal Measures – strata underlying Pisces and Vermont coal seams	1.00E-07	5.43E-05	1.00E-04
9, 16	Fort Cooper Coal Measures – Burngrove Formation	1.00E-06	7.20E-05	1.00E-03
10, 17	Fort Cooper Coal Measures – Fair Hill Formation	1.00E-06	3.59E-04	1.00E-03

Table F 7.2 Prior uncertainty range - Vertical hydraulic conductivity

Model layer	Lithology	Vertical hydraulic conductivity (Kv) multiplier (lower)	Vertical hydraulic conductivity (Kv) multiplier (optimum)	Vertical hydraulic conductivity (Kv) multiplier (upper)
1	Alluvium	0.001	8.49E-02	1
2	Tertiary	0.001	7.29E-02	1
3	Weathered Zone (Rangal Coal Measures)	0.001	0.139	1
4, 11	Rangal Coal Measures – overburden Rewan Formation	0.001	0.217	1
5, 12	Rangal Coal Measures – Middlemount coal seam Leichhardt coal seam	0.001	0.405	1

Model layer	Lithology	Vertical hydraulic conductivity (Kv) multiplier (lower)	Vertical hydraulic conductivity (Kv) multiplier (optimum)	Vertical hydraulic conductivity (Kv) multiplier (upper)
6, 13	Rangal Coal Measures – interburden	0.001	5.38E-03	1
7, 14	Rangal Coal Measures – Pisces coal seam Vermont coal seam	0.001	0.862	1
8, 15	Rangal Coal Measures – strata underlying Pisces and Vermont coal seams	0.001	7.70E-02	1
9, 16	Fort Cooper Coal Measures – Burngrove Formation	0.001	0.901	1
10, 17	Fort Cooper Coal Measures – Fair Hill Formation	0.001	5.74E-02	1

Table F 7.3 Prior uncertainty range - Specific yield

Model layer	Lithology	Specific yield - Sy (lower)	Specific yield - Sy (optimum)	Specific yield - Sy (upper)
1	Alluvium	0.001	2.00E-02	0.1
2	Tertiary	0.001	2.00E-02	0.1
3	Weathered Zone (Rangal Coal Measures)	0.001	1.00E-02	0.1
4, 11	Rangal Coal Measures – overburden Rewan Formation	1.00E-03	1.00E-02	5.00E-02
5, 12	Rangal Coal Measures – Middlemount coal seam Leichhardt coal seam	1.00E-03	1.00E-02	5.00E-02
6, 13	Rangal Coal Measures – interburden	1.00E-03	1.00E-02	5.00E-02
7, 14	Rangal Coal Measures – Pisces coal seam Vermont coal seam	1.00E-03	1.00E-02	5.00E-02
8, 15	Rangal Coal Measures – strata underlying Pisces and Vermont coal seams	1.00E-03	1.00E-02	5.00E-02
9, 16	Fort Cooper Coal Measures – Burngrove Formation	1.00E-03	1.00E-02	5.00E-02
10, 17	Fort Cooper Coal Measures – Fair Hill Formation	1.00E-03	1.00E-02	5.00E-02

Table F 7.4 Prior uncertainty range - Specific storage

Model layer	Lithology	Specific Storage m ⁻¹ (lower)	Specific Storage m ⁻¹ (optimum)	Specific Storage m ⁻¹ (upper)
1	Alluvium	5.00E-06	6.40E-05	5.00E-04
2	Tertiary	5.00E-06	1.76E-05	5.00E-04
3	Weathered Zone (Rangal Coal Measures)	5.00E-06	5.00E-05	5.00E-04
4, 11	Rangal Coal Measures – overburden Rewan Formation	1.00E-07	1.00E-06	1.00E-05
5, 12	Rangal Coal Measures – Middlemount coal seam Leichhardt coal seam	1.00E-07	1.00E-06	1.00E-05
6, 13	Rangal Coal Measures – interburden	1.00E-07	1.00E-06	1.00E-05
7, 14	Rangal Coal Measures – Pisces coal seam Vermont coal seam	1.00E-07	1.00E-06	1.00E-05
8, 15	Rangal Coal Measures – strata underlying Pisces and Vermont coal seams	1.00E-07	1.00E-06	1.00E-05
9, 16	Fort Cooper Coal Measures – Burngrove Formation	5.00E-06	8.42E-05	5.00E-04
10, 17	Fort Cooper Coal Measures – Fair Hill Formation	5.00E-06	8.21E-05	5.00E-04

Table F 7.5 Prior uncertainty range - Recharge

Model layer	Lithology	Recharge factor (lower)	Recharge factor (optimum)	Recharge factor (upper)
1, 2,	Alluvium and Tertiary	0.01	1	10

The posterior range and optimum values were used to generate random realisations. In summary, a total of 500 realisations were generated using a random parameter generator for which the model was run for each realisation. The 500 model runs were tested against the objective function to derive a threshold for model ‘de-calibration’. Versions of the model that exceeded this threshold were assumed to be sufficiently un-calibrated, and hence were omitted from the uncertainty analysis. A threshold objective function of 1,200 m² was applied, which represented an increase of around 20% over the optimal solution. Of these 500 model runs, 304 versions had an objective function less than the threshold, which were included in the analysis. The remaining 196 simulations were removed from the analysis because they did not meet the criteria.

F7.3 Results

As discussed above, a total of 304 models achieved model convergence and produced acceptable calibration statistics. A summary of the calibration performance and predictive uncertainty is provided in Appendix F3. The hydrographs show the composite distribution of the heads across all 304 realisations and indicate that the majority of the models are acceptably calibrated.

F7.3.1 Predicted groundwater inflow

Figure F 7.1 presents the uncertainty of Permian groundwater inflow into the approved mining and the Project from 2011 to 2037.

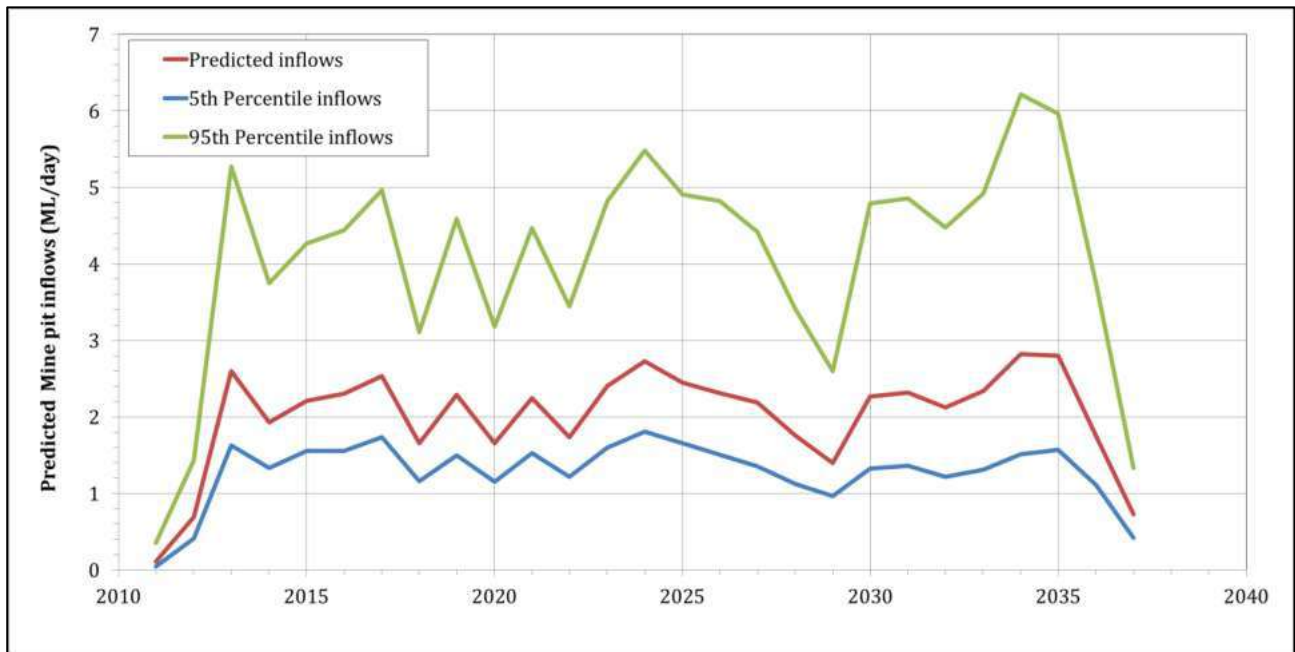


Figure F 7.1 Predicted Project groundwater inflow uncertainty

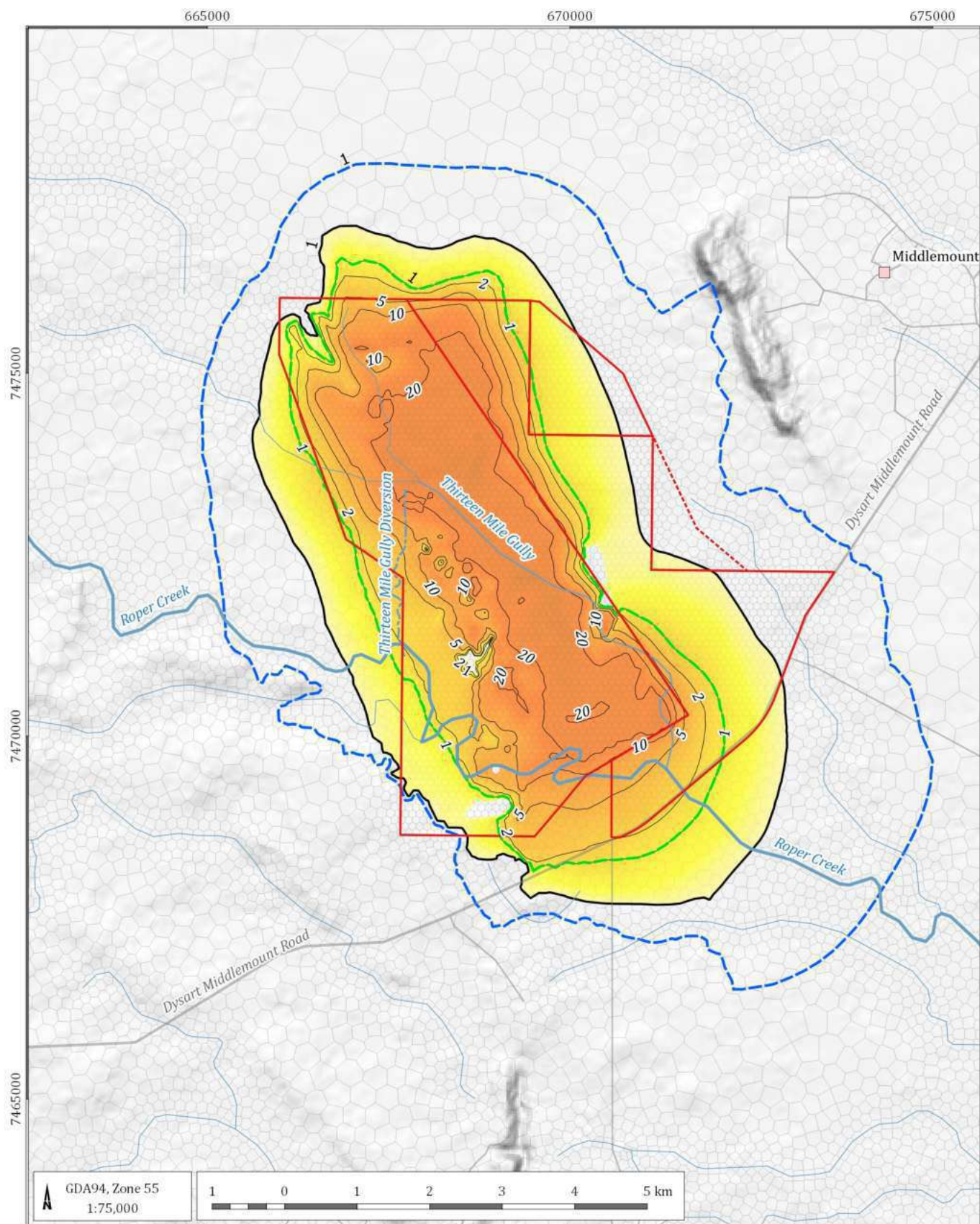
The uncertainty analysis indicated predicted the maximum inflows ranging between 1.81 ML/day (5th percentile) and 6.22 ML/day (95th percentile) in year 2024 and 2034 respectively. Table F 7.6 presents the uncertainty in the total inflow to the Project only for each year.

Table F 7.6 Predicted groundwater inflow – 2011 to 2037

Year	Groundwater inflow (P05)	Groundwater inflow (Calibration)	Groundwater inflow (P95)
2011	0.05	0.11	0.35
2012	0.41	0.69	1.44
2013	1.63	2.60	5.27
2014	1.33	1.93	3.75
2015	1.55	2.21	4.27
2016	1.55	2.31	4.44
2017	1.73	2.54	4.97
2018	1.16	1.66	3.11
2019	1.50	2.29	4.59
2020	1.15	1.66	3.18
2021	1.53	2.24	4.47
2022	1.22	1.74	3.45
2023	1.60	2.41	4.82
2024	1.81	2.72	5.48
2025	1.66	2.45	4.91
2026	1.50	2.31	4.82
2027	1.36	2.19	4.42
2028	1.12	1.76	3.41
2029	0.97	1.40	2.60
2030	1.33	2.27	4.79
2031	1.36	2.31	4.86
2032	1.22	2.12	4.47
2033	1.31	2.34	4.92
2034	1.51	2.82	6.22
2035	1.57	2.80	5.96
2036	1.11	1.75	3.74
2037	0.42	0.73	1.34
Max	1.81	2.82	6.22

F7.3.2 Groundwater drawdown

To assess the level of uncertainty in the extent of predicted drawdown, the calibrated drawdown extent was compared to the 1m drawdown extent for the 5th and 95th drawdown percentiles. Figure F 7.2 to Figure F 7.4 present the uncertainty in maximum groundwater drawdown at any time during mining within the Tertiary and Weathered Zone (layers 2 and 3), Middlemount and Pisces Seams (layers 5 and 7). Figure F 7.2 shows that the 95th drawdown percentile has a larger drawdown extent within the weathered layer compared to the calibrated case. In particular, the 1 m drawdown extent was mainly contained around the mine area in the calibrated case and with the 95th drawdown; the drawdown extends approximately 3 km east of the mine extent and approximately 4 km west and south of the open cut. Figure F 7.3 and Figure F 7.4 show that 95th percentile drawdown in the Middlemount and Pisces Seams occurs up to 1 km further south of calibrated case.



LEGEND

- Populated place
- ▬ Mining Lease boundary (ML)
- - - Mining Lease Application boundary (MLA)
- - - Model grid
- Watercourse
- Drainage feature
- Road

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- Drawdown contour (1 m)
- P05 drawdown contour (1 m)
- P95 drawdown contour (1 m)

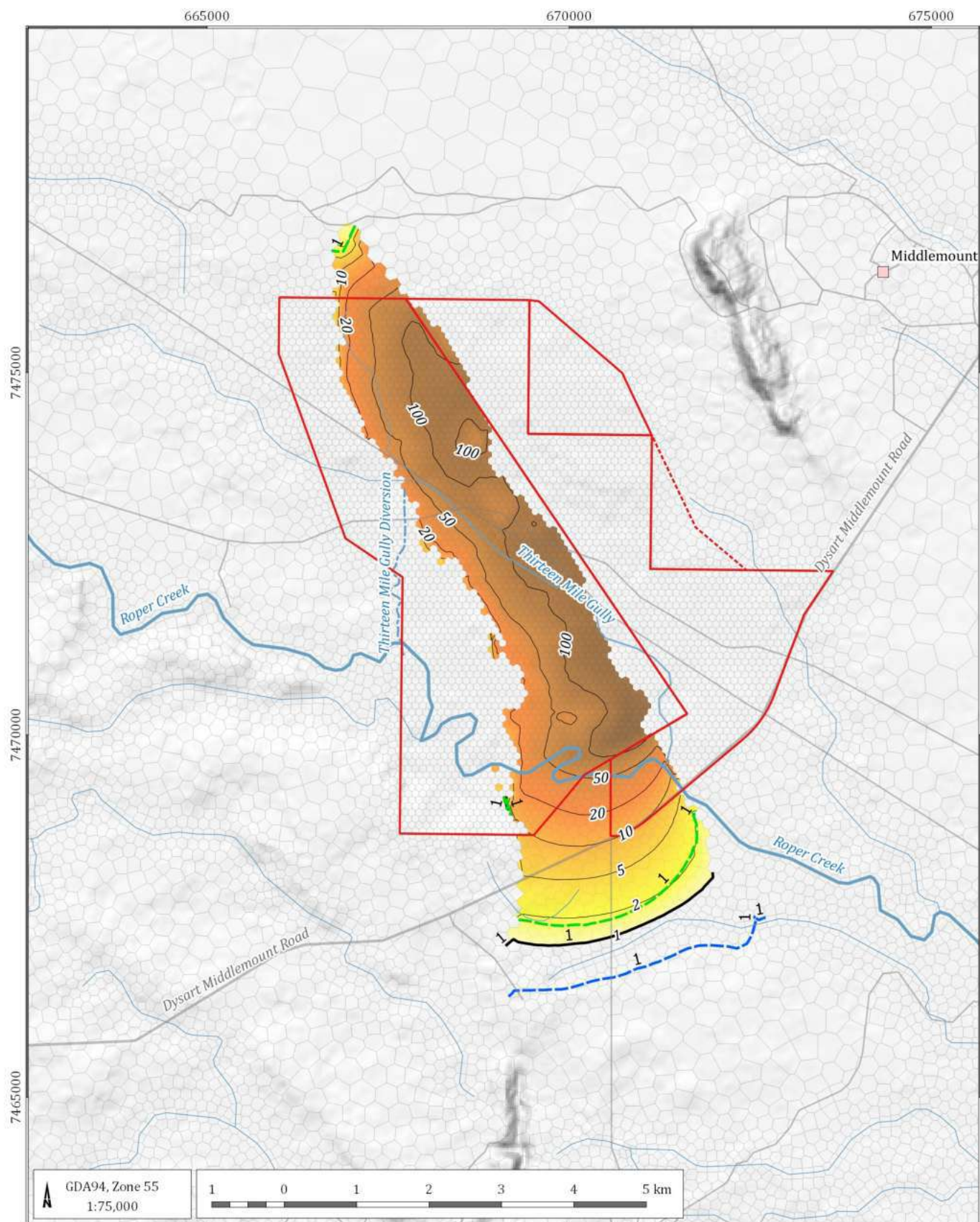
Middlemount Coal Mine Western Extension Project
(G1840D)

**Tertiary & Weathered Permian (Layers
2 & 3) - Uncertainty of maximum zone of
drawdown during mining**



DATE
27/04/2018

FIGURE No:
F 7.2



LEGEND

- Populated place
- ▬ Mining Lease boundary (ML)
- - - Mining Lease Application boundary ()
- Model grid
- ▬ Road
- ▬ Watercourse
- ▬ Drainage feature

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- ▬ Drawdown contour (1 m)
- ▬ P05 drawdown contour (1 m)
- ▬ P95 drawdown contour (1 m)

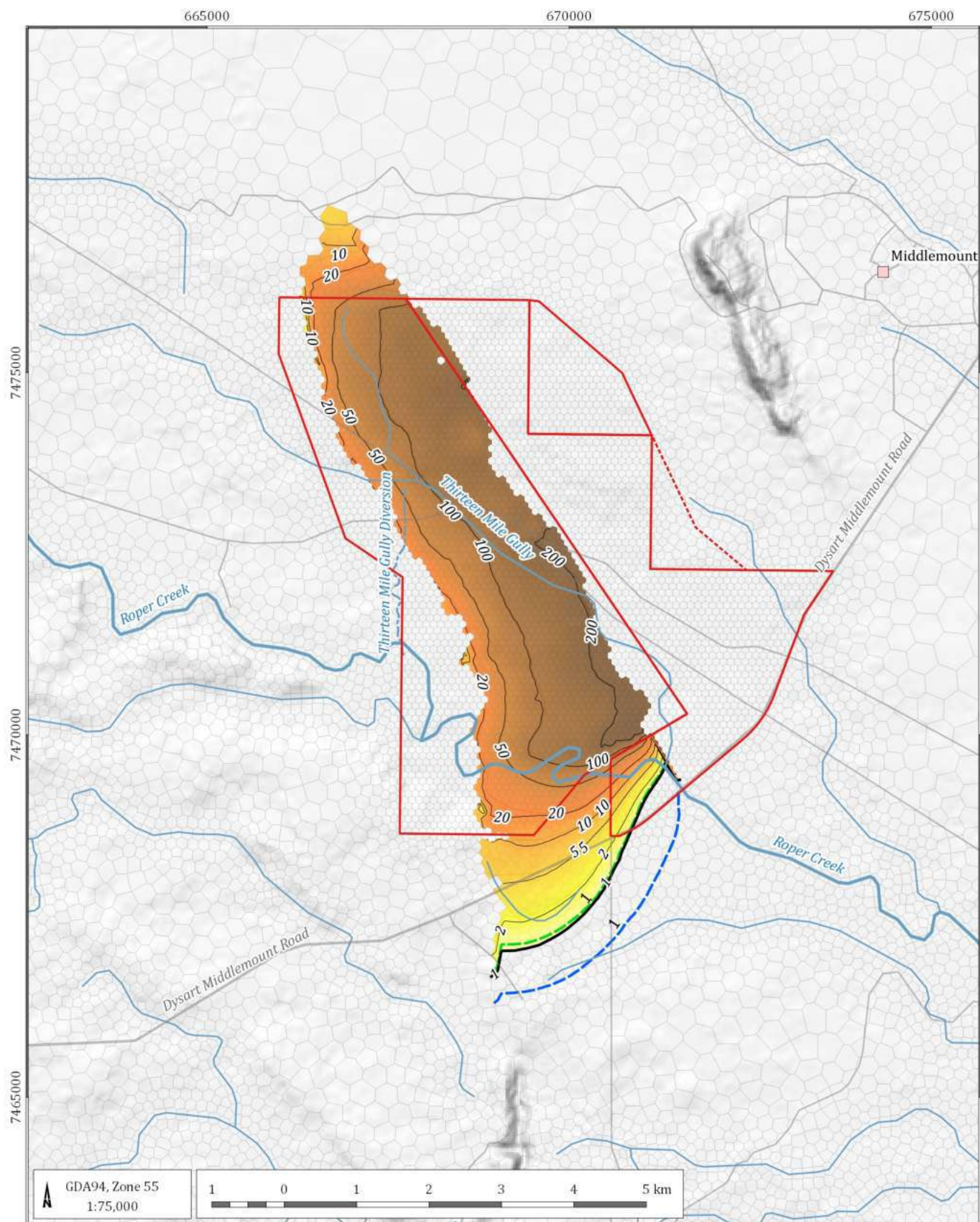
Middlemount Coal Mine Western Extension Project (G1840D)

Middlemount Seam (Layer 5) - Uncertainty of maximum zone of drawdown during mining



DATE
27/04/2018

FIGURE No:
F 7.3



LEGEND

- Populated place
- ▬ Mining Lease boundary (ML)
- - - Mining Lease Application boundary (MLA)
- ▬ Model grid
- ▬ Road
- ▬ Watercourse
- ▬ Drainage feature

Drawdown (m)

- ▬ 0
- ▬ 1
- ▬ 2
- ▬ 5
- ▬ 10
- ▬ 20
- ▬ 50
- ▬ 100
- ▬ 200
- ▬ Drawdown contour (1 m)
- ▬ P05 drawdown contour (1 m)
- ▬ P95 drawdown contour (1 m)

Middlemount Coal Mine Western Extension Project
(G1840D)

Pisces Seam (Layer 7) – Uncertainty of maximum zone of drawdown during mining



DATE
27/04/2018

FIGURE No:
F 7.4

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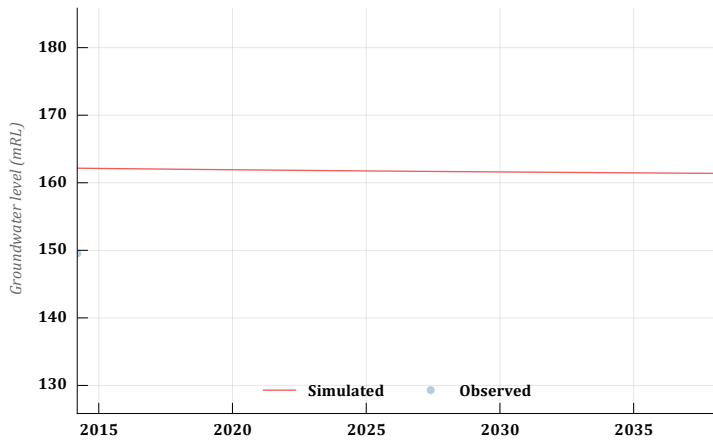
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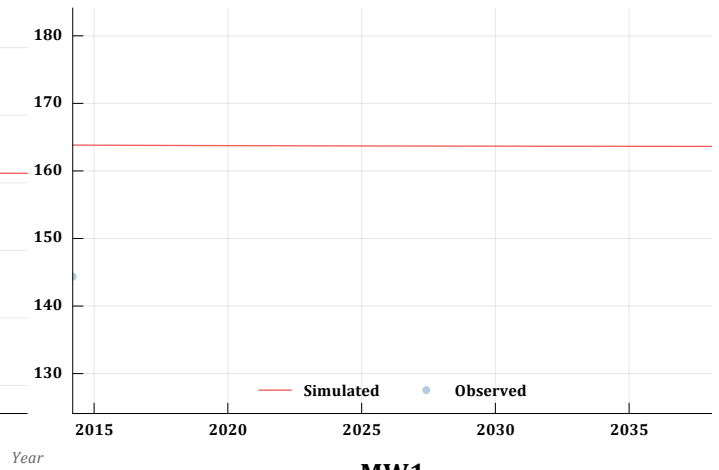
Appendix F1

Simulated and observed hydrographs

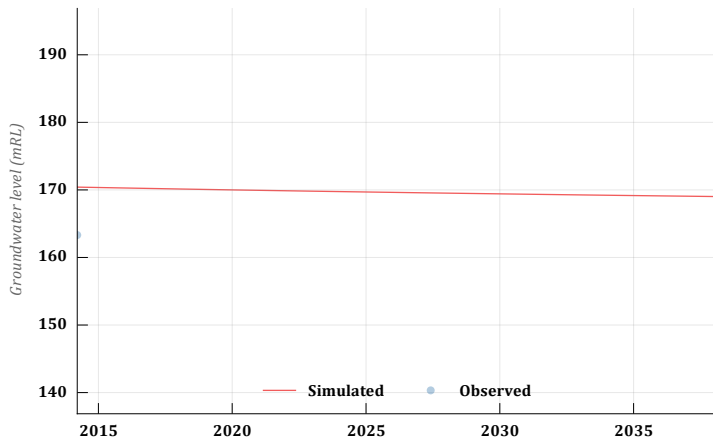
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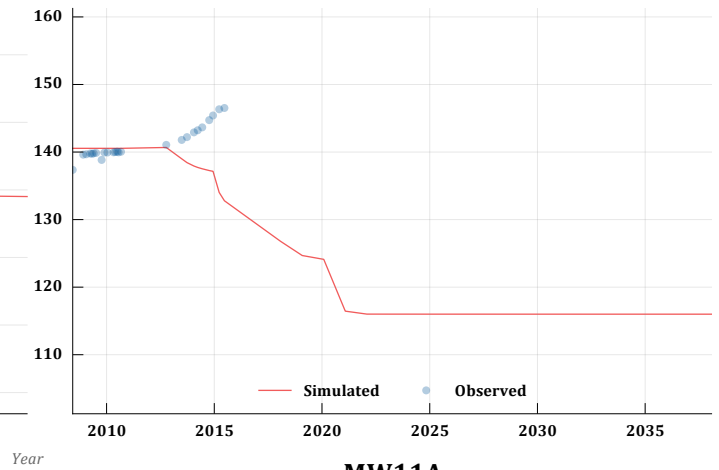
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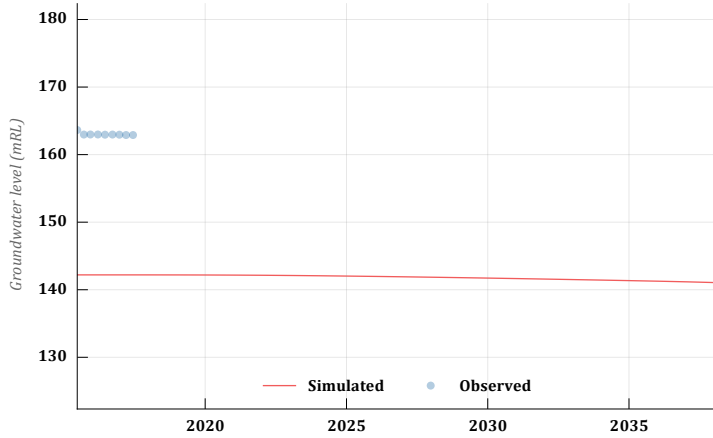
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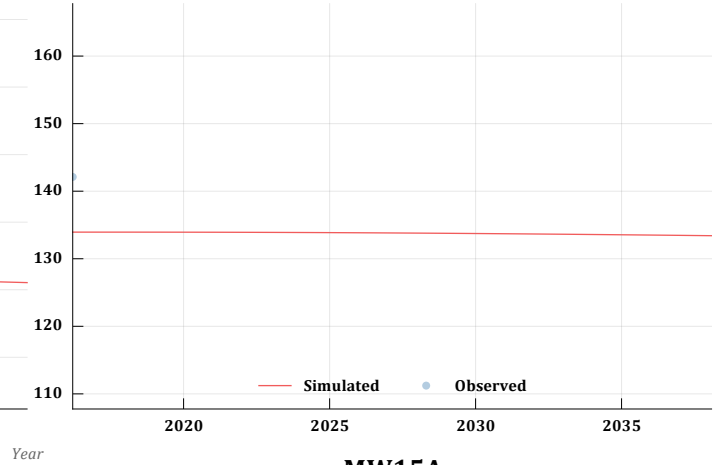
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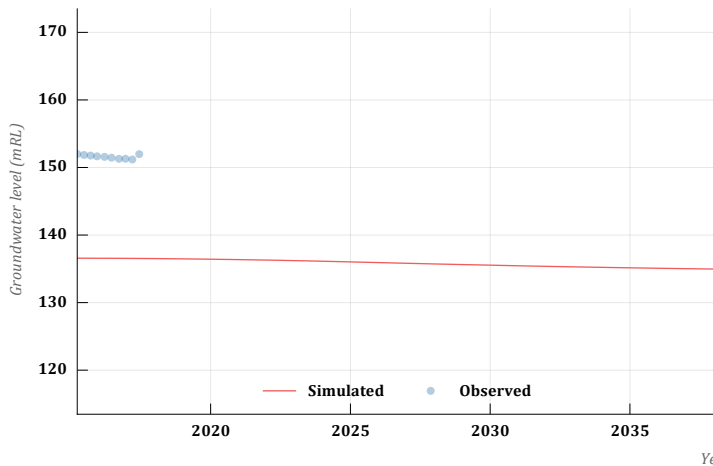
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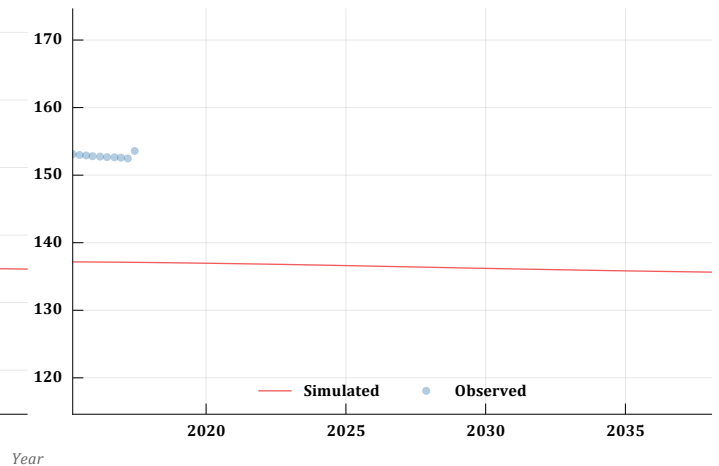
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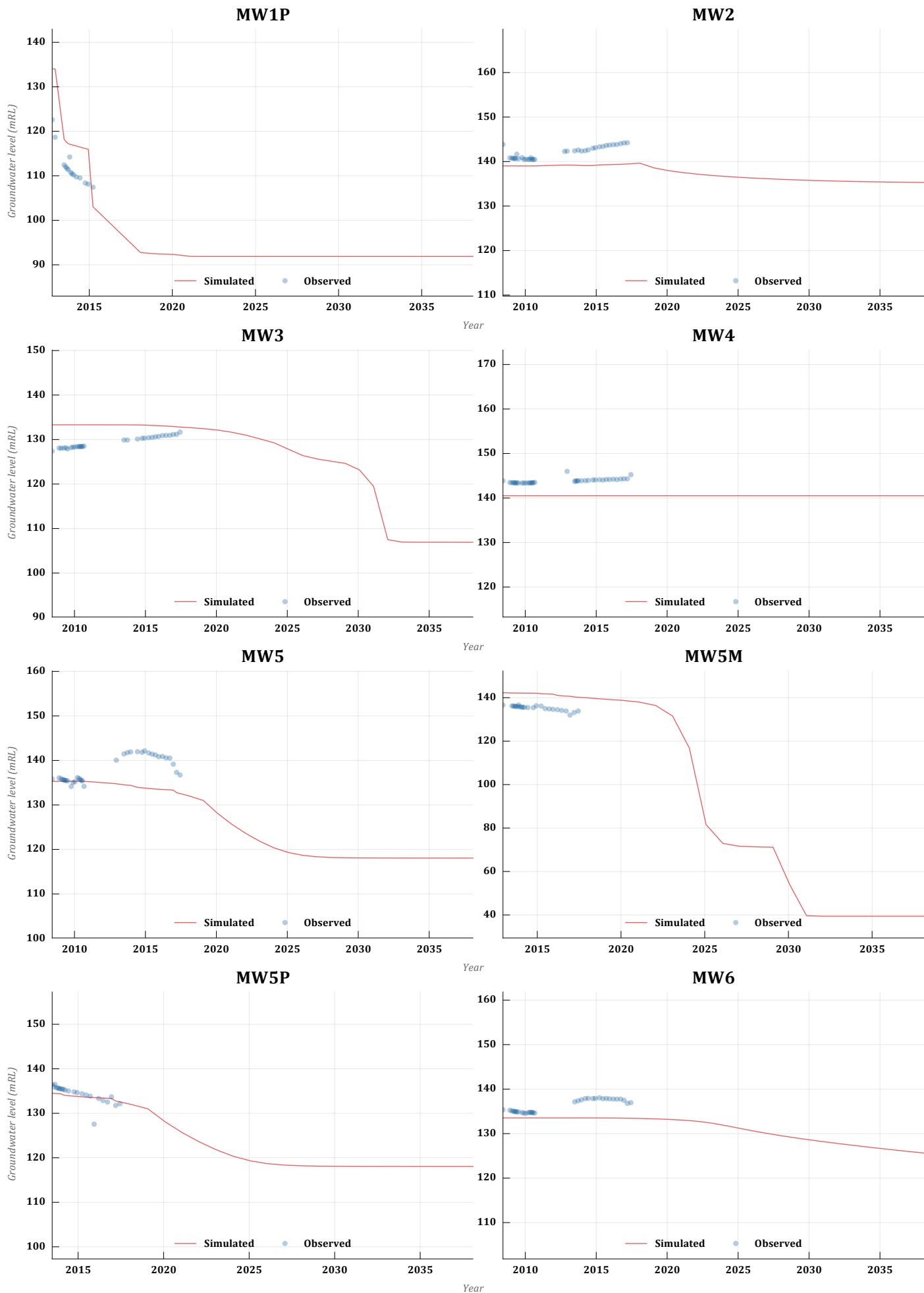


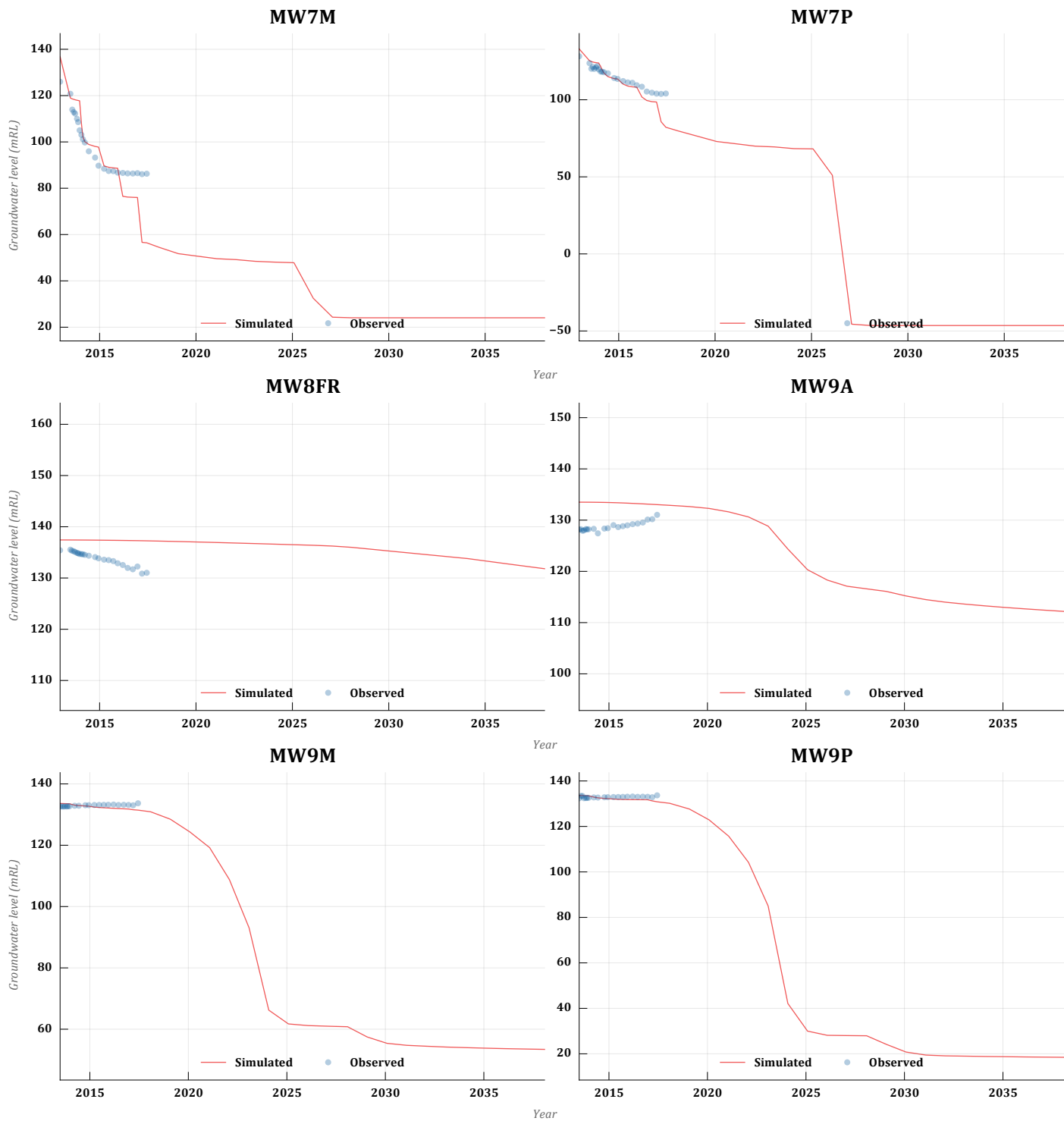
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MW15A

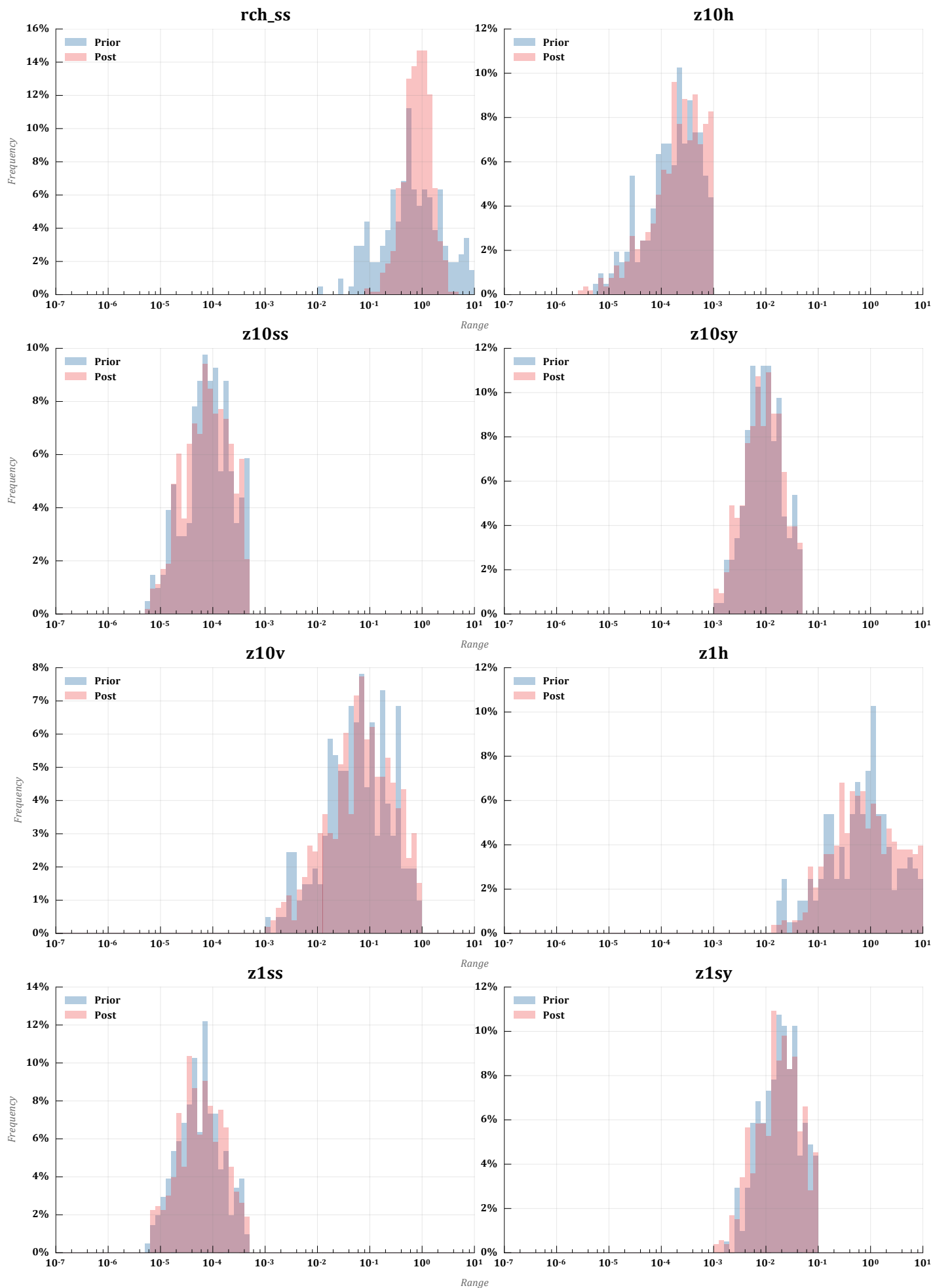


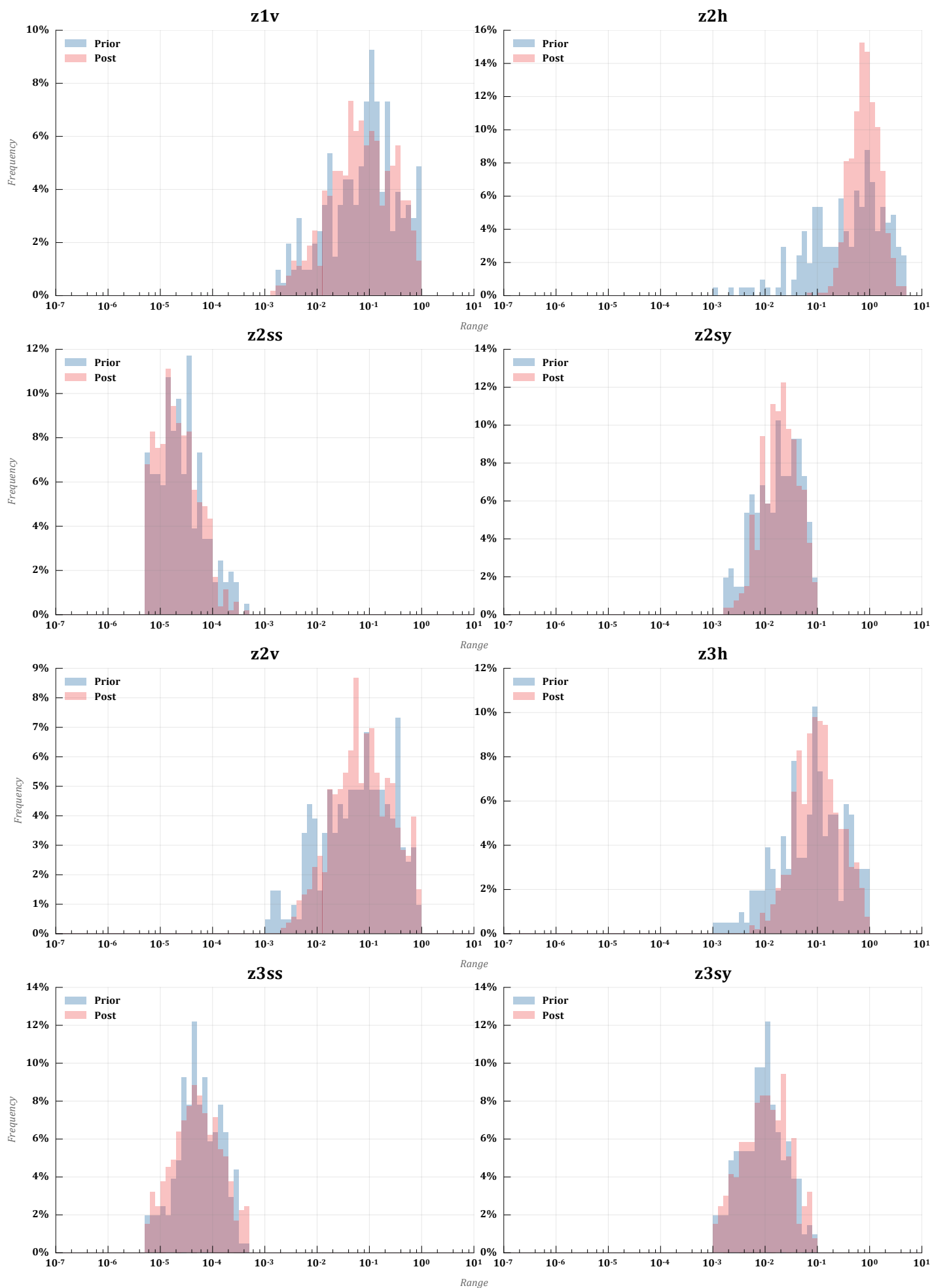


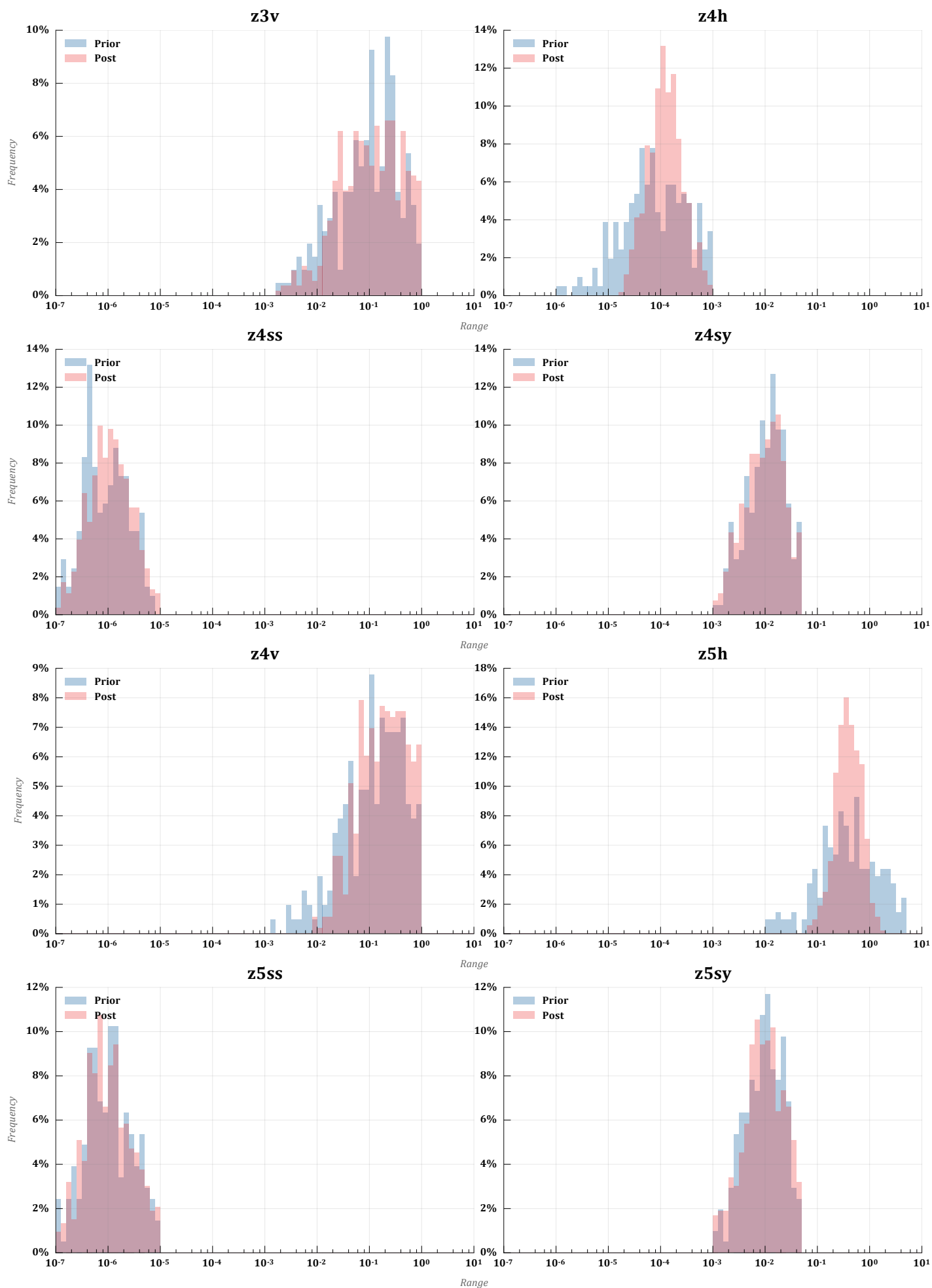


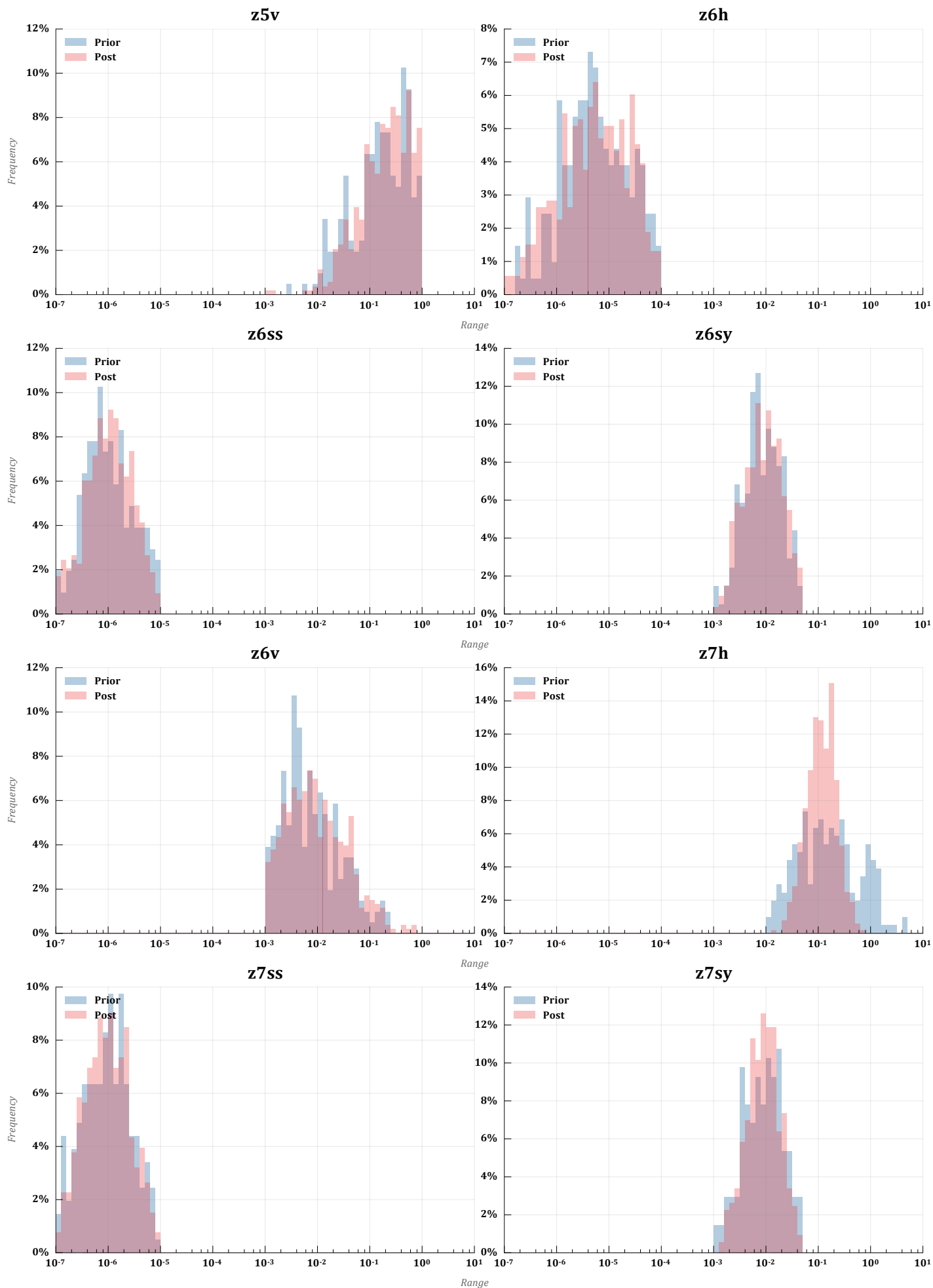
Appendix F2

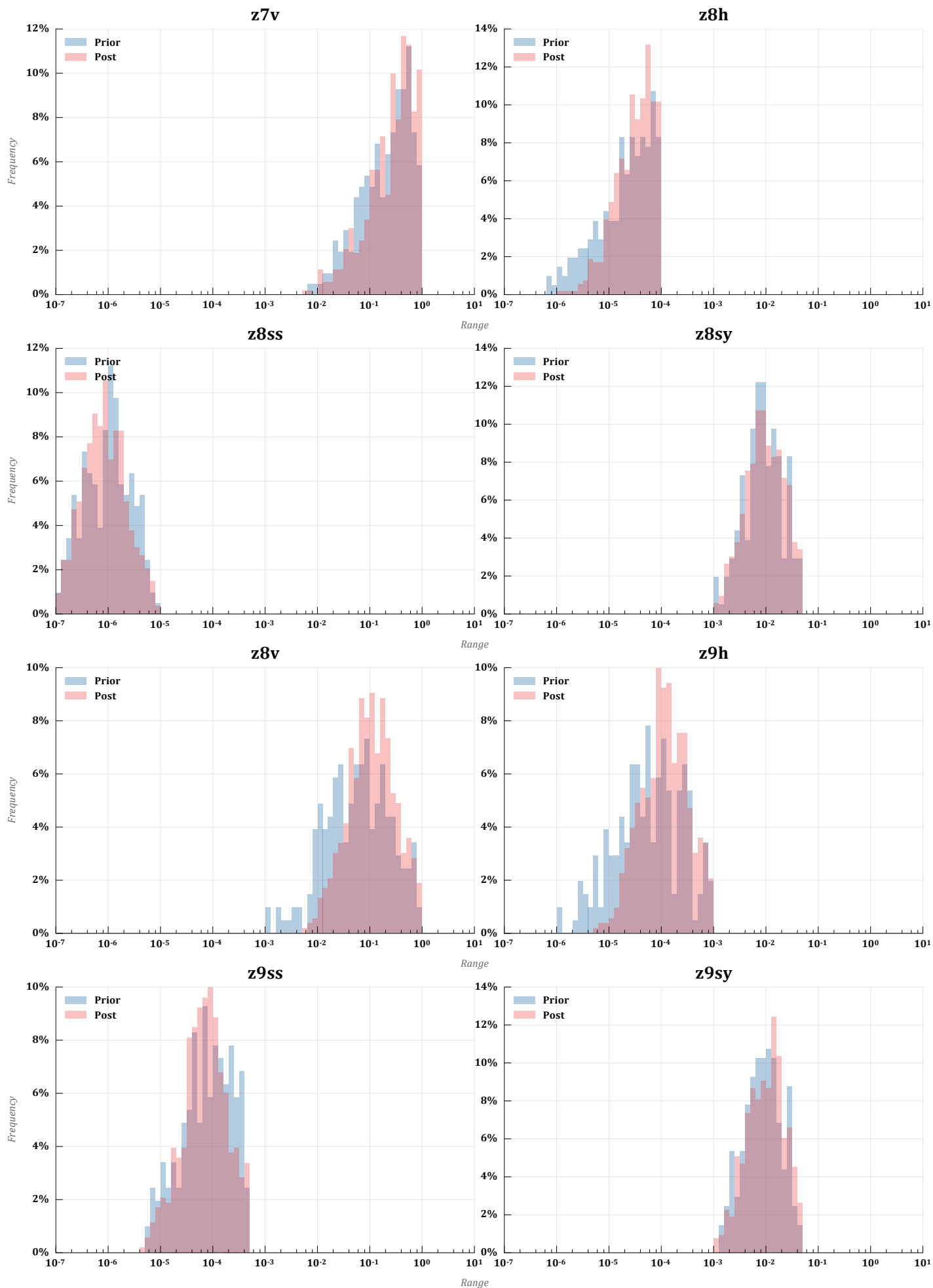
Prior and posterior parameter distributions

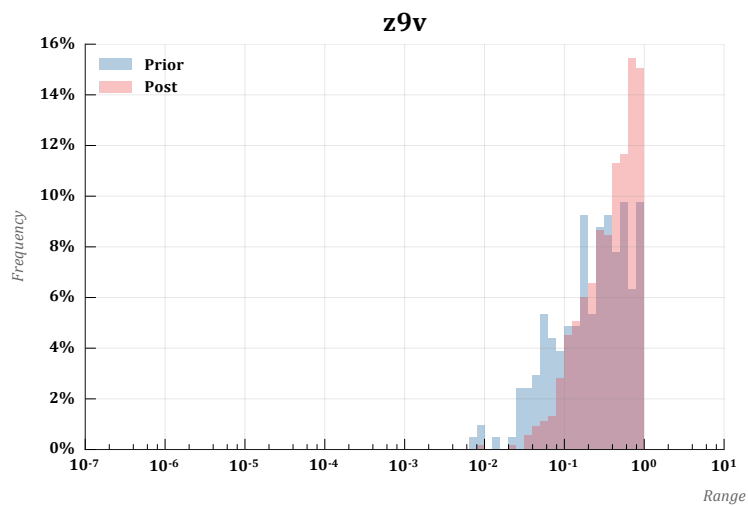








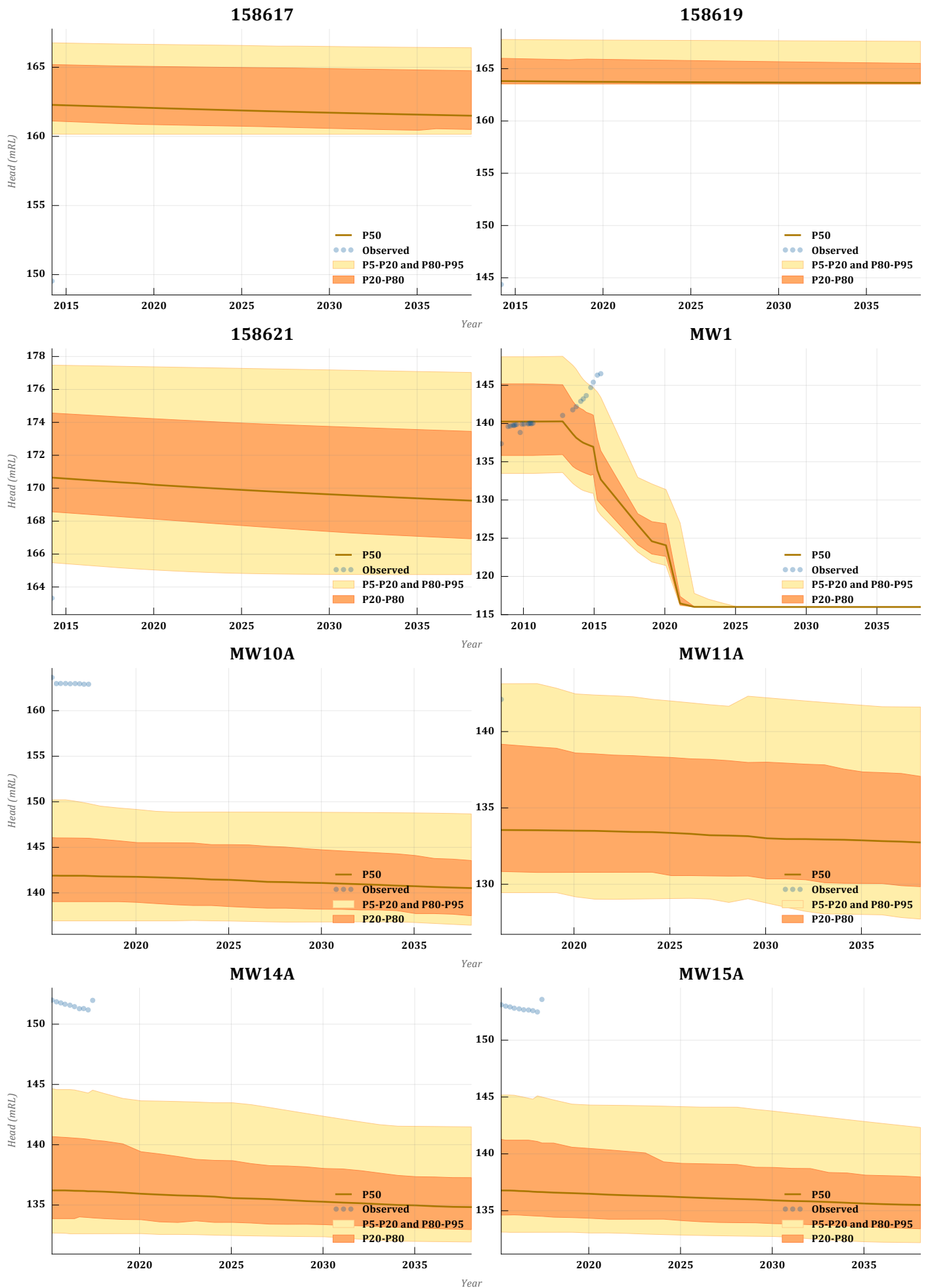


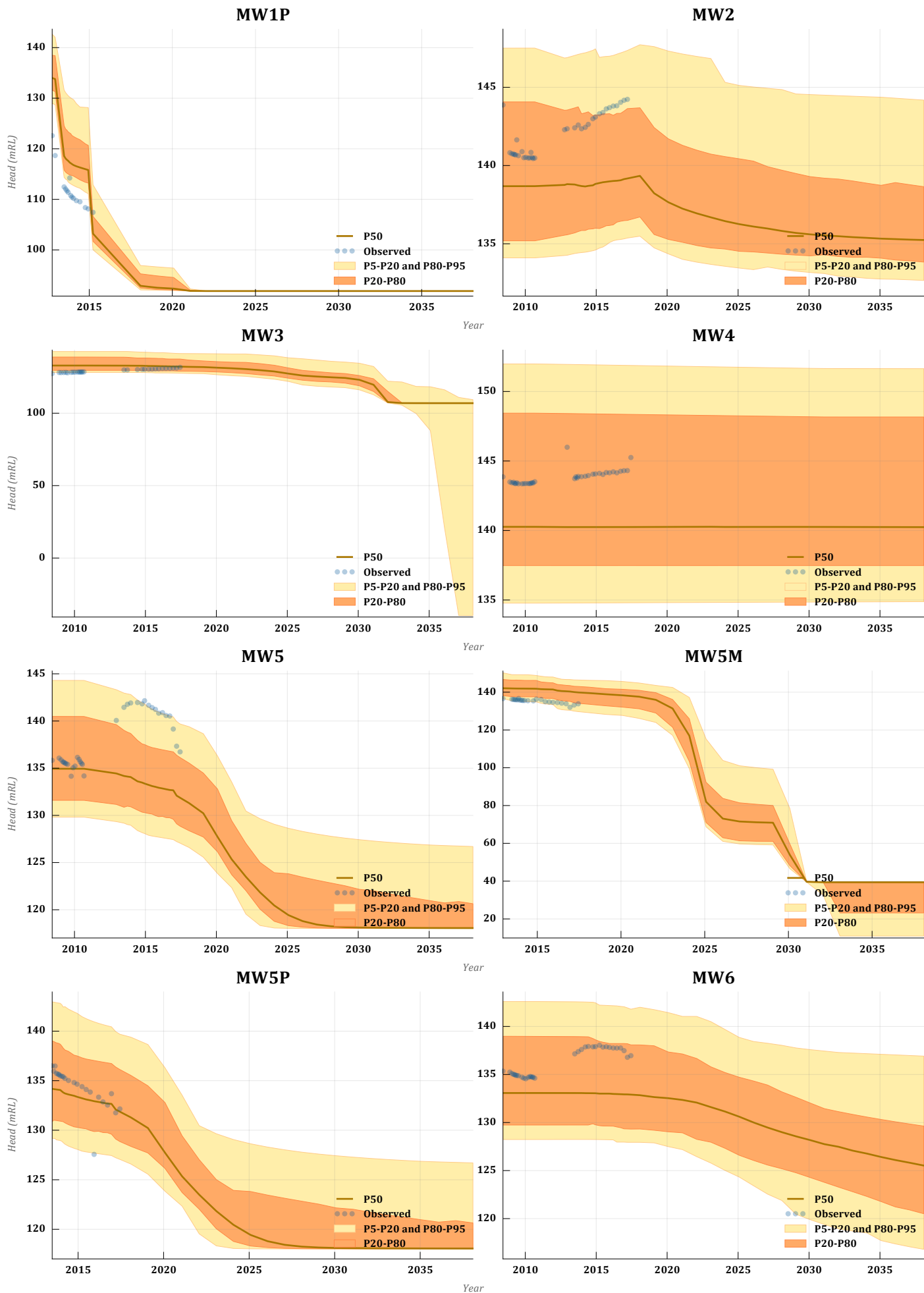


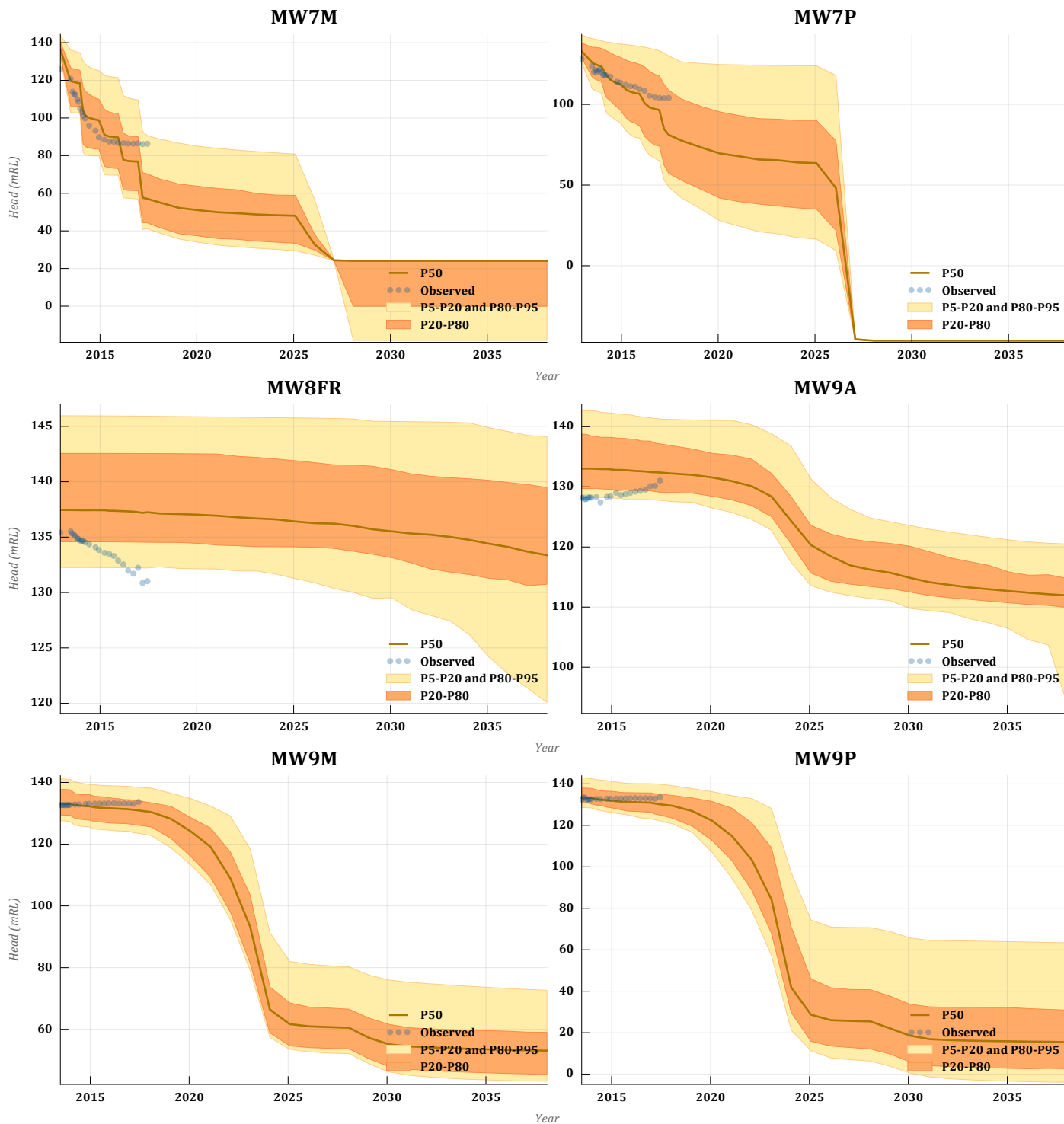
Appendix F3

Predictive uncertainty hydrographs









APPENDIX D
ECOLOGY IMPACT ASSESSMENT



Biodiversity
AUSTRALIA

Ecological Impact Assessment:

Project:

Western Extension Project,
Middlemount Coal Mine, Middlemount

Client:

Middlemount Coal Pty Ltd

June 2018



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Rev 0.4	Draft	Will Steggall	Resource Strategies	Will Steggall	9/2/2018
Rev 1.0	Final Draft	Will Steggall	Resource Strategies	Will Steggall	1/5/2018
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9	26/6/2018	Hard Copy/Electronic	Biodiversity Australia Info	Elspeth Thorpe	File Copy
10	26/6/2018	Electronic/E-mail	Resource Strategies Pty Ltd	Joe Fittell/Jamie Gleeson	Client Copy

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Executive Summary

Middlemount Coal Pty Ltd (MCPL) propose to seek Queensland Government and Commonwealth Government approval for changes to the approved Middlemount Coal Mine, herein referred to as the Western Extension Project (the Project).

The main activities associated with the Project are an extension of the open cut pit within ML 70379, expansion of the eastern dump, progressive development of haul roads, sediment dams and other associated infrastructure, and diversion of a drainage line around the mine extension footprint.

The primary outcomes of this study were to verify Regional Ecosystem mapping for the site; identify any threatened species under the *Nature Conservation Act 1992* (NC Act) and *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act); identify and describe any Matters of State and National Environmental Significance; and identify proposed avoidance and mitigation measures to protect the natural values including consideration of biodiversity offset requirements.

The study area is divided into two separate study areas comprising the western study area, and the eastern study area. These study areas are characterised by a mix of remnant and non-remnant vegetation communities including eucalypt woodland and Brigalow. The landform is generally very flat with no significant geological features such as outcrops, cliff lines or major creeks. Two drainage lines run through the western study area, with one in the eastern study area.

The surrounding landuses are dominated by cattle grazing which have led to extensive clearing in the area and have introduced a number of threats to biodiversity such as weed invasion, feral species, edge effects, fragmentation and anthropogenic impacts such as dust. This is likely to have excluded many sensitive species from the area and reduced the value of the study area for flora and fauna, especially rare and threatened species.

No threatened flora species listed under the NC Act or EPBC Act were detected during the survey. Two Regional Ecosystems that occur in the study area (RE 11.3.1 and RE 11.4.9) consist of Brigalow forest and are listed as Endangered under the *QLD Vegetation Management Act, 1999* (VM Act) and EPBC Act. Two Regional Ecosystems comprising Open Woodland on alluvial plains are listed as Of Concern under the VM Act (RE 11.3.2 and RE 11.3.4).

Three threatened fauna species were recorded during the field surveys, the Koala (*Phascolarctus cinereus*), Greater Glider (*Petauroides volans*) and Squatter Pigeon (Southern) (*Geophaps scripta scripta*). These species are listed as Vulnerable under the NC Act and EPBC Act. Two additional threatened fauna species, the Ornamental Snake (*Denisonia maculata*) and Powerful Owl (*Ninox strenua*), were considered potential occurrences in the study areas based on local records identified in the literature and database searches and presence of suitable habitat.

The Project is likely to result in a number of adverse impacts on biodiversity and contribute to threatening processes, however many of these are already acting in the study area due



to the disturbance history and surrounding land uses. The assessment identified several Matters of State or Environmental Significance in the study area. These were regulated vegetation, connectivity areas, high ecological significance wetlands, protected wildlife habitat and legally secured offset areas. Assessment of these matters determined that the Project would result in significant residual impacts.

Assessment of nationally listed threatened species and ecological communities determined that the Project has the potential to result in a significant impact on the Greater Glider, Koala and *Brigalow* (*Acacia harpophylla* dominant and co-dominant) (Brigalow EEC) and therefore potential impacts on these entities would also be mitigated and offset. The Squatter Pigeon (Southern) and Ornamental Snake are not considered to be significantly impacted by the Project, but potential impacts on these species would also be mitigated and offset.

Mitigation measures for the Project are expected to be consistent with existing Environmental Authority conditions and MCPL plans (e.g. Erosion and Sediment Control Plan and Rehabilitation Management Plan). Specific measures to reduce impacts on biodiversity include marking clearing limits, pre-clearing surveys and clearing supervision, and reducing light spillage into adjacent retained habitat.

An extensive offset package will form part of the Project. This will dedicate 1,843 hectares of land to the west of the revised mine footprint area as conservation lands to offset the impacts of the Project. In July and November 2017, Biodiversity Australia undertook flora and fauna surveys in accordance with contemporary Qld and Commonwealth survey guidelines to assess the suitability of the proposed offset areas. The proposed offset areas provide a suitable offset for all Matters of State or Environmental Significance and Matters of National or Environmental Significance that are likely to be impacted by the Project.



1.0 Introduction

Middlemount Coal Pty Ltd (MCPL) has lodged an amendment application to the Middlemount Coal Mine Environmental Authority (EA) EPML00716913 in accordance with section 224 of the Queensland (Qld) *Environmental Protection Act 1994* (EP Act) to approve an extension of the Middlemount Coal Mine (Figure 1) (herein referred to as the Middlemount Coal Mine Western Extension Project [the Project]).

On 8 January 2018, the Project was referred under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (2016/7649). On 8 February 2018, a delegate of the Commonwealth Minister for the Environment declared the Action to be a 'controlled action' for the purpose of the EPBC Act due to potential adverse impacts on the following controlling provisions under Part 3 of the EPBC Act:

- sections 18 and 18A of the EPBC Act (listed threatened species and communities); and
- sections 24D and 24E of the EPBC Act (a water resource, in relation to coal seam gas development and large coal mining development).

Biodiversity Australia Pty Ltd has been requested by MCPL to undertake an Ecological Impact Assessment for the Project.

1.1. Project Description

In May 2017, Mining Lease (ML) 70379 was extended to the north-west of currently approved operations at the Middlemount Coal Mine. The Project involves extension of operations within the recently acquired portion of ML 70379 and a ML for infrastructure to facilitate the extension of the East Dump (Figure 2).

The Project includes the following activities:

- extension of the open cut pit within ML 70379 to the north-west;
- continued extraction of run-of-mine (ROM) coal at up to 5.7 million tonnes per annum (Mtpa) using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (Eastern Dump) and within the mined-out void;
- continued backfilling of coarse rejects into the pit within spoil, and temporary storage of fine rejects from coal crushing and washing in existing tailings storage facility cells for drying and reclaim for in-pit co-disposal;
- progressive development of sediment dams, pipelines and other water management equipment and structures (including levees and realignment of an existing diversion structure);
- progressive development of new haul roads and internal roads;
- continued development of soil stockpiles, laydown areas and borrow areas;



- continued use of existing and approved supporting mine infrastructure (including coal handling and preparation plant [CHPP] and ROM and product stockpiles);
- continued rail transport of coal products to the Dalrymple Bay Coal Terminal, Abbott Point Coal Terminal or Wiggins Island Coal Export Terminal for export;
- extension of the approved mine life by approximately six years (to 2037); and
- a change to the final landform at the Middlemount Coal Mine for the end of the mine life to include two final voids.

1.2. Study Objectives

The following lists the objectives of the Ecological Impact Assessment:

- Desktop literature review of relevant government databases and previous ecological assessments.
- Flora survey and field validation of Regional Ecosystems (RE) and habitat types within the Project area as per the *Methodology for Survey and Mapping of Regional Ecosystems and vegetation Communities in Queensland* (Nelder et al, 2017).
- Survey as per the requirements of *Guide to Determining Terrestrial Habitat Quality Version 1.2* (Department of Environment and Heritage Protection [DEHP] 2017a) to determine land-based offset requirements.
- Targeted surveys for threatened flora and fauna species listed under the *Nature Conservation Act 1994* (NC Act) and EPBC Act.
- Identification of any Matters of State Environmental Significance (MSES) and Matters of National Environmental Significance (MNES).
- Identification of avoidance and mitigation measures to protect the natural values, particularly threatened or near-threatened species, including consideration of biodiversity offset requirements in accordance with the *Queensland Environmental Offsets Policy* (DEHP 2017b).
- Assessment of the magnitude and duration of potential significant residual impacts and description of how the activity and any associated offset (if required) would be staged.

1.3. Project Location and Key Definitions

MCPL owns and operates the Middlemount Coal Mine, an existing open cut coal mine located approximately 3 kilometres (km) to the south-west of the Middlemount township (Figure 1) within the Isaac Regional Local Government Area. The Project occurs within the Isaac-Comet Downs subregion of the Brigalow Belt North Bioregion.

The Project area is defined as the actual area directly impacted by the proposed development including the mine pit, dump areas and infrastructure. This area totals approximately 571 hectares (ha).



The **eastern study area** is defined as the area to the east of the existing mining area.

The **western study area** is defined as the area to the west of the existing mining area.

The **study area** contains both the eastern and the western study areas.

The **locality** is defined as land within 10 km of the Project.



Figure 1: Location of the study areas

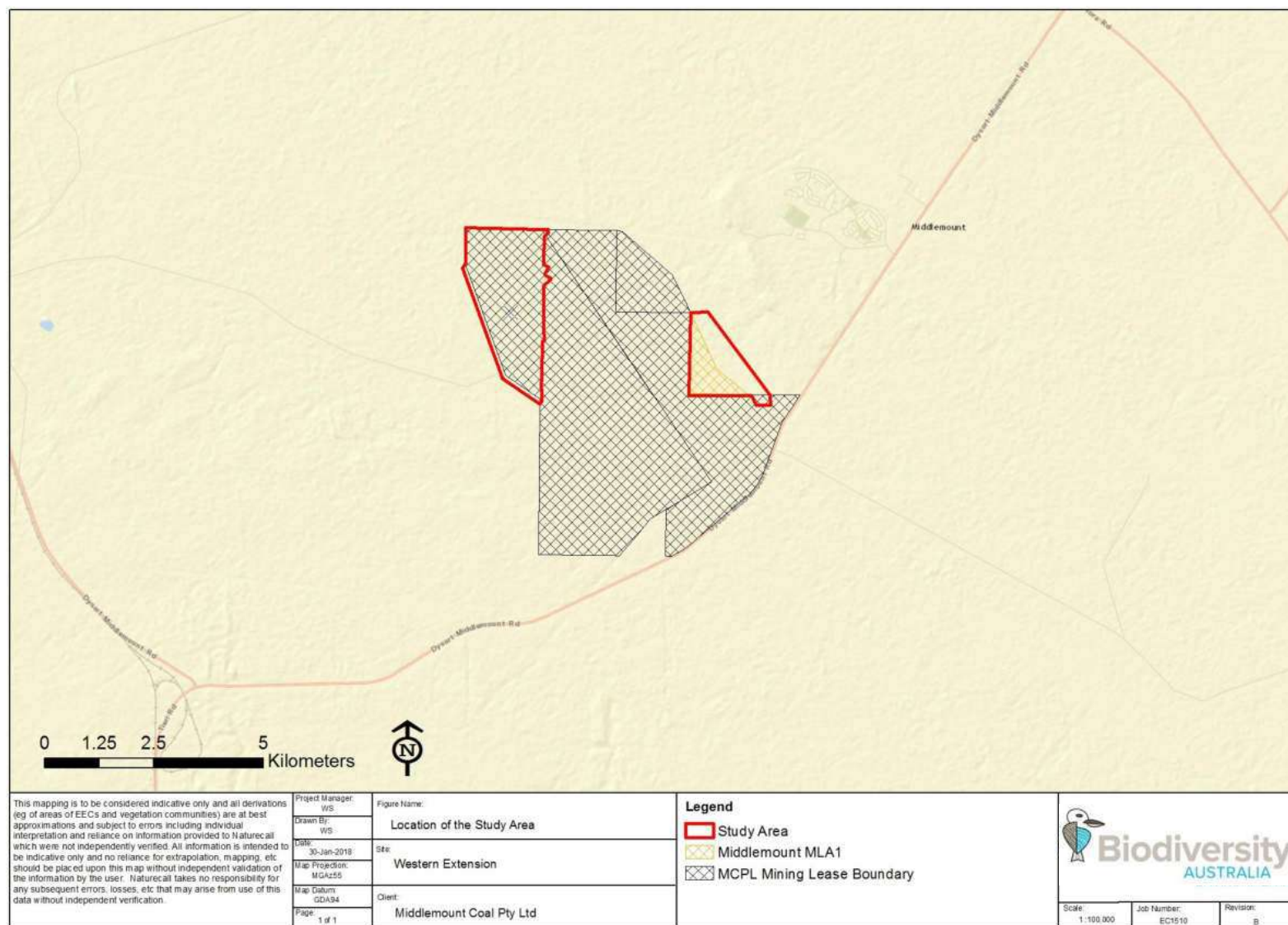
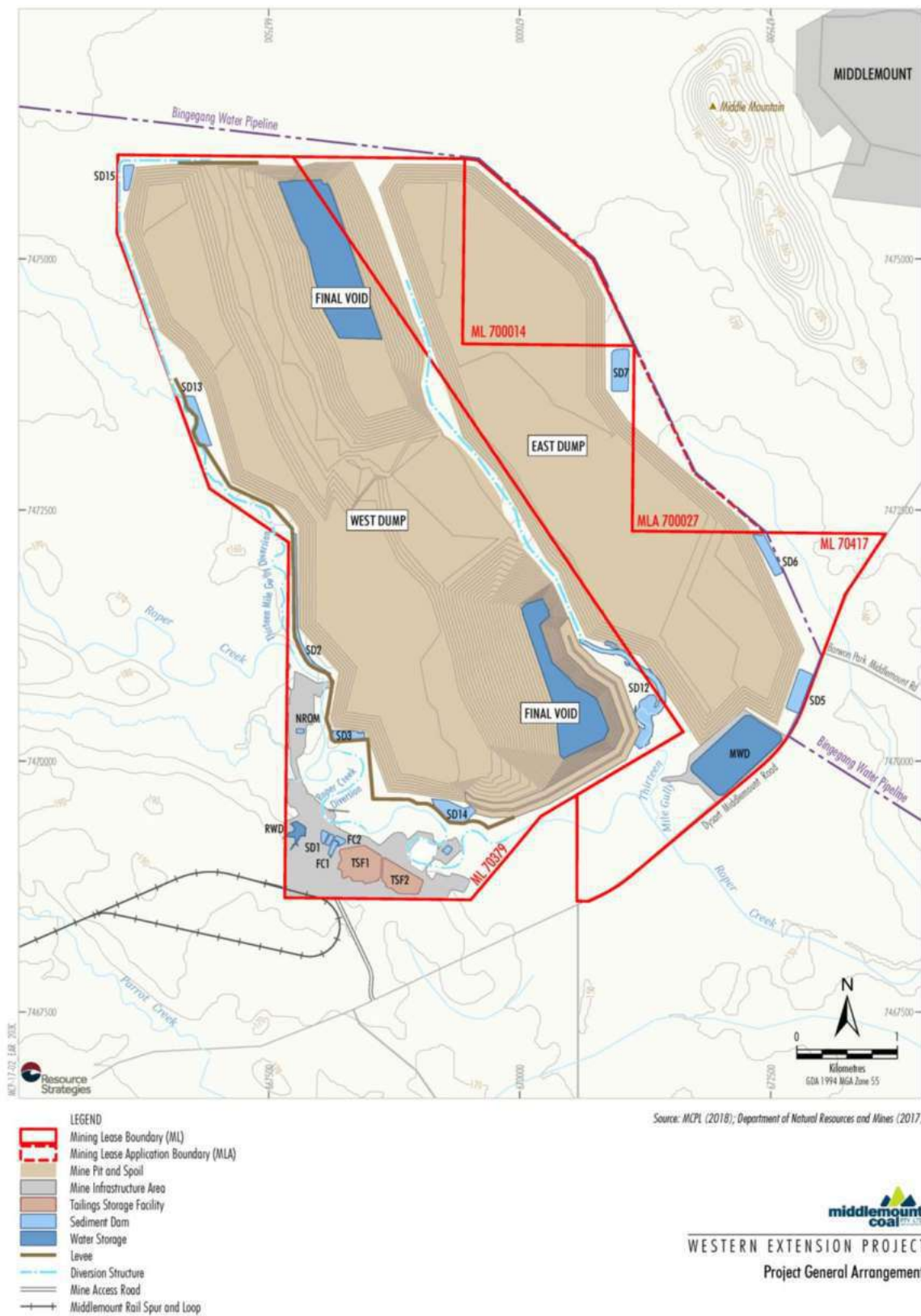




Figure 2: Proposed general arrangement





2.0 Background Information

2.1. Regional and Local Setting

The study area occurs within the Isaac-Comet Downs subregion of the Brigalow Belt North Bioregion, which falls with Isaac Regional Council. Surrounding landuses largely comprise open cut and underground coal mines and grazing land. The nearest protected area is Junee National Park which occurs 30 km to the east. Bundoora State Forest is located approximately 25 km to the south-west of the study area.

2.2. Soils, Topography and Geology

2.2.1. Western Study Area

The western study area is located on a relatively flat landform with elevation ranging from approximately 160-170 metres (m) Australian Height Datum (AHD). No distinct geological features such rocks outcrops, cliffs or escarpments occur on the study area (Figure 3).

The main topographic feature of the western study area is an ephemeral creek line which is referred to as Drainage Line 1. This runs west to east across the northern portion of the study area. A second drainage line, named Drainage Line 2, also traverses through the centre of the study area and feeds into Drainage Line 1 (Figure 4).

The study area contains three Land Zones as per Wilson and Taylor (2012). Alluvial formations associated with Drainage Line 1 and 2 fall in to Land Zone 3 which is defined as recent Quaternary alluvial systems. This zone typically comprises fertile alluvial soils including Vertosols and Sodosols. In the study area, this zone supports eucalypt woodland and Brigalow vegetation.

The study area contains areas of low lying clay plains which fall into Land Zone 4, described as Tertiary – early Quaternary clay plains. This zone largely comprises vertosols with gilgai microrelief. Soils encountered in this zone generally comprised deep clays and loams, sometimes with surface gravel present. Many of the gilgai contained water in the May 2017 field survey due to the preceding heavy rains. This land zone supports regrowth and remnant Brigalow vegetation in the study area.

The level sandy plains which cover the majority of the study area fall into Land Zone 5 which is described as Tertiary to early Quaternary loams and sandy plains and plateaus. In western QLD, this land zone typically contains sandy to loamy red Kandosols and Tenosols (Wilson and Taylor 2012). Soils encountered on the study area were well drained and contained a high sand content with a shallow organic layer. This zone typically supports Poplar Box woodland in the study area.



The western study area is underlain by the Burngrove Formation as part of the Bowen Basin. The dominant lithology of this formation is described as mudstone, siltstone, sandstone, coal and tuff (Department of Natural Resources and Mines [DNRM] 2015), as shown in Figure 3.



Figure 3: Geology of the study area

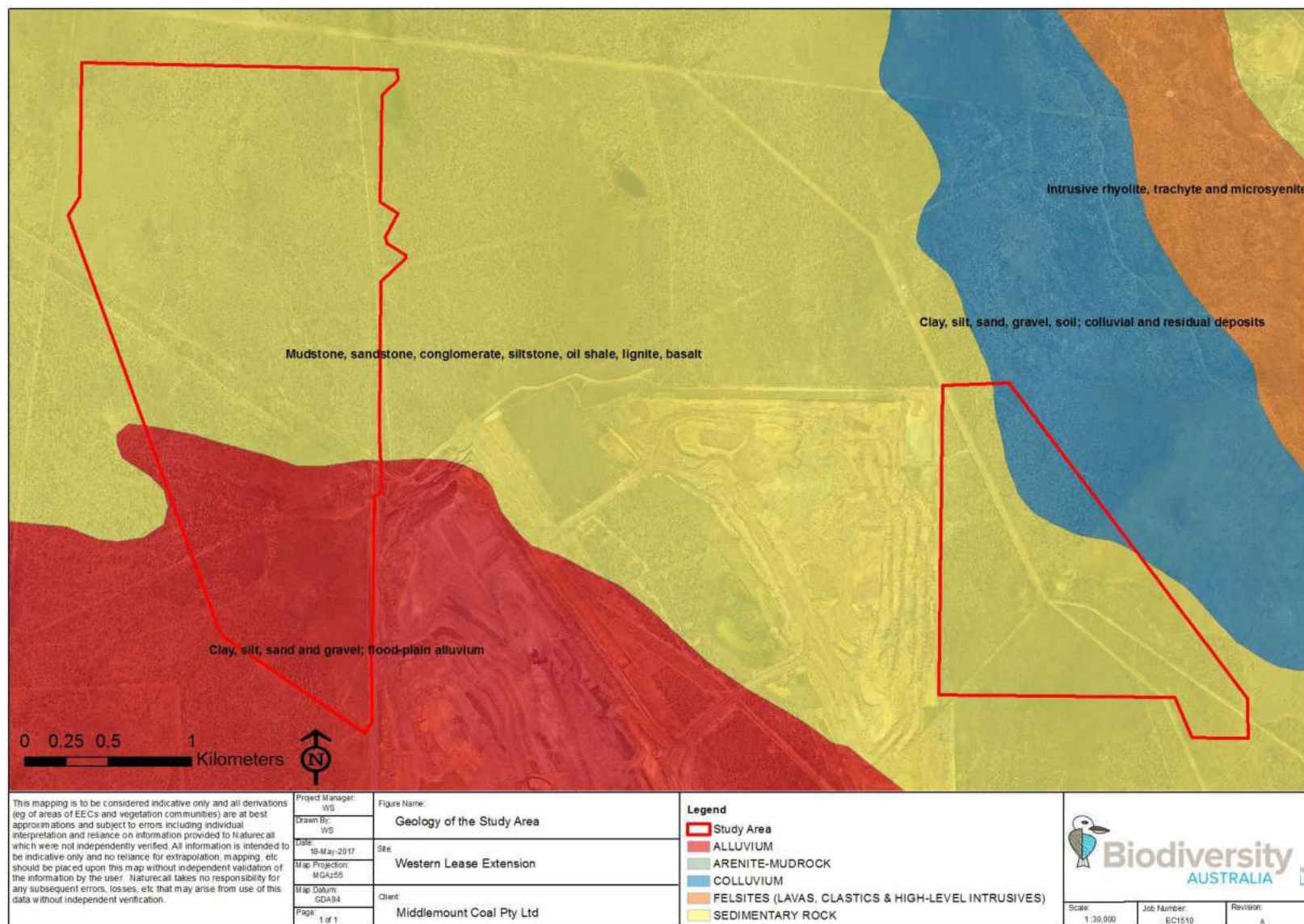
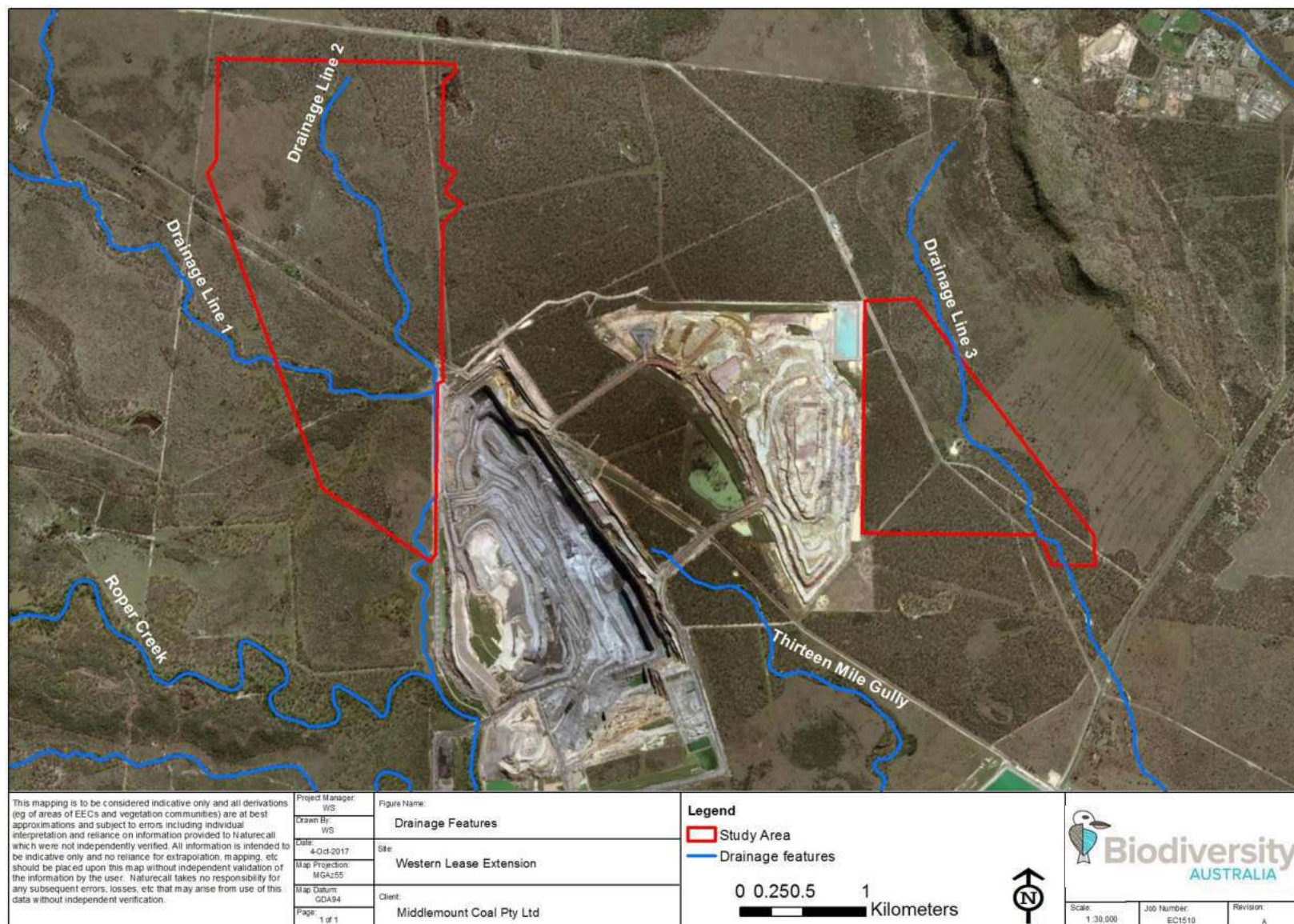




Figure 4: Drainage features in the study area





2.2.2. Eastern Study Area

The eastern study area is located on a relatively flat sandplain with elevation ranging from approximately 160-170 m AHD. No distinct geological features such as rocks, outcrops, cliffs or escarpments occur on the study area.

The eastern study area falls into Land Zone 5 which is described as Tertiary to early Quaternary loams and sandy plains and plateaus. In western Qld, this land zone typically contains sandy to loamy red Kandosols and Tenosols (Wilson and Taylor 2012). Soils encountered on the study area were well drained and contained a high sand content with a shallow organic layer.

The eastern study area is underlain by the Burngrove Formation as part of the Bowen Basin. The dominant lithology of this formation is described as mudstone, siltstone, sandstone, coal and tuff (DNRM 2015), as shown in Figure 3.

2.3. Drainage Features

2.3.1. Western Study Area

The study area is located in the Roper Creek catchment within the Fitzroy River Basin, which drains an area of approximately 150 000 square kilometres (DNRM 2015).

The main drainage feature of the study area is Drainage Line 1 (formerly referred to as 13 Mile Gully) which is an ephemeral creek line (Photo 1). This is not defined as a watercourse under the Qld *Water Act 2000* (MCPL 2017). This runs west to east across the southern portion of the study area. As part of the Stage 2 Mine extension, this drainage line was diverted southwards to run into Roper Creek.

A second drainage line (Drainage Line 2) also traverses through the centre of the study area and feeds into Drainage Line 1 (Figure 4). A farm dam is located on this drainage line approximately 1km north of its intersection with Drainage Line 1 (Photo 2).

Both of these watercourses are ephemeral, and flow is restricted to periods of high rainfall. A number of pools were present in these watercourses during the May 2017 surveys.

Localised depressions occur within the patches of Brigalow which occur on Land Zone 4. These contain a shallow layer of clay and hold water after heavy rains. Standing water was present in many of these Brigalow patches during the May 2017 field surveys.

The edges of a palustrine wetland occur within the north-east corner of the western study area. This only holds water in the wet season after heavy rains and contains a number of aquatic flora species at these times.



Photo 1: Drainage Line 1



Photo 2: Farm dam on Drainage Line 2 in western study area





2.3.2. Eastern Study Area

One unnamed drainage line, referred to as Drainage Line 3, is mapped in the eastern study area as shown in Figure 4. This runs south, eventually meeting Roper Creek approximately 5 km south of the study area. Drainage Line 3 is not defined as a watercourse under the Qld *Water Act 2000* and did not contain any water during the surveys (Photo 3).

Due to the study area's highly permeable soils, water drainage would generally be through infiltration, with some localised overland flow expected during heavy rains. A few small depressions were encountered in the eastern study area which contained a shallow layer of clay. These areas would only hold water for short periods after heavy rains in the wet season, and would not support aquatic fauna or wetland plants.

A small farm dam is located in the centre of the eastern study area which generally holds water year-round. It does not contain any aquatic vegetation or habitat structures.

Photo 3: Drainage Line 3 in eastern study area



2.4. Landuse History

Pastoral properties dominate the local landuse along with a number of open cut and underground coal mines. No cropping or fruit growing areas are known to occur in the locality.



Clearing for cattle grazing in the region has been extensive, and both of the study areas contain cleared areas that are currently grazed or have been grazed in the past. Cattle grazing has also required the establishment of fences and stock dams on the study areas which has facilitated further clearing.

Cleared grazing lands also occur to the north of the western study area and to the east of the eastern study area. As a result of this clearing and grazing, vegetation in the region is highly fragmented and exists as a mosaic of remnant and regrowth woodland and derived pasture grassland.

2.5. Fire History

No recent fires are known to have occurred on the study areas. Charcoal was only noted on a few older dead trees indicating that a fire has not occurred within at least the past 15-20 years.

2.6. Previous Relevant Ecological Investigations

2.6.1. Biodiversity Australia (Naturecall)

2.6.1.1. Naturecall 2013-2017

Biodiversity Australia (formerly Naturecall) conducts annual monitoring of the Middlemount Coal Offset Areas comprising the Stage 2 Offset, Rail Loop and Spur, Parrot Quarry and 13 Mile Gully Diversion offset areas (Naturecall 2013, 2014a, 2015a, 2016a, 2017a). Monitoring is undertaken in accordance with the MCPL Offset Management Plan (MCPL 2012) and comprises annual Biocondition surveys as per Eyre et al. (2015) at 11 permanent transects, photo monitoring at 13 points as well as visual inspections and assessment of threats to the success of the Offset Areas. Three of the Biocondition survey points are located within the current Western Extension study area.

In accordance with the MCPL Offset Management Plan, dedicated fauna surveys were undertaken in the offset areas in May 2014 and May 2017. The following fauna survey techniques were employed:

- spotlighting;
- diurnal bird surveys;
- diurnal herpetofauna searches;
- installation of Passive Infrared (PIR) cameras;
- amphibian searches;
- opportunistic observations; and
- assessment of habitat features and complexity.



The fauna surveys have detected three conservation significant fauna species within the offset areas comprising the following:

- Koala (*Phascolarctos cinereus*) – Vulnerable NC Act and EPBC Act.
- Squatter Pigeon (southern) (*Geophaps scripta scripta*) - Vulnerable NC Act and EPBC Act.
- Greater Glider (*Petauroides volans*) – Vulnerable NC Act and EPBC Act.

2.6.1.2. Naturecall 2014a

Naturecall (2014b) prepared an ecological assessment report for the realignment of the Bingegang Pipeline which is located to the north and east of the Middlemount Coal Mine. A section of the realigned pipeline runs through the eastern study area.

The ecological survey was conducted in July 2014 and consisted of RE verification and mapping, passive fauna surveys along with habitat and weed mapping.

The RE mapping and field validation found the majority of vegetation along the realigned pipeline route consisted of Poplar Box Woodland analogous to RE 11.5.3. Small patches of a Brigalow community were detected along the realigned pipeline route which qualified as the State and Commonwealth listed Brigalow (*Acacia harpophylla* dominant and co-dominant [RE 11.5.16]) community, listed as Endangered under the NC Act and the EPBC Act. No threatened flora species were detected.

The fauna surveys detected a single threatened species – the Squatter Pigeon (southern) (*Geophaps scripta scripta*) which is listed as Vulnerable under the NC Act and the EPBC Act. This species was detected next to the small farm dam in the centre of the current eastern study area.

2.6.1.3. Naturecall 2015

Naturecall conducted field surveys and prepared a Terrestrial Ecological Impact Assessment for the North-eastern Extension project, located to the east and north of the current study areas. The surveys were undertaken over one week in October 2015. The field survey methodology comprised the following:

- *Flora and Habitat Quality Surveys* – RE verification and mapping, threatened flora transects, Terrestrial Habitat Quality Assessments.
- *Fauna Surveys* – Spotlighting, call playback, PIR cameras, diurnal bird surveys, herpetofauna searches, scat and track searches.

The flora and habitat quality surveys confirmed that the entire site comprised Poplar Box Woodland analogous to RE 11.5.3. Several small localized depressions were also recorded which were mapped as 11.5.3b. No threatened flora species were recorded during the surveys and none were considered potential occurrences.



The fauna survey only detected common fauna species.

The entire study area comprised one habitat type which was Eucalypt woodlands/forests. This was found to be in good remnant condition and contained several important habitat features such as hollow-bearing trees, coarse woody debris, flowering eucalypts and native grass dominated groundcover.

2.6.2. Ecology and Heritage Partners 2012

Ecology and Heritage Partners (EHP) (2012) conducted ecological investigations within the Offset Area for the Stage 2 Middlemount Coal Mine project. The scope of work for the investigations were to verify the REs and high value regrowth present within the Offset Area, quantify the area of each RE, identify the status of REs under the QLD *Vegetation Management Act, 1999* (VM Act) conduct surveys for conservation significant flora and fauna species and conduct surveys for weeds and pest species.

2.6.2.1. Survey Methods

Field surveys were conducted by a team of four botanists from 10-14 July, 29 July-3 August and 13-17 August 2012. The main survey methodology employed was quaternary vegetation surveys as per Neldner et al. (2017). Targeted surveys for threatened flora species were undertaken via foot traverses along randomly 50m transects along with opportunistic searches in potential habitat. Fauna survey methods involved opportunistic surveys and habitat assessments.

2.6.2.2. Results

The Stage 2 Offset Area was found to contain 17 distinct REs. Approximately half of the Offset Area qualified as remnant vegetation with the remainder comprising non-remnant vegetation. The only endangered RE found in the Offset Areas was Brigalow EEC, which is also listed as Endangered under the EPBC Act.

Two threatened flora species listed under the VM Act were detected during the surveys comprising *Desmodium macrocarpum* (no longer listed as a threatened species) and *Cerbera dumicola*. Two threatened fauna species listed under the NC Act were detected comprising the Koala and Squatter Pigeon (southern). These species are now both listed as Vulnerable under the EPBC Act. The Koala was found in the southwest of the Offset Area (over 4 km from the current western study area) while the Squatter Pigeon (southern) was recorded in roughly the centre of the Offset Area (approximately 1.5km west of the current western study area) and also in the south of the Offset Area.

Four vertebrate pest species were recorded comprising the Pig, Dog, Rabbit and Cat. Three weed species listed under the former *Land Protection (Pest and Stock Route Management) Act, 2002* were recorded comprising the Harissia Cactus, Velvety Tree Pear and Parthenium Weed.



2.6.3. Parsons Brinckerhoff 2010

Parsons Brinckerhoff Pty Ltd (PB) (2010) undertook the Environmental Impact Statement for the Middlemount Coal Mine Stage 1 and 2 areas. Part of their area of investigation extended onto the current study areas.

The field survey methodology employed by PB involved a comprehensive terrestrial flora and fauna survey. A brief outline of the methods and major findings of this study are described below.

2.6.3.1. Flora Survey

A flora survey was undertaken based on the methods described in Neldner et al (2017) in November 2009 and February/March 2010. A combination of secondary, tertiary and quaternary survey sites were used to sample vegetation and validate RE mapping. Targeted searches for threatened flora were also undertaken.

This resulted in the validation and mapping of 15 REs in the Stage 2 mine area. Three of these communities are listed as Endangered under the VM Act and the EPBC Act, with a further two listed as 'Of Concern'.

Two threatened flora species listed as 'Near Threatened' under the NC Act were detected in the project area, these being *Desmodium macrocarpum* and *Cerbera dumicola*. *Desmodium macrocarpum* has since been de-listed.

2.6.3.2. Fauna Survey

PB's (2010) fauna survey used a range of survey techniques to sample fauna species and their habitats in the project area. These included habitat classification and assessment, bird census, herpetofauna searches, spotlighting, live animal trapping and ultrasonic bat call detection. These were undertaken over two survey periods in November 2009 and February/March 2010.

The PB (2010) fauna survey detected 165 species of vertebrate animal, including eight introduced species. Three threatened species were detected; these being the Squatter Pigeon (southern), Ornamental Snake (*Denisonia maculata*) and the Little Pied Bat (*Chalinobolus picatus*). The Little Pied Bat has since been de-listed under the NC Act.



2.6.4. FRC Environmental 2010

2.6.4.1. General

An Aquatic Ecology Assessment Report was developed by FRC Environmental (FRC) in October of 2010. The report was prepared for PB to inform the *Middlemount Coal Project Stage 2 Environmental Impact Statement* (MCLP 2011)

The scope of the study included an assessment of aquatic habitat, aquatic flora and fauna distribution and biological values of the waterways. The assessment was confined to Roper Creek and Thirteen Mile Gully which were found to be the only major waterways that occur within the study area.

2.6.4.2. Survey Methods

Aquatic habitat, flora and fauna was assessed over two field surveys; one which occurred in early wet season of 2009, from the 7th to the 9th of December and another which occurred during mid wet season of 2010, from 22nd to the 26th of February.

A total of nine sites were surveyed including sites upstream, within and downstream of the mine (Table 1 and Figure 5). These sites included palustrine and lacustrine wetlands mapped upstream, within and downstream of the mine as per Department of Environmental Resource Management (DERM) wetland mapping at the time of survey.

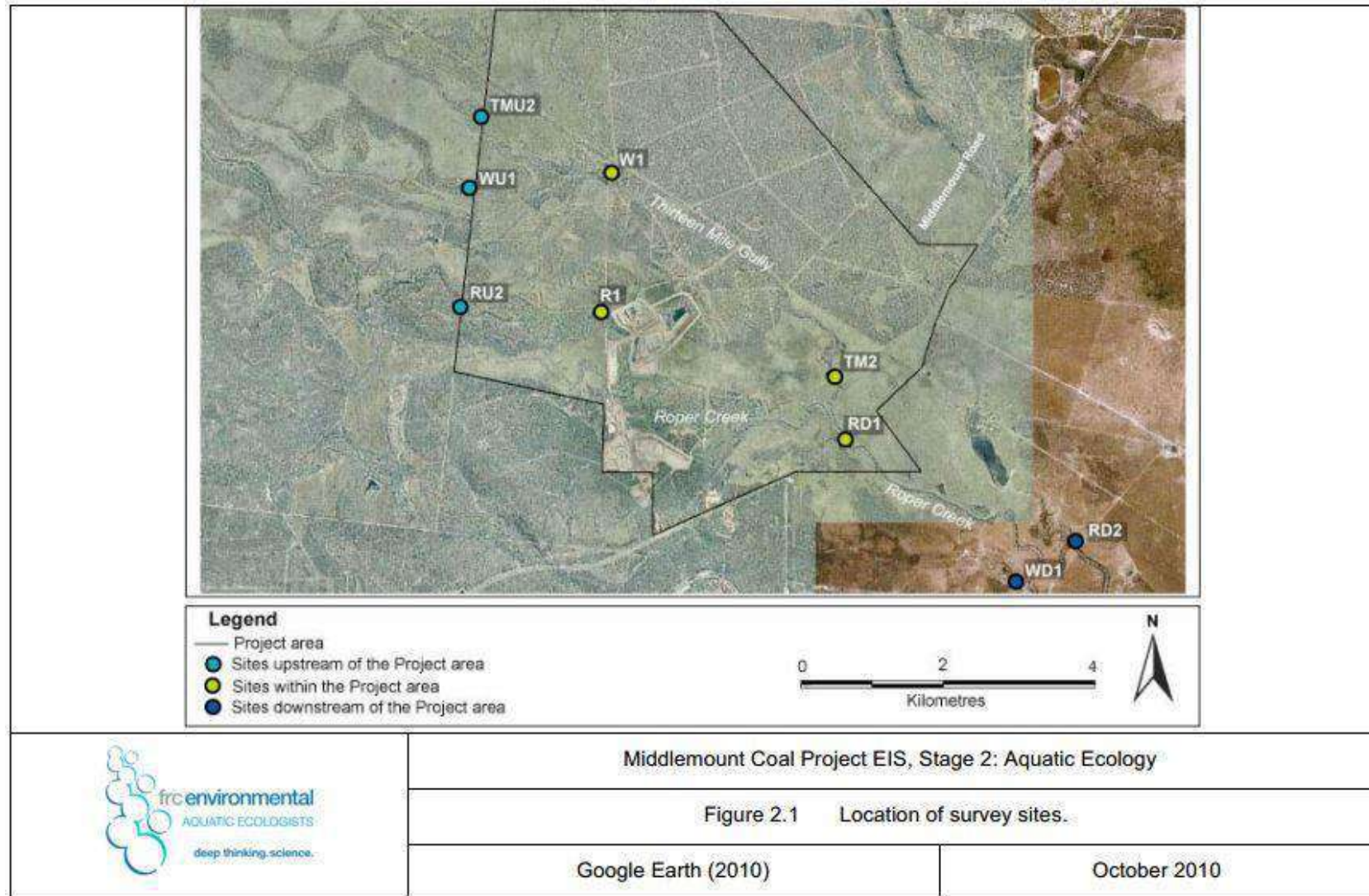
All habitat was surveyed using standardised Australian River Assessment System (AusRivAs) protocols, including survey of both the physical and biotic environments.

Table 1: Aquatic ecology survey locations

Site	Location (Figure 5)
RU2	Roper Creek
TMU2	Thirteen Mile Gully
WU1	Palustrine wetland
R1	Roper Creek
RD1	Roper Creek
TM2	Thirteen Mile Gully
W1	Lacustrine wetland
RD2	Roper Creek
WD1	Lacustrine wetland



Figure 5: Aquatic survey sites





Aquatic Habitat

Aquatic habitat of the study area was assessed during both the December 2009 and February 2010 surveys at all nine locations presented within Table 1 and Figure 5.

Habitat assessment was undertaken in accordance with the *Qld AusRivAS Sampling and Processing Manual* (DNRM 2001). Visual assessment was undertaken at the time of survey using the following attributes:

- the type and condition of riparian vegetation;
- habitats;
- mean water depth;
- substrate and the presence of bars;
- bed and bank stability;
- the presence of snags, overhangs, undercuts, and other forms of shelter, and
- the presence of any physical barriers of fish passage.

River Bioassessment habitat assessment score datasheets (DNRM 2001) were also completed in the field. The assessment of aquatic habitat described above was used to numerically assess nine criteria, and design them to one of four categories; excellent, good, moderate and poor. These numeric values were combined to produce an overall River Bioassessment Program (RBP) habitat assessment score which is categorised into one of the following categories: excellent > 100; good 75 – 100; fair 39 – 74; and poor < 38.

Water Quality was undertaken at each site via the use of a Hydrolab QUANTA water quality meter. The following parameters were measured:

- Water Temperature (°C).
- Conductivity (µS/cm).
- pH.
- Dissolved oxygen (DO) (% saturation).
- Turbidity (NTU).

These parameters were compared to the *Qld Water Quality Guidelines* (DEHP 2009) (QWQG) values for lowland streams in central QLD. It must be noted that the results for DO were not compared with QWQG, as the DO guidelines should only be applied to flowing streams and not stagnant pools (DERM 2009). There was no flow in the December 2009 survey and sites RU2, TMU2 and R1 were dry. Flow occurred during the February 2010 survey, however equipment issues occurred during the field survey and data was not considered to be reliable.



Aquatic Flora

Aquatic flora of the study area was assessed during both the December 2009 and February 2010 surveys at all nine locations presented within Table 1 and Figure 5. Macrophytes were surveyed in a 100m section at each site. The following attributes were recorded:

- The presence of all native and exotic macrophytes.
- The percent coverage of each species at each site.
- The percent coverage of submerged, floating (free-floating or rooted) and emergent macrophytes.

Percentage cover was calculated by the percentage of substrate covered by vegetation. The methodology utilised, noted that due to the overlap of emergent, floating and submerged growth forms, the total percentage cover can exceed 100%. Identification was undertaken via photograph's taken in-situ and in the field where practicable. The DERM list of hydrophytes was used to classify macrophytes as native or exotic Environmental Protection Agency [EPA] (EPA 2008)

Aquatic Macroinvertebrates

The chosen methodology and potential species occurrence of aquatic macroinvertebrate communities was informed by a literature review of aquatic macroinvertebrate studies across the Fitzroy Basin. This included review of DERM macroinvertebrate surveys near the study area. Study sites included; Roper Creek at Wilpeena (Site 1301025), the Mackenzie River at Tartrus Weir Headwater (Site 130109A) and the Mackenzie River at Bedford Weir Tailwater (Site 13011A).

Communities were surveyed at all nine sites described within Table 1 and Figure 5. During the December 2009 survey three sites; TMU2, RU2 and R1 were not surveyed due to them being dry at that time.

Sampling methodology followed the procedures in the *Qld AusRivAS Sampling and Processing Manual* (DNRM 2001). Macroinvertebrate sample was collected at each site from both edge and bed habitats using a standard triangular framed, cone shaped net with 250 micrometre (μm) mesh. Samples were frozen and returned to the FRC laboratory for identification and analysis to identify and quantify macroinvertebrates to the lowest taxonomic level as per AusRivAS standards.



Aquatic Vertebrates

Aquatic vertebrate surveys were undertaken during both the December 2009 and February 2010 surveys at all nine locations presented within Table 1 and Figure 5. In December 2009, only five sites were surveyed due to the lack of water and time constraints.

Fish communities were surveyed using a combination of backpack and boat electrofishing, baited traps and seine nets. Electrofishing was the favoured survey technique and was attempted at all sites. Electrofishing was undertaken via a Smith-Root LR-24 backpack electro fisher when in shallow water and via a Smith-Root boat 2.5GPP electrofishing system in deep water in accordance with the *Australian Code of Electrofishing Practice, 1997*.

2.6.4.3. Results

The Aquatic Ecology Assessment Report (FRC 2010) found that no threatened flora or fauna species listed under State or Federal legislation were recorded, or are likely to occur within the study area. There were also no wetlands of regional, State or Federal significance in the study area. As such, the project concluded by stating that; *“The project is not likely to impact upon conservation-significant habitat, listed vulnerable or endangered species or on Matters of National Environmental Significance (MNES) with respect to aquatic ecology”*.

The biological values of the aquatic ecosystems within the study area were found to be relatively low which is consistent with those of the wider catchment. The physical parameters of the waterways were dictated primarily by their ephemeral nature, with flow being largely dependent upon wet season rainfall. In addition to this, the 2010 FRC report did acknowledge that development and existing mining within the region has influenced water quality and the physical characteristics of aquatic habitat.

Creeks within the catchment were described as being in moderate condition. These waterways were described as being characterised by low habitat diversity, numerous access areas for cattle and road crossings, restricting passage for fish and other aquatic fauna and allowing the invasion of weed species.

Physical parameters of water quality within the study area were identified as poor to moderate at the time of survey. Typically, the waterways within the study area were characterised by high turbidity and low DO levels. Despite this, the report acknowledged that the creeks within the study area provide upstream dispersal habitat for fish species and possible breeding habitat for some of those which were recorded.

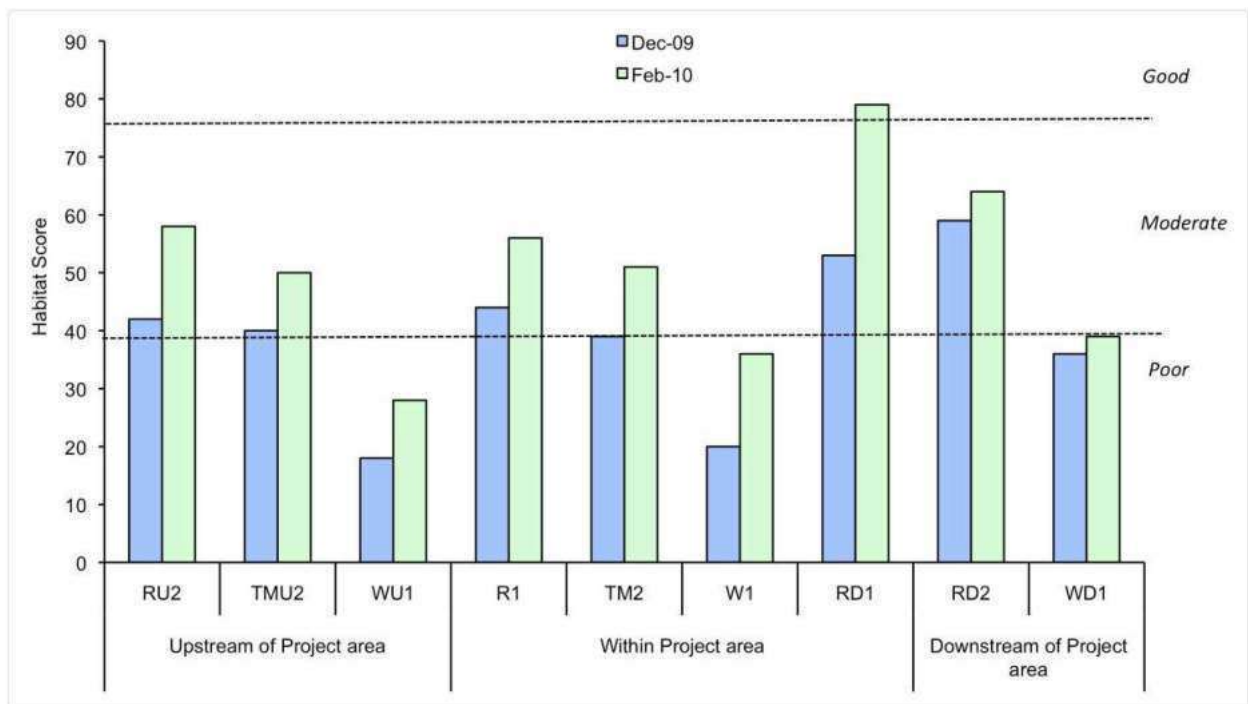


Aquatic Habitat

The aquatic habitat recorded within the FRC 2010 Aquatic Ecology assessment was considered unlikely to support any threatened fauna listed under either State or Federal legislation.

Most sites recorded moderate habitat assessment scores according to the RBP (Figure 6). This was attributed to low habitat diversity and channel alteration caused by the movement of fine sand and silt. Scores for wetlands (WU1, W1 and WD1) were poor, however it was also acknowledged that the RBP is primarily designed for use in streams and consequently wetlands habitats typically score poorly. RBP scores improved at all sites between December 2009 and February 2010, due to the higher water levels and flows in February of 2010.

Figure 6: RBP habitat assessment scores



The results of sites: TMU2 – Drainage Line 1, immediately upstream of the mine; WU1 – Wetland, immediately upstream of the mine and W1 – Wetland, within the mine, are all particularly relevant to the current assessment as they are located within, or in close proximity to the Project area. The descriptions of these sites are provided within Table 2.



Table 2: Aquatic habitat descriptions (FRC 2010)

Site	Description	Photographs
Upstream of Current Project Area		
MU2	In December 2009, this site was dry. In February 2010, the site was relatively shallow (0.3 m) and had low flow. The site had a wide (approximately 20 m) channel with sloping, and moderately stable banks. Instream habitat included woody debris and tree roots, trailing bank vegetation and undercut banks. The substrate was dominated by sand but also included silt / clay, gravel and pebbles. The riparian zone was wide (>30 m) and was dominated by grasses, shrubs and trees. There was a dirt ford crossing the creek approximately 30 m downstream of the site, which would impede fish passage during low flow, but have little impact to fish passage during moderate or high flows.	 Upstream December 2009.  Upstream, February 2010
WU1	This site was a large palustrine wetland which had similar characteristics in both surveys. The wetland was created by a dam on a small tributary of Thirteen Mile Gully. It was approximately 110 m wide and 1.2 m deep and there was no flow. The banks were sloping and had low stability due to cattle access and vegetation clearing. Instream habitat included woody debris, deep pools and trailing bank vegetation. A number of dead trees also provided instream habitat. The substrate was dominated by fine sediments (silt / clay and sand). The riparian zone was wide (>30 m) and was dominated by grasses, shrubs and trees.	 Channel, February 2010



Within Current Project Area		
W1	This site was a large lacustrine wetland created by a dam on Thirteen Mile Gully, and had similar characteristics in both surveys. The wetland was wide (approximately 80 m), and deep (4 m) with no flow. The banks were sloping and had low stability due to cattle accessing the area and vegetation clearing. Instream habitat included instream vegetation, floating vegetation and deep pools. The substrate was dominated by fine sediments (silt / clay and sand), but also included some gravel. The riparian zone was relatively wide (20 m) and was dominated by grasses, shrubs and trees.	 Channel, February 2010



Aquatic Flora

The aquatic flora assessment completed by FRC in 2010 as part of the Aquatic Ecology assessment for Stage 2 of the Middlemount Mine Extension Project, recorded no threatened aquatic flora listed under either State or Federal legislation and considered it unlikely that any such species would have potential to occur. Fifteen species of aquatic flora were recorded in the 2010 FRC Aquatic Ecology assessment, five with the December 2009 survey and 14 in February of 2010. A species list is provided within Table 3 below.

Table 3: Stage 2 - Aquatic Ecology - Aquatic flora list

Common Name	Scientific Name
Lesser Joyweed	<i>Alternanthera denticulata</i>
Dirty Dora	<i>Cyperus difformis</i>
Sharp Edge Sedge	<i>Cyperus haspan</i>
Bunchy Sedge	<i>Cyperus polystachyos</i>
-	<i>Cyperus sp.</i>
Common Water Hyacinth	<i>Eichhornia crassipes*</i>
-	<i>Eleocharis sp.</i>
-	<i>Juncus sp.1</i>
Duckweed	<i>Lemna minor</i>
Green Mat-rush	<i>Lomandra hystrix</i>
Spiny-head Mat-rush	<i>Lomandra longifolia</i>
Monochoria	<i>Monochoria cyanea</i>
Water Snowflake	<i>Nymphoides indica</i>
Prince's Feather	<i>Persicaria orientalis</i>
-	<i>Schoenoplectus lateriflorus</i>

The February 2010 survey recorded greater species richness and cover due to the increased standing and flowing water. For example, site WD1 recorded the greatest macrophyte species richness and cover during the February 2010 survey, while in December of 2009 no macrophytes were recorded at this site.

Aquatic Macroinvertebrates

During the 2010 FRC Aquatic Ecology assessment, the macroinvertebrate communities within the study area were dominated by; Non-biting Midge larva, Water Boatmen, Common Dragonfly nymphs and Seed Shrimps. The distribution and richness of taxa was varied with the different aquatic habitats at each site.

Richness was higher in February 2010 when compared to December 2009 which was likely a result of increased water quality, greater water depth and availability of habitat features at this time. W1 and RD2 were exceptions to this, and showed a decline in richness, the reasons for which were unclear.



Macrocrustaceans were recorded throughout the survey periods through incidental observations during other surveys and targeted dip netting. Species recorded included: The River Prawn (*Macrobrachium sp.*), Freshwater Shrimp (*Paratya sp.*), Orange-fingered Yabby (*Cherax depressus*) and the Freshwater Crab (*Austrothelphusa sp.*). An estimated 757 macrocrustaceans were captured from both surveys and abundance was greatest at sites WU1 and TM2 in December 2009, indicating that these sites would likely provide refuge habitat for macrocrustaceans during prolonged dry periods. Whilst abundance was lower during the February surveys, records were more widespread which can be attributed to increased water flow and accessibility throughout the waterways of the study area.

Aquatic Vertebrates

The Aquatic Ecology assessment undertaken by FRC in 2010 did not record any threatened aquatic vertebrate species listed under state or federal legislation, in addition no threatened aquatic vertebrates were considered likely to occur within the study area. The survey did not record any exotic aquatic vertebrate species.

For each site, the taxonomic richness, total abundance, abundance of listed protected species and abundance of each life cycle stage was determined. Eight species of fish were recorded during the field surveys, these are presented in Table 4.

Table 4: Stage 2 - Aquatic Ecology - Recorded Fish Species

Common Name	Scientific Name
Agassiz's Glassfish	<i>Ambassis agassizii</i>
Fly-specked Hardyhead	<i>Craterocephalus stercusmuscarum</i>
Carp Gudgeon	<i>Hypseleotris sp.</i>
Spangled Perch	<i>Leiopotherapon unicolor</i>
Eastern Rainbowfish	<i>Melanotaenia s. splendida</i>
Purple-spotted Gudgeon	<i>Mogurnda adspersa</i>
Bony Bream	<i>Nematalosa erebi</i>
Hyrtl's Tandan	<i>Neosilurus hyrtlii</i>

Adults dominated the fish communities during both surveys. The number of juveniles decreased slightly between the December and February surveys while the number of intermediates increased. This has been attributed to the maturation of juveniles over this time period.

Krefft's River Turtle (*Emydura macquarii krefftii*) was recorded in the study area at sites WU1 and W1. Seven individuals were captured during the December 2009 survey and 24 were captured in February 2010.



3.0 Methodology

3.1. Desktop Study and Literature Review

A comprehensive desktop study was carried out prior to the field survey. The following databases and Geographic Information System (GIS) layers were searched/obtained:

- DNRM Regulated vegetation report (2017b).
- DEHP MSES, REs and terrestrial biodiversity and aquatic conservation values map and report with a 2km radius from the project area (2017c).
- DEHP Protected plants flora survey trigger map (2017d).
- Department of State Development, Infrastructure and Planning (2017). SPP Interactive Mapping System.
- Department of the Environment and Energy (DEE) Protected Matters Search Tool with a 10 km radius from the centre of the project area (2017a).
- Species Profile and Threats Database (DEE, 2018).
- DEHP Wildlife Online database with a 10 km radius from the centre of the project area (2017)
- Department of Science, Information, Technology and Innovation (DSITI) REs Mapping digital data layer (2017).
- Bureau of Meteorology (BoM) Groundwater Dependant Ecosystems (GDE) Map Report with a 5km radius from the centre of the project area (2017a).
- Atlas of Living Australia (ALA) database with a 10km radius from the centre of the project area (2017).
- Birdlife Australia Atlas of Australian Birds (AAB) database with a 10km radius from the centre of the project area (2017).

The results of these searches are presented in Section 4 and Appendices 5-11. In addition to the desktop searches, the following literature was reviewed:

- PB (2010). Middlemount Coal Project (Stage 2) Terrestrial Ecological Impact Assessment. In PB (2011) Middlemount Coal Project (Stage 2) Environmental Impact Statement.
- FRC (2010). Middlemount Coal Project EIS, Stage 2: Aquatic Ecology. In PB (2011) Middlemount Coal Project (Stage 2) Environmental Impact Statement.
- EHP. (2012). Ecological Investigations within the Offset Area for Stage 2 of the Middlemount Coal Mine, Qld.
- MCPL. (2013). Middlemount Coal Mine Offset Management Plan/Vegetation Management Plan.
- Naturecall (2014b). Ecological Assessment Report for Bingegang Pipeline Relocation, Middlemount Coal Mine. Naturecall (2014b). Ecological Monitoring for Offset Area: Annual Report.



- Naturecall (2015b). Terrestrial Ecology Impact Assessment: North-eastern Extension of Middlemount Coal Mine, Middlemount QLD. Unpublished Report to MCPL.
- Naturecall (2015a). Ecological Monitoring for Offset Area: Annual Report.
- Naturecall (2016a). Ecological Monitoring for Offset Area: Annual Report.
- Naturecall (2017a). Ecological Monitoring for Offset Area: Annual Report.
- Naturecall (2017b). Baseline Ecological Assessment for North-eastern Extension Offset Area.

3.2. Flora Surveys

Field surveys for these assessments were undertaken by two ecologists over two survey periods. Field surveys dates were 2-6th May 2017 for the western study area and 22-24th July for the eastern study area.

The primary aims of the field survey were to verify DEHP RE mapping for the study areas; refine previous RE mapping by PB (2010) and EHP (2012); identify and describe MSES and MNES (e.g. threatened flora species, REs and Commonwealth listed threatened ecological communities [TEC]); and collect sufficient data to conduct a terrestrial habitat quality assessment in accordance with the Guidelines (DEHP 2017a). Details of the flora and habitat quality surveys are provided in the following sections.

3.2.1. Flora Sampling and Vegetation Mapping

REs on the study areas were surveyed and field verified as per the *Methodology for Survey and Mapping of REs and Vegetation Communities in Qld* (Neldner et al. 2017). This consisted of both secondary and quaternary flora survey methods.

Five secondary sites and ten quaternary sites were undertaken over the two study areas. The location of these is shown in Figure 7.

Changes to RE mapping were made in the field using a tablet loaded with GIS Kit Pro (Garafa Inc.). This allowed highly accurate mapping of vegetation boundaries live in the field. This was followed by desktop mapping using ArcGIS 10.2 for Windows and recent satellite imagery (June 2017) supplied by MCPL.

3.2.2. Targeted Searches for Threatened Flora Species

The DEHP *Flora Survey Guidelines - Protected Plants* (DEHP 2014a) states that threatened flora surveys are required if the site falls within a high risk area (as defined by an online mapping tool) or if a threatened species is known to occur within the impact area. The study areas does not fall within a high risk area (see map in Appendix 9) and no threatened flora species are known to occur in the impact area.

However, given nearby records of *Cerbera dumicola* (near threatened) (PB 2010), and that only part of the study areas have been previously surveyed for threatened flora by PB (2010) and Naturecall (2014c); searches for threatened flora were carried out to increase confidence of the presence/absence of threatened flora.



This was achieved via conducting walking transects across the study areas, along with opportunistic searches during other activities.

3.2.3. Threatened Ecological Community Identification

Vegetation communities identified during the surveys were assessed for their conservation status under the EPBC Act, VM Act and DEHP Biodiversity Status. Brigalow communities were also assessed according to the Approved conservation advice for the Brigalow EEC (Department of the Environment, [DofE] 2013) and the Species Profile and Threats Database (DEE, 2018).

3.2.4. Habitat Quality Assessment

The survey methodology outlined in the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a) was used to collect field attributes and determine a terrestrial habitat quality score for the study areas. This methodology uses BioCondition plots to collect field data (Eyre et al 2015).

A total of 16 site condition assessments (plots and transects) were undertaken on the western study area with six on the eastern study area. The location of these plots is shown in Figure 8. Site selection was based on ground-truthed RE mapping and analysis of high resolution satellite imagery, and aimed to sample a representative coverage of the site vegetation.

The following information was recorded at each of the field sampling sites:

- Observer, location and date.
- RE map unit.
- Photographic record of vegetation.
- Habitat description.
- Tree canopy and subcanopy height.
- Native plant species richness in each layer.
- Number of large trees.
- Recruitment.
- Coarse woody debris.
- Non-native plant cover.
- Percent cover of each layer.

The data collected was also used to determine a terrestrial habitat quality score for the study area, in accordance with the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a) and to assist in determining offset requirements for the Project.



Figure 7: Location of secondary and quaternary survey sites

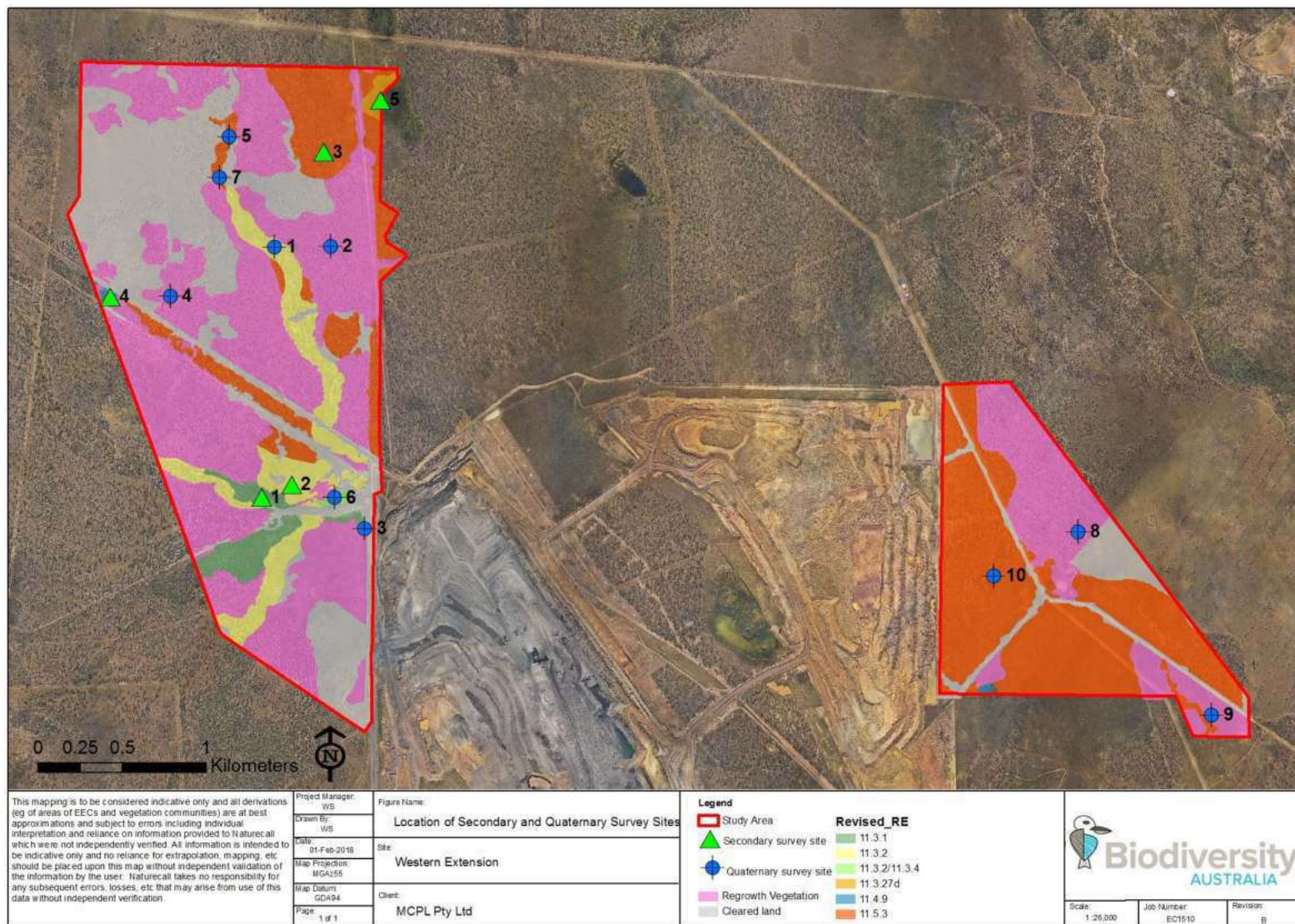
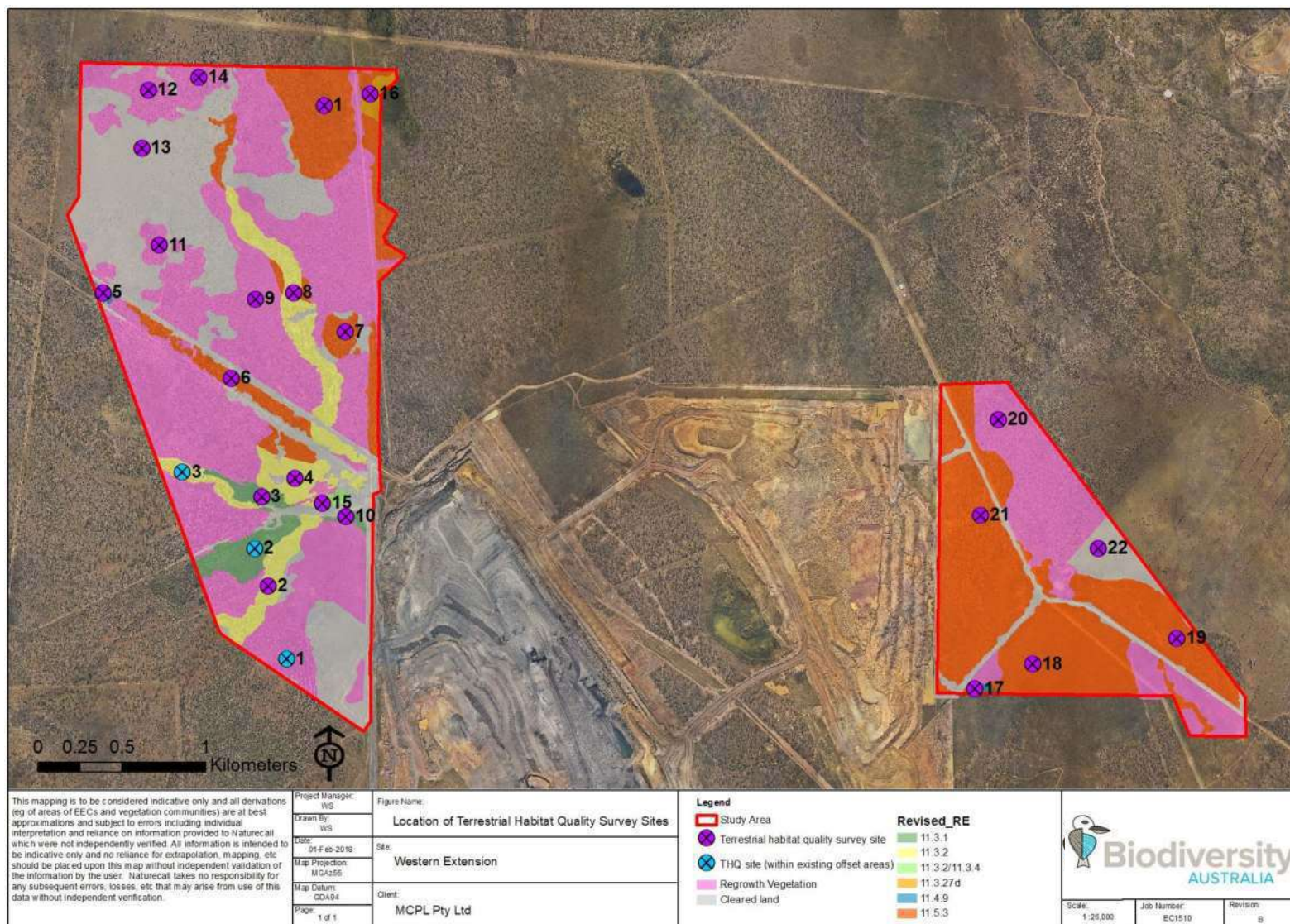




Figure 8: Location of terrestrial habitat quality survey sites





3.3. Fauna Surveys

3.3.1. General

Fauna surveys were undertaken over the study areas by two ecologists over four survey periods. The western study area was surveyed from 2-6 May 2017 and 14-18 September 2017. The eastern study area was subject to a preliminary survey from 22-24 July 2017 and a full fauna survey from 14-18 September 2017.

The first survey occurred in the autumn/winter survey period, with the second survey taking place in the spring/summer period to account for seasonal variation in fauna usage and abundance. Weather conditions for the survey periods are detailed in Section 4.3.4.

Fauna surveys were conducted in accordance with the following guidelines:

- *Terrestrial Vertebrate Fauna Survey Guidelines for Qld* (Eyre et al, 2014)
- *Survey Guidelines for Australia's Threatened Reptiles* (DSEWPC 2011a).
- *Survey Guidelines for Australia's Threatened Mammals* (DSEWPC 2011b).
- *Survey Guidelines for Australia's Threatened Birds* (Department of the Environment, Water, Heritage and the Arts [DEWHA] 2010a).
- *Survey Guidelines for Australia's Threatened Bats* (DEWHA 2010b).
- *EPBC Act referral guidelines for the vulnerable Koala (combined Qld, NSW and the Australian Capital Territory)* (DofE 2014).
- *EPBC Act Draft Referral Guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPC 2011c).
- Species Profile and Threats Database (DEE, 2018).

3.3.2. Fauna Sampling

Fauna surveys targeted threatened species listed under the NC Act and EPBC Act, as well as pest species, however common species were also surveyed. The following fauna surveys methods were utilised:

- Terrestrial and aquatic habitat assessments.
- Spotlighting.
- Call playback.
- Microbat call recording and analysis
- Harp traps.
- Herpetofauna surveys.
- Diurnal bird surveys.
- PIR camera stations.
- Koala SAT surveys
- Scat, track and secondary evidence searches.



These survey methods are described in detail in the following sections.

3.3.2.1. Terrestrial Habitat Assessment

Habitat assessments were undertaken across the study areas at the terrestrial habitat quality survey plots (Figure 8) and during foot traverses over the Study areas.

Habitats were defined according to parameters such as:

- Structural and floristic characteristics of the vegetation (e.g. understorey type and development, crown depth, groundcover density, etc.).
- Degree and extent of disturbance (e.g. fire, logging, weed invasion, modification to structure and diversity, etc.).
- Presence of water in any form (e.g. dams, creeks, drainage lines, soaks).
- Size and abundance of hollows and fallen timber.
- Availability of shelter (e.g. rocks, logs, hollows, undergrowth).
- Wildlife corridors, refuges and proximate habitat types (i.e. connectivity between suitable habitats).
- Presence of resources (e.g. mistletoe, nectar, gum, seed, sap, etc.).

This information, along with information obtained from the desktop assessment was used to formulate a list of potentially occurring threatened fauna species for the Study areas.

3.3.2.2. Aquatic Habitat Assessment

Assessments were undertaken at each ephemeral drainage line in the Study areas during the September survey period. This involved recording physical characteristics of the ephemeral drainage lines, their current condition and assessing their suitability to support aquatic fauna.

3.3.2.3. Spotlighting

Spotlighting was conducted for 1.5-2 hours per night for eight nights over the western Study area and four nights over the eastern Study area.

This involved driving transects from a vehicle moving at walking pace along roads and tracks and walking transects using hand-held spotlights through both vegetated areas and along tracks. The location of spotlight transects is shown on Figures 9 and 11.

All habitat components (i.e. understorey/canopy trees for arboreal fauna), the ground and terrestrial strata (e.g. logs, areas with good leaf litter accumulations, etc.) were searched for terrestrial fauna.

Spotlighting was conducted approximately one hour after dusk. Conditions varied between clear and overcast, and wind ranged from placid to moderate.



3.3.2.4. Call Playback

Call playback was carried out for eight nights over the western Study area and for four nights over the eastern Study area. The location of call playback points is shown on Figures 9 and 11.

Recorded calls of the threatened Powerful Owl (*Ninox strenua*), Squirrel Glider (*Petaurus norfolcensis*) and Koala (*Phascolarctos cinereus*) along with common species such as the Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*), Bush-stone Curlew (*Burhinus grallarius*) and Sugar Glider (*Petaurus breviceps*) were broadcast during call playback surveys.

Calls were played through a portable MP3 player via a 30W PA system from the rear of a utility at a level approximating natural intensities of the species. The general methodology involved an initial period of listening and spotlighting; followed by playback of the calls simulating a natural pattern. This was followed by 10 minutes of listening and 15-20 minutes spotlighting for fauna attracted by the calls (but not responding vocally), within a 100m radius of the playback point.

Calls were generally played soon after dusk, when such calls are normally heard.

3.3.2.5. Microbat Call Recording and Analysis

Microbat call detection was undertaken over both Study areas using two Anabat Express units (Titley Scientific). The units were deployed overnight at various locations including roads/tracks, ephemeral drainage lines and forested areas (see Figure 9 and 11). Nine nights of recording was conducted at the western Study area and four nights at the eastern Study area. This resulted in >130 hours of recording over both areas.

The recordings were forwarded to Greg Ford of Balance! Environmental, a bat call identification consultant, for identification of the bat species.

3.3.2.6. Harp Trapping

A harp trap was set at each study area during the September survey period targeting the South-eastern Long-eared Bat (*Nyctophilus corbeni*). These were set along ephemeral drainage lines which could potentially be used as flyways by Microbats (Photo 4, Figure 12). The traps were checked each night during spotlighting and within one hour of dawn each morning. Any bats captured were kept in an air-conditioned office during the day and released near the point of capture after dark.



Photo 4: Harp trap at eastern Study area



3.3.2.7. Herpetofauna Searches

Searches primarily targeting the Ornamental Snake, Yakka Skink (*Egernia rugosa*), Brigalow Scaly-foot (*Paradelma orientalis*), Dunmall's Snake (*Furina dunmalli*), and Golden-tailed Gecko (*Strophurus taenicauda*) were undertaken within 50m x 50m quadrats. These were conducted at six locations within the western Study area (surveyed in May and September) and three locations in the eastern Study area (Figures 10 and 12).

Herpetofauna searches involved active diurnal lifting up and rolling of timber and debris, inspection of dense vegetation and leaf litter and observation of likely basking sites for a total of 60 person minutes per site. Nocturnal herpetofauna torch searches were carried out in suitable habitat in conjunction with walking spotlight transects.

3.3.2.8. Diurnal Bird Surveys

Birds were surveyed by detecting calls and searching using binoculars at point positions or along a walking transect within 2 hours of dawn when peak activity usually occurs.

Specific bird censuses were undertaken each morning during the survey periods for 30 minutes with two observers. A total of 11 bird surveys were carried out on the western Study area and four on the eastern Study area over both autumn/winter and spring/summer survey periods (Figure 10 and 12).



Incidental observations of birds were also recorded during other survey activities. This provided short-term seasonal data on bird occurrences in the area for the particular seasons.

3.3.2.9. Passive Infrared Camera Stations

Six infra-red cameras were deployed at various locations over the western Study area (Photo 5) during the May surveys and four during the September surveys. Cameras were set for ten nights during the May surveys and five nights during the September survey. Four infrared cameras were set over the eastern Study area for five nights during the September survey period (Figures 9 and 11).

The cameras were set either in forested areas or facing a road/track and were baited with either a mixture of oats, peanut butter and apple, or a meat bait consisting of chicken necks and tinned cat food.

Target species were the Northern Quoll (*Dasyurus hallucatus*), arboreal mammals, raptors and feral species such as European Red Foxes (*Vulpes vulpes*), dogs/dingoes (*Canis* sp.), feral cats (*Felis catus*) and pigs (*Sus scrofa*).

Photo 5: Anabat and PIR camera set at western Study area



3.3.2.10. Koala SAT Surveys

Three Koala Spot Assessment Technique (SAT) surveys were undertaken at the western Study area and two at the eastern Study area. The location of these is shown in Figures 10 and 12.



The SAT surveys consisted of checking the ground and leaf litter in a 1m radius around 30 trees for a period of two minutes per tree or until a scat was found. This technique is recognised as a very efficient method of detecting Koala presence, and in some instances, is a method used to identify areas of major Koala activity/significance e.g. Core Koala Habitat (Phillips and Callahan 1995).

The method is used by the Australian Koala Foundation primarily for mapping Koala habitat at a landscape scale (Phillips and Callahan 1995, 2011). The methodology uses a specific sampling technique to gauge the level of Koala activity at a sampling site, by the number of trees recording Koala scats divided by the total number of trees in the sampling area expressed as a percentage (Phillips and Callaghan 2011).

3.3.2.11. Track, Scat and Sign Searches

Searches for scats, tracks, feeding signs and scratch marks on trees were undertaken opportunistically along roads/tracks and within forested areas at the herpetofauna survey sites.

The sandy roads within and around the Study areas provided ideal locations for track searches, and any tracks found were photographed and identified using the methodology outlined in Triggs (1996). Predator scats were targeted for survey as remains can provide records of cryptic fauna.



Figure 9: Location of autumn/winter fauna survey sites part A

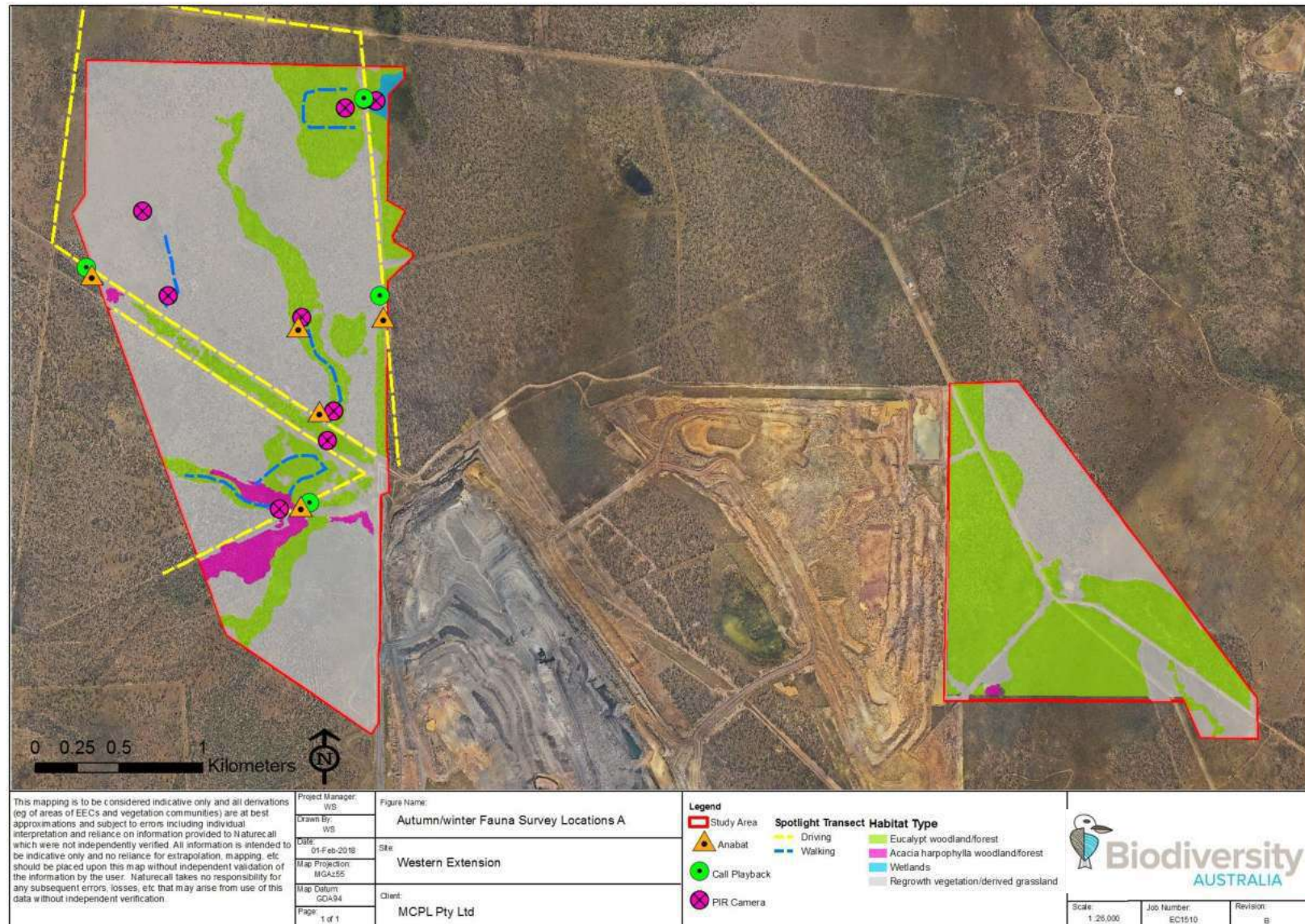




Figure 10: Location of autumn/winter fauna survey sites part B

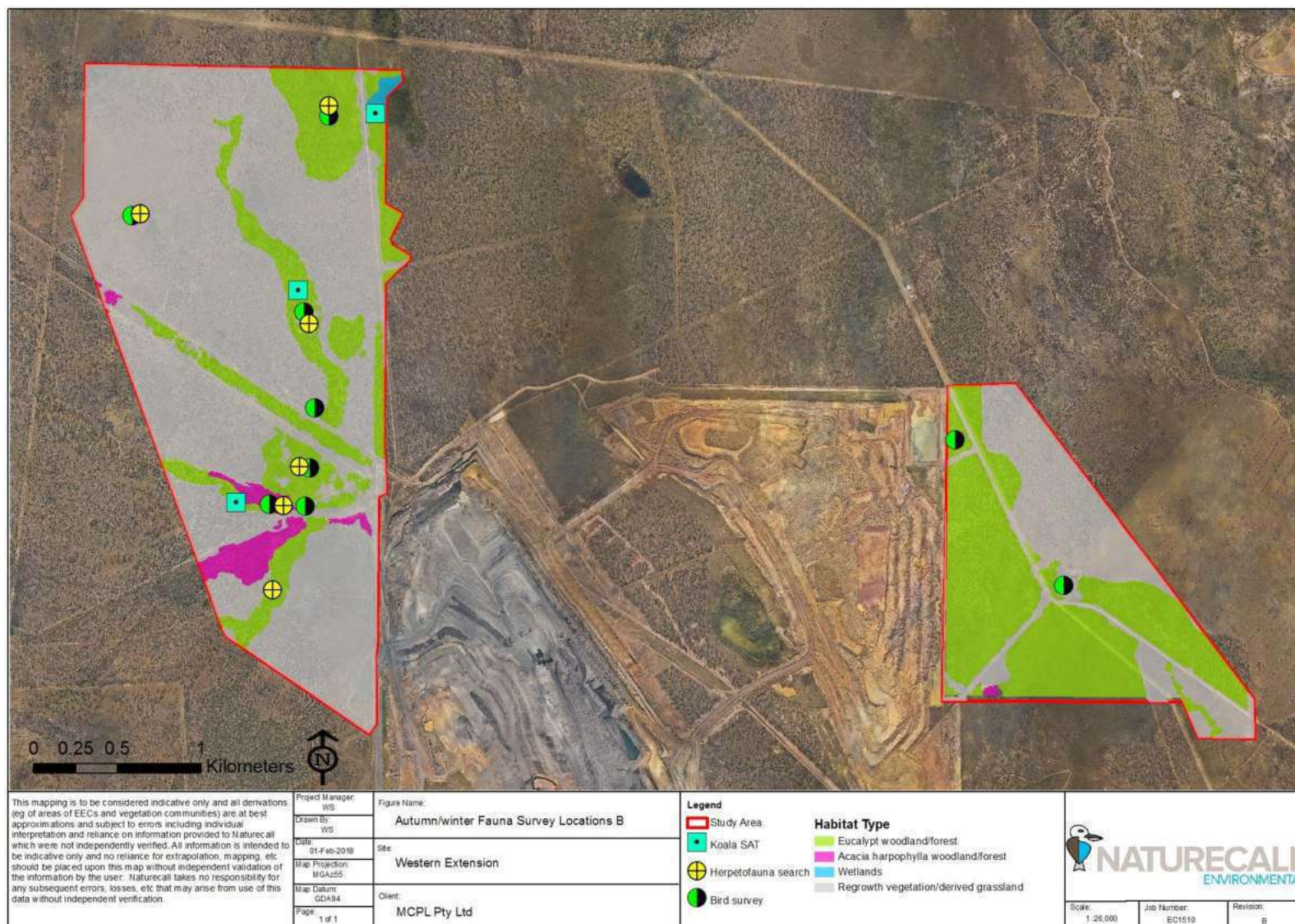




Figure 11: Location of spring/summer fauna survey sites part A

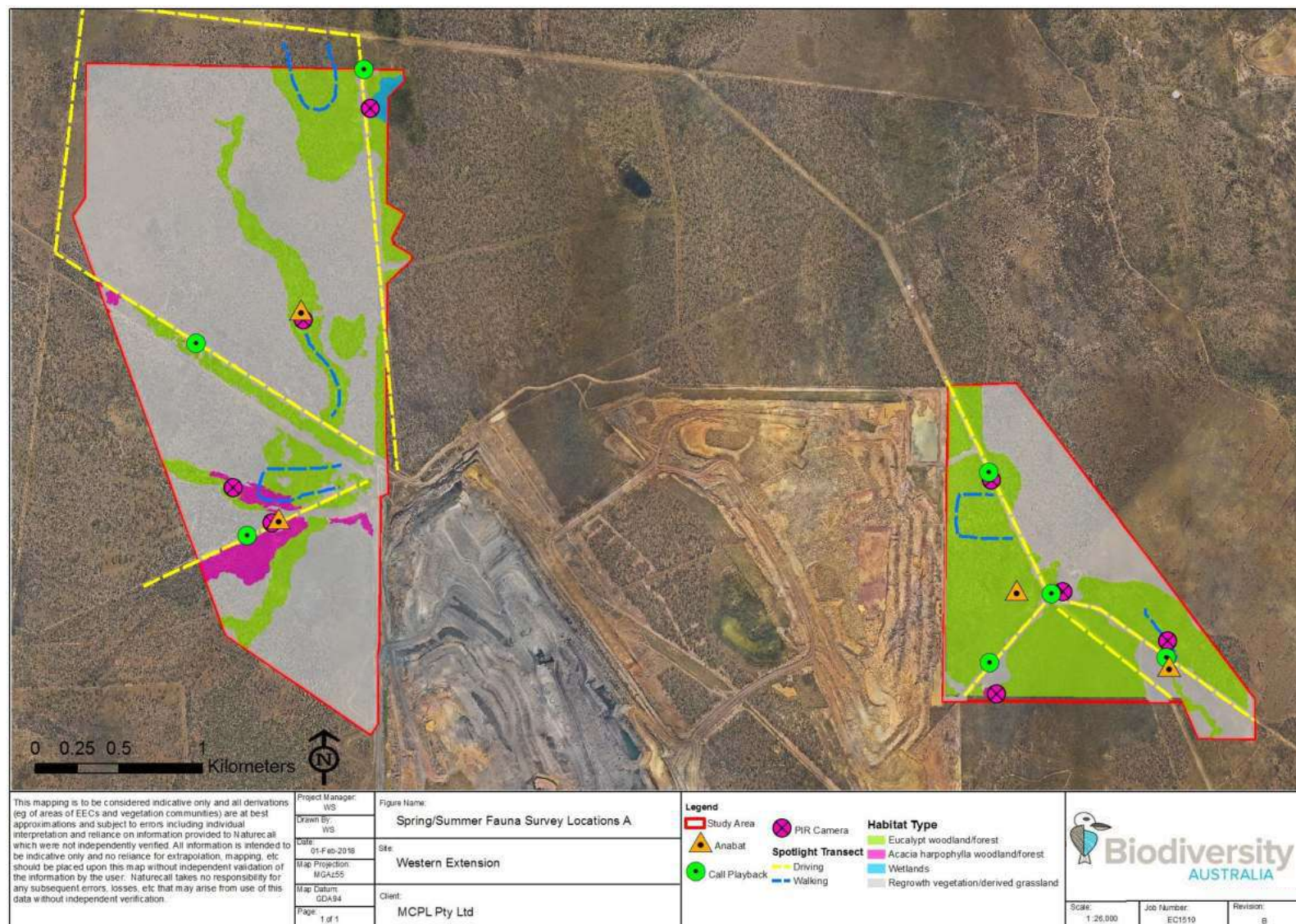
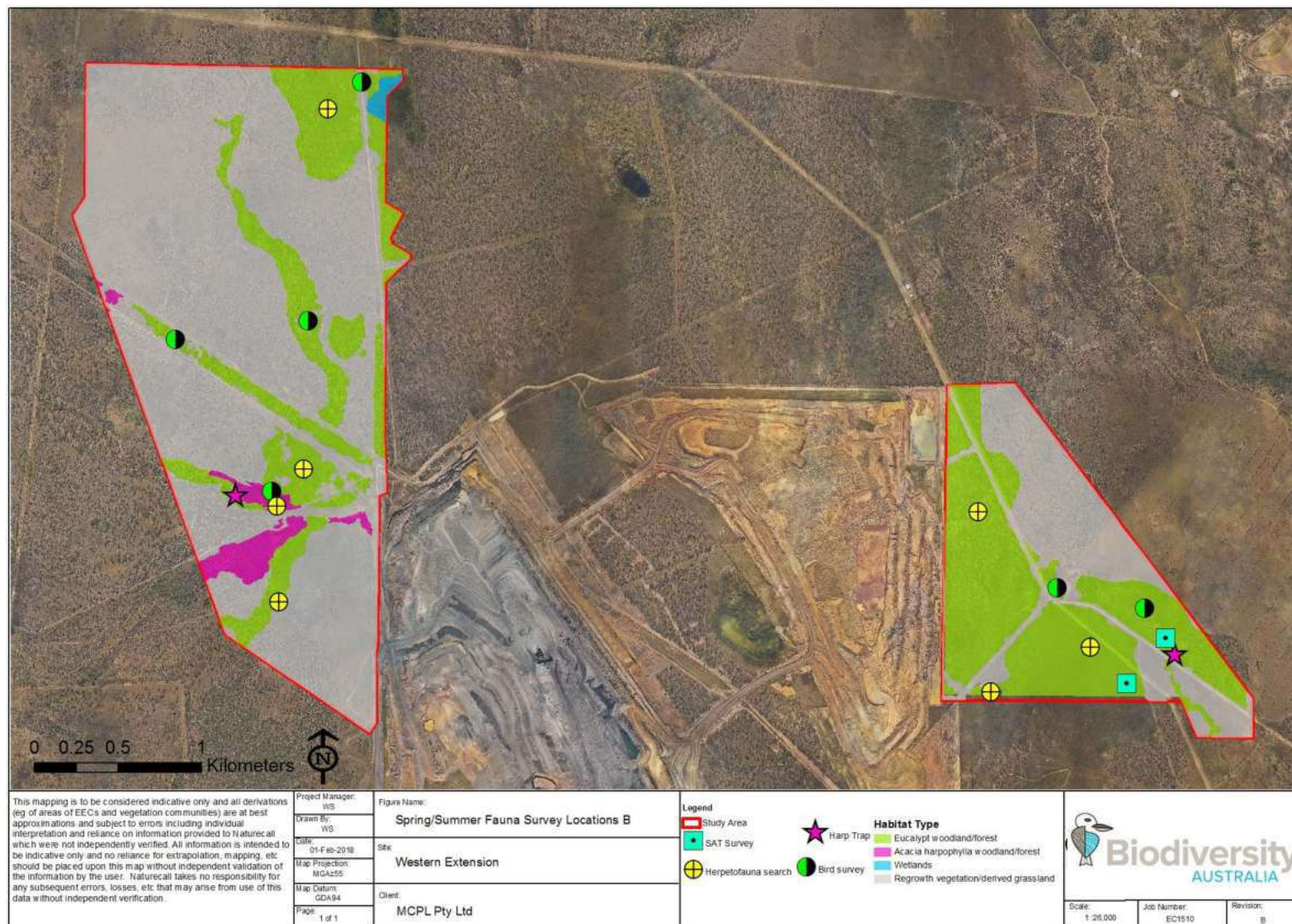




Figure 12: Location of spring/summer fauna survey sites part B





3.4. Weather Conditions During the Surveys

3.4.1. Survey Periods

3.4.1.1. May 2017 Survey

Weather conditions were generally fine and sunny with no rainfall recorded during the survey period. Winds ranged from nil to moderate. Minimum temperatures ranged from 8.3°C to 15°C with maximum temperatures ranging from 23.1°C to 28.5°C (BoM 2017 – nearest weather station at Emerald Airport, station 035264).

The moon phase ranged from new moon to first quarter.

Heavy rain and flooding preceded the survey. Middlemount Coal Mine recorded 342 millimetres (mm) of rainfall in March 2017.

3.4.1.2. September 2017 Survey

Weather conditions were fine, warm and sunny with no rainfall recorded during the survey period or the preceding month. Winds ranged from nil to moderate. Minimum temperatures ranged from 9.3°C to 17.9°C with maximum temperatures ranging from 26.8°C to 30.4°C (BoM 2017b – nearest weather station at Emerald Airport).

The moon phase ranged from half-moon to last quarter.

3.4.2. Limitations

3.4.2.1. Flora

The field surveys were undertaken over two different seasons in late autumn (post-wet season) and early spring (pre-wet season).

The post-wet season survey in May 2017 was preceded by heavy rains and flooding, and most grass species were in seed at this time making them easily detectable. Drier conditions were experienced during the July and September 2017 survey periods making grasses less detectable, however the warmer temperatures stimulated the flowering of many trees and shrubs. The seasonal variation in surveys allowed for a high rate of detection of flora species. Locally recorded threatened flora species would be easily detectable either year round (e.g. *Cerbera dumicola* – near threatened) or during either of the two survey periods.

3.4.2.2. Fauna

Fauna detectability is limited by seasonal, behavioral or lifecycle characteristics of each species (e.g. seasonal migrants), and by habitat variations (e.g. flowering and seeding periods), which can occur within a year, between years, decades, etc. (Eyre et al. 2014).



The fauna surveys were undertaken over two different seasons in late autumn/winter (post-wet season) and early spring (pre-wet season). While fauna activity may have been low or declining during the surveys in May and July, the Spring survey in September coincided with a period of high activity for many fauna groups due to increased temperatures, resource accessibility and lifecycle stages (e.g. arboreal mammals, Microchiropteran bats and reptiles).

Heavy rains preceded the May survey and standing water was still present in the creek lines, palustrine wetlands and gilgai. This allowed for high detection rates of amphibians (and species which prey on them) and water birds.



4.0 Results

4.1. Desktop Search Results

4.1.1. Threatened Species (NC Act)

Database and literature searches returned records of four fauna and one flora species within a 10 km radius of the study area as shown in Table 5 below. The complete online search results are provided in Appendix 5.

Table 5: Locally recorded threatened species

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Source
Fauna				
Squatter Pigeon (southern)	<i>Geophaps scripta scripta</i>	V	V	EHP 2012, PB 2010, AAB 2017, Naturecall 2014b, Naturecall 2013-2017
Greater Glider	<i>Petauroides volans</i>	V	V	DEHP 2017e, Naturecall 2011-2017
Koala	<i>Phascolarctos cinereus</i>	V	V	EHP 2012, DEHP 2017e, Naturecall 2013-2017
Ornamental Snake	<i>Denisonia maculata</i>	V	V	DEHP 2017e, PB 2010
Flora				
NCN	<i>Cerbera dumicola</i>	NT	-	DEHP 2017e, ALA 2017, PB 2010

V – Vulnerable.

NT – Near Threatened.

4.1.2. Endangered and Of Concern Regional Ecosystems

The following threatened REs listed in Table 6 have been mapped on the western Study area:

Table 6: Locally recorded Endangered and Of Concern Regional Ecosystems

Regional Ecosystem	Code	VMA Status	Biodiversity Status	Source
<i>Acacia harpophylla</i> shrubby woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains	11.4.9	Endangered	Endangered	DSITI 2017, PB 2010
<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains	11.3.1	Endangered	Endangered	DSITI 2017, PB 2010
<i>Eucalyptus populnea</i> woodland on alluvial plains	11.3.2	Of concern	Of concern	DSITI 2017, PB 2010



4.1.3. Matters of State Environmental Significance

The results of the MSES search are provided in Table 7. The full report is provided in Appendix 6 and the search was undertaken using a 2 km search radius from the Study areas.

Table 7: Matters of State Environmental Significance search results

Category	Present on Site?	Description
Protected areas	No	-
Marine parks	No	-
Fish habitat areas	No	-
High ecological significance (HES) wetlands	Yes	Palustrine wetland in northeast of western study area
High ecological value wetlands	No	-
High ecological value waterways	No	-
Threatened species habitat (plants, animals and breeding places)	No	-
Regulated vegetation	Yes	Regulated vegetation occurs in the south and northeast of the western Study area
Legally secured offset areas	Yes	Not shown in search results, however the Stage 2 and Rail Loop & Spur Offset Areas occur within the western Study area.



4.1.4. Matters of National Environmental Significance

The results of the MNES search are provided in Table 8. The search was undertaken using a 10km search radius from the study area. See Appendix 10 for the full report.

Table 8: Matters of National Environmental Significance search results

Category	Result	Description
World Heritage Properties	No	-
National Heritage Places	No	-
Wetlands of International Importance	No	-
Great Barrier Reef Marine Park	No	-
Commonwealth Marine Area	No	-
Listed TECs	2	One listed TEC is known to occur within the area and one is likely to occur within the area.
Listed Threatened Species	21	Species or species habitat known/likely/may occur within the area.
Listed Migratory Species	12	Migratory wetland, terrestrial and marine species or species habitat known/likely/may occur within the area

4.1.5. Groundwater Dependant Ecosystems

A GDE is one in which the plant and/or animal community is dependent on the availability of groundwater to maintain its structure and function. Desktop mapping of potential GDEs through-out QLD (BoM 2017a) indicates that areas of with possible high, moderate and low potential for groundwater interaction occur within the Project locality. The desktop GDE mapping (BoM, 2017a) indicates:

- Terrestrial vegetation associated with watercourses (Roper Creek) and a drainage line (Drainage Line 1) is mapped as having a high potential to be associated with subsurface presence of groundwater.
- Aquatic habitat associated with watercourses (Roper Creek) and a drainage line (Drainage Line 1) is mapped as having a moderate potential to be reliant on surface expression of groundwater.
- Terrestrial vegetation and aquatic habitat associated with palustrine wetlands outside of ML 70417 and ML 70379 is mapped as having a high potential to be associated with subsurface presence of groundwater.

All other terrestrial vegetation (REs mapped by DSITI, 2017), is broadly mapped as having a low to moderate potential of being associated with subsurface presence of groundwater (BoM, 2017a).



The accuracy of the desktop GDE mapping (BoM 2017a) of the Project locality has been reviewed by AGE (2018) and Biodiversity Australia, with the following conclusions made in relation to the presence/absence of GDEs based on detailed site surveys and assessments:

- The majority of the terrestrial vegetation associated with Roper Creek and Drainage Line 1 is unlikely to be dependent on groundwater given the vegetation along these drainage features also occurs more widely across the landscape and is not restricted to areas where it could potentially access groundwater. There are small areas of RE 11.3.25 along Roper Creek which contains Qld Blue Gum (*Eucalyptus tereticornis*) and River Oak (*Casuarina cunninghamiana*) which are sometimes reliant on access to groundwater, however, the groundwater levels adjacent to Roper Creek range between 18.9 m below ground level (mbgl) and 22.7 mbgl (AGE 2018). Based on the depth to groundwater surrounding Roper Creek being around 20 mbgl it is unlikely that these communities would be reliant on access to groundwater.
- Aquatic habitat associated with Roper Creek and Drainage Line 1 is unlikely to be dependent on groundwater given the ephemeral nature of the drainage features (Plates 1 and 2).
- Terrestrial vegetation and aquatic habitat associated with palustrine wetlands north of ML 70417 and ML 70379 could potentially be reliant on groundwater given the RE mapped in these areas by DSITI (2017). DSITI (2017) has mapped these areas as RE 11.3.27, which contains River Red Gum (*Eucalyptus camaldulensis*) and Queensland Blue Gum, both species that could be reliant on subsurface expression of groundwater to some degree. However, given groundwater levels in this area have been identified as being in excess of 12 mbgl, it is likely that these communities would have limited reliance on groundwater.
- All other terrestrial vegetation is unlikely to be dependent on groundwater given that there is no evidence that any vegetation surrounding the Project area has experienced any impacts (i.e. dieback) from the existing operations.

The database map report is provided in Appendix 11.

4.2. Flora Survey Results

4.2.1. Floristics

The study areas were found to have reasonable floristic diversity, however exotic grasses and herbs have outcompeted native species over large areas of the study area, which has led to changes in forest structure and composition.

A total of 174 flora species were recorded during the survey (Appendix 2). Nineteen of these were introduced species with the remainder being native. The highest flora diversity was found in remnant communities which had an intact ground layer. No threatened flora species were recorded during the surveys. The flora list for the study areas is provided in Appendix 2.

RE descriptions are provided in the following Section.



4.2.2. Regional Ecosystems

Vegetation surveys ground-truthed six distinct RE's on the western Study area and two on the eastern Study area. Minor changes to existing RE mapping by PB (2010) and DSITI (2017) were made by the field validation process described in Section 3.2.1, by refining RE boundaries and separating out mixed RE's.

A description of the ground-truthed REs in the study area are provided in Tables 9 to 14. The communities are named as per the *Regional Ecosystem Description Database V10.0* (DSITI 2016). The DSITI RE mapping is shown in Figure 13 and a field verified RE map has been produced and is shown in Figure 14.

Photos 6-11 following the description illustrate the vegetation within the study areas.

A flora list for the study areas is provided in Appendix 2.



Table 9: Regional Ecosystem 11.5.3 description

RE Type	11.5.3: <i>Eucalyptus populnea</i> ± <i>E. melanophloia</i> ± <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces.
Extent on Site	Occurs as a several patches and linear stands in the western study area. Covers most of the eastern study area. The total area across both study areas is 154 ha (Photo 6).
General Description	a) Canopy Structure and species: The canopy consists of an open layer of generally even aged mature trees ranging from 15-20 m in height. Poplar Box (<i>Eucalyptus populnea</i>) is the dominant species. Common to occasional canopy associates include Clarkson's Bloodwood (<i>Corymbia clarksoniana</i>), Reid River Box (<i>Eucalyptus brownii</i>), Moreton Bay Ash (<i>C. tessellaris</i>) and Ghost Gum (<i>C. dallachiana</i>). b) Subcanopy Structure and species: The subcanopy generally consists of an open to sparse tall shrub/small tree layer from 4-10 m in height dominated by Leichardt Bean (<i>Cassia brewsteri</i>), Quinine Tree (<i>Petalostigma pubescens</i>), Ironwood (<i>Acacia excelsa</i>), Native Willow (<i>Acacia salicina</i>) and False Sandalwood (<i>Eremophila mitchellii</i>). Other less common species in this layer include Silver Oak (<i>Grevillea parallela</i>), Dead Finish (<i>Archidendropsis basaltica</i>), Bootlace Oak (<i>Hakea lorea</i>) and Red Ash (<i>Alphitonia excelsa</i>). c) Shrub layer Structure and species: A low shrub layer to 0.5 m in height is occasionally present and consists of patches of Currant Bush (<i>Carissa ovata</i>) along with other species such as Stylo (<i>Stylosanthes scabra</i>*), Dysentery Bush (<i>Grewia latifolia</i>), <i>Sida filiformis</i> and <i>Sida cordifolia</i>. d) Groundcover Structure and species: The groundcover ranges from dense to open with height usually ranging from 0.1-0.5 m in height. Introduced grasses such as Buffel Grass (<i>Cenchrus ciliaris</i>*), Sabi Grass (<i>Urochloa mosambicensis</i>*) and Red Natal Grass (<i>Melinis repens</i>*) are the dominant species overall, however less disturbed areas also existed that feature an open groundcover of native grasses such as Kangaroo Grass (<i>Themeda australis</i>), Black Speargrass (<i>Heteropogon contortus</i>), Native Millet (<i>Panicum decompositum</i>), Queendland Bluegrass (<i>Dichanthium sericeum</i>), and Forest Bluegrass (<i>Bothriochloa blahdii</i>).
Condition	Good condition overall with most areas featuring an intact canopy and understorey. Grazing has impacted the ground layers however via trampling and spreading exotic grasses. Weed cover is moderate to high but limited to exotic grass infestations in the ground layer and occasional Prickly Pear (<i>Opuntia stricta</i>). Large non-remnant areas of this community also occur in the study area. These areas feature a regenerating layer of canopy trees to approximately 8 m height and a groundcover dominated by exotic pasture grasses.
Conservation Status	'Least Concern' under VM Act and 'Not of Concern' Biodiversity Status.

* Exotic species.



Photo 6: RE 11.5.3



Table 10: Regional Ecosystem 11.3.2 description

RE Type	11.3.2: <i>Eucalyptus populnea</i> woodland on alluvial plains
Extent on Site	Occurs in the south and central parts of the western study area on floodplains associated with Drainage Line 1 and 2. Total area is 43.5 ha (Photo 7).
General Description	a) Canopy <i>Structure and species:</i> The canopy comprises an open tree layer which is dominated by Poplar Box. Other canopy associates include Moreton Bay Ash and Clarkson's Bloodwood. Height ranges from 17-20 m. b) Subcanopy <i>Structure and species:</i> A low tree layer ranging from 12-15 m in height is occasionally present. This consists of young Poplar Box and Moreton Bay Ash. c) Shrub layer <i>Structure and species:</i> This community features an open to mid-dense tall shrub layer ranging from 5-8 m in height. Commonly recorded species in this layer include False Sandalwood, Leichardt Bean, <i>Melaleuca nervosa</i>, and Ironwood. A low shrub layer is occasionally present and range from 1-2 m in height. Species recorded in this layer include <i>Grewia latifolia</i>, Coffee Bush (<i>Breynia oblongifolia</i>) and Western Boobialla (<i>Myoporum montanum</i>). d) Groundcover <i>Structure and species:</i> In most situations the groundcover is dense, however is sometimes open and patchy. Height ranges from 0.05-0.5 m. Dominant species recorded in this layer include Buffel Grass, Sabi Grass, <i>Chrysopogon fallax</i>, Black Speargrass, <i>Sida cordifolia</i> and Yellow Buttons.
Condition	Good remnant condition overall, with most disturbance occurring in the ground layer as a result of cattle grazing.
Conservation Status	'Of concern' under VM Act and 'Of concern' Biodiversity Status.



Photo 7: RE 11.3.2



Table 11: Regional Ecosystem 11.3.2/11.3.4 description

RE Type	11.3.2/11.3.4: <i>Eucalyptus populnea</i> woodland on alluvial plains / <i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus</i> spp. woodland on alluvial plains.
Extent on Site	A single patch occurs in the south-east of the site adjacent to Drainage Line 1. Area is 1.5 ha (Photo 8).
General Description	a) Canopy <i>Structure and species:</i> The canopy is relatively dense (approx. 45% cover) and ranges in height from 17-23 m. It is dominated by Qld Blue Gum (<i>Eucalyptus tereticornis</i>) and Moreton Bay Ash. Poplar Box is an uncommon canopy associate. b) Subcanopy <i>Structure and species:</i> A low tree layer to 13 m in height is present and consists of a mid-dense layer of <i>Melaleuca nervosa</i>. c) Shrub layer <i>Structure and species:</i> Limited to juvenile <i>Melaleuca</i> and occasional Leichardt Bean. d) Groundcover <i>Structure and species:</i> Comprises a dense groundcover (almost 100% cover) of grass. The dominant species is Green Panic (<i>Panicum maximum</i>) and Buffel Grass is also common. Occasional sedges including Dirty Dora (<i>Cyperus difformis</i>) are also present.
Condition	Fair condition, however very few native species are present in the groundcover. The dense layer of grasses has also suppressed regeneration of native forbs and shrubs.
Conservation Status	'Of concern' under VM Act and 'Of concern' Biodiversity Status.



Photo 8: RE 11.3.2/11.3.4



Table 12: Regional Ecosystem 11.3.27d description

RE Type	11.3.27d: <i>Eucalyptus camaldulensis</i> and/or <i>E. tereticornis</i> woodland
Extent on Site	A small extent of this RE occurs in the northeast of the western study area and forms the edge of larger patch. Area on site is 1.9 ha (Photo 9).
General Description	a) Canopy <i>Structure and species:</i> The canopy comprises an open tree layer which is dominated by Qld Blue Gum and Moreton Bay Ash with occasional Poplar Box located around the edges. Height ranges from 18-25m. b) Subcanopy <i>Structure and species:</i> A sparse lower tree layer ranging from 10-15 m in height occurs throughout. This consists of young Qld Blue Gum. c) Shrub layer <i>Structure and species:</i> Absent. d) Groundcover <i>Structure and species:</i> A low layer of sedges, forbs and grasses is present, with density changing throughout the year depending on the season. During the May survey the groundcover was very dense and lush with standing water present, however was largely comprised of bare ground and dead grass during the September survey. Height ranges from 0.01-1 m. Common to dominant species include <i>Cyperus exaltatus</i>, Nardoo (<i>Marsilea hirsuta</i>), <i>Eleocharis sphacelata</i>, Water Snowflake (<i>Nymphoides indica</i>) and Clustered Lovegrass (<i>Eragrostis elongata</i>).
Condition	Very good condition with little evidence of disturbance. Feral pigs were noted to have rooted up large areas of groundcover during the September survey. No weeds recorded.
Conservation Status	'Least concern' under VM Act and 'Of concern' Biodiversity Status.



Photo 9: RE 11.3.27d





Table 13: Regional Ecosystem 11.3.1 description

RE Type	11.3.1: <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains
Extent on Site	Occurs as several patches in the south of the western study area adjacent to Drainage Line 1. Total area is 15 ha (Photo 10).
General Description	a) Canopy <i>Structure and species:</i> Consists of a mid-dense tree layer ranging from 10-15 m in height. Brigalow (<i>Acacia harpophylla</i>) is the dominant species. Uncommon canopy associates include Dawson's Gum (<i>Eucalyptus cambageana</i>) and Emu Apple (<i>Owenia acidula</i>), Bauhinia (<i>Lysiphyllum caronii</i>) and Yellow Wood (<i>Terminalia oblongata</i>). b) Subcanopy <i>Structure and species:</i> A low tree/tall shrub layer to 6 m in height is often present. Common to occasional species in this layer include juvenile Brigalow, False Sandalwood, Sandalwood (<i>Santalum lanceolatum</i>) and Whitewood (<i>Atalaya hemiglauca</i>). c) Shrub layer <i>Structure and species:</i> A patchy shrub layer to 1 m in height is sometimes present. Consists of Currant Bush, Nepine (<i>Capparis lasiantha</i>) and Dysentery Bush. d) Groundcover <i>Structure and species:</i> Groundcover is generally open with large patches of leaf litter and bare ground present. Grasses and forbs are dominant, and very few weed species occur. Species recorded include a range of grasses including <i>Chloris divaricata</i>, <i>Paspalidium distans</i>, <i>Panicum effusum</i>, <i>Enteropogon ascicularis</i>; and forbs such as Ruby Saltbush (<i>Enchylaena tomentosa</i>), Common Joyweed (<i>Alternanthera nodiflora</i>), <i>Phyllanthus sp.</i> and <i>Cyperus gracilis</i>.
Condition	Generally in good remnant condition with few disturbances noted. Weeds are uncommon and limited to occasional Buffel Grass and Harissia Cactus. Patches of non-remnant Brigalow also occur near Drainage Line 1. These areas feature a dense layer of young Brigalow to 6m in height and a sparse shrub and groundcover.
Conservation Status	'Endangered' under VM Act and 'Endangered' Biodiversity Status. Also listed as Endangered under the EPBC Act.



Photo 10: RE 11.3.1





Table 14: Regional Ecosystem 11.4.9 description

RE Type	11.4.9: <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains
Extent on Site	A small remnant patch occurs in the central west of the western study area. A small patch also occurs in the southwest of the eastern study area. Area totals 1.5 ha (Photo 11).
General Description	a) Canopy <i>Structure and species:</i> Consists of a mid-dense tree layer ranging from 10-17 m in height. Brigalow (<i>Acacia harpophylla</i>) is the only canopy species present. b) Subcanopy <i>Structure and species:</i> A low tree/tall shrub layer to 8 m in height occurs throughout. This layer consists of regenerating Brigalow, Scrub Leopardwood (<i>Flindersia dissosperma</i>), Lime Bush (<i>Citrus glauca</i>), False Sandalwood, Vine Tree (<i>Ventilago viminalis</i>), Whitewood and Emu Apple. c) Shrub layer <i>Structure and species:</i> A patchy shrub layer to 3 m in height is sometimes present. Largely consists of Currant Bush and Nepine. d) Groundcover <i>Structure and species:</i> Groundcover is generally open with large patches of leaf litter and bare ground present. Grasses and forbs are dominant, and very few weed species occur. Species recorded include a range of grasses including <i>Chloris divaricata</i>, <i>Cymbopogon refractus</i>, <i>Bothriochloa ewartiana</i>, <i>Paspalidium distans</i>, <i>Panicum effusum</i> and <i>Enteropogon ascicularis</i>. Sedges and forbs including <i>Cyperus gracilis</i>, Ruby Saltbush and Potato Bush (<i>Solanum ellipticum</i>).
Condition	Generally in good remnant condition with few disturbances noted. Weeds are uncommon and limited to occasional Buffel Grass and Harissia Cactus.
Conservation Status	'Endangered' under VM Act and 'Endangered' Biodiversity Status. Also listed as Endangered under the EPBC Act.



Photo 11: RE 11.4.9





Figure 13: Mapped Regional Ecosystems

Source: DSITI 2017

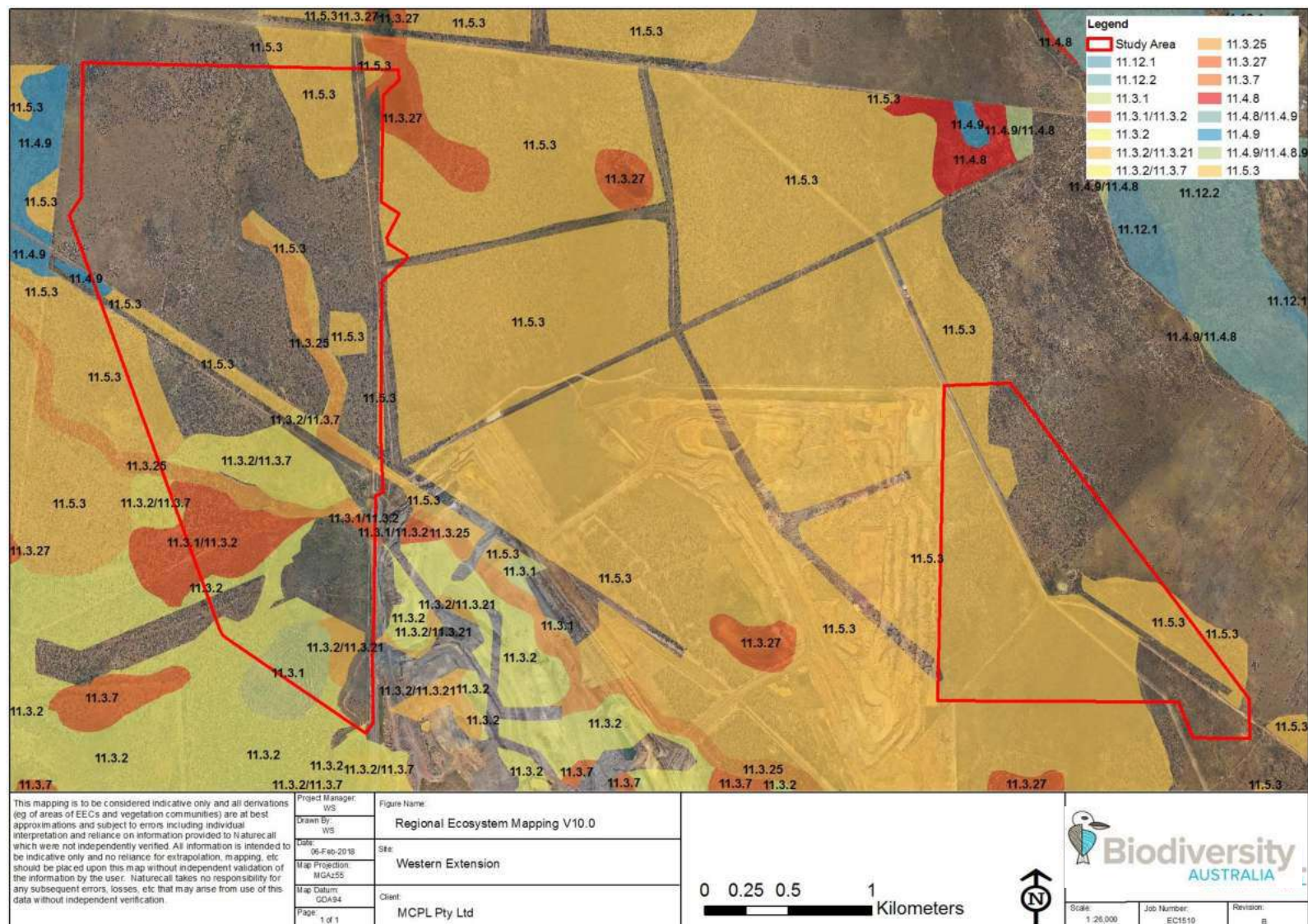
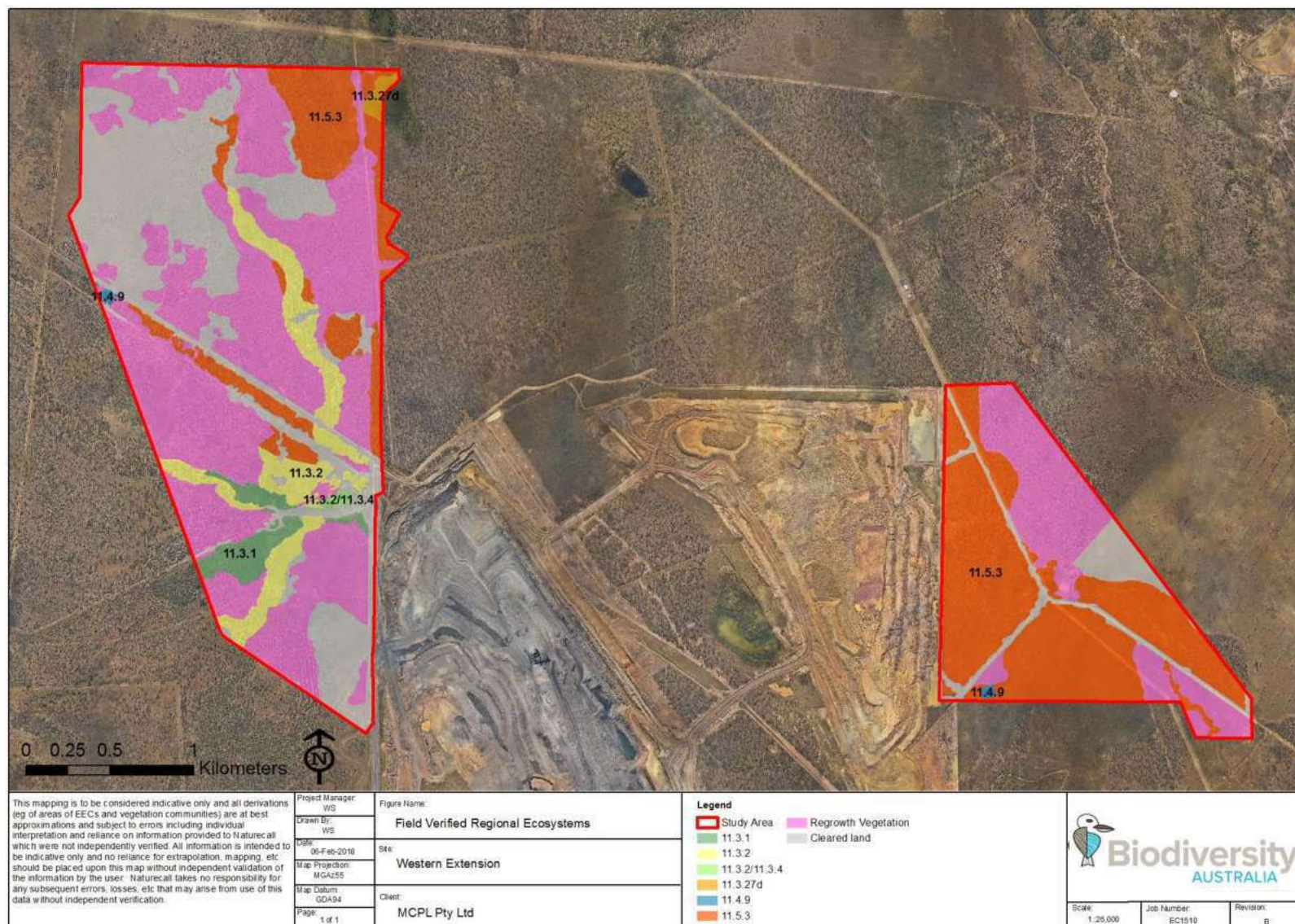




Figure 14: Field verified Regional Ecosystems





4.2.3. Endangered and Of Concern Regional Ecosystems

Four RE's listed as Endangered or Of Concern under the VM Act were recorded during the field surveys. The details of these are provided in Table 15. Figure 15 shows the location of these communities in the study areas. Section 4.2.2 provides a description of these communities.

All patches of Brigalow EEC in the Study areas were assessed to determine if they qualified as remnant vegetation using the criteria in Neldner et al. (2017).

Table 15: Endangered and Of Concern Regional Ecosystems recorded in the study area

Regional Ecosystem	Code	VMA Status	Area
<i>Acacia harpophylla</i> shrubby woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains	11.4.9	Endangered	1.5 ha
<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains	11.3.1	Endangered	15 ha
<i>Eucalyptus populnea</i> woodland on alluvial plains	11.3.2	Of concern	43.5 ha
<i>Eucalyptus populnea</i> woodland on alluvial plains / <i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus</i> spp. woodland on alluvial plains	11.3.2/ 11.3.4	Of concern	1.5 ha

4.2.4. Threatened Ecological Communities

The Brigalow communities within the Study area have been assessed against the diagnostic and condition criteria listed in the approved conservation advice (DoE 2013) and the Species Profile and Threats Database (DEE, 2018). This is provided in Table 16:

Table 16: Brigalow EEC assessment

Criteria	Result
1) The presence of <i>Acacia harpophylla</i> as one of the most abundant tree species in the patch. <i>A. harpophylla</i> is either dominant in the tree layer, or co-dominant with other species (notably <i>Casuarina cristata</i> , other species of <i>Acacia</i> , or species of <i>Eucalyptus</i>).	Yes – Brigalow is dominant in the patches in the study area (see vegetation descriptions in Section 4.2.2 Table 13)
2a) In Qld - the patch is in one of the following Qld bioregions (including outliers) and it meets the description of one of 16 Qld REs determined at the time of the national listing of the Brigalow ecological community under the EPBC Act. The 16 REs are, as described by the Qld Herbarium (Wilson and Taylor 2013): In the Qld Brigalow Belt Bioregion – REs 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 and 11.12.21.	Yes – Patches of Brigalow in the study area conform to 11.3.1 and 11.4.9.
2b) In NSW - the patch meets one of the following NSW Vegetation Classification and Assessment (VCA) community descriptions. The NSW VCA communities are: VCA IDs 29, 31 and 35; as described in Benson et al. (2006).	Not applicable



Criteria	Result
2c) The vegetation in the patch is brigalow regrowth with species composition and structural elements broadly typical of one of the identified Qld REs or NSW vegetation communities (although species density may be reduced). This can be assumed to be the case where it has been at least 15 years since it was last comprehensively cleared (not just thinned); unless direct evidence proves otherwise.	Yes – All of the remnant patches and some non-remnant/regrowth patches of Brigalow meet this criteria. Some younger regrowth patches have been cleared within the last 15 years (determined through analysis is historic satellite imagery) and do not have typical structure and composition. These areas have been excluded.
3) The patch is 0.5 ha or more in size	Yes - Most patches of Brigalow in the study area are >0.5 ha in area. Some smaller patches did not meet the minimum size threshold and have been excluded.
4) Exotic perennial plants comprise less than 50% of the total vegetation cover of the patch, as assessed over a minimum sample area of 0.5 ha (100 m by 50 m), that is representative of the patch.	Yes – exotic perennial plants comprised <50% cover in all Brigalow patches in the study area.
Result	All remnant and some non-remnant Brigalow communities in the study area qualify as Brigalow EEC.

The above assessment confirms that Brigalow communities in the Study areas qualify as the Brigalow EEC listed under the EPBC Act. The location of the TEC's in the Study areas is shown on Figure 16.



Figure 15: Endangered and Of Concern Regional Ecosystems

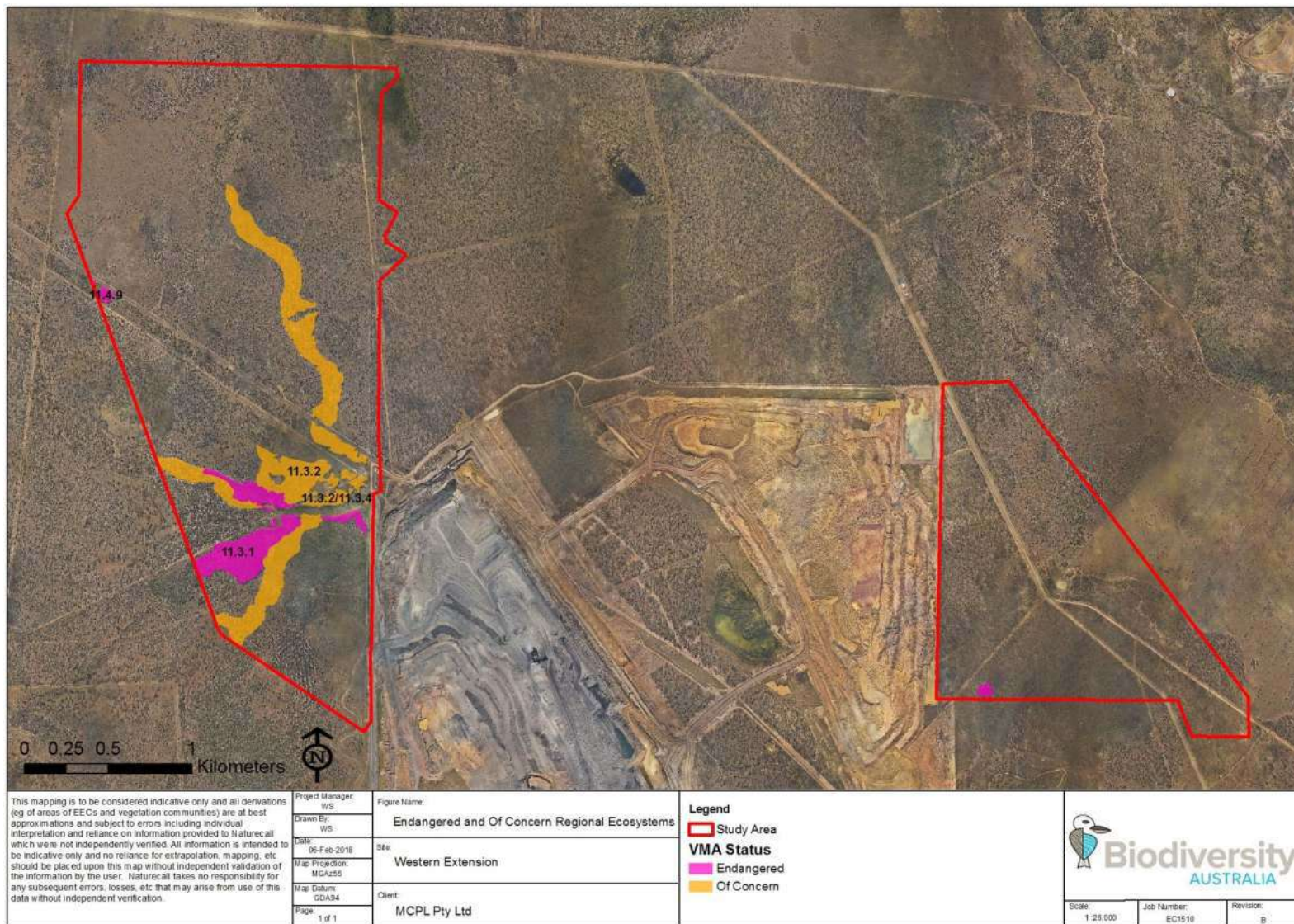
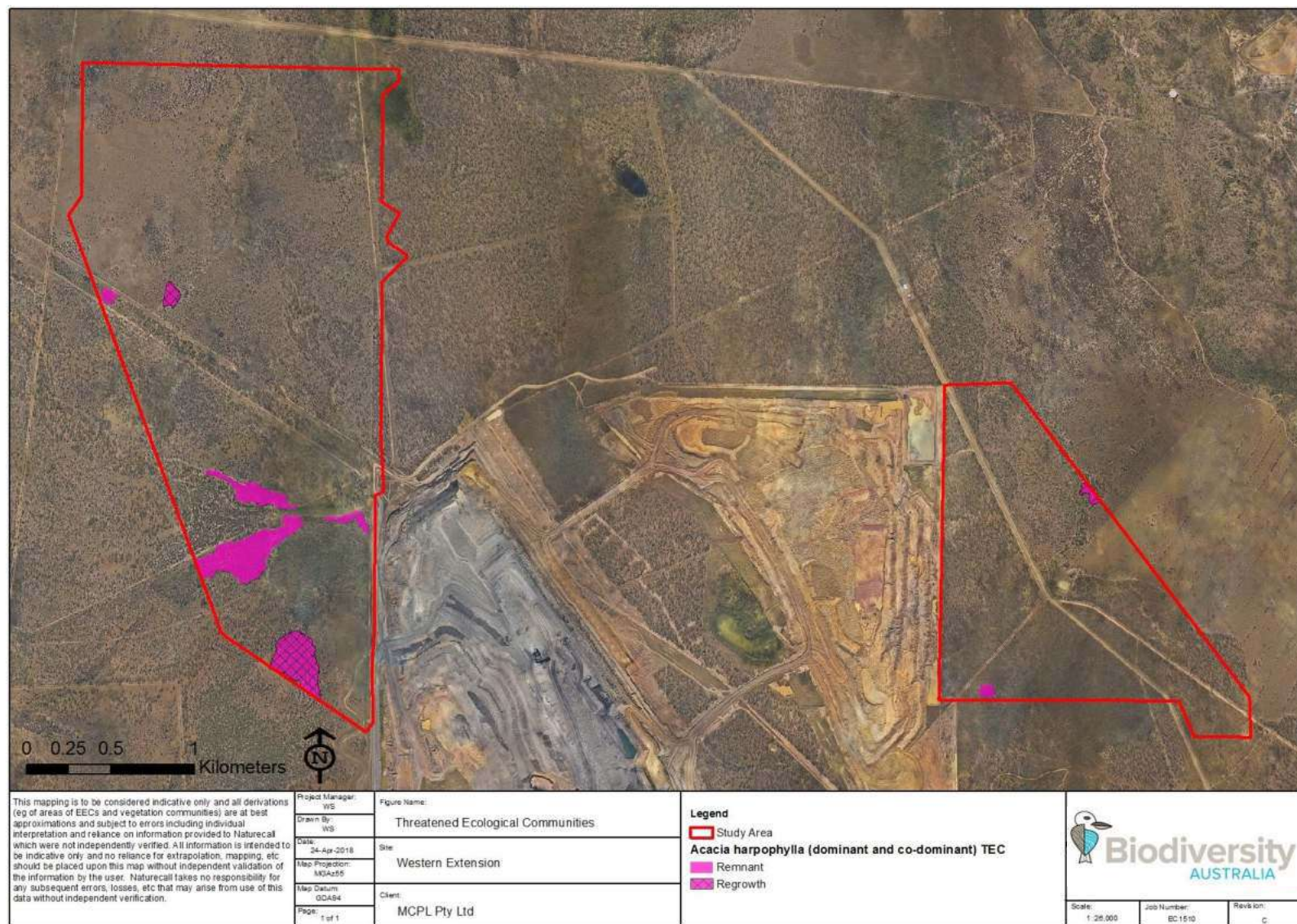




Figure 16: Threatened ecological communities





4.2.5. Threatened Flora

No threatened flora species were recorded during the field surveys which were conducted over two separate survey periods to account for seasonal variations and detectability for threatened flora. There are no previous records of threatened flora species on either of the study areas. Neither study area occurs within a high risk trigger area (see report in Appendix 9).

Due to the disturbance history over most of the study areas (e.g. grazing, weed invasion), lack of local records and limited habitat types present, the potential for threatened flora to occur would be significantly reduced and no threatened flora species are considered potential occurrences.

4.2.6. Declared Weeds

As detailed in Section 4.2.1, a total of 19 exotic flora species were recorded within the study areas. Weed invasion is common throughout the study areas, especially in disturbed areas, however it is largely limited to the groundcover stratum. Naturalised introduced pasture species such as Buffel Grass (*Cenchrus ciliaris*), Sabi Grass (*Urochloa mosambicensis*) and Red Natal Grass (*Melinis repens*) along with herbs including *Sida* spp., Cobblers Pegs (*Bidens pilosa*), Gomphrena Weed (*Gomphrena celosioides*) and Stylo (*Stylosanthes scabra*) were the main weeds encountered. These species dominated the ground layer in the derived grassland habitats, and incursion of these species into adjacent eucalypt woodlands was common.

Table 17 lists the noxious weeds declared under the *Biosecurity Act 2014* recorded within the study area. Prickly Pear (*Opuntia elata*.) and Harrisia Cactus (*Harissa martini*) were recorded. The distribution of these species was patchy and these species are unlikely to pose a significant risk to the ecological integrity of the study areas due to their low density.

Table 17: Noxious Weeds Recorded Within the study Area

Scientific Name	Common name	Biosecurity Act Category	Weed of National Significance	Abundance
<i>Opuntia elata</i>	Prickly Pear	Class 2,3,4,5	Yes	Low
<i>Opuntia tomentosa</i>	Velvety Tree Pear	Class 3	Yes	Low
<i>Harrisia martini</i>	Harrisia Cactus	Class 3	No	Low



4.3. Fauna Survey Results

4.3.1. Broad Fauna Habitats

Fauna habitats within the study area were categorised and mapped into four broad habitat types using the same classifications as PB (2010). The broad fauna habitat types present in the study area are:

- Eucalypt woodland/forest.
- Wetlands.
- *Acacia harpophylla* woodland/forest.
- Regrowth/derived grassland.

Table 18 details the REs which make up each broad fauna habitat type along with the area (in ha) of each.

Table 18: Broad Fauna Habitat Types

Broad Fauna Habitat Type	Regional Ecosystem	Field Verified Area (ha)
Eucalypt Woodland	11.3.2	43.5
	11.3.2/11.3.4	1.5
	11.5.3	154
Subtotal (Eucalypt Woodland)		199
Wetlands	11.3.27d	1.9
<i>Acacia harpophylla</i> woodland/forest	11.3.1	15
	11.4.9	1.5
Subtotal (<i>Acacia harpophylla</i> woodland/forest)		18.4
Regrowth/derived grassland	-	249.5
Total		467*

* Rounded number.

Table 19 describes the habitat values per category, with focus on habitat value and suitability for foraging, nesting, roosting, and breeding requirements for potentially occurring threatened species listed under the NC Act and EPBC Act. Selected habitat features located within the study areas are shown in Photos 12 and 13.



Table 19: Fauna habitat assessment

Habitat Attribute/ Category	Site Values			
	1. Eucalypt Woodland	2. Wetland habitat	3. <i>Acacia harpophylla</i> woodland/forest	4. Regrowth/derived grassland
Groundcover	Variable density and composition depending on disturbance history e.g. rotational grazing regime. Some areas feature a moderately dense cover of exotic grasses while some are more open and dominated by native grasses and shrubs. A number of native grass species provide a potential food resource for the Squatter Pigeon. Some areas also have a mosaic of open sandy areas and native grasses which is preferred habitat for this species.	Generally a good cover of native grasses, sedges and herbs. Aquatic species present during wet season.	Sparse to open ground cover of mostly native grasses, with areas of bare ground. Provides potential shelter and prey habitat for threatened reptiles.	Dominant ground cover composition of exotic grasses with native grasses and herbs being less common. Areas with a higher percentage of native grass species would provide food resources for the Squatter Pigeon. Squatter Pigeon recorded along a roadside on the eastern study area.
Leaf Litter	High under canopy trees, and scattered throughout the mixed grass undergrowth.	Generally thin leaf litter throughout due to open canopy.	Mature Brigalow habitats contained dense accumulations of leaf litter which would provide shelter and prey habitat for a range of small reptiles.	Sparse leaf litter.
Logs and Debris	Reasonable abundance of hollow logs and debris present due to the nature of Eucalyptus shedding limbs. Larger logs provide shelter and prey habitat for ground dwelling reptiles (Photo 12).	Some accumulations of coarse woody debris and logs under canopy trees. Marginal potential habitat values for threatened fauna overall.	High density of coarse woody debris, which is typical of this habitat type. Could provide potential shelter and prey habitat for the Ornamental Snake. Hollow logs are however rare.	Very few logs observed. Some log and debris piles as a result of past clearing occur.
Rocky outcrops	Only some small to medium surface rock present. No values to threatened species.	Absent	Absent	Absent
Aquatic habitat	Aquatic habitats in this habitat type are largely limited to small ephemeral creeks and soaks that would only hold water for short periods.	The wetland in the northeast comprises ephemeral aquatic habitat and contained water during the May survey. This would provide seasonal water sources for the Squatter Pigeon (southern).	Brigalow habitats contain gilgai that hold water during the wet season and provide habitat for amphibians. Water was present in gilgai during the May survey.	A few farm dams were located within non-remnant areas. One dam on the unnamed drainage line in the western study area contained established aquatic vegetation, while others were devoid of aquatic vegetation. Dams on site attracted a range of wetland birds and provided permanent water sources for a range of fauna including the Squatter Pigeon (southern).



Habitat Attribute/ Category	Site Values			
	1. Eucalypt Woodland	2. Wetland habitat	3. <i>Acacia harpophylla</i> woodland/forest	4. Regrowth/derived grassland
Hollows	Hollow-bearing trees and stags are common within this habitat type (Photo 13). A range of hollow-sizes are present i.e. <5 cm to >20 cm diameter cavities. Hollows provide nesting/denning/roosting habitat for a number of threatened fauna species such as the Corben's Long-eared bat and Greater Glider.	Hollow-bearing trees were generally uncommon in this habitat type and would largely be occupied by common birds such as Galahs and Lorikeets.	Low occurrence of tree hollows in occasional eucalyptus species present. Hollows that are present would provide potential roosting habitat for threatened bat species such as the South-eastern Long-eared Bat.	No live hollow bearing trees present due to previous clearing history. Occasional stags present which do contain small to medium hollows.
Nectar sources	Woodland habitats contain a range of nectar producing species e.g. eucalypts, acacias and grevilleas. Some Poplar Box were in flower during the survey. A range of shrubs and small trees were in flower during the September survey.	Nectar sources in riparian habitats include eucalypts and Melaleucas, some of which were flowering during the survey.	<i>Acacia harpophylla</i> is the primary nectar source and would provide foraging resources for fauna when in flower.	This habitat type does not provide a significant nectar source due to the lack of mature trees.
Koala food trees	Moreton Bay Ash, Reid River Box and Poplar Box are the main Koala browse species in this community (DofE 2014). Koala scats were recorded in this habitat type.	This community is dominated by Qld Blue Gum which is a preferred browse species for Koalas.	<i>Eucalyptus cambageana</i> is located within this habitat type and, although a less common food source for the Koala, meets the definition of a Koala food tree (DofE 2014).	Absent aside from occasional areas of regrowth <i>Eucalypts</i> and <i>Corymbia spp.</i>
Connectivity values	On the western study area, woodland communities are patchy and fragmented and do not provide strong connectivity across the site. Highly mobile species would easily move through this habitat type. Woodland is more contiguous on the eastern study area and provides connectivity, however is fragmented by several roads and fencelines. This habitat type would benefit the local movements of a range of fauna species, including arboreal species such as the Koala.	Only minor connectivity values.	The small patches of Brigalow habitats would contribute to the connectivity values of the other site habitats, however it is generally isolated, and would not provide any specific connectivity values for fauna.	Continued regeneration of non-remnant areas over time would help re-establish linkages for flora and fauna across the site and broader landscape.



Photo 12: Large hollow log in woodland



Photo 13: Large hollow-bearing tree in woodland





4.3.2. Aquatic Habitat Assessment

Aquatic habitat assessments were undertaken at the ephemeral drainage lines in the study area during the survey. This found that the ephemeral drainage lines were in a similar condition as was reported in FRC (2010) (see summary in Section 2.6.4). Given that there has been little change in the physical attributes of the drainage features in the study area, the conclusions of the FRC 2010 report remain valid and as such, the aquatic habitat on site would not be considered to be capable of supporting any threatened aquatic species.

During the May survey period, the drainage line contained standing water as shown in Photo 14. Brigalow habitats containing gilgai also contained standing water which provided habitat for a range of frog species (Photo 15).

All of the drainage lines in the study area were found to be dry during the September survey period as shown in Photo 16.

Some evidence of fish and aquatic invertebrates were found in the dry creek lines. These included Eel-tailed Catfish, Spangled Perch, Inland Freshwater Crab (Photo 17) and Freshwater Mussels.

Photo 14: Water in Drainage Line 1





Photo 17: Inland Freshwater Crab



Photo 15: Gilgai wetland in Brigalow





Photo 16: Drainage line 2 during the September survey



4.3.3. Field Survey Results

4.3.3.1. Observed and Detected Fauna

A total of 119 fauna species were detected during the survey either opportunistically or during specific survey methods. A list of fauna species detected is provided in Section 4.4 Appendix 3. Birds were the most common fauna group observed with a total of 68 species detected. Twenty nine mammals, 12 amphibians, eight reptiles and two fish were also detected. Photos 18-23 were taken during the surveys of the study areas.

The threatened species recorded during the surveys are discussed in Section 4.3.6.

Pest species comprising the wild pig, wild dog, feral cat, fox and rabbit were commonly detected in the study areas, mostly via numerous tracks along the sandy roads surrounding the site. Several feral cats were also observed during spotlighting.

Appendix 3 provides the total fauna list for the study area and the method of detection. Photographs of some of the species recorded are provided below and in Appendix 4.



Photo 15: Greater Glider near Drainage Line 1



Photo 16: Pair of Squatter Pigeons (southern) at the eastern study area





Photo 17: Jacky Lizard



Photo 18: Short-footed Frog





Photo 19: Gould's Long-eared Bat



Photo 20: Gould's Wattled Bat





4.3.4. Success and Limitations of Methodology

As evident in the survey results, a broad range of fauna species were detected during the survey, and the methods used are considered effective for detecting a range of threatened species in the region during the two seasonal surveys undertaken. Methods used were consistent with those recommended by DES and DEE (Section 3), and effort was consistent with or exceeding the specified minimum.

Surveys were undertaken in two different seasons to account for variations in fauna usage and availability of foraging resources. The heavy rainfall that preceded the first survey allowed detection of a range of amphibian and waterbird species. Although there were drier conditions in the September survey, the warmer temperatures were likely to have resulted in increased fauna activity, particularly arboreal mammals and microbats.

4.3.5. Assessment of Site Ecology

4.3.5.1. Fauna Assemblages

The fauna detected on the site generally consisted of common, generalist and wide ranging species capable of persisting in modified habitats. Native mammals were reasonably well represented in the survey results, especially microbats. A total of 14 microbat species were positively identified through the anabat analysis and four species were captured in the harp traps. The diverse range of habitats would provide a good foraging base and numerous hollows present in the Study area would provide a range of roosting and breeding opportunities for these species.

Only three arboreal mammals were detected and this is most likely to be a reflection of the extent of local fragmentation which may prevent some species from accessing the Study area and presence of feral predators such as the fox, feral cat and wild dog.

Bird diversity was high with a relatively diverse range of passerines detected across the Study area. Several raptor species were also detected which indicates the Study area has a reasonable prey base. The results are considered an indication of the range of foraging resources present (e.g. flowering canopy and understorey trees, fruiting species); and good understorey development in places providing shelter.

Ideal conditions for amphibian surveys were experienced in the May survey and numerous frog species were detected at this time. Very few amphibians were detected during the September survey which is a result of the dry conditions at this time. Amphibians would provide a good prey base for snakes.

Reptiles were poorly represented in the survey results considering the above average survey effort employed. This is likely to be an indication of the level of local habitat loss and fragmentation which may have historically excluded some species and lack of a habitat components such as rock outcrops and cracking clays (Wilson 2003). The presence of Cane Toads and other feral species (Cats, dogs foxes) is likely to have heavily impacted on reptile abundance. The limited detectability of many reptile species may also be a contributing factor (Wilson 2003).



4.3.5.2. Local Corridors and Habitat Linkages

Large areas of remnant vegetation occur in Junee National Park about 30km east of the site, however no vegetative link exists to here from the site due to fragmentation by cleared grazing land.

Remnant vegetation in the study area can be seen to be loosely connected to Bundoora State Forest, approximately 15 km to the south-west. Some remnant vegetation fringing Drainage Line 1 adjoins the west of the Study area, and this would allow for movement of less mobile terrestrial fauna (e.g. amphibians, rodents, reptiles) or 'gap-shy' species. Most other adjoining vegetation comprises modified/regrowth habitats which would only be used by highly mobile fauna. Species such as the Koala and Greater Glider would be unlikely to move across these modified landscapes.

Regeneration of vegetation in the MCPL offset area to the west of the study areas will help improve connectivity between remnant habitats in the area.

4.3.6. Threatened Fauna Species

Three listed threatened fauna species were recorded during the field surveys. These are discussed in the following sections. Figure 17 shows the location of the recorded threatened fauna.

4.3.6.1. Greater Glider

The Greater Glider occurs in forests and woodlands across eastern Australia where it forages on eucalypt leaves and occasionally flowers (Threatened Species Scientific Committee) [TSSC] 2016). It requires large tracks of remnant forests which contain old growth trees containing hollows which it uses for denning.

Conservation advice (TSSC 2016) details that the Greater Glider is largely restricted to Eucalypt forests and woodland, with its diet comprising mostly Eucalypt leaves. Consistent with this, previous observations of this species on MCPL land have noted that it prefers Eucalypt woodlands and open forest associated with major creeks and drainage lines, equivalent to RE types 11.3.25, 11.3.2, 11.3.4 and 11.3.7. It has also been occasionally noted in Poplar Box woodland equivalent to RE 11.5.3. Based on these previous observations, preferred forage species appear to be Moreton Bay Ash, Silver-leaved Ironbark and Poplar Box.

The Greater Glider (Vulnerable – EPBC Act) was detected during both fauna survey periods during spotlighting surveys. In the western study area, a single adult glider was detected near Drainage Line 1 during the May survey (Photo 18) and four individuals were detected in the September survey, with 2 located near Drainage Line 1 and two in the northeast of the site.

Four Greater Gliders were recorded in the south-east of the eastern study area during the September survey.



Greater Gliders have small home ranges ranging between 1.3 and 4 ha (Comport et al. 1996, Pope et al. 2005, TSSC 2016). The study areas would therefore encompass entire home ranges of the Gliders, and they would be also expected to extend off site to the west and east of the western study area and to the east of the eastern study area.

The Greater Glider has been previously recorded on MCPL lands during fauna surveys and clearing supervision works. Recent Biocondition monitoring surveys of the existing offset areas observed at least 16 Greater Gliders which were primarily recorded along Roper Creek (Naturecall 2017b).

4.3.6.2. Koala

The Koala is an obligate folivore that predominantly feeds on leaves from Eucalyptus trees (DEE, 2017c). Koalas feed on a wide range of eucalypt species, however they have a small number of preferred food trees. These preferred tree species vary depending on location. A review of available literature and information from previous surveys within MCPL lands (see Section 3.1) have found that the following trees are preferred species in the area:

- Queensland Blue Gum (*Eucalyptus tereticornis*).
- Queensland Peppermint (*Eucalyptus exserta*).
- Moreton Bay Ash (*Corymbia tessilaris*).
- Narrow-leaved Ironbark (*Eucalyptus crebra*).
- Reid River Box (*Eucalyptus brownii*).

Queensland Blue Gum are scarce over the Study area and generally only occur in the wetland in the northeast of the western study area (RE 11.3.27d) and occasionally along drainage lines (RE 11.3.2). Moreton Bay Ash is occasionally present throughout Poplar Box woodland communities comprising RE 11.5.3 and more so RE 11.3.2. Reid River Box was an uncommon occurrence in RE 11.5.3.

Queensland Peppermint and Narrow-leaved Ironbark were not detected within the Study area, however are found on MCPL owned land further south in RE 11.5.9 and 11.7.2.

No Koalas were observed or heard calling during the survey despite targeted surveys. The five Koala SAT surveys undertaken also did not find Koala scats. Opportunistic scat searches did however detect Koala scats at the eastern study area in Poplar Box woodland under a Reid River Box. The age of the scats from visual identifiers was estimated at 3 months old. The scats were confirmed by scat analysis expert Luke Forster (Trace Ecology).

Individual Koalas, and Koala scats have been previously recorded in MCPL owned land. In 2012, EHP recorded an individual Koala in the south of the Stage 2 Offset Area and Biodiversity Australia recorded an individual adjacent to Parrot Quarry Road in 2014 (Naturecall 2014a). The record during the most recent survey is the first confirmed record of the Koala in the eastern part of MCPL lands. It is not known if the study area is part of the habitat for a resident Koala population or that the individual recorded via scats was merely a transient Koala moving through the area.



Given the survey results and sparse records in the area (despite numerous past surveys and ongoing offset monitoring/management), it appears that a very low density Koala population is present on MCPL lands and surrounds. Given the general low nutrient soils and scarcity of preferred foraging trees, Koala home ranges would be very large.

A large portion of the REs mapped within the study areas would provide potential foraging habitat for the Koala based on the occurrence of potential Koala food trees including preferred species described above (i.e. Blue Gum, Reid River Box and Moreton Bay Ash). This includes RE 11.3.2, RE 11.5.3, and RE 11.3.27d, equating to approximately 198ha of potential Koala habitat across both study areas. These areas would provide beneficial movement corridors (i.e. connectivity) for the Koala throughout the landscape, particularly areas of contiguous habitat and riparian corridors.

4.3.6.3. Squatter Pigeon (southern)

The Squatter Pigeon (southern) was recorded in the north of the eastern study area during the September field surveys. Two adult birds were observed at close range foraging on a road (Photo 19).

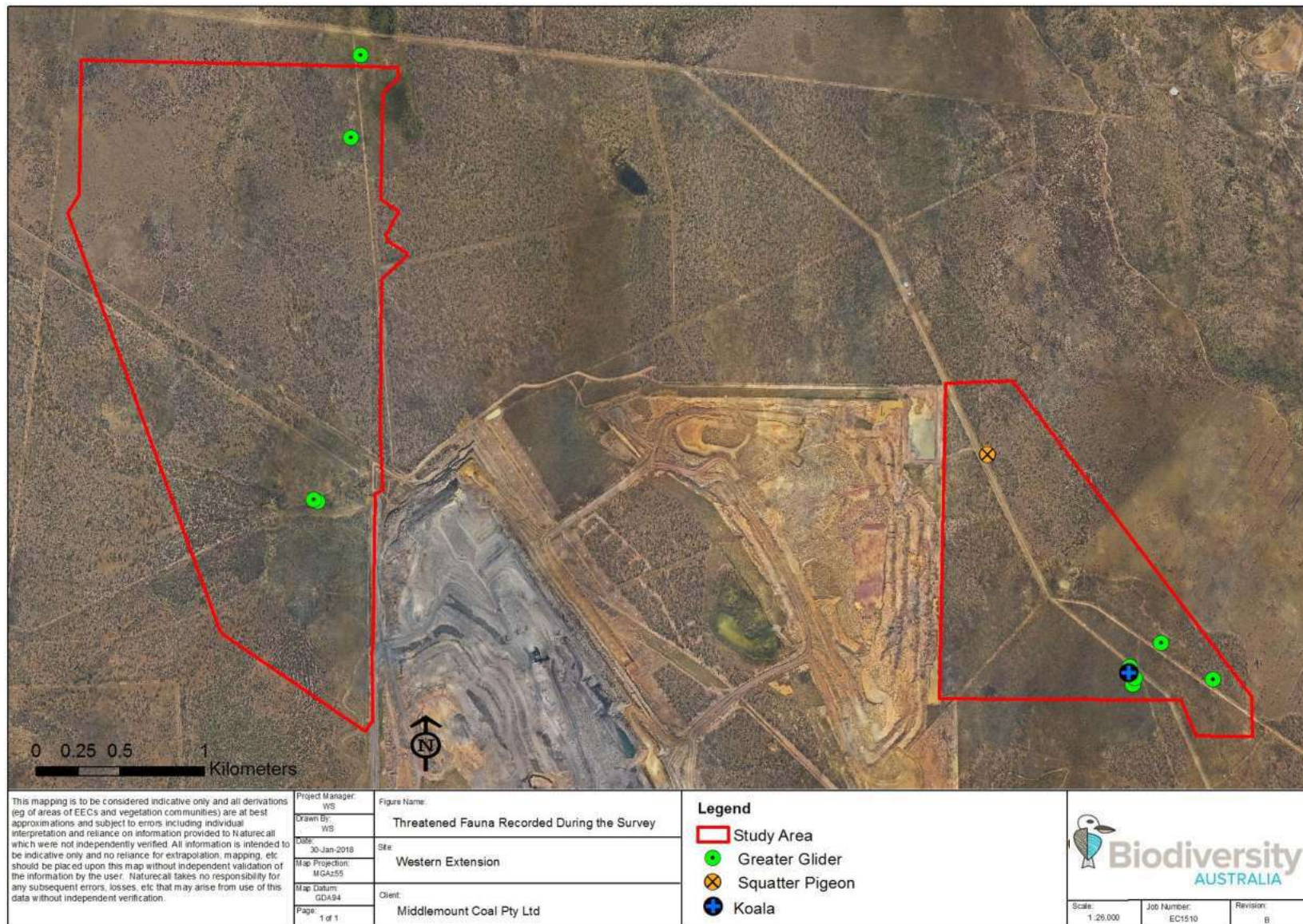
This species has also been previously recorded on the eastern study area in 2015 at the farm dam located in the centre of the site (Will Steggall pers obs). It has been previously recorded in the western study area on a road near Drainage Line 1 (Naturecall 2013, PB 2010).

As identified in Table 19 a number of habitat attributes which would provide suitable habitat for the Squatter Pigeon (southern) are present. These include a number of native grass species, permanent water resources and a mosaic of open sandy areas.

As identified by DEE (2017a), the Squatter Pigeon is known to utilise habitat located on land zones 3, 4, 5 and 7. Within the Study area, suitable habitats are likely to comprise RE 11.3.1, RE 11.3.2, RE 11.3.2/11.3.4, RE 11.4.8 and RE 11.5.3. In addition to these remnant habitats, the Squatter Pigeon is regularly sighted foraging in non-remnant habitats including pasture grassland, regrowth woodland and roadside clearings (Naturecall 2013, 2014a, PB 2010). There are a number of ephemeral and permanent water bodies within the study area which would provide a suitable water source for the Squatter Pigeon.



Figure 17: Location of recorded threatened species





4.3.7. Habitat Quality Assessment Results

Terrestrial habitat quality assessments were undertaken in the study area during the field survey. The data collected in the field was analysed to produce habitat quality scores out of 10 for individual species as follows:

- Greater Glider: 6.79
- Koala: 6.61
- Ornamental Snake: 5.65
- Squatter Pigeon: 6.47

These scores are compared to the scores generated for the proposed offset areas in Section 9 of this report and the Offset Area Baseline Report in Appendix 15.

4.4. Matters of State Environmental Significance

Table 20 defines the MSES that are relevant to the project. Figures showing the location of the matters in the study areas are provided within the table.

Table 20: Matters and State Environmental Significance

Prescribed Environmental Matter	Location of Impact	Maximum Extent of Impact
Regulated Vegetation		
RE 11.4.9 <i>Acacia harpophylla</i> shrubby woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains	Figure 18	0.5 ha
RE 11.3.1 <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains	Figure 18	15 ha
RE 11.3.2 <i>Eucalyptus populnea</i> woodland on alluvial plains	Figure 18	43.5 ha
RE 11.3.2/RE 11.3.4 <i>Eucalyptus populnea</i> woodland on alluvial plains / <i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus</i> spp. woodland on alluvial plains	Figure 18	1.5 ha
Regional ecosystems (not within an urban area) that intersect a wetland on the vegetation management wetlands map RE11.3.27d	Figure 19	1.9 ha
Connectivity areas		
Connectivity area that is a regional ecosystem (not in urban area) The study area contains remnant vegetation that forms part of a corridor mapped as being of State biodiversity significance.	Figure 14	190.5 ha
Wetlands and watercourses		
A wetland of high ecological significance (HES) shown on the Map of referable wetlands	Figure 19	0.75 ha
Protected wildlife habitat		
Habitat for an animal that is vulnerable wildlife Ornamental Snake Greater Glider Koala Squatter Pigeon (southern)	Figure 21a Figure 21b Figure 21c	15.5 ha 175 ha 175 ha 388.5
Habitat for an animal that is Special Least Concern wildlife – Echidna		190.5 ha



Legally secured offset area		
Two legally secured offset areas are located within the western study area. These comprise of the: Stage 2 Offset Area Rail Loop and Spur Offset Area	Figure 20	32 ha 22 ha

4.4.1. Regulated Vegetation

Regulated vegetation mapped on the study area includes Endangered and Of Concern REs. These comprises RE's 11.3.1, 11.3.2, 11.3.2/11.3.4 and 11.4.9. Vegetation within 50 m of the banks of the wetland in the northeast of the western study area are also mapped as regulated vegetation.

This is shown in Figure 18.

4.4.2. Connectivity Areas

The landscape fragmentation and connectivity tool (DEHP, 2016) has been applied to the Project. The results are provided in Section 7.2.

4.4.3. Wetlands and Watercourses

The palustrine wetland in the northeast of the western study area is identified as a HES wetland. The location of this wetland is shown in Figure 19. Section 4.2.2 provides a floristic description of the wetland.

There are no watercourses defined under the *Water Management Act 2000* within the study area and no watercourses are mapped as high ecological value waters.

4.4.4. Protected Wildlife Habitat

The field surveys identified three species which are listed threatened species in Qld under the NC Act and qualify as MSES. These are the Squatter Pigeon, Greater Glider and Koala. The Echidna was also recorded which is a Special Least Concern species. These species are subject to the Significant Residual Impact Test in Section 7.

Based on local records and presence of suitable habitat on the site, two additional threatened fauna species listed under the NC Act are also considered potential occurrences, as shown in Table 21. The potential for these species to occur on the site is also reviewed in Appendix 1. These species are subject to the Significant Residual Impact Test in Section 7.

Table 21: Potentially occurring threatened species under the NC Act

Group	Species	Listing Status		Occurrence Likelihood
		NC Act	EPBC Act	
Reptiles	Ornamental Snake (<i>Denisonia maculata</i>)	V	V	Low chance of occurrence given disturbance history and lack of preferred habitat.
Birds	Powerful Owl (<i>Ninox strenua</i>)	V	-	Low chance of occurrence using study area as part of home range.



4.4.5. Legally Secured Offset Areas

Two legally secured offset areas are partly located within the western study area. These comprise the Stage 2 Offset Area and Rail Loop and Spur Offset Area secured via a Voluntary Declaration under the VM Act (Declared Area Map 2013/003919). Figure 20 shows the location of these offset areas relative to the study area.

4.4.6. Fish Habitat Areas and Waterway Providing for Fish Passage

No Fish Habitat Areas or waterways providing fish passage are declared in the study area.



Figure 18: Regulated vegetation

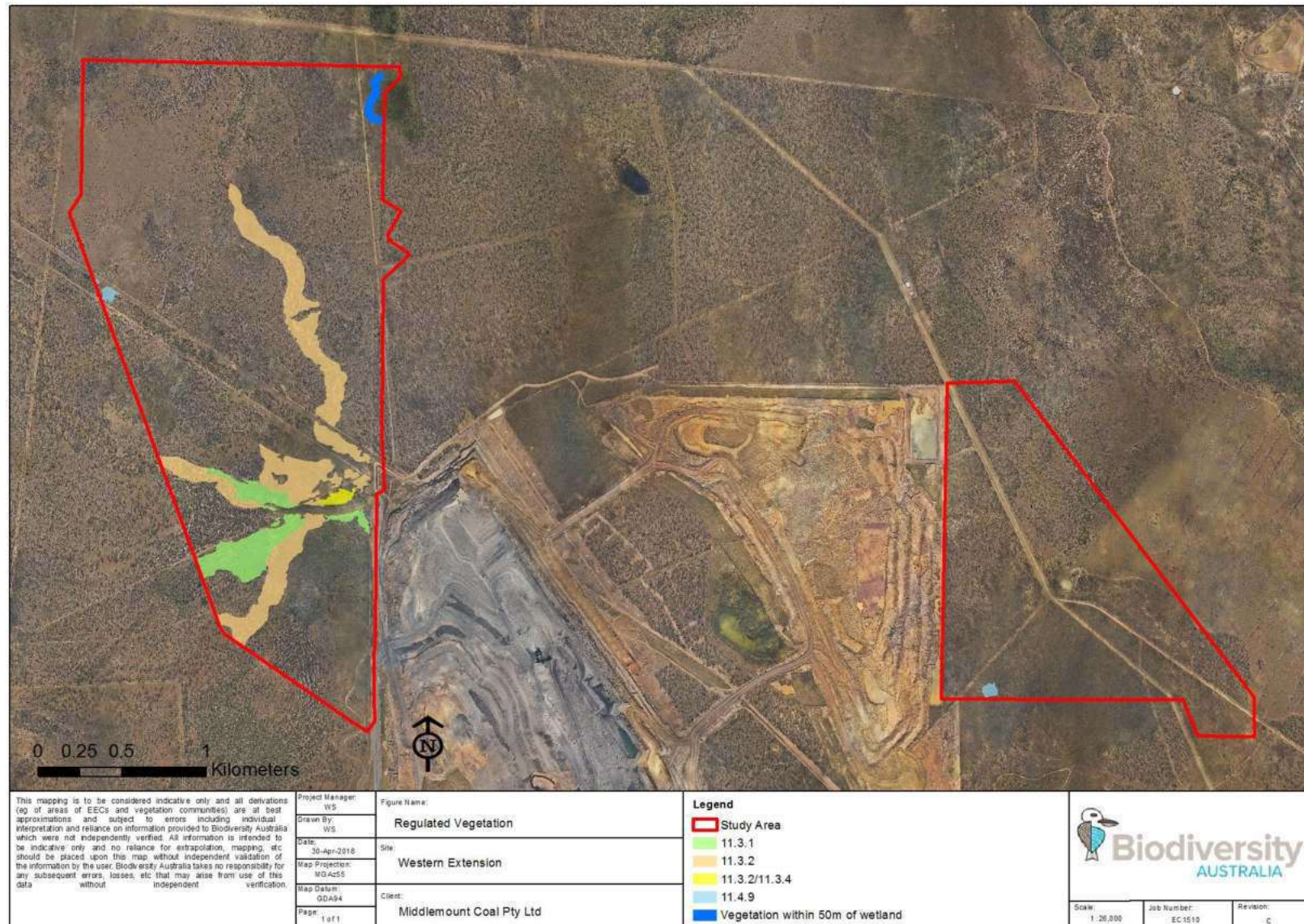




Figure 19: High ecological significance wetlands

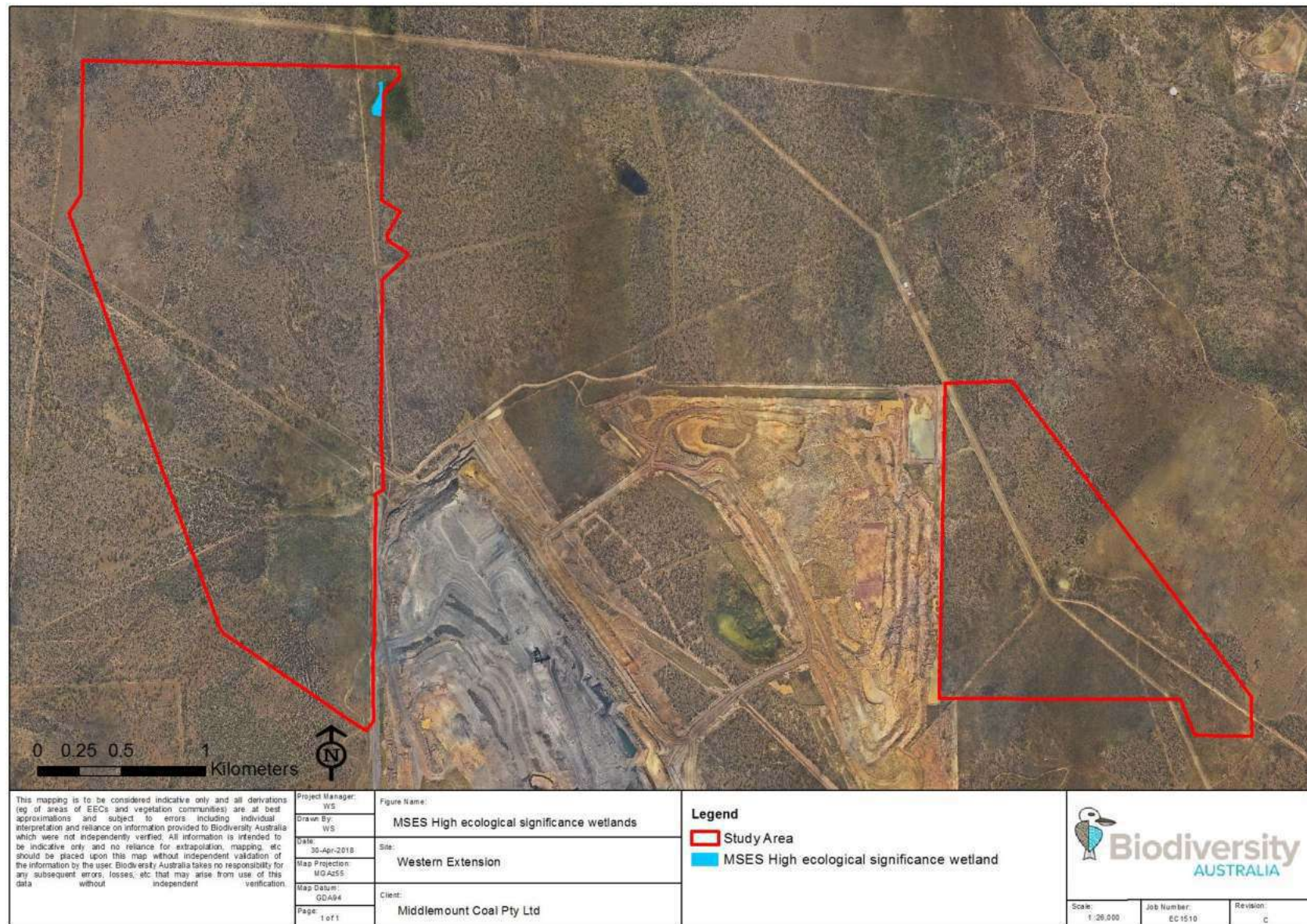




Figure 20: Legally secured offset areas

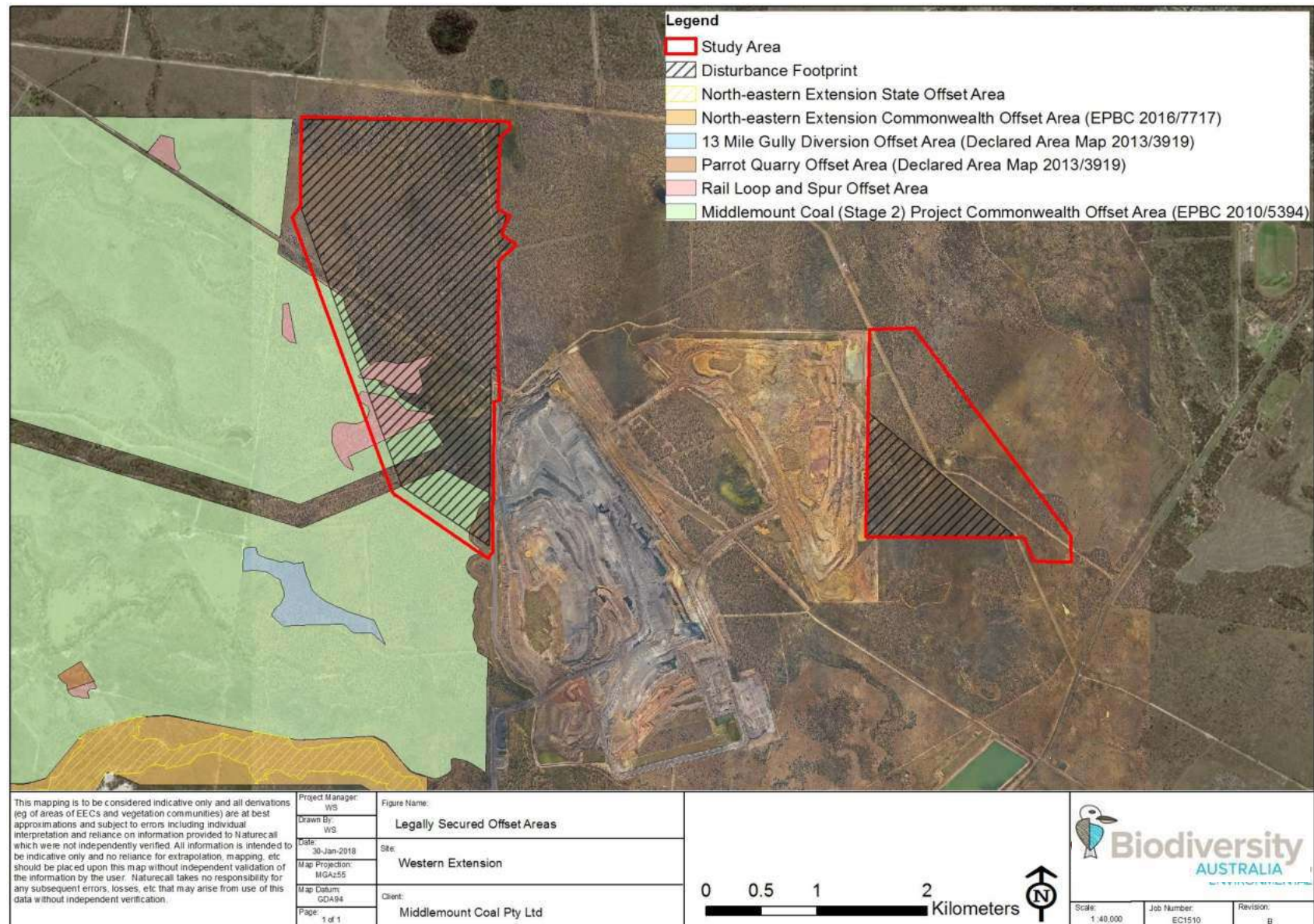




Figure 21a: Protected wildlife habitat – Ornamental Snake

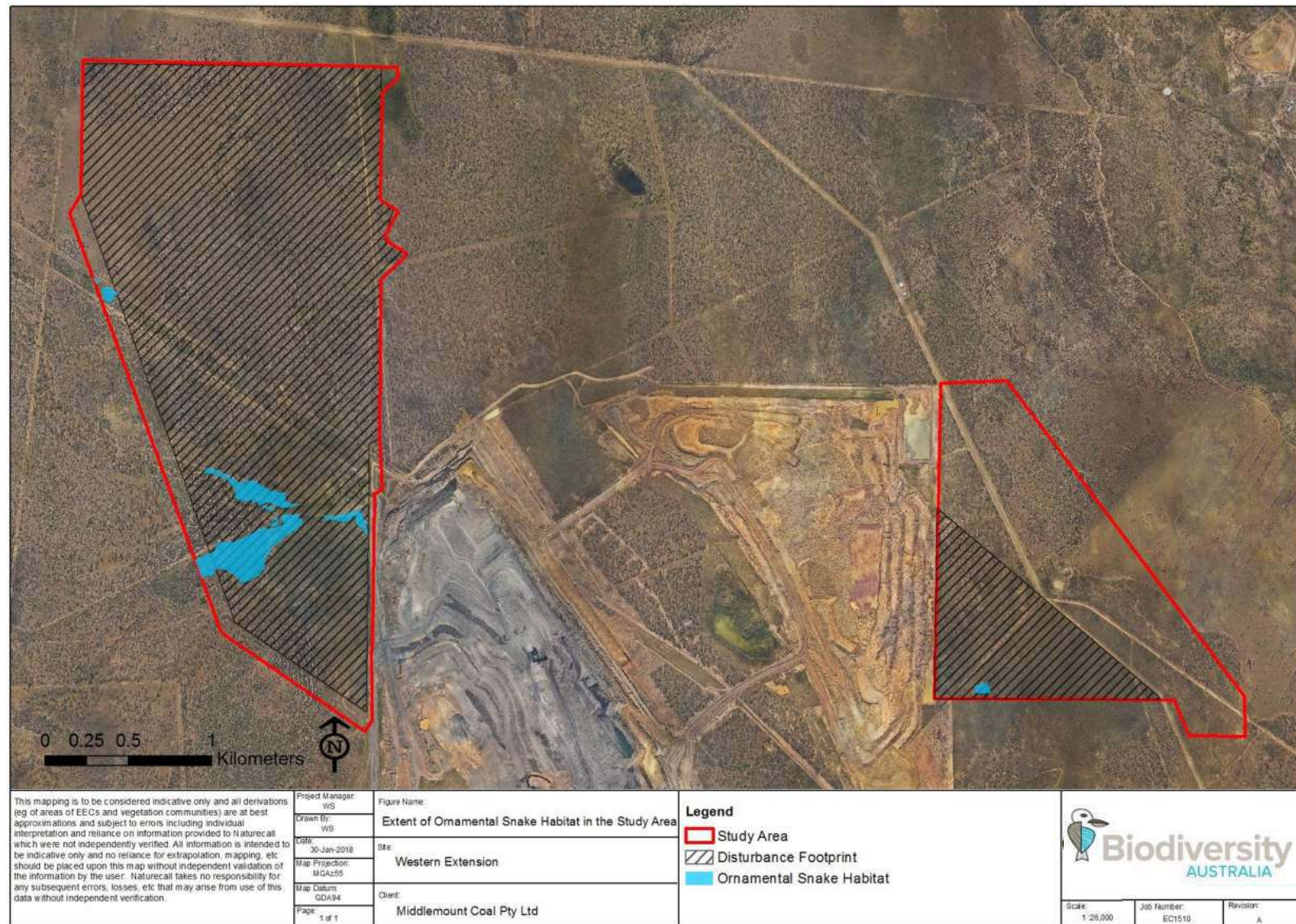




Figure 21b: Protected wildlife habitat – Greater Glider

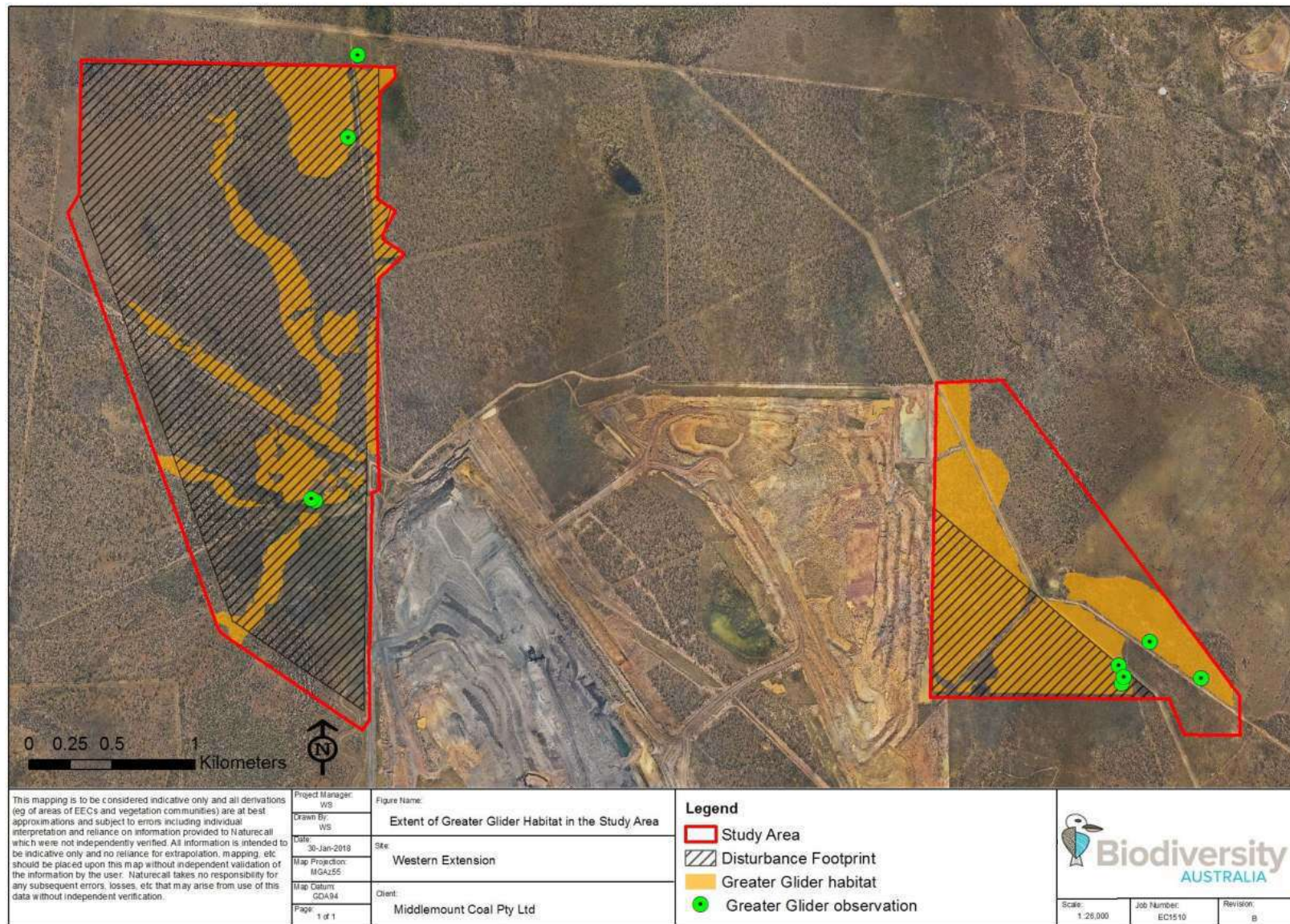




Figure 21c: Protected wildlife habitat – Koala

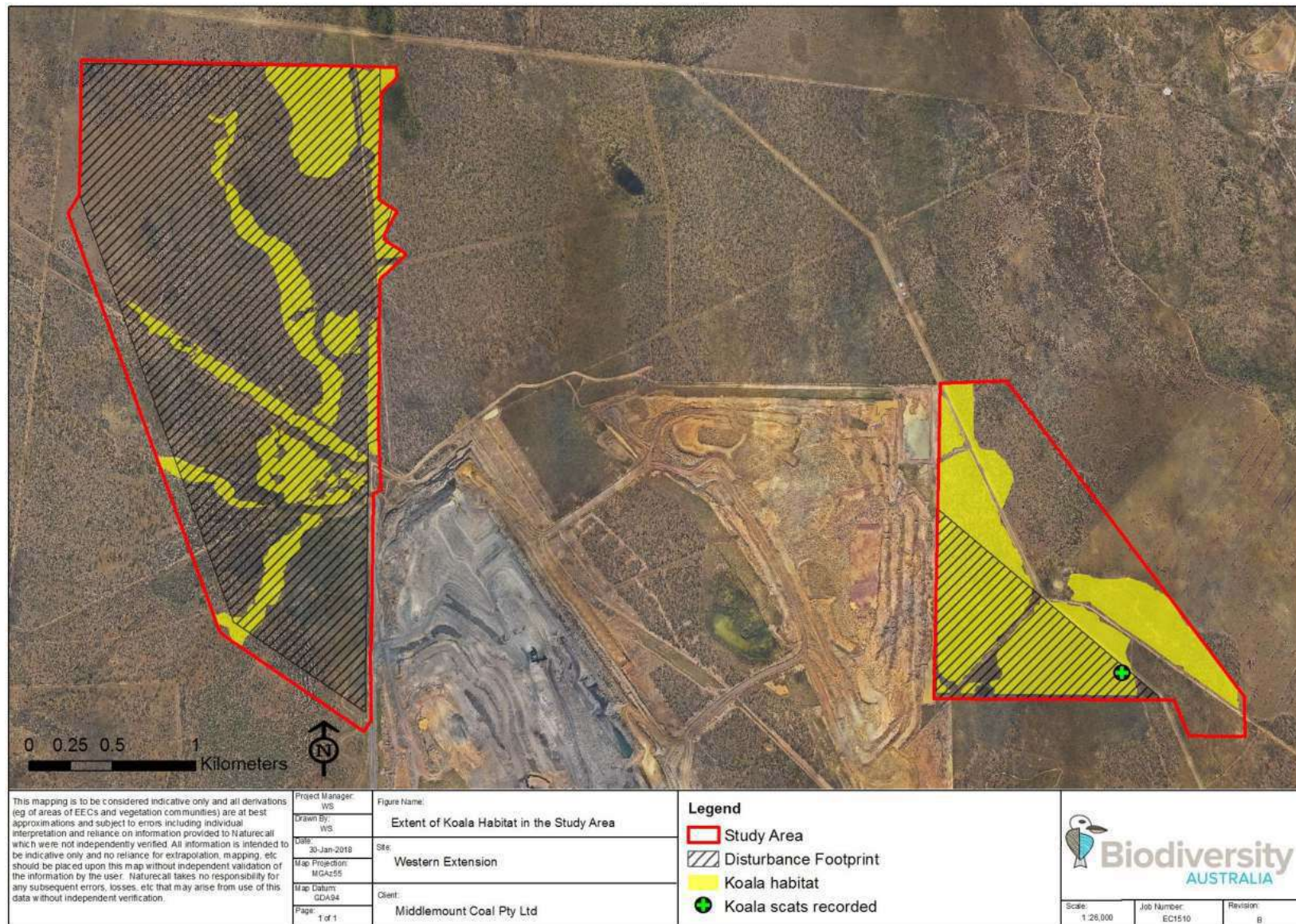
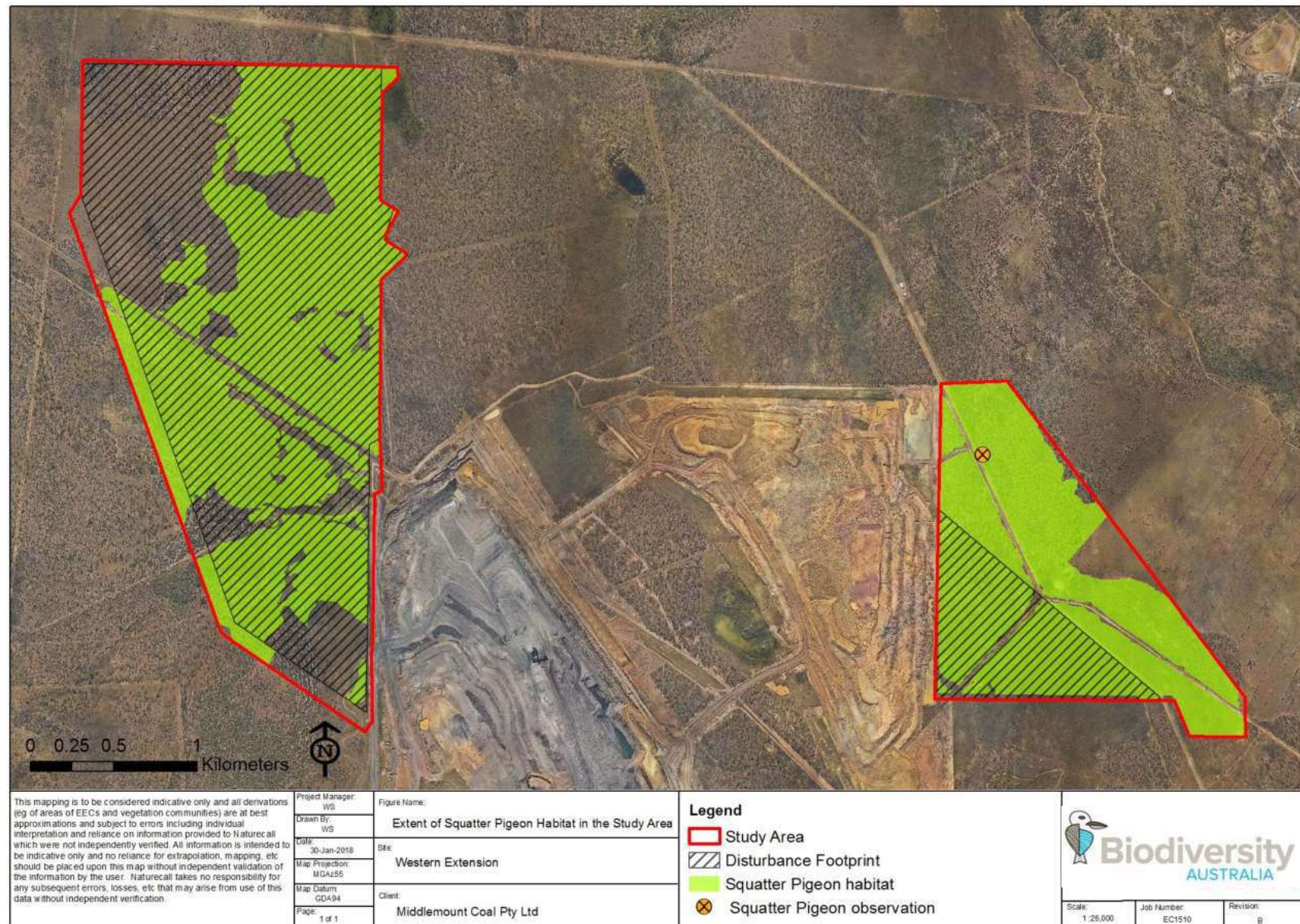




Figure 21d: Protected wildlife habitat – Squatter Pigeon





4.5. Matters of National Environmental Significance

The protected matters search tool (DEE 2017) identified a range of MNES that could potentially occur in the locality. Threatened species and ecological communities listed as MNES were recorded in the study area during the field surveys. These are discussed in the following sections.

4.5.1. Threatened Ecological Communities

Vegetation conforming to the Brigalow EEC was recorded on both the eastern and western study area during the field survey. The process used to identify this TEC is described in Section 3.2.3.

A total of 25.5 ha of Brigalow EEC has been mapped in the study area, with 22 ha occurring within the Project area. The Brigalow communities in the study areas are equivalent to RE 11.3.1 (15 ha), 11.4.9 (0.5 ha) and regrowth vegetation (6.5 ha).

A description of these communities is provided in Section 5.2.1. Figure 16 shows the distribution of this TEC over the study area.

4.5.2. Threatened Species

Three federally listed threatened species were recorded in the study area during the field surveys – the Greater Glider, Squatter Pigeon and Koala. These are all listed as Vulnerable under the EPBC Act. The occurrence and distribution of these species on site has been discussed in Section 4.3.6.

As shown in Table 22 below, one additional fauna species listed as vulnerable under the EPBC Act is considered a potential occurrence in the study area. This, along with the recorded species, are assessed in the MNES Significance Assessment in Section 8. The potential for threatened species to occur in the study area is also reviewed in Appendix 1.

Table 22: Potentially occurring threatened fauna species

Group	Species	Predicted Type of Occurrence	Listing Status		Likelihood Of Occurrence
			NC Act	EPBC Act	
Reptiles	Ornamental Snake (<i>Denisonia maculata</i>)	Species or species habitat likely to occur within area	V	V	Low chance of occurrence given disturbance history and lack of preferred habitat.



4.5.3. Migratory Species

No migratory species recorded during the survey. A significant number of EPBC Act listed migratory bird species are known or considered potential occurrences in the locality (DEE 2017b).

These species are shown in Table 23, with an evaluation made on likelihood of occurrence based on cited ecology.

Table 23: Potentially occurring migratory species

Group	Species	Predicted Type of Occurrence	Likelihood Of Occurrence
Birds	Fork-tailed Swift (<i>Apus pacificus</i>)	Species or species habitat likely to occur within area	Fair potential, as transient, between October-April.
	Glossy Ibis (<i>Plegadis falcinellus</i>)	Species or species habitat likely to occur within area	Small areas of suitable habitat occur within the study areas. Moderate chance of occurrence
	Satin Flycatcher (<i>Myiagra cyanoleuca</i>)	Species or species habitat may occur within area	Broadly suitable habitat on site. Low chance of occurrence.
	Black-faced Monarch (<i>Monarcha melanopsis</i>)	Species or species habitat known to occur within area	Broadly suitable habitat on site. Low chance of occurrence.
	Oriental Cuckoo (<i>Cuculus optutus</i>)	Species or species habitat may occur within area	Broadly suitable habitat on site. Low chance of occurrence.

Migratory birds listed under international agreements (and the EPBC Act) are also 'Special Least Concern' fauna species listed under the NC Act.



5.0 Potential Impacts

5.1 Direct Impacts

Direct impacts on flora and fauna from the Project are evaluated below.

5.1.1. Vegetation and Habitat Loss

MCPL has minimised potential impacts associated with land clearance through the use of existing infrastructure and facilities (where possible) and minimising out-of-pit waste emplacements via backfilling of the open cut pit void.

As a result, the Project area covers an area of approximately 571 ha, of which the majority (380.5 ha) is cleared or non-remnant vegetation. Over the life of the Project, a total of approximately 190.5 ha of remnant vegetation would be cleared (Table 24).

The vegetation that would be removed contains a number of fauna habitat components such as potential nesting/denning/roosting habitat for hollow-obligate species in hollow-bearing trees, shelter provided by dense vegetation and fallen timber, foraging resources (e.g. nectar and sap sources), fruiting resources, seeds and grains along with prey habitat.

Table 24: Details on vegetation to be removed

Field-verified RE	BD Status	VMA Status	EPBC Status	Habitat type	Area (ha)
11.3.1	Endangered	Endangered	Endangered	Acacia harpophylla woodland/forest	15
11.3.2	Of Concern	Of Concern	-	Eucalypt woodland/forest	43.5
11.3.2/11.3.4	Of Concern	Of Concern	-	Eucalypt woodland/forest	1.5
11.3.27d	Of Concern	Least Concern	-	Wetlands	1.9
11.4.9	Endangered	Endangered	Endangered	Acacia harpophylla woodland/forest	0.5
11.5.3	No concern at present	Least Concern		Eucalypt woodland/forest	128
				Total	190.5
				Regrowth	249.5

The vegetation proposed to be removed by the Project includes potential habitat resources for the following threatened fauna species:

- Ornamental Snake (15.5 ha, comprising only of remnant vegetation);
- Squatter Pigeon (388.5 ha, comprising 189ha of remnant vegetation and 199.5 ha of regrowth);
- Greater Glider (175 ha, comprising only of remnant vegetation); and
- Koala (175 ha, comprising only of remnant vegetation).



5.1.2. Impacts to Individual Fauna

The removal of native vegetation associated with the Project, particularly hollow-bearing trees and logs, has the potential for direct mortality of fauna species. This potential risk is increased during the breeding seasons (generally spring to late autumn), and cooler seasons when mammals and reptiles enter torpor.

To reduce the likelihood of direct mortality to native fauna species, MCPL would implement the vegetation clearance protocol described in Section 6.

5.1.3. Habitat Fragmentation

The woodland communities in the western area are patchy and fragmented and do not provide strong connectivity across the study areas. The woodland is more contiguous on the eastern study area and provides connectivity, however is fragmented by several roads and fencelines.

The Project area is adjacent to the approved mine surface disturbance area and clearance of the vegetation in the Project area is not likely to isolate any external habitats (only increase the size of the existing footprint). The removal of vegetation from the study area would however increase the level of local fragmentation and reduce connectivity between remaining habitats in the locality.

The Project would also increase the barrier already presented by the existing mine for terrestrial fauna species which would generally avoid crossing cleared land. This would have the greatest impact on less mobile species including herpetofauna (e.g. snakes, lizards and frogs), arboreal mammals (e.g. Sugar Glider and Greater Glider) and small mammals (e.g. rodents).

While fragmentation at the local scale would be high, the loss of habitat resulting from the Project in the wider area would only incrementally increase fragmentation in an already highly fragmented landscape. Many of the fauna groups represented in the area are highly mobile (e.g. birds, bats macropods), and would be accustomed to the level of fragmentation. Post-mine landforms are proposed to be progressively rehabilitated to include woodland habitat.

5.2. Indirect Impacts

The Project may also potentially result in indirect impacts, as detailed in the following sections.

5.2.1. Edge Effects

Existing vegetation in the Project area and adjacent land is currently fragmented from pastoral areas, roads and easements; hence any edge effects are likely to have already manifested. Newly exposed edges created by clearing works may be subject to higher levels of weed invasion.

Further, given the open nature of the adjacent woodland habitats, no alterations to microclimate or species assemblage are likely to occur as a result of the Project.



5.2.2. Erosion and Sedimentation

The Project has the potential to increase the natural rate of erosion and sediment with, and downstream of, the Project area due to the additional disturbance areas associated with the extension to the open cut pit and waste emplacement. MCPL would revise the existing *Erosion and Sediment Control Plan* (WRM Water and Environment [WRM] 2012) to manage erosion and sedimentation in the Project area and downstream.

With the continuation of these management measures it is unlikely that the Project would result in significant erosion or sedimentation impacts that would adversely impact native flora and/or fauna within, or downstream of the Project area.

5.2.3. Hydrological Regime Changes

The Project would result in changes to the natural flow regimes of the local drainage features due to the capture and re-use of drainage from operational disturbance areas. The Project water management system would generally be based on the existing water management system with revisions undertaken progressively over the life of the Project (WRM, 2018).

No measurable impacts on surface water quality are likely to occur from changes in surface water as (WRM, 2018):

- no uncontrolled spills of mine affected water from the mine water dam are predicted;
- release of treated water from sediment dams (designed in accordance with the Best Practice Erosion and Sediment Control [International Erosion Control Association Australasia, 2008]) to the downstream environment would only occur in accordance with the existing EA conditions which is unlikely to have a measurable impact on receiving water quality; and
- there is a predicted negligible impact on the downstream water quality through controlled releases from the Project in accordance with the existing EA.

In addition, WRM (2018) has concluded that the diversion of Drainage Line 1 is unlikely to result in a change to the natural flow regime of the receiving waters, given it would:

- be designed in accordance with the relevant guidelines;
- replicate the natural features of Drainage Line 1; and
- have the same hydrological characteristics of Drainage Line 1.

Based on the implementation of management strategies and measures described in WRM (2018) it is unlikely that the Project would result in significant hydrological regime changes that would adversely impact native flora and/or fauna within, or downstream of the Project area.

MCPL would continue to conduct annual monitoring of the water quality, habitat characteristics and macroinvertebrate diversity of the receiving waters as described in their Receiving Environment Monitoring Program (MCPL, 2016).



5.2.4. Dust

The Project would result in the generation and distribution of dust from Project-related activities such as blasting, materials handling and vehicle movements (Katestone 2018).

While the potential dust impacts on flora and/or fauna in surrounding habitats associated with the Project may increase in comparison to the existing operations, it is expected that the Project would result in a reduction in potential dust impacts in comparison to the existing/approved Middlemount Coal Mine operations (Katestone, 2018) and this would in turn decrease the potential impacts on native species.

5.2.5. Weed Invasion

Weed cover on the study area is generally limited to introduced pasture species (e.g. Buffel Grass, Sabi Grass, *Stylosanthes* sp.) and occasional Prickly Pear. The Project has limited potential to be invaded by weeds due to on-going soil disturbance, however road edges may become colonised by weeds.

There is a low likelihood of weeds spreading into adjoining native woodland/forest vegetation as a result of the Project because the control of declared weeds is an existing management measure that would be adopted for the Project area. Further, construction areas and the post-mine landforms would be progressively rehabilitated with native vegetation (limiting opportunities for weeds to grow).

5.2.6. Vehicle Strike

The Project would contain new haul roads which would increase the risk of road strike to the site. All roads on the mine site are however limited to 40km/h which would greatly reduce the risk of road strike.

5.2.7. Noise

The Project would result in the generation noise from Project-related activities such as blasting, materials handling and vehicle movements (Renzo Tonin 2018). Similarly to the potential dust impacts, the scale of noise impacts would increase in comparison to the existing operations as operational noise sources and the extent of blasting would be extended into the new mining areas (Renzo Tonin 2018).

Any potential noise-related impact on fauna residing in surrounding habitat would likely be localised and minor given fauna often readily habituate to continuous noise and sudden noises from blasting would only occur in intervals. This has been evidenced during the current, and previous, survey work surrounding the existing operations through sightings of fauna using habitat adjacent to active mining areas.

5.2.8. Artificial Lighting

The Project would result in an increase (relative to the existing operations) in the use of artificial lighting within the Project locality. Despite this, the incremental impact of this additional night-lighting is expected to be minor given the lights would be operated in accordance with the relevant Australian Standard.



5.2.9. Introduction of Feral/Introduced Species

A number of feral species were detected during the survey, most notably the feral cat, wild dog and fox which are known to prey upon native fauna. Feral pests that are already present in the Project area are likely to displace into adjoining areas during construction, however, the number of feral pests that would be displaced would be reduced by controlling feral pests. As outlined in Section 6.4, the control of feral pests is an existing measure that would be adopted for the Project area.

5.2.1. Fauna and Final Void

Owen Foley (2014) prepared a *Residual Void Flora and Fauna Capability Study* for the *Residual Void Study* (MCPL 2014). As per the approved final void, the base of the proposed final voids would gradually begin to fill with water which would gradually increase in salinity over time (WRM Water & Environment 2018). The high walls of the final void would not contain vegetative cover but rather steep rock slopes and cliffs (Owen Foley 2014).

5.2.2. Bushfire

Bushfire is an essential component of vegetation dynamics in Australia, but the frequency and intensity must be appropriate to each vegetation type and most accidental wildfires are not likely to be beneficial.

An increase in mine activities and mine vehicles could potentially increase the risk of starting wildfires through hot exhausts, hot works or human error. The Project area is contiguous with areas of vegetated land, and as such is both prone to wildfire incursion and a potential source of fire.

Bushfire prevention and management measures are described in Section 6.7.

5.3. Cumulative Impacts

Removal of vegetation and habitat for the Project would add to cumulative loss of vegetation from past landuses and significant clearing associated with the existing/approved Middlemount Coal Mine. The Project would also contribute to the cumulative impacts of vegetation clearance associated with a number of operational mines within the wider locality, these include:

- German Creek East – located approximately 5 km south of the Project area;
- Foxleigh – located approximately 15 km south-east of the Project area;
- Lake Lindsay – located approximately 15 km south south-east of the Project area; and
- Norwich Park – located approximately 20 km north-west of the Project area.

At a site level, the proposed clearance associated with the Project would result in an increase in remnant vegetation clearance of approximately 43% when compared to the existing/approved Middlemount Coal Mine.



Approximately 440 ha of native vegetation is approved to be cleared for the Middlemount Coal Mine, however, the loss of vegetation associated with the approved mining operations has already been offset in accordance with the relevant State and Commonwealth legislation.

On a larger scale, the native vegetation communities/regional ecosystems to be cleared during the life of the Project all occur more widely in surrounding landscapes and subregions (after Accad *et al.*, 2017). The Project would result in the loss of approximately 0.03% of the remnant vegetation remaining within the Isaac Comet Dows Subregion (Accad, et al., 2017).

The proposed offset areas for the Project would significantly increase the area of protected habitat that will be managed for conservation (bringing the total to 5,871 ha [Section 9]). The existing and proposed offset areas provide habitat for a number of common and threatened species as demonstrated from monitoring surveys (EHP 2012, Naturecall 2014-2017) and their continued regeneration will help offset biodiversity losses from the Middlemount Coal Mine. In addition, the progressive rehabilitation of mining areas over the life of the Project would provide habitat in the medium to long term.

Given the above, the additional clearance associated with the Project is considered to represent only a minor increase in cumulative vegetation loss. Accordingly, the Project is not anticipated to have a significant cumulative impact on terrestrial ecology.



6.0 Mitigation Measures

The Project would be subject to a number of mitigation measures to reduce the overall impact of the development on biodiversity and ensure potential off-site impacts are minimised. The conclusions of the impact assessments undertaken have assumed that the following mitigation measures will be implemented.

6.1. Refinement of the Mine Design to Avoid Land Clearance

The following refinements to the mine design have resulted in minimising additional land disturbance:

- use of existing infrastructure and facilities at the Middlemount Coal Mine, where possible, to avoid the need for additional clearance works;
- optimising the backfilling of the open cut pit to minimise the overall mine footprint (i.e. reduce the size of the out-of-pit waste emplacement); and
- locating the proposed waste emplacements to be continuous with the existing/approved waste emplacements to minimise the total disturbance footprint.

6.2. Vegetation Clearing Management

The following measures would be implemented to manage clearing on site:

- The sequence of vegetation clearing would be undertaken in a manner to ensure fauna is not isolated from adjacent habitat preventing their escape.
- Approved disturbance limits would be clearly marked (e.g. via pegging and/or flagging tape) before clearing in order to prevent any inadvertent clearance. Site induction would specify that no clearing is to occur beyond the marked area and any machinery or materials associated with the development are not to be parked/stored in adjacent retained vegetation.
- Where possible, timing of vegetation clearing would avoid the breeding season for the Greater Glider (i.e. April to June).
- The area of clearing work is to be inspected for fauna by a fauna spotter immediately prior to commencement of any vegetation removal. Pre-clearing checks would include searches of habitat (e.g. lifting and destructive searches of logs) and searches for bird nests. If possible, any detected fauna is to be relocated to nearby suitable areas prior to clearing.
- During the pre-inspection, all hollow-bearing trees, stags and large hollow logs are to be clearly marked with flagging tape to allow easy identification during clearing.
- A fauna spotter is to remain on site to supervise clearing to retrieve any fauna detected during works and undertake appropriate action (e.g. euthanize severely injured animals and/or relocate uninjured animals where possible).
- If a Koala is present in the proposed clearing area, it would be left to move away from the clearance area on its own accord.



- Measures described in the Middlemount Coal Species Management Program would continue to be followed.

6.3. Rehabilitation

Consistent with EA EPML00716913, the rehabilitation goals for the existing Middlemount Coal Mine would remain unchanged for the Project. These areas are:

- to ensure the final landform is safe to humans and wildlife;
- to ensure the site is non-polluting;
- to ensure the final landform is stable; and
- to ensure the site is able to sustain an agreed post-mining land use.

Rehabilitation progress and rehabilitation activities would regularly be re-evaluated and the results would inform future rehabilitation initiatives. All post-mine landforms, except final voids and sections of the low wall, would have a self-sustaining vegetation or rock mulch cover.

6.4. Weed Management

MCPL currently implements weed control measures at the existing operations in accordance with the *Middlemount Coal Mine Environmental Management Plan* (MCPL, 2017).. These measures would be continued for the Project and include spot spraying of *Biosecurity Act 2014* listed weed species.

6.5. Feral Animal Management

MCPL currently implements feral animal control measures at the existing operations in accordance with the *Middlemount Coal Mine Environmental Management Plan* (MCPL, 2017). These measures would be continued for the Project and include wild dog and cat control.

6.6. Erosion and Sedimentation

MCPL currently implements standard erosion and sedimentation control measures at the existing operations. These measures would be continued for the Project and would be applied as per an Erosion and Sediment Control Plan (WRM 2012).

6.7. Artificial Lighting

Artificial lighting would be required during the operation of Project. This would not be directed into adjacent retained habitat to reduce impacts on nocturnal fauna potentially using this habitat.

6.8. Bushfire prevention and management

MCPL would aim to maintain vegetation structure and composition, protect mine assets and safeguard human life through the implementation of bushfire management techniques, including:



- physical protection of assets through clean firebreaks
- active fire suppression of unplanned and potentially destructive fires (to vegetation and built assets)
- pro-active fuel and ecosystem management to sustain ecological fire regimes as much as possible.



7.0 Significant Residual Impact Assessment - Matters of State Environmental Significance

The *Queensland Environmental Offsets Policy* (DEHP 2017b) has a *Significant Residual Impact Guideline* (DEHP 2014c) to determine if a prescribed activity would have a significant residual impact on MSES. A significant residual impact is defined as an adverse impact, whether direct or indirect, of a prescribed activity on all or part of a prescribed environmental matter that:

- a) *remains, or will or is likely to remain, (whether temporarily or permanently) despite on-site avoidance and mitigation measures for the prescribed activity; and*
- b) *is, or will or is likely to be, significant.*

Table 25 provides a significant residual impact assessment summary on MSES for the Project.

Table 25: Matters of State Environmental Significance - Significant Residual Impact Assessment

Prescribed Environmental Matter	Presence on site	Significant Residual Impact Likely?
Regulated Vegetation		
Endangered or Of Concern RE	The Project area contains Endangered and Of Concern REs	Yes. Refer to Section 7.1.
Regional ecosystems (not within an urban area) that intersect a wetland on the vegetation management wetlands map	RE 11.3.27d intersects a mapped wetland in the north of the Project area	No. The potential impact would be less than 2 ha, which is not considered to be significant.
Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map	The Project area does not contain a watercourse as per the advice provided by DNRm on 3 October 2017.	-
Connectivity areas		
Connectivity area that is a regional ecosystem (not in urban area) The study area contains remnant vegetation that forms part of a corridor mapped as being of State biodiversity significance.	The study area contains remnant vegetation	Yes. Refer to Section 7.2 for discussion.
Wetlands and watercourses		
A wetland of HES shown on the Map of referable wetlands	A small area of a wetland of HES (0.75 ha) occurs within the Project area and has been assessed for significant residual impacts.	Yes. Refer to detailed assessment in Section 7.3



Prescribed Environmental Matter	Presence on site	Significant Residual Impact Likely?
Protected wildlife habitat		
Habitat for an animal that is vulnerable wildlife	Three species listed as vulnerable under the NC Act were recorded on site during the survey (Koala, Greater Glider and Squatter Pigeon). Two additional threatened fauna species (Powerful Owl and Ornamental Snake) are considered to have potential to occur on the site and be potentially impacted by the Project.	Yes. Assessment in Section 7.4 has determined that a significant residual impact on the Koala and Greater Glider is likely.
Habitat for an animal that is special least concern wildlife	One species listed as special least concern fauna under the NC Act was recorded on site during the survey (Echidna).	No significant residual impact is likely.
Legally secured offset area		
Any areas declared as an environmental offset protection area, high nature conservation value under the VM Act or another area prescribed under a regulation.	A portion of two legally secured Offset Areas occur in the Study area. These have been assessed against the criteria in Section 7.5	Assessment in Section 7.5 has determined that the Project will have a significant residual impact on these areas.



7.1. Regulated Vegetation

7.1.1. Components to Be Assessed

Regulated vegetation is a 'prescribed regional ecosystem' that:

- is an Endangered or Of Concern RE;
- intersects with an area shown on the vegetation management wetlands map; or
- is located within the defined distance from the defining banks of a watercourse identified on the vegetation management watercourse map.

7.1.2. Factors to Be Considered

For clearing other than clearing for linear infrastructure, a significant residual impact is triggered if the following thresholds are exceeded (Figure 22).

Figure 22: Significant residual impact criteria – regulated vegetation

		Clearing in a regional ecosystem that is: <i>endangered, or of concern</i>	Clearing in the portion of a regional ecosystem that lies within a mapped wetland	Clearing in a regional ecosystem that is within the defined distance of a watercourse
1	For clearing for linear infrastructure: – greater than 25m wide in a grassland (structural category) regional ecosystem; or – greater than 20m wide in a sparse (structural category) regional ecosystem; or – greater than 10m wide in a dense to mid-dense (structural category) regional ecosystem. For clearing other than clearing for linear infrastructure: – area greater than 5 ha where in a grassland (structural category) regional ecosystem; or – area greater than 2 ha where in a sparse (structural category) regional ecosystem; or – area greater than 0.5 ha where in a dense to mid-dense (structural category) regional ecosystem.	✓	✓	✓
2	Clearing within 50m of the defining bank	N/A	✓	N/A
3	Clearing within 5m of the defining bank	N/A	N/A	✓

Source: (DEHP, 2014c)

7.1.3. Assessment of Significance

The Project would involve the removal of Endangered and Of Concern REs. The area of impact and trigger thresholds for a significant residual impact are shown in Table 26.

**Table 26: Significant residual impact test – regulated vegetation**

Field-verified RE	VMA Status	Category	Structural category	Area to be removed	Significant impact?
11.3.1	Endangered	Regulated Vegetation	Mid dense	15 ha	Yes
11.3.2	Of Concern	Regulated Vegetation	Sparse	43.5 ha	Yes
11.3.2/11.3.4	Of Concern	Regulated Vegetation	Sparse	1.5 ha	No
11.3.27d	Least concern	Mapped Wetland	Sparse	1.9 ha	No
11.4.9	Endangered	Regulated Vegetation	Mid dense	0.5 ha	Yes

7.1.4. Conclusion

Clearing of regulated vegetation for the Project would exceed the threshold a trigger a significant residual impact for RE 11.3.1, 11.3.2 and 11.4.9.

7.2. Connectivity Areas

As mentioned in Table 26, the LFC Tool was applied to the Project. The output from the tool showed that the Project exceeded the threshold for an impact on connectivity and fragmentation (see log file in Appendix 12).

7.3. Wetlands and Watercourses

7.3.1. Components to Be Assessed

An offset may be required for the following wetlands:

- wetland in a wetland protection area;
- wetlands of HES; and
- wetland or watercourse in a high ecological value waters.

The western study area contains part of a HES wetland (0.75 ha) as shown in Figure 19.

7.3.1.1. Factors to Be Considered

An action is likely to have a significant residual impact on prescribed wetlands or watercourses if it is likely that the action would result in environmental values being affected in any of the following ways (DEHP, 2014b):

- areas of the wetland or watercourse being destroyed or artificially modified;*
- a measurable change in water quality of the wetland or watercourse—for example a change in the level of the physical and/or chemical characteristics of the water, including salinity, pollutants, or nutrients in the wetland or watercourse, to a level that exceeds the water quality guidelines for the waters; or*
- the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected; or*



- d) a substantial and measurable change in the hydrological regime or recharge zones of the wetland, e.g. a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or*
- e) an invasive species that is harmful to the environmental values of the wetland being established (or an existing invasive species being spread) in the wetland.*

7.3.1.2. Assessment of Significance

This section addresses each of the previous points listed.

a) areas of the wetland or watercourse being destroyed or artificially modified;

The portion of ephemeral wetland on the site (0.75 ha) would be removed as part of the Project as it falls within the Project area. The remainder of the wetland falls within the area covered by the existing/approved Middlemount Coal Mine and outside the existing/approved Middlemount Coal Mine to the north.

b) a measurable change in water quality of the wetland or watercourse—for example a change in the level of the physical and/or chemical characteristics of the water, including salinity, pollutants, or nutrients in the wetland or watercourse, to a level that exceeds the water quality guidelines for the waters; or

The HES wetland would be removed.

c) the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected; or

It is unlikely that any aquatic fauna species would be dependent on the ephemeral wetland.

d) a substantial and measurable change in the hydrological regime or recharge zones of the wetland, e.g. a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or

The HES wetland would be removed.

e) an invasive species that is harmful to the environmental values of the wetland being established (or an existing invasive species being spread) in the wetland

The HES wetland would be removed.

7.3.1.3. Conclusion

The Project is likely to have a significant residual impact on the HES wetland because it removes an area (0.75 ha) of the mapped HES wetland.



7.4. Protected Wildlife Habitat

7.4.1. Components to be Assessed - Endangered and Vulnerable Wildlife

The following species are subject to the significant residual impact test as they have been recorded within the wider locality or are considered to have at least a low potential to use habitat in the Project area at some time (e.g. now or if they were to potentially recover and expand) and thus have potential to be impacted by the Project:

- **Mammals:** Koala, Greater Glider.
- **Birds:** Squatter Pigeon, Powerful Owl.
- **Reptiles:** Ornamental Snake.

7.4.1.1. Factors to be Considered

An action is likely to have a significant impact on endangered and vulnerable wildlife if the impact on the habitat is likely to (DEHP, 2014b):

- *lead to a long-term decrease in the size of a local population; or*
- *reduce the extent of occurrence of the species; or*
- *fragment an existing population; or*
- *result in genetically distinct populations forming as a result of habitat isolation; or*
- *result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat; or*
- *introduce disease that may cause the population to decline, or*
- *interfere with the recovery of the species; or*
- *cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species.*

A population for a species is defined by the guidelines (DEHP 2014b) as an occurrence of the species in a particular area. In relation to endangered, vulnerable and special least concern species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations; or
- a population, or collection of local populations, that occurs within that particular bioregion.



7.4.1.2. Assessment of Significance

This section addresses each of the previous points listed.

a) lead to a long-term decrease in the size of a local population; or

Koala

The Koala recorded in the eastern study area during the survey, and has also been recorded on MCPL lands to the south-west of the site. Sparse local records and poor local soil quality (and hence low quality habitat) would mean Koalas in the area would have large home ranges which are likely to be associated with riparian areas where preferred browse trees are common. This is consistent with Koala sightings on MCPL lands on alluvial flats and riparian areas associated with Roper Creek.

The Project would remove approximately 175 ha of known/potential habitat for the Koala, and in conjunction with existing/approved Middlemount Coal Mine, would result in a significant loss of habitat. Due to limited abundance of preferred browse species and poor soils, the habitat to be removed is however considered lower quality habitat that would only form part of the marginal home range of a Koala.

The Project would reduce connectivity and habitat linkages for the local Koala population, however some connective habitat would be retained to the north of the study area which would continue to provide a corridor for the Koala. No significant increase in threats to the Koala such as road kill or dog attack would result from the Project.

The removal/modification of a portion of habitat for the Koala is unlikely to lead to a long-term decrease in the size of a local population of Koala given:

- the Koala has not been observed within the Project area (only scats);
- similar potential habitat for this species is more widespread in the landscape outside the Project area; and
- Koala records are widespread in the landscape outside the Project area.

Greater Glider

The Greater Glider was recorded in several locations in the Project area. It has also been extensively recorded in the Stage 2 Offset Area to the west of the site (Naturecall 2017b). Greater Gliders have small home ranges ranging between 1.3 and 4 ha (Comport et al. 1996, Pope et al. 2005, TSSC 2016). The study areas would therefore encompass entire home ranges of the Gliders, and they would be also expected to extend off site.

The Project would remove approximately 175 ha of habitat for this species comprising open woodlands. This habitat would be used for both foraging and denning/breeding within hollow-bearing trees. When the cumulative impact of the Project and the existing/approved Middlemount Coal Mine is considered, the large loss of habitat and reduction in connectivity is likely to lead to a long term decrease of the local population.



Squatter Pigeon (southern)

The Squatter Pigeon was recorded in the eastern study area, but not within the Project area. It has also been previously recorded in the south of the western study area during previous studies (Naturecall 2013, PB 2010).

The study areas contain suitable habitat for this species in the form of woodland habitat as well as non-remnant woodland vegetation and disturbed areas which are also frequently used for foraging (DEE 2017). This species has large seasonally nomadic home ranges (DotE TSSC 2015) hence the local population would extend well beyond the Project area.

The Project would see the removal of approximately 388.5 ha of known/potential habitat for this species. In terms of the large home range of this species, its high mobility and the presence of extensive alternative habitat in the locality, the Project is unlikely to lead to a decrease in the local population.

Powerful Owl

The Powerful Owl has not been recorded on MCPL lands or in the locality, hence the site only provides potential habitat for this species. Due to the large home range of this species (Soderquist and Gibbons 2007), a potential population would extend well beyond the site.

The Project would impact this species via the loss of approximately 175 ha of open woodland habitat which has the potential to be used for foraging and nesting within hollow-bearing trees. While this may lead to a localised reduction of prey resources and nesting sites, given that the territories of this species are measured in terms of thousands of hectares (Soderquist and Gibbons 2007), the relatively minor loss of carrying capacity resulting from the Project, while a negative impact, is not sufficient to undermine a local pair's ability to obtain sufficient forage to raise young to fledging. Given this, and the extent of habitat remaining in the locality, the Project would unlikely lead to a long term decrease in the size of a local population.

Ornamental Snake

This species was not recorded in the study area during the surveys despite targeted surveys undertaken in different seasons. It has however been recorded on MCPL land to the south of the site near Roper Creek by PB in 2010 (Section 2.6.3).

The Project area provides suitable habitat for the Ornamental Snake in the form of Brigalow habitats nearby ephemeral drainage lines which provide habitat for preferred prey species.

The Project would remove 15.5 ha of potential habitat which comprises remnant Brigalow habitats. Given that a number of targeted surveys undertaken by Biodiversity Australia and other consultants since 2010 have not detected this species within the study area, it is only considered to be a low chance of occurrence within the potential habitat in the Project area. As such, the removal of potential habitat in the project area is unlikely to lead to a long term decrease in the local population.



b) reduce the extent of occurrence of the species; or

The habitats present on the study areas only contain a low density of preferred foraging trees for the Koala and would only provide secondary foraging habitat and habitat linkages. The Project would remove an estimated 175ha of habitat for this species, and given that known habitat in the eastern study area would be removed, the extent of occurrence is likely to be reduced to some degree.

For the Greater Glider, the Project would remove approximately 175ha of known and potential habitat which is likely to reduce the extent of occurrence of the local population.

For the Powerful Owl and Squatter Pigeon, while the Project would reduce the amount of potential habitat for these species on a local scale, given the extent of higher quality habitat on adjacent land and in the locality, and the large home range of these species, the removal of the habitat would unlikely reduce the extent of occurrence.

For the Ornamental Snake, given that a population of this species has not been detected in the study area, no known habitat would be removed and the extent of occurrence of this species would not be reduced as a result of the Project. The extent of potential habitat for this species would however be reduced, and this could impact the species recovery in the local area.

c) fragment an existing population; or

The Powerful Owl and Squatter Pigeon are highly mobile species and known to be capable of crossing human-modified habitat. The Project would thus offer no barrier to movement and hence would not fragment an existing population.

The Koala is also relatively mobile, able to cross clearings and roads, though is highly susceptible to other threats such as dog attack and vehicle strike. The Project would reduce connectivity for the Koala population, however connective habitat would still remain around the study area to the north. As such, while the Project would lead to further fragmentation of habitat and reduce connectivity, there is not potential for fragmentation of an existing population.

The Greater Glider relies on canopy connection to move throughout its home range and would rarely come to the ground and cross clearings and open ground. The Project would remove connective habitat for this species, and in conjunction with approved mining activities in MCPL leases, is likely to fragment populations of the Greater Glider, especially those which occur in the eastern study area.

Removal of habitat for the Project would be unlikely to fragment a population of the Ornamental Snake given its low likelihood to occur on the site and that some connective habitat would remain around the sites to the north.

d) result in genetically distinct populations forming as a result of habitat isolation; or

As mentioned above, the Project would be unlikely fragment or isolate an existing population of the more mobile species (Squatter Pigeon, Powerful Owl, Koala). Similarly for the Ornamental Snake, the habitat remaining to the north of the sites would provide connective habitat for this species if it were to occur in the study area and hence gene flow between potential populations could continue and not result in genetic isolation.



For the Greater Glider, the Project has the potential to isolate populations of the Greater Glider given that they are less mobile and require a continuous canopy connection to move through their home range and disperse. There is some potential for any isolated populations to reestablish dispersal and gene flow post mining operations when the disturbance footprint is rehabilitated.

e) result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat; or

The Project area currently has a number of introduced and invasive species including predators such as the feral cat and fox and weed species including Prickly Pear. No new species that is likely to affect any of the subject species would likely be introduced as a result of the Project.

f) introduce disease that may cause the population to decline, or

Due to the nature of the Project, the risk of a new disease (relevant to the species) being introduced to the site would be unlikely.

g) interfere with the recovery of the species; or

Ideally, the goal in threatened species recovery is to increase the abundance and range of the threatened species, so that it is not in risk of becoming extinct. As detailed previously, the Project would lead to habitat loss and contribute to threatening processes which would interfere with the recovery of the subject threatened species to varying degrees. This includes directly reducing habitat for the species known to occur and reducing the amount of available potential habitat for other species.

h) cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species.

For the Squatter Pigeon and Powerful Owl, the habitat in the Project area has an evident disturbance history and is unlikely to qualify as an ecologically significant location, especially given the extent of identical and higher quality habitat that occurs in the wider area.

The Koala and Greater Glider have been recorded in the study area and that habitats within the Project area would provide foraging and breeding habitat, as well as habitat linkages

The Ornamental Snake has not been recorded in the study area and it is unlikely that the habitats present would constitute ecologically significant locations for this species.

7.4.1.3. Conclusion

The Project is not considered to result in a significant residual impact on the Powerful Owl and Squatter Pigeon, due to their high mobile nature and the large extent of suitable habitat in the wider area that is readily accessible.

The impact of the Project on the Ornamental Snake is uncertain, however given that it was not recorded on site, the impact of the Project is unlikely to be significant.

For the Koala and Greater Glider, the Project would have a greater impact, especially when the cumulative impact of other approved mining activities are considered. The Project is likely to result in a significant residual impact on these species.



Thus, as per the *Significant Residual Impact Guideline* (DEHP 2014b), the Project would require an offset for these species.

7.4.2. Components to be Assessed – Special Least Concern (non-migratory) Animals

The Echidna is listed as a Special Least Concern species under the NC Act and was recorded in the western study area during the survey.

7.4.2.1. Factors to be Considered

An action is likely to have a significant impact on a special least concern (non-migratory) animal wildlife habitat if it is likely that it will result in (DEHP, 2014b):

- *a long-term decrease in the size of a local population; or*
- *a reduced extent of occurrence of the species; or*
- *fragmentation of an existing population; or*
- *result in genetically distinct populations forming as a result of habitat isolation; or*
- *disruption to ecologically significant locations (breeding, feeding or nesting sites) of a species.*

7.4.2.2. Assessment of Significance

This section addresses each of the previous points listed.

a) a long-term decrease in the size of a local population; or

The Echidna was recorded via PIR camera located near a dam on unnamed Drainage Line 2. The Echidna has also been recorded previously on MCPL land in the Stage 2 offset area and near Parrot Quarry Road during previous surveys (Naturecall 2016a). A local population of the Echidna would extend well beyond the study area given these previous records and that large areas of suitable habitat occurs on adjacent and nearby lands.

The Project would impact the Echidna via removing habitat which includes open woodland and regrowth. This would affect foraging habitat and connectivity would also be reduced. However given that the local population would extend well beyond the site, and that large areas of suitable habitat would remain to the west within the Stage 2 offset area, the Project is only likely to affect a few individuals of the overall population and would be unlikely to lead to a decline.

b) a reduced extent of occurrence of the species; or

The Project would remove habitat that may be used by the local population of this species. This would result in a minor contraction of the extent of occurrence.

c) fragmentation of an existing population; or

The Echidna is relatively mobile and would be able to cross disturbed areas and open ground. Sufficient connectivity for this species is likely to remain after clearance and no populations are likely to become fragmented as a result of the Project.



d) result in genetically distinct populations forming as a result of habitat isolation; or

As discussed above, no fragmentation or isolation of the local population is likely to result from the Project.

e) disruption to ecologically significant locations (breeding, feeding or nesting sites) of a species.

The Project would affect generic foraging and potentially breeding habitat for the local Echidna population. Given the extent of similar and higher quality habitat located on adjacent and nearby lands, the habitat on site is unlikely to be of any specific significance to the local population.

7.4.2.3. Conclusion

The Project is unlikely to have a significant impact on the habitat or local population of the Echidna.

7.5. 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.

As discussed in Section 4.4.5, portions of two legally secured offset areas are located within the Project area. These comprise the Stage 2 Offset Area and Rail Loop and Spur Offset Area. The Project area would impact part of these offset areas.

The proposed offset strategy (Section 9) addresses the impacts on these offset areas.



8.0 Significance Assessments - Matters of National Environmental Significance

8.1. General Assessment Overview

On 8 January 2018, the Project was referred under the EPBC Act (2016/7649). On 8 February 2018, a delegate of the Commonwealth Minister for the Environment declared the Action to be a 'controlled action' for the purpose of the EPBC Act due to potential adverse impacts on the following controlling provisions under Part 3 of the EPBC Act:

- sections 18 and 18A of the EPBC Act (listed threatened species and communities); and
- sections 24D and 24E of the EPBC Act (a water resource, in relation to coal seam gas development and large coal mining development).

The EPBC Act referral decision DoEE included a list of MNES which DoEE considers is likely to be significantly impacted by the Project. These included:

- Brigalow EEC;
- Squatter Pigeon (Vulnerable);
- Koala (Vulnerable);
- Greater Glider (Vulnerable);
- Ornamental Snake (Vulnerable); and
- Grey-headed Flying Fox (Vulnerable).

These MNES are all considered in the following assessments with the exception of the Grey-headed Flying Fox. The Grey-headed Flying Fox has very few formal records within the locality, with no historical records within Wildlife Online (DEHP 2016). The only reference to Grey-headed Flying Fox records within the locality comes from the Department of the Environment and Energy (2018e) – National Flying-fox Monitoring viewer which has a annually monitored Flying-fox camp in the centre of the Middlemount Township (approximately 3km north-east).

In 2014, the Flying-fox camp was recorded to have a population of between 2500 – 9,999 Grey-headed Flying Fox present (DEE, 2018e) and does not represent a nationally important Flying-fox camp. There have been no subsequent Grey-headed Flying Fox records since August 2014. The Project area does not have tall closed forests near streams, rivers or estuaries that would provide favourable habitat for Grey-headed Flying Fox roosts. As such, the species is considered unlikely to occur in a roosting capacity. At very most, the species may use the study site as a minute portion of a much larger foraging range hence any potential impacts would be minute.

8.2. Protected Species Assessments

The following EPBC Act threatened species require assessment:

- Squatter Pigeon (Vulnerable).
- Koala (Vulnerable).



- Greater Glider (Vulnerable).
- Ornamental Snake (Vulnerable).

8.2.1. Factors to be Considered

The *MNES, Significant Impact Guidelines 1.1* (DEWHA, 2013) define an action is as likely to have a significant impact on a vulnerable species, if it will:

- *lead to a long-term decrease in the size of an important population of a species.*
- *reduce the area of occupancy of an important population:*
- *fragment an existing important population into two or more populations*
- *adversely affect habitat critical to the survival of a species,*
- *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*
- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*
- *introduce disease that may cause the species to decline:*
- *interfere substantially with the recovery of the species.*

An *important population* is defined under the *MNES Significant Impact Guidelines 1.1* (DEWHA, 2013) as one that is necessary for a species' long-term survival and recovery. This includes such populations as:

- key populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and or
- populations that are near the limit of the species range.

8.2.2. Assessment of Significance

This section addresses each of the significant impact criteria listed above.

- **lead to a long-term decrease in the size of an important population of a species or:**

Koala

The Koala recorded in the eastern study area during the survey, and has also been recorded on MCPL lands to the south-west of the site. Sparse local records and poor local soil quality (and hence low quality habitat) would mean Koalas in the area would have large home ranges which are likely to be associated with riparian areas where preferred browse trees are common. This is consistent with Koala sightings on MCPL lands on alluvial flats and riparian areas associated with Roper Creek.



The Project would remove approximately 175 ha of known/potential habitat for the Koala, and in conjunction with the existing/approved Middlemount Coal Mine, would result in a significant loss of habitat. Due to limited abundance of preferred browse species and poor soils, the habitat to be removed is however considered lower quality habitat that would only form part of the marginal home range of a Koala.

The Project would reduce connectivity and habitat linkages for the local Koala population, however some connective habitat would be retained to the north of the study area which would continue to provide a corridor for the Koala. No significant increase in threats to the Koala such as road kill or dog attack would result from the Project.

The removal/modification of a portion of habitat for the Koala is unlikely to lead to a long-term decrease in the size of a local population of Koala given:

- the Koala has not been observed within the Project area (only scats);
- similar potential habitat for this species is more widespread in the landscape outside the Project area; and
- Koala records are widespread in the landscape outside the Project area.

Greater Glider

The Greater Glider was recorded in several locations in the Project area. It has also been extensively recorded in the Stage 2 Offset Area to the west of the site (Naturecall 2017b). Greater Gliders have small home ranges ranging between 1.3 and 4 ha (Comport et al. 1996, Pope et al. 2005, TSSC 2016). The study areas could therefore encompass entire home ranges of the Gliders.

The Project would remove approximately 175 ha of habitat for this species comprising open woodlands. This habitat would be used for both foraging and denning/breeding within hollow-bearing trees. The removal/modification of a portion of habitat for the Greater Glider is unlikely to lead to a long-term decrease in the size of a local population of this species given:

- much of the habitat within the Project area has been subject to past disturbances (e.g. logging);
- similar potential habitat for this species is more widespread in the landscape outside the Project area; and
- Greater Glider records are widespread in the landscape outside the Project area.

Squatter Pigeon (southern)

The Squatter Pigeon was recorded in the eastern study area, outside the Project area. It has also been previously recorded in the south of the western study area during previous studies (Naturecall 2013, PB 2010).

The study areas contain suitable habitat for this species in the form of woodland habitat as well as non-remnant woodland vegetation and disturbed areas which are also frequently used for foraging (DEE 2017d). This species has large seasonally nomadic home ranges (TSSC 2015) hence the local population would extend well beyond the study area.



The Project would see the removal of approximately 388.5 ha of potential habitat for this species. In terms of the large home range of this species, its high mobility and the presence of extensive alternative habitat in the locality, the Project is unlikely to lead to a decrease in the important population.

Ornamental Snake

This species was not recorded in the study area during the surveys despite targeted surveys undertaken in different seasons. It has however been recorded on MCPL land to the south of the site near Roper Creek by PB in 2010 (Section 2.6.3).

The Project area provides suitable habitat for the Ornamental Snake in the form of Brigalow habitats nearby ephemeral drainage lines which provide habitat for preferred prey species.

The Project would remove 15.5 ha of potential habitat which comprises remnant Brigalow habitats. Given that a number of targeted surveys undertaken by Biodiversity Australia and other consultants since 2010 have not detected this species within the study area, it is only considered to be a low chance of occurrence within the potential habitat in the Project area. As such, the removal of potential habitat in the project area is unlikely to lead to a long term decrease in the local population.

• reduce the area of occupancy of an important population or:

The habitats present on the study areas only contain a low density of preferred foraging trees for the Koala and would only provide secondary foraging habitat and habitat linkages. The Project would remove an estimated 175 ha of habitat for this species, and given that known habitat in the eastern study area would be removed, the area of occupancy is likely to be reduced to some degree.

For the Greater Glider, the Project would remove approximately 175 ha of known and potential habitat which is likely to reduce the area of occupancy of the local population.

For the Powerful Owl and Squatter Pigeon, while the Project would reduce the amount of potential habitat for these species on a local scale, given the extent of higher quality habitat on adjacent land and in the locality, and the large home range of these species, the removal of the site habitat would unlikely reduce the area of occupancy.

For the Ornamental Snake, given that a population of this species has not been detected in the study area, no known habitat would be removed and the area of occupancy of this species would not be reduced as a result of the Project. The extent of potential habitat for this species would however be reduced, and this could impact the species recovery in the local area.

• fragment an existing important population into two or more populations or:

The Powerful Owl and Squatter Pigeon are highly mobile species and known to be capable of crossing human-modified habitat. The Project would thus offer no barrier to movement and hence would not fragment an existing population.



The Koala is also relatively mobile, able to cross clearings and roads, though is highly susceptible to other threats such as dog attack and vehicle strike. The Project would reduce connectivity for the Koala population, however connective habitat would still remain around the study area to the north. As such, while the Project would lead to further fragmentation of habitat and reduce connectivity, there is not potential for fragmentation of an existing population.

The Greater Glider relies on canopy connection to move throughout its home range and would rarely come to the ground and cross clearings and open ground. The Project would remove connective habitat for this species, and in conjunction with approved mining activities in MCPL leases, is likely to fragment populations of the Greater Glider, especially those which occur in the eastern study area.

Removal of habitat for the Project would be unlikely to fragment a population of the Ornamental Snake given its low likelihood to occur on the site and that some connective habitat would remain around the sites to the north.

• adversely affect habitat critical to the survival of a species or:

According to the *MNES, Significant Impact Guidelines 1.1* (DEWHA 2013), “critical habitat” refers to areas critical to the survival of a species or ecological community and may include areas that are necessary for/to:

- activities such as foraging, breeding, roosting or dispersal;
- succession;
- maintain genetic diversity and long term evolutionary development; or
- reintroduction of populations or recovery of the species/community.

No critical habitat for the Squatter Pigeon, Greater Glider and/or Ornamental Snake is present within the Project area according to any databases or registers, including the Register of Critical Habitat maintained by the minister under the EPBC Act

The Project would remove habitat which meets the definition of ‘Critical Habitat’ for the Koala as defined in the *EPBC Act referral guidelines for the vulnerable Koala (combined Qld, New South Wales and the Australian Capital Territory)* (DotE, 2014).

• disrupt the breeding cycle of an important population or:

The Project would be unlikely to disrupt the breeding cycle of an important population of the Squatter Pigeon given that the site does not represent known breeding habitat and the presence of extensive alternative potential habitat in the locality.

Given that the Ornamental Snake has not been recorded within the Project area, and the only known location on MCPL land occurs off site to the south-east, the Project is unlikely to affect the breeding cycle of an important population.

For the Koala, the habitat within the study area is unlikely to support breeding given the low density of preferred food trees and existing habitat fragmentation.



For the Greater Glider, the habitat within the study area represents known foraging and breeding habitat. Removal of this habitat for the Project is likely to disrupt breeding by removing hollow-bearing trees which are used for denning and potentially result in isolation of populations which would reduce breeding success over time.

- **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline or:**

For the Squatter Pigeon, the removal and modification of habitat that would result from the Project would be unlikely to cause a decline of an important population given this species high mobility and ability to relocate to suitable habitat which occurs nearby if required.

For the Ornamental Snake, the Project would result in the direct removal of potential habitat. This would reduce the amount of habitat that is available to the species on MCPL land, however it is unlikely that this would lead to a decline in the species given the lack of records in the Project area and limited records in the surrounding locality.

For the Koala and Greater Glider, the Project would remove known and potential habitat. It would also reduce connectivity for these species. Indirect impacts associated with the mine also have the potential to affect Koala habitat adjacent to the mine footprint.

These direct and indirect impacts, as well as impacts associated with approved mining activities, have the potential to cause the decline of the important populations of these species.

- **result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

The study areas currently have a number of introduced and invasive species including predators such as the feral cat and fox and weeds such as Red Natal Grass and Buffel Grass. No new species that affects any of the subject species would likely be introduced as a direct result of the Project.

- **introduce disease that may cause the species to decline, or**

Due to the nature of the Project, the risk of a new disease being introduced to the locality would be unlikely.

- **interfere substantially with the recovery of the species.**

The Project would lead to habitat loss and contribute to threatening processes which would interfere with the recovery of the subject threatened species to varying degrees. This includes directly reducing habitat for the species known to occur and reducing the amount of available potential habitat for other species.

8.2.3. Conclusion

The Project is likely to have a significant impact on the Koala and Greater Glider. The Project is unlikely to have a significant impact on the Squatter Pigeon and Ornamental Snake.



8.3. Endangered Ecological Communities

The TEC *Acacia harpophylla* (dominant and co-dominant) occurs in the study area. Its extent on site is shown in Figure 16.

8.3.1. Factors for Consideration

The *MNES, Significant Impact Guidelines 1.1* (DEWHA 2013), define an action as likely to have a significant impact on an Endangered Ecological Community if the action would:

- *reduce the extent of an ecological community.*
- *fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines*
- *adversely affect habitat critical to the survival of an ecological community*
- *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*
- *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*
- *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, or*
- *interfere with the recovery of an ecological community.*

8.3.2. Assessment of Significance

This section addresses each of the previous points listed.

- **reduce the extent of an ecological community**

The Project would remove approximately 22 ha of Brigalow EEC (including 6.5 ha of regrowth vegetation)

- **fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines**

The Project would result in further fragmentation of Brigalow EEC through clearing the Project. Patches which occur within the Project area would be removed and leave smaller patches.



- **adversely affect habitat critical to the survival of an ecological community**

The Project would remove some patches of the Brigalow EEC, however these areas, along with other areas of Brigalow regrowth are unlikely to be critical to the survival of the community in the locality.

- **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**

The Project is unlikely to affect abiotic factors that would be necessary to the survival of the local extent of the community given that large patches of Brigalow EEC would remain on adjacent and nearby lands that would not be directly or indirectly affected by the Project.

Surface water patterns would be altered through the Project and associated drainage line diversions, however this would not affect nearby patches of Brigalow that occur on MCPL lands or threatened the survival of the Brigalow EEC in the local area.

- **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**

The Project would cause a substantial change in species composition of the Brigalow communities which occur within the site, as they would be completely removed.

- **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.**

The Project would not introduce an invasive species, however invasive weed species may be advantaged through clearing activities which have the potential to spread into nearby patches of Brigalow EEC. Weed control would continue to occur at the mine and offset areas.

The Project would not cause the regular mobilisation of harmful chemicals or pollutants.

- **interfere with the recovery of an ecological community.**

The Project is likely to interfere with the recovery of Brigalow EEC in the local area, as 22 ha of the Brigalow EEC would be removed.

8.3.3. Conclusion

The Project is likely to have a significant impact on Brigalow EEC.



8.4. Migratory Species

No migratory species were recorded during the survey. The following migratory species are considered potential occurrences:

- Glossy Ibis.
- Fork-tailed Swift.
- Satin Flycatcher.
- Black -faced Monarch.
- Oriental Cuckoo.

These species are collectively assessed below.

8.4.1. Factors To Be Considered

The *MNES, Significant Impact Guidelines 1.1* (DEWHA 2013), define an action as likely to have a significant impact on a migratory species, if it will:

- a) Substantially modify (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species; or*
- b) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species; or*
- c) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.*

An important area of habitat is defined under the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DEWHA, 2013) as:

- 1. Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; or*
- 2. Habitat utilised by a migratory species which is at the limit of the species range; or*
- 3. Habitat within an area where the species is declining.*

8.4.2. Assessment of Significance

The study area is not considered likely to constitute an important area of habitat for any migratory species on the basis of the following:

1. Although migratory species may pass through the Project area, it is not of sufficient extent to support an ecologically significant proportion of any migratory species. This value of the habitat is as a fraction of a significant extent of similar habitat not only in the locality, but the Brigalow Belt Bioregion and across Australia.
2. No migratory species were recorded during the targeted survey work undertaken in the study area.
3. Habitat for these species is locally abundant, and better quality habitat exists within nearby State Forest, conservation reserves, etc.



- **substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species**

As described above, the Project area does not contain any important habitat for migratory species. Although the Project would remove potential habitat for these species, the occurrence of these species is considered most likely to be as vagrants or potentially as a short term seasonal forager with the study area. The habitat within the Project area constitutes only a small part of their large seasonal nomadic range. Given this, the Project would not substantially modify, destroy or isolate an area of important habitat for any migratory species.

- **result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species**

Feral pests that are already present in the Project area are likely to displace into adjoining areas during construction, however, the number of feral pests that would be displaced would be reduced by controlling feral pests. As outlined in Section 6.4, the control of feral pests is an existing measure that would be adopted for the Project area. Given this, it is unlikely that the Project would result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species.

- **seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.**

The Project would not seriously disrupt the lifecycle of an ecologically significant proportion of the population any migratory species, given:

- No migratory species were recorded in the study area.
- Potential habitat that would be removed by the Project is only marginally suitable, has been subject to past disturbances (e.g. logging) and is widespread in the surrounding locality.

8.4.3. Conclusion

In view of the above, it is considered unlikely that the Project would significantly impact any migratory species listed under the EPBC Act.



9.0 Offset Strategy

9.1. Existing Middlemount Coal Mine Offset Areas

MCPL has existing State and Commonwealth approved offset areas which were established for various components of the Middlemount Coal Mine, including the following (Figure 23):

- Middlemount Coal (Stage 2) Project (EPBC 2010/5394).
- Middlemount Coal Mine Rail Loop and Spur.
- Parrot Quarry.
- Thirteen Mile Gully Diversion.
- Middlemount North-eastern Extension.

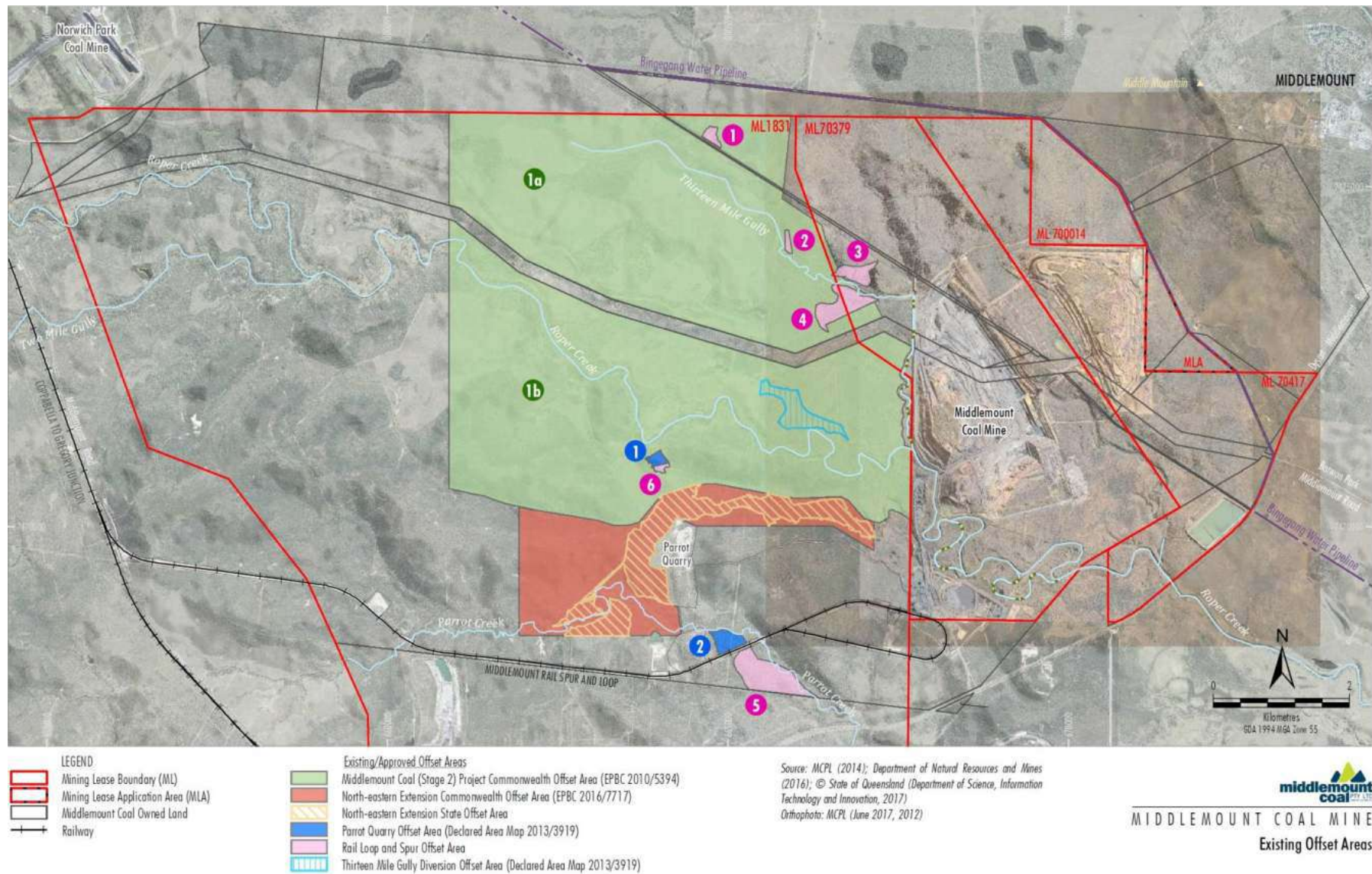
The area of each of these existing offset areas is detailed in Table 27 below.

Table 27: Existing Middlemount Coal Mine Offset Areas

Offset Area	Source	Size (ha)	Security
Middlemount Coal (Stage 2) Project Commonwealth Offset Area	EPBC 2010/5394	3,280	Declared Area Map 2013/003919
Rail Loop and Spur Offset Area	Decision Notice IC0410MKY003 Deed of Agreement	84.6	
Parrot Quarry Offset Area	DERM Permit number: 2010/003611 Deed of Agreement	15.4	
Thirteen Mile Gully Diversion Offset Area	SPA and EPBC 2010/5394*	31	
North-eastern Extension Commonwealth Offset Area	EPBC 2016/7717	532	Security due March 2019
North-eastern Extension State Offset Area	EPML00716913	181	
Total		4,124	



Figure 23: Existing Offset Areas





9.2. Commonwealth Offsets

A delegate of the Commonwealth Minister for the Environment declared the Action to be a 'controlled action' for the purpose of the EPBC Act.

A proposed biodiversity offset package to mitigate the Project clearance of potential habitat for the Ornamental Snake, Squatter Pigeon (southern), Greater Glider and Koala is described in this section.

Characteristics of the Western Extension Commonwealth Offset Area

The proposed Western Extension Commonwealth Offset Area is located to the west and south of the existing Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394). The Western Extension Commonwealth Offset Area would offset the clearance of 22 ha of Brigalow EEC (represented by 15.5 ha of RE 11.4.9 and RE 11.3.1 as well as 6.5 ha of regrowth). The Western Extension Commonwealth Offset Area contains approximately 76 ha of Brigalow EEC (represented by RE 11.3.1, RE 11.4.8, RE 11.4.9 and RE 11.4.9a).

The Western Extension Commonwealth Offset Area has been developed in accordance with the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012a), and the *EPBC Act Offsets Assessment Guide* (DSEWPC 2012b). Table 28 outlines the area of each MNES in the Project disturbance area and the Western Extension Commonwealth Offset Area, including a breakdown of the REs which make up these areas.

Table 28: Commonwealth Offset Area for the Western Extension Project

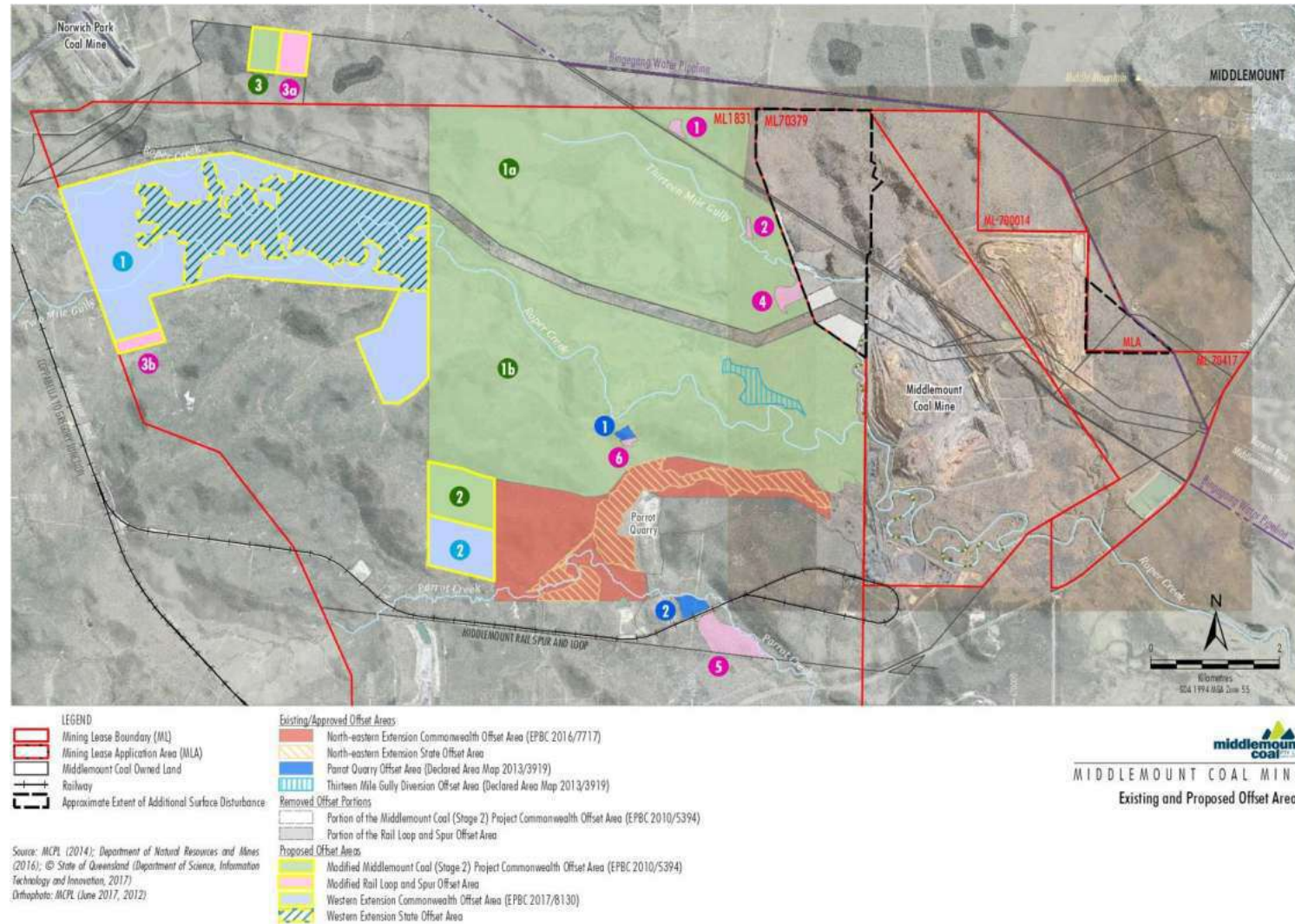
Matters of National Environmental Significance	Disturbance Area (ha)	Commonwealth Offset Area for the Western Extension Project (ha)
Brigalow EEC		
RE 11.3.1	15	16.5
RE 11.4.8	0	17
RE 11.4.9	0.5	29
RE 11.4.9	0	13.5
Regrowth	6.5	0
Total	22	76
Ornamental Snake		
RE 11.3.1	15	16.5
RE 11.4.8	0	17
RE 11.4.9	0.5	29
RE 11.4.9	0	13.5
Total	15.5	76
Squatter Pigeon		
RE 11.3.1	15	16.5
RE 11.3.2	43.5	281
RE 11.3.25	0	57
RE 11.3.4	0	91.5
RE 11.3.4a	0	26
RE 11.3.7	0	29
RE 11.3.27d	1.9	4



Matters of National	Disturbance	Commonwealth Offset Area for the Western
RE 11.4.8	0	17
RE 11.4.9	0.5	29
RE 11.4.9a	0	13.5
RE 11.5.2a	0	52.5
RE 11.5.3	128	86.5
RE 11.5.18	0	4
RE 11.5.9	0	18.5
RE 11.7.4	0	13.5
Regrowth	199.5	394.5
Total	388.5	1,155
Koala		
RE 11.3.2	43.5	281
RE 11.3.25	0	57
RE 11.3.2/11.3.4	1.5	0
RE 11.3.4	0	91.5
RE 11.3.4a	0	26
RE 11.3.7	0	29
RE 11.3.27d	1.9	4
RE 11.5.3	128	86.5
RE 11.5.2a	0	52.5
RE 11.5.9	0	18.5
RE 11.7.4	0	13.5
Total	174.9	683.5
Greater Glider		
RE 11.3.2	43.5	281
RE 11.3.25	0	57
RE 11.3.2/11.3.4	1.5	0
RE 11.3.4	0	91.5
RE 11.3.4a	0	26
RE 11.3.7	0	29
RE 11.3.27d	1.9	4
RE 11.5.3	128	86.5
Total	174.9	575



Figure 24: Existing and Proposed Offset Areas





Drainage Line 1 also runs through the centre of the Western Extension Commonwealth Offset Area providing a temporary water supply for threatened species which such as the Squatter Pigeon which prefer habitat in close proximity to available water (DEE 2017d).

Commonwealth Offset Assessment Guide

Table 29 provides a reconciliation of the area (in ha) of each MNES being impacted by the Project and the area of land which would be included in the Commonwealth Offset Area.

The *EPBC Act Offsets Assessment Guide* (DSEWPC 2012b) has been used to determine the percentage of the offset liability which would be met by the Commonwealth Offset Area. The inputs used to assess the suitability of the Western Extension Commonwealth Offset Area and the justification for the values chosen is provided in Appendix 15. As demonstrated by Table 29, the Western Extension Commonwealth Offset Area provides for more than 100% of the Project's offset liability.

Table 29: Habitat for MNES Known or Considered Likely to Occur in the Action Area and Proposed Offset Area and Summary of Percentage Offset Requirements Met

Matters of National Environmental Significance	Conservation Status ¹	Area of Habitat to be Impacted (ha) ²	Total Area of Existing Habitat in Offset Area (ha) ³		Recorded in Offset Area	Percent Offset by Commonwealth Offset Areas
			Remnant Vegetation	Non-Remnant Vegetation		
Brigalow EEC	E	22	76	0	Yes	124%
Ornamental Snake	E	15.5	76	0	No	129.45%
Squatter Pigeon (southern)	V	388.5	739.5	394.5	No	123.95%
Koala	V	175	683.5	0	Yes	132.58%
Greater Glider	V	175	575	0	Yes	114.44%

¹ Threatened species status under the EPBC Act (current as at February 2018). E = Endangered, V = Vulnerable.

² Area based on ground-truthed vegetation mapping.

³ Area based on ground-truthed vegetation mapping.

Reconciliation against EPBC Act Offset Policy Principles

A reconciliation of the Western Extension Commonwealth Offset Area against the Commonwealth offset principles (DSEWPC 2012a) is presented in Table 30.



Table 30: Commonwealth Offset Area for the Western Extension Project Reconciliation against EPBC Act Offset Policy Principles

Offset Principles ¹	Elements of the Proposed Biodiversity Offset Package that Address these Requirements
<i>1. deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environmental law and affected by the proposed action</i>	The proposed offset area is specifically tailored to the relevant protected matters (i.e. Brigalow, Ornamental Snake, Squatter Pigeon [southern], Koala and Greater Glider) and to deliver an overall conservation outcome that improves or maintains the viability of each protected matter.
<i>2. be built around direct offsets but may include other compensatory measures</i>	As demonstrated in Table 29, over 100% of the Commonwealth offset liability would be satisfied by the Western Extension Commonwealth Offset Area (Figure 24).
<i>3. be in proportion to the level of statutory protection that applies to the protected matters</i>	The size and scale of the Western Extension Commonwealth Offset Area provides for greater than 100% of the offset liability for each protected matter relevant to the Project. This was determined by applying the <i>EPBC Act Offsets Assessment Guide</i> (DSEWPC, 2012b), as demonstrated by Table 29.
<i>4. be of a size and scale proportionate to the residual impacts on the protected matter.</i>	The size and scale of the Western Extension Commonwealth Offset Area provides for greater than 100% of the offset liability for each protected matter relevant to the Project. This was determined by applying the <i>EPBC Act Offsets Assessment Guide</i> (DSEWPC, 2012b), as demonstrated by Table 29. Given this, it is determined that the Western Extension Commonwealth Offset Area is of a suitable size and scale proportionate to the impacts of each protected matter.
<i>5. effectively account for and manage the risks of the offset not succeeding</i>	The <i>EPBC Act Offsets Assessment Guide</i> (DSEWPC, 2012b), which was applied to the Project accounts for the risk of the offset not succeeding. In addition, measures to manage the Western Extension Commonwealth Offset Area would provide for ongoing adaptive management in the unlikely event that the offset is not succeeding. The implementation of the offset strategy is likely to be a condition of Environmental Approval.
<i>6. be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets under the EPBC Act for the same section, see Section 7.6)</i>	The implementation of the offset strategy is beyond existing requirements, in that it is not part of any private conservation reserve system. The enduring protection that would be applied to the Western Extension Commonwealth Offset Area are new and additional under duty of care or any environmental planning laws.
<i>7. be efficient, effective, timely, transparent, scientifically robust and reasonable</i>	The Western Extension Commonwealth Offset Area would efficiently and effectively compensate for the impacts on the protected matters and help maintain the viability of the protected matters. Flora and fauna surveys of the Western Extension Commonwealth Offset Area have already been, undertaken to determine: - the area of the offset in comparison to the area of impact; - the nationally threatened fauna and flora species present (or predicted to occur) and their conservation status; - the connectivity and condition of the native vegetation/fauna habitat; and management actions and security for the Western Extension Commonwealth Offset Area.
<i>8. have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced</i>	Consistent with the existing offset area, MCPL will seek to secure the proposed offset area through a VDec under the QLD VM Act.

¹ DSEWPC, 2012a.



9.3. Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area

As outlined in Section 5.1.1, the Project would involve clearance of a portion of the existing Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394). The area of the Middlemount Coal (Stage 2) Project Offset Area proposed to be disturbed was originally designed to offset potential impacts to the Squatter Pigeon (Southern), Ornamental Snake, and Brigalow EEC.

Offset Approach

The *EPBC Act Offsets Assessment Guide* (DSEWPC, 2012b) has been used to determine an additional offset for the portion of the Middlemount Coal (Stage 2) Project Commonwealth Offset Area (EPBC 2010/5394) proposed to be cleared. The result is a larger Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area (Figure 24).

Characteristics of the Revised Offset Area

The Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area is located in two patches (Areas 2 and 3 on Figure 24), located to the north-west, and south of the existing Stage 2 Biodiversity Offset Area.

The Revised Offset Area is comprised of approximately 114 ha of remnant vegetation and 0.5 ha of non-remnant vegetation which contain suitable habitat for the Ornamental Snake (approximately 29.5 ha) and the Squatter Pigeon (southern) (approximately 114.5 ha). In addition, the Revised Offset Area contains approximately 29.5 ha of Brigalow EEC, comprising all remnant vegetation (RE 11.4.8 and RE 11.4.9).

Table 31 provides a reconciliation of the area of MNES within the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area against the requirements of EPBC 2010/5394.

Table 31: Revised Commonwealth Middlemount Coal (Stage 2) Project Offset Area

Matters of National Environmental Significance	Requirement (EPBC 2010/5394) (ha)	Revised Commonwealth Middlemount Coal (Stage 2) Project Offset Area (ha)	Additional Area provided Exceeding Requirement (EPBC 2010/5394)
Brigalow EEC	150	168.5	29.5
Ornamental Snake	1,670	1,692.5	29.5
Squatter Pigeon	3,280	3,362	153.5

Commonwealth Offset Assessment Guide

The *EPBC Act Offsets Assessment Guide* (DSEWPC, 2012b) has been used to determine the percentage of the offset liability which would be met by the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area. The inputs used to assess the suitability of the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area and the justification for the values chosen is provided in Appendix 15. As demonstrated in Appendix 15, the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area provides for more than 100% of the offset liability.



Reconciliation against EPBC Act Offset Policy Principles

A reconciliation of the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area against the Commonwealth offset principles is presented in Table 32.

Table 32: Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area - Reconciliation against EPBC Act Offset Policy Principles

Offset Principles ¹	Elements of the Proposed Biodiversity Offset Package that Address these Requirements
1. deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environmental law and affected by the proposed action	The proposed offset area is specifically tailored to the relevant protected matters (i.e. Brigalow, Ornamental Snake and Squatter Pigeon [southern]) and to deliver an overall conservation outcome that improves or maintains the viability of each protected matter.
2. be built around direct offsets but may include other compensatory measures	100% of the Commonwealth offset liability would be satisfied by the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area.
3. be in proportion to the level of statutory protection that applies to the protected matters	The Environmental Offsets Policy (DEHP, 2017b), which was applied for the Project, accounts for the level of statutory protection (vulnerable to critically endangered) of the relevant protected matters in calculating the offset requirement. The land-based offset areas would satisfy greater than 100% of the offset liability for each threatened species and community potentially impacted by the Project.
4. be of a size and scale proportionate to the residual impacts on the protected matter	The size and scale of the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area provides for greater than 100% of the offset liability for each protected matter relevant to the Project. This was determined by applying the EPBC Act Offset Assessments Guideline. Given this, it is determined that the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area is of a suitable size and scale proportionate to the impacts of each protected matter.
5. effectively account for and manage the risks of the offset not succeeding	The EPBC Act Offset Assessments Guideline, which was applied to the Project accounts for the risk of the offset not succeeding. In addition, measures to manage the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area would provide for ongoing adaptive management in the unlikely event that the offset is not succeeding. The implementation of the offset strategy is likely to be a condition of Environmental Approval.
6. be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets under the EPBC Act for the same section, see Section 7.6.	The implementation of the offset strategy is beyond existing requirements, in that it is not part of any private conservation reserve system. The enduring protection that would be applied to the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area are new and additional under duty of care or any environmental planning laws.
7. be efficient, effective, timely, transparent, scientifically robust and reasonable	The Commonwealth Offset Area would efficiently and effectively compensate for the impacts on the protected matters and help maintain the viability of the protected matters. Flora and fauna surveys of the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area have already been, undertaken to determine: - the area of the offset in comparison to the area of impact; - the nationally threatened fauna and flora species present (or predicted to occur) and their conservation status; - the connectivity and condition of the native vegetation/fauna habitat; and management actions and security for the Modified Middlemount Coal (Stage 2) Project Commonwealth Offset Area.
8. have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced	Consistent with the existing offset area, MCPL will seek to secure the proposed offset area through a VDec under the QLD VM Act.

¹ DSEWPC, 2012a.



9.4. State Offsets

9.4.1. State Offset Areas for the Western Extension Project

A proposed biodiversity offset package to mitigate the clearance of MSES is described in this section.

The offset package has been developed in accordance with the *Qld Environmental Offsets Policy – Version 1.4* (DEHP 2017b) and the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a). Table 33 outlines the area of each MSES relevant to the Project, including a breakdown of the REs which make up these areas.

The Western Extension State Offset Area would offset the Project's impact on:

- approximately 43.5 ha of RE 11.3.2 (an Of Concern RE);
- approximately 0.75 ha of a wetland of high ecological significance; and
- approximately 190.5 ha of remnant vegetation resulting in a significant impact on Connectivity (as determined by the DEHP Landscape Fragmentation and Connectivity tool).

Characteristics of the Western Extension State Offset Area

The Western Extension State Offset Area is located to the west of the existing Stage 2 Biodiversity Offset Area and is a subset of the Western Extension Commonwealth Offset Area. The Western Extension State Offset Area is comprised of approximately 240.5 ha of remnant vegetation and 213.5 ha of non-remnant vegetation which contain suitable habitat for the four threatened species relevant to the Project.

As described in Appendix 15, natural regeneration is occurring extensively throughout the proposed Western Extension State Offset Area. The size of the offset area was informed by habitat quality analysis in accordance with the *Guide to Determining Terrestrial Habitat Quality – Version 1.2* (DEHP, 2017a). In summary, the overall Habitat Quality Score for the Western Extension State Offset Area was calculated to be 6.94 in accordance with the *Guide to Determining Terrestrial Habitat Quality – Version 1.2* (DEHP, 2017b) (Appendix 15). The details of this analysis are provided in Appendix 15.

After 20 years, the intended conservation outcome for the non-remnant vegetation within the proposed Western Extension State Offset Area is the regeneration and re-vegetation (where needed) of approximately 190.5 ha of non-remnant vegetation to achieve:

- a habitat quality score at least 1 point greater than the impact site habitat quality score (at the time of impact);
- a habitat quality score gain of 2 points; and
- remnant status.

The habitat quality scores of the impact site range from 5.65 to 6.92 and the current habitat quality score of the proposed Western Extension State Offset Area is 6.94 (Appendix 15). Given this, along with reaching remnant status, the proposed offset area would need to achieve a habitat quality score of 8.94 within 20 years.



Drainage Line 1 also runs through the centre of the Western Extension State Offset Area providing a temporary water supply for threatened species such as the Squatter Pigeon which prefer habitat in close proximity to available water (DEE 2017d).

Table 33: Reconciliation Matters of State Environmental Significance within the Project and State Offset Area

Matters of State Environmental Significance	Extent of Maximum Impact (ha)	Environmental Offset Required	Western Extension State Offset Area (ha)
Regulated Vegetation 'Endangered' or 'Of Concern' regional ecosystems (RE 11.3.1)	15	No*	N/A
Regulated Vegetation 'Endangered' or 'Of Concern' regional ecosystems (RE 11.3.2)	43.5	Yes	185
Regulated Vegetation 'Endangered' or 'Of Concern' regional ecosystems (RE 11.3.2/11.3.4)	1.5	No	N/A
Regulated Vegetation 'Endangered' or 'Of Concern' regional ecosystems (RE 11.4.9)	0.5	No*	N/A
Connectivity Areas	190.5	Yes	213.5
Habitat for an animal that is 'Vulnerable' Wildlife - Squatter Pigeon (southern)	388.5	No*	N/A
Habitat for an animal that is 'Vulnerable' Wildlife - Greater Glider	175	No*	N/A
Habitat for an animal that is 'Vulnerable' Wildlife - Koala	175	No*	N/A
Habitat for an animal that is 'Vulnerable' Wildlife - Ornamental Snake	15.5	No*	N/A
Legally Secured Offset Areas - Rail Loop and Spur Offset Area	22	Yes	26

^ This MSES is equivalent to Brigalow EEC

* This MSES is also a MNES would be offset under the EPBC Act (Table 25)



9.5. Modified Rail Loop and Spur Offset Area

The Project would involve disturbance to the existing Rail Loop and Spur Offset Area. The area of the State Rail Loop and Spur Offset Area proposed to be disturbed was originally designed to offset potential impacts to the following:

- approximately 10.5 ha of RE 11.3.2; and
- approximately 16 ha of RE 11.4.8.

In accordance with the *Qld Environmental Offsets Policy – Version 1.4* (DEHP, 2017b), MCPL would be required to provide a replacement offset (compensating for the original impact) associated with the State Rail Loop and Spur Offset Area.

Characteristics of the Revised State Rail Loop and Spur Offset Area

The revised State Rail Loop and Spur Offset Area is located in two patches (Areas 3a and 3b on Figure 24), located to the north-west, and west of the existing Stage 2 Biodiversity Offset Area (Figure 24). The Revised State Rail Loop and Spur Offset Area is comprised of approximately 32 ha of remnant vegetation and 24.5 ha of non-remnant vegetation which contain RE 11.3.2 and RE 11.4.8.

9.6. Land Tenure and Offset Security

MCPL has existing State and Commonwealth approved offset areas which were established for various components of the Middlemount Coal Mine, including the Middlemount Coal (Stage 2) Project, Middlemount Coal Mine Rail Loop and Spur, Parrot Quarry and Thirteen Mile Gully Diversion.

These existing offset areas are secured via a VDec under the VM Act. As part of the VDec application process, an Offset Management Plan/Vegetation Management Plan was approved by the (then) DSEWPC in 2013.

Consistent with the existing offset area, MCPL will seek to secure the proposed offset area through a VDec under the VM Act.

Table 34 details the land tenure information for the proposed offset area.

Table 34: Relevant Offset Area Details

Reference	Landholder Details
Registered Owner on Title	Middlemount Coal Pty Ltd
Real Property Description	Lot 2, SP 248577 [part of]

Consistent with the existing offset area, MCPL would seek to secure the proposed offset area through a VDec under the VM Act.



9.7. Offset Management

An existing Offset Management Plan/Vegetation Management Plan is approved for the Middlemount Coal Mine (MCPL 2013), and describes how MCPL manages approved offset areas for the Middlemount Coal Mine.

The primary method for regenerating the proposed offset area will be through the management of threatening processes that inhibit natural regeneration.

In this regard, the likely management measures that will be developed for the proposed offset area include (but are not limited to) the following:

- On-ground set up of the proposed offset area (e.g. fencing, installing locked gates, signage, access tracks).
- Weed Management Strategy.
- Vertebrate Pest Management Strategy.
- Fire management.
- Management of livestock.

In the unlikely event that natural regeneration is not readily occurring or species composition is poor, active seeding/planting will be undertaken as needed.



10.0 Conclusion

The assessment and survey has identified that the site and surrounding area is generally in a modified state as a result of a number of past and current disturbances such as clearing, cattle grazing and mining activities. This has reduced the support value of the habitat on site for locally recorded and potentially occurring species and resulted in indirect impacts that may have discouraged them from using habitat in the area.

Desktop searches and confirmation during field surveys found that the study areas contain two REs listed as Endangered under the NC Act and EPBC Act and two listed as Of Concern under the NC Act. These comprised Brigalow and Open Woodland on alluvial plains communities. No threatened flora species were recorded on the site during surveys, and none were considered to be potential occurrences.

Targeted fauna surveys undertaken on the study areas over two different seasons detected three threatened fauna species listed as Vulnerable under the NC Act and EPBC Act. These comprised the Koala, Greater Glider and Squatter Pigeon. Due to the presence of suitable habitat/vegetation associations and local records, two threatened fauna species, comprising the Powerful Owl and Ornamental Snake, were considered to be potential occurrences on the study areas. One Special Least Concern species comprising the Echidna was also recorded on site during the field surveys.

The recorded and potentially occurring threatened fauna species were assessed under the relevant State and Federal legislation which determined that the Project has the potential to result in a significant residual impact/significant impact on the Greater Glider, Koala and Brigalow ecological communities.

Other MSES that occur in the study areas are regulated vegetation, HES wetlands and legally secured offset areas. These have been assessed against the relevant significant residual impact criteria.

No other MSES or MNES were identified on site during the desktop assessment or found during the survey.

An offset strategy has been prepared for the Project which would see a large tract of land dedicated as a conservation area and managed accordingly. With the impact avoidance, mitigation and offset measures proposed there not expected to be a significant residual impact on biodiversity from the Project.



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Appendix 1: Potential Occurrence Assessment

A1.0 Potential Occurrence Assessment

The following tables are used as a summary to address threatened species (as detailed below) in terms of potential occurrence, and likelihood of being significantly affected by the Project, and hence requiring formal assessment. A threatened species has been assessed if it is:

- a) Recorded on-site;
- b) Not recorded on site, but recorded within a 10 km radius (the locality), and may occur to some degree on-site due to potential habitat, key habitat component, etc.;
- c) Not recorded in the locality as yet, but recorded in the bioregion, and thus may occur in the locality, and possibly to some extent, may occur on the site, due to potential habitat.

The “*habitat requirements*” column is derived from the previously listed references. Likelihood of occurrence is based on the probability of occurrence in terms of:

- Habitat extent (e.g. sufficient to support an individual or the local population; comprises all of home range; forms part of larger territory, etc.); quality (i.e. condition, including an assessment of threats, historical land uses on and off-site, and future pressures); interconnectivity to other habitat; and ability to provide all the species life-cycle requirements (either the site alone, or other habitat within its range);
- Occurrence frequency (i.e. on-site resident; portion of larger territory; seasonal migrant or transitory opportunist and thus when and how often, etc.)
- Usage ie breeding or non-breeding; opportunistic foraging (e.g. seasonal, migratory or opportunistic); marginal fringe of core range; refuge; roosts; etc.

An indicative 1-5 scale used by the author to indicate the likelihood of the species to potentially occur in the habitat on the study sites (if they have not been recorded in the locality) is as follows:

- 0: *Unlikely* (<1% probability) - no potentially suitable habitat; too disturbed; or habitat is very poor. No or few records in region or records/site very isolated e.g. by pastoral land, urbanisation, etc.
- 1: *Low* (1-10%)- few minor areas of potential habitat; highly modified site/habitat; or few habitat parameters present, but others absent or relatively insignificant (sub-optimum habitat). Usually very few records in locality.
- 2: *Fair* (11-25%) - some significant areas of potential habitat, but some habitat parameters limited. Potential for occasional foraging e.g. from nearby more optimal areas or known habitat. Records at least within 10-15 km radius of site.
- 3: *Good* (26-50%) - significant abundance of habitat parameters/areas of habitat, and more locally e.g. adjacent. Potential part of larger territory, but probably unable to support breeding in isolation. Recorded within 10 km in similar habitat/environs.



- 4: *Moderate* (51-75%) - quite good potentially suitable habitat on and adjacent to the site, and/or good quality and abundance of some vital habitat parameters. Records within <10km, or adjacent to site, or adjacent to high quality habitat where species likely to occur.
- 5: *High* (>75%) - very good to optimum habitat occurring on or adjacent to the site (support breeding pair or population). Recorded within 5-10 km of site in same or similar habitat.

A1.1 Flora

Searches of relevant literature and databases (DEHP 2017e) only found records of a single flora species in the locality. A number of other species have the potential to occur within the locality based on regional records and presence of suitable habitat. In the table below, these species are evaluated for their potential to occur on the site.

**Table 35: Potential occurrence assessment for threatened flora species**

Species	No. of local records	NC Act	EPBC Act	Link to profile	Likelihood of Occurrence
<i>Cerbera dumicola</i>	1	NT	-	http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?cerbera-dumicola	Recorded in the locality and in the Stage 2 project to the west of the site (PB 2010). The site did not contain suitable habitat for this species and it was not found. Unlikely to occur.
<i>Cycas megacarpa</i>	0	E	E	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=55794	No preferred habitat on site and not recorded locally. This distinctive species would be expected to be readily detected if present. Unlikely to occur.
<i>Dichanthium queenslandicum</i>	0	V	E	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=5481	Only small areas of preferred habitat on site and not recorded locally or on MCPL lands during previous surveys. Site disturbance history would also reduce potential to occur. Unlikely to occur.
<i>Digitaria porrecta</i>	0	NT	-	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=12768	Only small areas of preferred habitat on site and not recorded locally or on MCPL lands during previous surveys. Site disturbance history would also reduce potential to occur. Unlikely to occur.
<i>Homopholis belsonii</i>	0	E	V	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=2406	No typical habitat on site and no local records. Unlikely to occur.
<i>Picris evae</i>	0	V	V	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=10839	Site may broadly qualify as potential habitat, however no local records and site occurs beyond known population extent. Unlikely to occur.
<i>Solanum elaeagnifolium</i>	0	E	-	http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:apni.taxon:139341	No suitable habitat and not recorded locally or on MCPL lands during previous surveys. Unlikely to occur.



Species	No. of local records	NC Act	EPBC Act	Link to profile	Likelihood of Occurrence
<i>Rhaponticum australe</i>	0	V	V	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=22647	No typical habitat on site and not recorded in the locality or on MCPL lands during previous surveys. Site disturbance history would also reduce potential to occur. Unlikely to occur.
<i>Hydrocharis dubia</i>	0	-	-	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=3650	No suitable habitat and not recorded locally or on MCPL lands during previous surveys. Unlikely to occur.
<i>Trioncinia retroflexa</i>	0	E	-	http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:apni.taxon:576466	No suitable habitat and not recorded locally or on MCPL lands during previous surveys. Unlikely to occur.
<i>Bertya pedicellata</i>	0	NT	-	http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:apni.taxon:278995	No suitable habitat and not recorded locally or on MCPL lands during previous surveys. Unlikely to occur.
<i>Daviesia discolor</i>	0	V	V	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=3567	No suitable habitat and not recorded locally or on MCPL lands during previous surveys. Unlikely to occur.
<i>Acacia arbiana</i>	0	NT	-	http://bie.ala.org.au/species/ACACIA+ARBIANA	Recorded outside the locality south-west of Middlemount. No suitable habitat occurs on the site however and it has not been recorded on MCPL lands during previous surveys. Unlikely to occur.
<i>Acacia spania</i>	0	NT	-	http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?acacia-spania	No suitable habitat and not recorded locally or on MCPL lands during previous surveys. Unlikely to occur.
<i>Cadellia pentastylis</i>	0	V	V	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=9828	No typical habitat on site and no local records. Expected to be readily detected if present. Unlikely to occur.



A1.2 Fauna

As previously noted, a number of threatened and migratory fauna have been recorded in the locality, and a number of others are considered potential occurrences. In the table below, these species are evaluated for their potential to occur on the site.

Table 36: Potential occurrence assessment for threatened and migratory species

Animal Group	Common Name (Scientific Name)	Local Records	NC Act	EPBC Act	Link to Profile	Likelihood Of Occurrence
Birds	Glossy Black Cockatoo (<i>Calyptorhynchus lathamii</i>)	0	V	-	http://www.birdsinbackyards.net/species/Calyptorhynchus-lathamii	No suitable foraging habitat is present in the study area. Not recorded locally or on MCPL lands during previous surveys. Unlikely chance of occurrence.
	Red Goshawk (<i>Erythrotriorchis radiatus</i>)	0	E	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=942	Site and general area comprises low quality foraging habitat due to lack of permanent waterways. No local or regional records. Unlikely to occur.
	Powerful Owl (<i>Ninox strenua</i>)	0	V	-	http://www.birdlife.org.au/bird-profile/powerful-owl	Site contains potential foraging and nesting habitat as part of a wider area. No local records and not recorded on MCPL lands during previous surveys. Low chance of occurrence.
	Australian Painted Snipe (<i>Rostratula australis</i>)	0	V	E	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=77037	No large permanent wetlands or waterways occur on site, and no local records, hence this species is unlikely to occur.
	Black-throated Finch (<i>Poephila cincta cincta</i>)	0	E	E	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64447	Site represents poor potential habitat for this species. No local records and site occurs beyond known distribution. Unlikely to occur.
	Star Finch (<i>Neochimla ruficauda ruficauda</i>)	0	E	E	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26027	Site represents poor potential habitat for this species due to lack of permanent water and disturbance history. No local records. Unlikely to occur.



Animal Group	Common Name (Scientific Name)	Local Records	NC Act	EPBC Act	Link to Profile	Likelihood Of Occurrence
	Painted Honeyeater (<i>Grantiella picta</i>)	0	V	V	http://www.birdlife.org.au/bird-profile/painted-honeyeater	Site provides generic foraging habitat for this species. Lack of local and regional records, disturbance history or site and locality would however reduce potential to occur. Unlikely to occur.
	Eastern Osprey (<i>Pandion cristatus</i>)	0	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=952	No suitable foraging habitat occurs on site. Unlikely to occur.
	Latham's Snipe (<i>Gallinago hardwickii</i>)	1	-	M	http://birdlife.org.au/bird-profile/lathams-snipe	No large permanent wetlands or waterways occur on site, and no local records, hence this species is unlikely to occur.
	Glossy Ibis (<i>Plegadis falcinellus</i>)	1	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=991	Some potential habitat occurs on site. Moderate chance of occurrence.
	Fork-tailed Swift (<i>Apus pacificus</i>)	0	-	M	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=678	Fair potential , as transient, between Oct-April
	Rufous Fantail (<i>Rhipidura rufifrons</i>)	0	-	M	http://birdlife.org.au/bird-profile/Rufous-Fantail	No suitable habitat on site. Unlikely to occur.
	Satin Flycatcher (<i>Myiagra cyanoleuca</i>)	0	-	M	http://birdlife.org.au/bird-profile/Satin-Flycatcher	Broadly suitable habitat occurs on site. Low chance of occurrence.
	Black-faced Monarch (<i>Monarcha melanopsis</i>)	1	-	M	http://www.birdlife.org.au/bird-profile/black-faced-monarch	Broadly suitable habitat occurs on site. Low chance of occurrence.
	Yellow Wagtail (<i>Motacilla flava</i>)	0	-	M	http://www.birdlife.org/datazone/speciesfactsheet.php?id=8411	No suitable habitat on site. Unlikely to occur.
	Oriental Cuckoo (<i>Cuculus optatus</i>)	0	-	M	https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=710	Broadly suitable habitat on site. Low chance of occurrence.
Mammals	Northern Quoll (<i>Dasyurus hallucatus</i>)	0	-	E	http://www.wildlife.org.au/wildlife/speciesprofile/mammals/northern_quoll.html	Site may provide generic foraging and denning habitat, however disturbance history of site and general area, presence of feral predators, coupled with lack of records would significantly reduce potential. Unlikely to occur.
	Bridled Nail-tail	0	E	E	http://www.environment.gov.au/cgi-	Site habitat generally unsuitable and beyond known



Animal Group	Common Name (Scientific Name)	Local Records	NC Act	EPBC Act	Link to Profile	Likelihood Of Occurrence
	Wallaby (<i>Onychogalea fraenata</i>)				bin/sprat/public/publicspecies.pl?taxon_id=239	distribution. Unlikely to occur.
	Grey-headed Flying Fox (<i>Pteropus poliocephalus</i>)	1	-	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186	Site contains a generic nectar foraging resource, however no potential roosting habitat occurs in the study site or adjacent. It is recognised that there is a DES monitored flying-fox camp at Middlemount township (DEE, 2018e), approximately 3 km north-east of the Project. There have been no Grey-headed Flying Fox records at this camp since August 2014 and the species has not been recorded on MCPL land despite numerous surveys. Very low to unlikely chance of occurrence.
	South-eastern Long-eared Bat (<i>Nyctophilus corbeni</i>)	0	V	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83395	Site contains generic potential foraging habitat for this species, however no preferred foraging habitats are present. Not detected on site during targeted surveys, or during previous surveys on MCPL land. Expert advice suggests that the site is beyond the known distribution of this species (Greg Ford pers comm.). Unlikely to occur.
Reptiles	Ornamental Snake (<i>Denisonia maculata</i>)	2	V	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1193	Recorded to the south-east of the site in the Stage 2 project area, however not found in the study site during this or previous surveys despite targeted searches. The site contains some preferred Brigalow habitats and a wetland. However these habitats have been disturbed as a result of cattle grazing and weed invasion. Low chance of occurrence.
	Yakka Skink (<i>Egernia rugosa</i>)	0	V	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1420	Site contains broadly suitable vegetation associations and habitat components for this species however it has not been recorded on site despite targeted surveys or on MCPL lands during previous surveys. Unlikely to occur.



Animal Group	Common Name (Scientific Name)	Local Records	NC Act	EPBC Act	Link to Profile	Likelihood Of Occurrence
	Golden-tailed Gecko (<i>Strophurus taenicauda</i>)	0	NT	-	https://www.ehp.qld.gov.au/wildlife/threatened-species/near-threatened/goldentailed_gecko.html	Site contains broadly suitable vegetation associations and habitat components for this species however it has not been recorded on MCPL lands during previous surveys. Disturbance history of the locality and presence of feral predators would also reduce potential to occur. Unlikely to occur.
	Dunmall's Snake (<i>Furina dunmalli</i>)	0	V	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59254	Some potential habitat occurs on site however no local records and not recorded on MCPL lands to date. Disturbance history and modification of surrounding habitats would also reduce potential to occur. Unlikely to occur.
	Common Death Adder (<i>Acanthophis antarcticus</i>)	0	V	-	https://www.ehp.qld.gov.au/wildlife/animals-az/common_death_adder.html	No typical or preferred habitat for this species is present on site and no local records. Unlikely to occur.
	Southern Snapping Turtle (<i>Elseya albagula</i>)	0	E	CE	https://www.ehp.qld.gov.au/wildlife/animals-az/whitethroated_snapping_turtle.html	No suitable habitat occurs on the site or adjacent. Unlikely to occur.
	Retro Slider (<i>Lerista allanae</i>)	0	E	E	https://www.ehp.qld.gov.au/wildlife/animals-az/allans_lerista.html	No suitable habitat occurs on the site or adjacent. Unlikely to occur.
	Fitzroy River Turtle (<i>Rheodytes leukops</i>)	0	V	V	https://www.ehp.qld.gov.au/wildlife/animals-az/fitzroy_river_turtle.html	No suitable habitat occurs on the site or adjacent. Unlikely to occur.



Appendix 2: Site Flora Species List

Frequency: D Dominant at least in some areas,
C Common,
O Occasional,
U Uncommon,
R Rare on site, few specimens.

* Denotes an introduced species

Common Name	Scientific Name	Frequency
Canopy Trees		
Brigalow	<i>Acacia harpophylla</i>	R
-	<i>Angophora leiocarpa</i>	U
Clarkson's Bloodwood	<i>Corymbia clarksoniana</i>	D
Ghost Gum	<i>Corymbia dallachiana</i>	O
Moreton Bay Ash	<i>Corymbia tessellaris</i>	O
Brown Bloodwood	<i>Corymbia trachyphloia</i>	U
Reid River Box	<i>Eucalyptus brownii</i>	U
Dawson's Gum	<i>Eucalyptus cambageana</i>	C
Silver-leaved Ironbark	<i>Eucalyptus melanophloia</i>	O
Poplar Box	<i>Eucalyptus populnea</i>	D
Queensland Blue Gum	<i>Eucalyptus tereticornis</i>	R
Weeping Paperbark	<i>Melaleuca leucadendra</i>	R
Understorey Trees and Shrubs		
Chalky Wattle	<i>Acacia cretata</i>	U
Ironwood	<i>Acacia excelsa</i>	O
Black Wattle	<i>Acacia leiocalyx</i>	O
Mimosa Bush	<i>Acacia farnesiana</i> *	U
Nelia	<i>Acacia oswaldii</i>	U
Native Willow	<i>Acacia salicina</i>	O
Bonaree	<i>Alectryon oleifolius</i>	R
Bull Oak	<i>Allocasuarina luehmannii</i>	U
Red Ash	<i>Alphitonia excelsa</i>	O
Bitter Bark	<i>Alstonia constricta</i>	U
Dead Finish	<i>Archidendropsis basaltica</i>	O
Whitewood	<i>Atalaya hemiglauca</i>	U
Coffee Bush	<i>Breynia oblongifolia</i>	O
Prickly Pine	<i>Bursaria incana</i>	U
Wild Orange	<i>Capparis canescens</i>	U
Nepine	<i>Capparis lasiantha</i>	O
-	<i>Capparis loranthifolia</i>	U
Currant Bush	<i>Carissa ovata</i>	O
Leichardt Bean	<i>Cassia brewsteri</i>	D
Belah	<i>Casuarina cristata</i>	O



Common Name	Scientific Name	Frequency
River Oak	<i>Casuarina cunninghamiana</i>	R
Limebush	<i>Citrus glauca</i>	U
Lollybush	<i>Clerodendrum floribundum</i>	U
Medicine Bush	<i>Coelospermum reticulatum</i>	U
-	<i>Denhamia cunninghamii</i>	U
Olive-leaved Denhamia	<i>Denhamia oleaster</i>	O
Small-leaved Ebony	<i>Diospyros humilis</i>	R
Sticky Hop Bush	<i>Dodonaea viscosa</i>	O
Yellow tulip	<i>Drypetes deplanchei</i>	U
Ellangowan Poison Bush	<i>Eremophila deserti</i>	O
Fuchsia Bush	<i>Eremophila maculata</i>	U
False Sandalwood	<i>Eremophila mitchellii</i>	D
Turkey Bush	<i>Erythroxylum australe</i>	C
Scrub Leopardwood	<i>Flindersia dissosperma</i>	C
Wilga	<i>Geijera parviflora</i>	O
Silver Oak	<i>Grevillea parallela</i>	O
Beefwood	<i>Grevillea striata</i>	U
Dysentery Bush	<i>Grewia latifolia</i>	O
Bootlace Oak	<i>Hakea lorea</i>	O
Harrisia Cactus	<i>Harrisia martini*</i>	O
Queensland Ebony	<i>Lysiphyllum carronii</i>	O
-	<i>Melaleuca nervosa</i>	U
Boobialla	<i>Myoporum acuminatum</i>	U
Native Olive	<i>Notelaea microcarpa</i>	U
Prickly Pear	<i>Opuntia stricta*</i>	O
Velvet Tree Pear	<i>Opuntia tomentosa*</i>	O
Emu Apple	<i>Owenia acidula</i>	U
Quinine Tree	<i>Petalostigma pubescens</i>	D
Weeping Pittosporum	<i>Pittosporum angustifolium</i>	U
-	<i>Psydrax attenuata</i>	U
Northern Sandalwood	<i>Santalum lanceolatum</i>	C
Maroon Bush	<i>Scaevola spinescens</i>	O
Potato Bush	<i>Solanum ellipticum</i>	U
Yellow-wood	<i>Terminalia oblongata</i>	D
Vine Tree	<i>Ventilago viminalis</i>	C
Grasses		
Cockatoo Grass	<i>Alloteropsis semialata</i>	O
Dark Wiregrass	<i>Aristida calycina</i>	U
Bunched Kerosene Grass	<i>Aristida contorta</i>	O
Jericho Wiregrass	<i>Aristida jerichoensis</i>	C
Feathertop Wiregrass	<i>Aristida latifolia</i>	O
Purple Wire-grass	<i>Aristida personata</i>	O



Common Name	Scientific Name	Frequency
Forest Blue Grass	<i>Bothriochloa bladhii</i>	C
Pitted Bluegrass	<i>Bothriochloa decipiens</i>	U
Desert Bluegrass	<i>Bothriochloa ewartiana</i>	O
Indian Bluegrass	<i>Bothriochloa pertusa</i> *	U
Common Native Couch	<i>Brachyachne convergens</i>	O
Buffel Grass	<i>Cenchrus ciliaris</i> *	D
Slender Chloris	<i>Chloris divaricata</i>	C
Rhodes Grass	<i>Chloris gayana</i> *	U
Windmill Grass	<i>Chloris truncata</i>	O
Golden Beard Grass	<i>Chrysopogon fallax</i>	O
Barbed Wire Grass	<i>Cymbopogon refractus</i>	O
Couch Grass	<i>Cynodon dactylon</i>	R
Button Grass	<i>Dactyloctenium radulans</i>	O
Queensland Bluegrass	<i>Dichanthium sericeum</i>	O
Cotton Panic	<i>Digitaria brownii</i>	U
Umbrella Grass	<i>Digitaria divaricatissima</i>	O
-	<i>Enteropogon acicularis</i>	O
Wiry Panic	<i>Entolasia stricta</i>	U
Brown's Lovegrass	<i>Eragrostis brownii</i>	O
Clustered Lovegrass	<i>Eragrostis elongata</i>	U
Purple Lovegrass	<i>Eragrostis lacunaria</i>	U
Woodland Lovegrass	<i>Eragrostis sororia</i>	O
Silky Browntop	<i>Eulalia aurea</i>	U
Black Speargrass	<i>Heteropogon contortus</i>	C
Swamp Ricegrass	<i>Leersia hexandra</i>	O
Green Panic	<i>Megathyrus maximus</i> *	O
Red Natal Grass	<i>Melinis repens</i> *	O
Native Millet	<i>Panicum decompositum</i>	O
Hairy Panic	<i>Panicum effusum</i>	O
Yabila Grass	<i>Panicum queenslandicum</i>	O
Brigalow Grass	<i>Paspalidium caespitosum</i>	U
-	<i>Paspalidium distans</i>	C
Freshwater Couch	<i>Paspalum distichum</i>	U
Comet Grass	<i>Perotis rara</i>	O
Fairy Grass	<i>Sporobolus caroli</i>	U
-	<i>Themeda avenacea</i>	U
Kangaroo Grass	<i>Themeda triandra</i>	O
Sabi Grass	<i>Urochloa mosambicensis</i> *	C
Groundcovers		
Chaff Flower	<i>Achyranthes aspera</i>	O
Common Joyweed	<i>Alternanthera nodiflora</i>	O
Khaki Weed	<i>Alternanthera pungens</i> *	O



Common Name	Scientific Name	Frequency
Prickly Poppy	<i>Argemone ochroleuca</i>	U
Cobbler's Pegs	<i>Bidens pilosa</i> *	C
Blue Trumpet	<i>Brunoniella australis</i>	O
Yellow Buttons	<i>Chrysocephalum apiculatum</i>	C
-	<i>Commelina cyanea</i>	U
Native Wandering Jew	<i>Commelina diffusa</i>	O
Scurvy Grass	<i>Commelina ensifolia</i>	U
Darling Lily	<i>Crinum flaccidum</i>	O
Yellow Rattlepod	<i>Crotalaria mitchellii</i>	C
-	<i>Desmodium sp.</i>	U
-	<i>Eclipta prostrata</i>	U
Ruby Saltbush	<i>Enchylaena tomentosa</i>	O
Winter Apple	<i>Eremophila debilis</i>	R
Asthma Plant	<i>Euphorbia hirta</i>	U
Tropical Speedwell	<i>Evolvulus alsinoides</i>	U
Gomphrena Weed	<i>Gomphrena celosioides</i>	C
Slender Violet-bush	<i>Hybanthus monopetalus</i>	U
Narrow-leaved Indigo	<i>Indigofera linifolia</i>	O
Phasey Bean	<i>Macroptilium lathryodes</i>	U
Spiked Malvastrum	<i>Malvastrum americanum</i> *	U
Native Sensitive Plant	<i>Neptunia gracilis</i>	U
-	<i>Oxalis perennans</i>	U
Pigweed	<i>Portulaca oleracea</i>	C
Hairy Pigweed	<i>Portucaca pilosa</i>	U
-	<i>Phyllanthus maderaspatensis</i>	U
-	<i>Rostellularia adscendens</i>	O
Soft Roly-poly	<i>Salsola australis</i>	O
-	<i>Sauropus hirtellus</i>	U
Galvanised Burr	<i>Sclerolaena birchii</i>	R
Sesbania Pea	<i>Sesbania cannabina</i>	O
Pin Sida	<i>Sida fibulifera</i>	U
Fine Sida	<i>Sida filiformis</i>	O
Flannel Weed	<i>Sida hackettiana</i> *	O
Paddy's Lucerne	<i>Sida rhombifolia</i> *	U
Spiked Sida	<i>Sida subspicata</i>	O
Small-leaved Nightshade	<i>Solanum parvifolium</i>	U
Stylo	<i>Stylosanthes scabra</i> *	D
Caltrop	<i>Tribulus terrestris</i>	U
Speedwell	<i>Veronica sp</i> *	U
Australian Bluebell	<i>Wahlenbergia gracilis</i>	U
Noogoora Burr	<i>Xanthium occidentale</i> *	U



Common Name	Scientific Name	Frequency
Sedges, Rushes and Aquatics		
Dirty Dora	<i>Cyperus difformis</i>	O
Tall Flatsedge	<i>Cyperus exaltatus</i>	O
Slender Flat-sedge	<i>Cyperus gracilis</i>	C
-	<i>Eleocharis sphacelata</i>	O
-	<i>Fimbristylis dichotoma</i>	U
Hairy Carpet Weed	<i>Glinus lotoides</i>	U
Common Rush	<i>Juncus usitatus</i>	U
Spiny-headed Matrush	<i>Lomandra longifolia</i>	U
Nardoo	<i>Marsilea hirsuta</i>	C
-	<i>Monochoria cyanea</i>	U
Water Snowflake	<i>Nymphoides indica</i>	U
Swamp Lily	<i>Ottelia ovatifolia</i>	R
Lianas, Scramblers and Epiphytes		
Tarvine	<i>Boerhavia dominii</i>	U
Small-leaved Water Vine	<i>Clematicissus opaca</i>	U
Tiger Orchid	<i>Cymbidium canaliculatum</i>	O
-	<i>Glycine latifolia</i>	U
-	<i>Glycine sp.</i>	U
Bush Banana	<i>Marsdenia viridiflora</i>	R
-	<i>Rhynchosia minima</i>	O



Appendix 3: Site Fauna Species List

Common Name	Scientific Name	Detection Method ¹
Birds		
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>	OBS, HC
Grey Teal	<i>Anas gracilis</i>	OBS
Pacific Black Duck	<i>Anas superciliosa</i>	OBS
Red-winged Parrot	<i>Aprosmictus erythropterus</i>	OBS
Wedge-tailed Eagle	<i>Aquila audax</i>	OBS
Intermediate Egret	<i>Ardea intermedia</i>	OBS
White-necked Heron	<i>Ardea pacifica</i>	OBS
Pacific Baza	<i>Aviceda subcristata</i>	OBS
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	OBS, HC
Pallid Cuckoo	<i>Cacomantis pallidus</i>	OBS
Pheasant Coucal	<i>Centropus phasianinus</i>	HC
Red-capped Plover	<i>Charadrius ruficapillus</i>	OBS
Spotted Bowerbird	<i>Chlamydera maculata</i>	OBS
Grey Strike-thrush	<i>Colluricincla harmonica</i>	OBS
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	OBS, HC
Torresian Crow	<i>Corvus orru</i> *	OBS, HC
Pied Butcherbird	<i>Cracticus nigrogularis</i>	HC
Grey Butcherbird	<i>Cracticus torquatus</i>	OBS
Blue-winged Kookaburra	<i>Dacelo leachii</i>	OBS, HC
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	HC
Mistletoebird	<i>Dicaeum hirundinaceum</i>	OBS
Emu	<i>Dromaius novaehollandiae</i>	OBS, CAM
White-faced Heron	<i>Egretta novaehollandiae</i>	OBS
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>	OBS
Galah	<i>Eolophus roseicapillus</i>	OBS
Bar-shouldered Dove	<i>Geopelia humeralis</i>	OBS, HC
Peaceful Dove	<i>Geopelia placida</i>	OBS
Squatter Pigeon[#]	<i>Geophaps scripta scripta</i>	OBS
White-throated Gerygone	<i>Gerygone albogularis</i>	HC
Magpie-lark	<i>Grallina cyanoleuca</i>	OBS, HC, CAM
Brolga	<i>Grus rubicunda</i>	OBS, CAM
Australian Magpie	<i>Gymnorhina tibicen</i>	OBS, HC
Whistling Kite	<i>Haliastur spheonurus</i>	OBS, HC
White-headed Stilt	<i>Himantopus leucocephalus</i>	OBS
Yellow Honeyeater	<i>Lichenostomus flavus</i>	OBS
Singing Honeyeater	<i>Lichenostomus virescens</i>	OBS



Common Name	Scientific Name	Detection Method ¹
Brown Honeyeater	<i>Lichmera indistincta</i>	OBS
Variegated Fairy Wren	<i>Malurus lamberti</i>	OBS
Red-backed Fairy-wren	<i>Malurus melanocephalus</i>	OBS
Noisy Miner	<i>Manorina melanocephala</i>	OBS, HC
Rainbow Bee-eater	<i>Merops ornatus</i>	OBS, HC
Black Kite	<i>Milvus migrans</i>	OBS
Leaden Flycatcher	<i>Myiagra rubecula</i>	OBS
Cotton Pygmy-goose	<i>Nettapus coromandelianus</i>	OBS
Southern Boobook	<i>Ninox novaeseelandiae</i>	OBS, HC
Crested Pigeon	<i>Ocyphaps lophotes</i>	OBS
Olive-backed Oriole	<i>Oriolus sagittatus</i>	OBS
Rufous Whistler	<i>Pachycephala rufiventris</i>	OBS
Striated Pardalote	<i>Pardalotus striatus</i>	OBS, HC
Red-capped Robin	<i>Petroica goodenovii</i>	OBS
Common Bronzewing	<i>Phaps chalcoptera</i>	OBS
Little Friarbird	<i>Philemon citreogularis</i>	OBS
Noisy Friarbird	<i>Philemon corniculatus</i>	OBS, HC
Royal Spoonbill	<i>Platalea regia</i>	OBS, CAM
Pale-headed Rosella	<i>Platycercus adscitus</i>	OBS, HC
Tawny Frogmouth	<i>Podargus strigoides</i>	OBS
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>	OBS
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>	OBS, HC
Grey Fantail	<i>Rhipidura albiscapa</i>	OBS
Willie Wagtail	<i>Rhipidura leucophrys</i>	OBS
Apostlebird	<i>Struthidea cinerea</i>	OBS
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>	OBS
Double-barred Finch	<i>Taeniopygia bichenovii</i>	OBS
Straw-necked Ibis	<i>Threskiornis spinicollis</i>	OBS
Forest Kingfisher	<i>Todiramphus macleayii</i>	OBS
Sacred Kingfisher	<i>Todiramphus sanctus</i>	OBS
Scaly-breasted Lorikeet	<i>Trichoglossus chlorolepidotus</i>	OBS
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	OBS, HC
Barn Owl	<i>Tyto alba</i>	OBS, HC
Masked lapwing	<i>Vanellus miles</i>	OBS
Mammals		
Rufous Bettong	<i>Aepyprymnus rufescens</i>	OBS, CAM
White-striped Freetail Bat	<i>Austronomus australis</i>	ANA
Wild Dog	<i>Canis lupus familiaris*</i>	TRA, CAM
Greater Northern Freetail bat	<i>Chaerephon jobensis</i>	ANA
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	HARP, ANA
Chocolate Wattled Bat	<i>Chalinolobus morio</i>	HARP, ANA



Common Name	Scientific Name	Detection Method ¹
Little Pied Bat	<i>Chalinolobus picatus</i>	ANA
Feral Cat	<i>Felis catus</i>	OBS, CAM
Water Rat	<i>Hydromys chrysogaster</i>	TRA, CAM
Eastern Grey Kangaroo	<i>Macropus giganteus</i>	OBS, SC, CAM
Common Wallaroo	<i>Macropus robustus</i>	OBS
Red-necked Wallaby	<i>Macropus rufogriseus</i>	OBS, CAM
Eastern Bent-wing Bat	<i>Miniopterus orianae oceanensis</i>	ANA
Northern Free-tailed bat	<i>Mormopterus lumsdenae</i>	ANA
Eastern Free-tailed Bat	<i>Mormopterus ridei</i>	ANA
Gould's Long-eared Bat	<i>Nyctophilus gouldi</i>	HARP
European Rabbit	<i>Oryctolagus cuniculus</i> *	OBS, SC, CAM
Greater Glider	<i>Petauroides volans</i>	OBS, SC
Koala[#]	<i>Phascolarctos cinereus</i>	SCA
Yellow-bellied Sheathtail-Bat	<i>Saccolaimus flaviventris</i>	ANA
Inland Broad-nosed Bat	<i>Scotorepens balstoni</i>	ANA
Little Broad-nosed Bat	<i>Scotorepens greyii</i>	ANA
Feral Pig	<i>Sus scrofa</i> *	Wallows
Short-beaked Echidna [^]	<i>Tachyglossus aculeatus</i>	CAM
Troughton's Sheathtail-Bat	<i>Taphozous troughtoni</i>	ANA
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	OBS, CAM, SCA
Inland Forest Bat	<i>Vespadelus baverstocki</i>	ANA
Eastern Cave bat	<i>Vespadelus troughtoni</i>	HARP, ANA
Fox	<i>Vulpes vulpes</i> *	TRA
Amphibians		
Green-striped Frog	<i>Cyclorana alboguttata</i>	OBS
Short-footed Frog	<i>Cyclorana brevipes</i>	OBS, HC
Eastern Snapping Frog	<i>Cyclorana novaehollandiae</i>	OBS, HC
Salmon Striped Frog	<i>Limnodynastes salmini</i>	OBS, HC
Spotted Grass Frog	<i>Limnodynastes tasmaniensis</i>	OBS
Dwarf Tree frog	<i>Litoria fallax</i>	HC
Emerald Spotted Treefrog	<i>Litoria peronii</i>	HC
Desert Tree Frog	<i>Litoria rubella</i>	OBS, HC
Barking Frog	<i>Lymnodynastes fletcheri</i>	OBS, HC
Ornate Burrowing Frog	<i>Platyplectrum ornatum</i>	OBS, HC
Ornate Burrowing Frog	<i>Platyplectrum ornatum</i>	OBS
Cane Toad	<i>Rhinella marina</i> *	OBS, HC
Reptiles		
Jacky Lizard	<i>Amphibolurus muricatus</i>	OBS
Brown Tree Snake	<i>Boiga irregularis</i>	OBS
Open-litter Rainbow-skink	<i>Carlia pectoralis</i>	OBS
Copper-tailed Skink	<i>Ctenotus taeniolatus</i>	OBS
Green Tree Snake	<i>Dendrelaphis punctulata</i>	OBS



Common Name	Scientific Name	Detection Method ¹
Dubious dtella	<i>Gehyra dubia</i>	OBS
Bynoe's Gecko	<i>Heteronotia binoei</i>	OBS
Eastern Mulch-slider	<i>Lerista fragilis</i>	OBS
Fish		
Spangled Perch	<i>Leiopotherapon unicolour</i>	OBS
Eel-tailed Catfish	<i>Tandanus tandanus</i>	OBS
¹ Codes: Direct Observation (OBS), Heard Call (HC), Tracks (TRA), Scat (SC), PIR Camera (CAM) Anabat recording (ANA), Harp Trap (HARP) * Denotes exotic species; BOLD denotes threatened under EPBC ACT # - Threatened under NC Act ^ - Special Least Concern under NC Act		



Appendix 4: PIR Camera Photos

PIR Camera photo 1: Wild Dog



PIR Camera photo 2: Glossy Ibis



PIR Camera photo 3: Feral Cat



PIR Camera photo 4: Whistling Kite



PIR Camera photo 5: Rufous Bettong



PIR Camera photo 6: Emu



PIR Camera photo 7: Brushtail Possum



PIR Camera photo 8: Eastern Grey Kangaroo



PIR Camera photo 9: Echidna





Appendix 5: Wildlife Online Search Results



Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Specified Point

Species: All

Type: Native

Status: Rare and threatened species

Records: All

Date: All

Latitude: -22.838

Longitude: 148.65

Distance: 10

Email: Will.Steggall@naturecall.com.au

Date submitted: Wednesday 13 Dec 2017 14:10:49

Date extracted: Wednesday 13 Dec 2017 14:30:02

The number of records retrieved = 3

Disclaimer

As the DSITIA is still in a process of collating and vetting data, it is possible the information given is not complete. The information provided should only be used for the project for which it was requested and it should be appropriately acknowledged as being derived from Wildlife Online when it is used.

The State of Queensland does not invite reliance upon, nor accept responsibility for this information. Persons should satisfy themselves through independent means as to the accuracy and completeness of this information.

No statements, representations or warranties are made about the accuracy or completeness of this information. The State of Queensland disclaims all responsibility for this information and all liability (including without limitation, liability in negligence) for all expenses, losses, damages and costs you may incur as a result of the information being inaccurate or incomplete in any way for any reason.

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	mammals	Phascolarctidae	<i>Phascolarctos cinereus</i>	koala		V	V	1
animals	mammals	Pseudocheiridae	<i>Petauroides volans</i>	greater glider		V	V	3
plants	higher dicots	Apocynaceae	<i>Cerbera dumicola</i>			NT		2/2

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992*. The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ().

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

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).

This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.

This number is output as 999 if it equals or exceeds this value.



Appendix 6: Matters of State Environmental Significance Report



Queensland Government

Department of Environment and Heritage Protection

Environmental Reports

Matters of State Environmental Significance

Area of Interest: Longitude: 148.62919 Latitude: -22.82804

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@ehp.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government 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.



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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, AOI details

Area of Interest	148.62919,-22.82804 with 2 kilometre radius
Size (ha)	1256.6
Local Government(s)	ISAAC REGIONAL
Bioregion(s)	Brigalow Belt
Subregion(s)	Isaac - Comet Downs
Catchment(s)	Fitzroy

Refer to **Map 1** for locality information.

Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992*;
- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004*;
- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;
- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;
- Regulated vegetation under the *Vegetation Management Act 1999* that is:
 - Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;
 - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
 - Category R areas on the regulated vegetation management map;
 - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;
 - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;
- Strategic Environmental Areas under the *Regional Planning Interests Act 2014*;
- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Referable Wetlands under the Environmental Protection Regulation 2008;
- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;
- Legally secured offset areas.

Refer to **Appendix 1** for a description of MSES categories.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

MSES Criteria 1 - STATE CONSERVATION AREAS	0.0 ha	0.0%
1.1 Protected Areas	0.0 ha	0.0%
1.2 Marine Parks	0.0 ha	0.0%
1.3 Fish Habitat Areas	0.0 ha	0.0%
MSES Criteria 2 - WETLANDS AND WATERWAYS - area features	29.5 ha	2.3%
MSES Criteria 2 - WETLANDS AND WATERWAYS - linear features	0.0 km	Not applicable
2.1 High Ecological Significance wetlands on the map of Referable Wetlands	29.5 ha	2.3%
2.2 High Ecological Value (HEV) wetlands	0.0 ha	0.0%
2.2 High Ecological Value (HEV) waterways **	0.0 km	Not applicable
2.3 Strategic Environmental Areas (SEA)	0.0 ha	0.0%
MSES Criteria 3 - SPECIES	0.0 ha	0.0%
3.1 Threatened species and Iconic species	0.0 ha	0.0%
MSES Criteria 4 - REGULATED VEGETATION - area features	74.7 ha	5.9%
MSES Criteria 4 - REGULATED VEGETATION - linear features	7.3 km	Not applicable
4.1 Vegetation Management Regional Ecosystems and Remnant Map *	44.2 ha	3.5%
4.2 Vegetation Management Wetland Map *	30.5 ha	2.4%
4.3 Vegetation Management Watercourse Map **	7.3 km	Not applicable
MSES Criteria 5 - OFFSET AREAS	0.0 ha	0.0%
5.1 Legally secured offset areas	0.0 ha	0.0%
Total MSES (criteria 1.1, 1.2, 1.3, 2.1, part of 2.2, 2.3, 3.1, 4.1, 4.2 and 5.1) calculated for area features only	76.1 ha	6.1%

Please note that the area and percent area figures in the table above will not necessarily add up to the "Total MSES" figures due to overlapping values.

*The total extent area of regulated vegetation (Criteria 4.1) may be overestimated due to the presence of dominant and/or subdominant non-regulated regional ecosystems in mixed patches of vegetation, i.e. the total area of mixed vegetated patches is included irrespective of whether the patch consists only partly of endangered, of concern or wetland regional ecosystems.

**The total linear extent of watercourses may be overestimated in some instances, as both banks (rather than the centreline) of waterbodies and larger watercourses where present are mapped by the State, increasing the extent of linear features.

Additional Information with Respect to MSES Values Present

Criteria 1 - State Conservation Areas

1.1 Protected Areas

(no results)

1.2 Marine Parks

(no results)

1.3 Fish Habitat Areas

(no results)

Refer to **Map 2 - MSES Criteria 1 - State Conservation Areas** for an overview of the relevant MSES.

Criteria 2 - Wetlands and Waterways

2.1 High Ecological Significance wetlands on the Map of Referable Wetlands

Natural wetlands that are 'High Ecological Significance' (HES) on the Map of Referable Wetlands are present

2.2 High Ecological Value (HEV) wetlands

(no results)

2.2 High Ecological Value (HEV) waterways

(no results)

2.3 Strategic Environmental Areas

(no results)

Refer to **Map 3 - MSES Criteria 2 - Wetlands and Waterways** for an overview of the relevant MSES.

Criteria 3 - Species

3.1 Threatened species and Iconic species

Threatened and/or iconic species habitat within the AOI (derived from records/essential habitat mapping)

(no results)

**NCA E or V - Endangered or Vulnerable status under the NCA; VMA ehab - VMA essential habitat; Iconic - Iconic species.*

To request a species list for an area, or search for a species profile, access Wildlife Online at:

<https://www.qld.gov.au/environment/plants-animals/species-list/>

Koala bushland habitat

(no results)

Dugong areas

(no results)

Refer to **Map 4 - MSES Criteria 3 - Species** for an overview of the relevant MSES.

Criteria 4 - Regulated Vegetation

4.1 Endangered and Of Concern regional ecosystems and Category R Regulated Vegetation

Regulated Vegetation Description	Regional Ecosystem Patch	VMA status
rem_oc	11.3.2	O-dom
rem_end	11.3.2/11.3.21	E-subdom
rem_end	11.3.1/11.3.2	E-dom
rem_oc	11.3.2/11.3.7	O-dom
rem_end	11.4.9	E-dom

For further information relating to regional ecosystems in general, go to:

<https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/>

For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:

<https://environment.ehp.qld.gov.au/regional-ecosystems/>

4.2 Vegetation Management Wetlands

Vegetation Management Wetlands are mapped as present

Wetlands datasource

Qld Wetlands
Mapping

4.3 Watercourses shown on the Vegetation Management Watercourse and Drainage Feature Map

A vegetation management watercourse is mapped as present

Watercourses datasource

Vegetation Management Watercourse Map

Refer to **Map 5 - MSES Criteria 4 - Regulated Vegetation** for an overview of the relevant MSES.

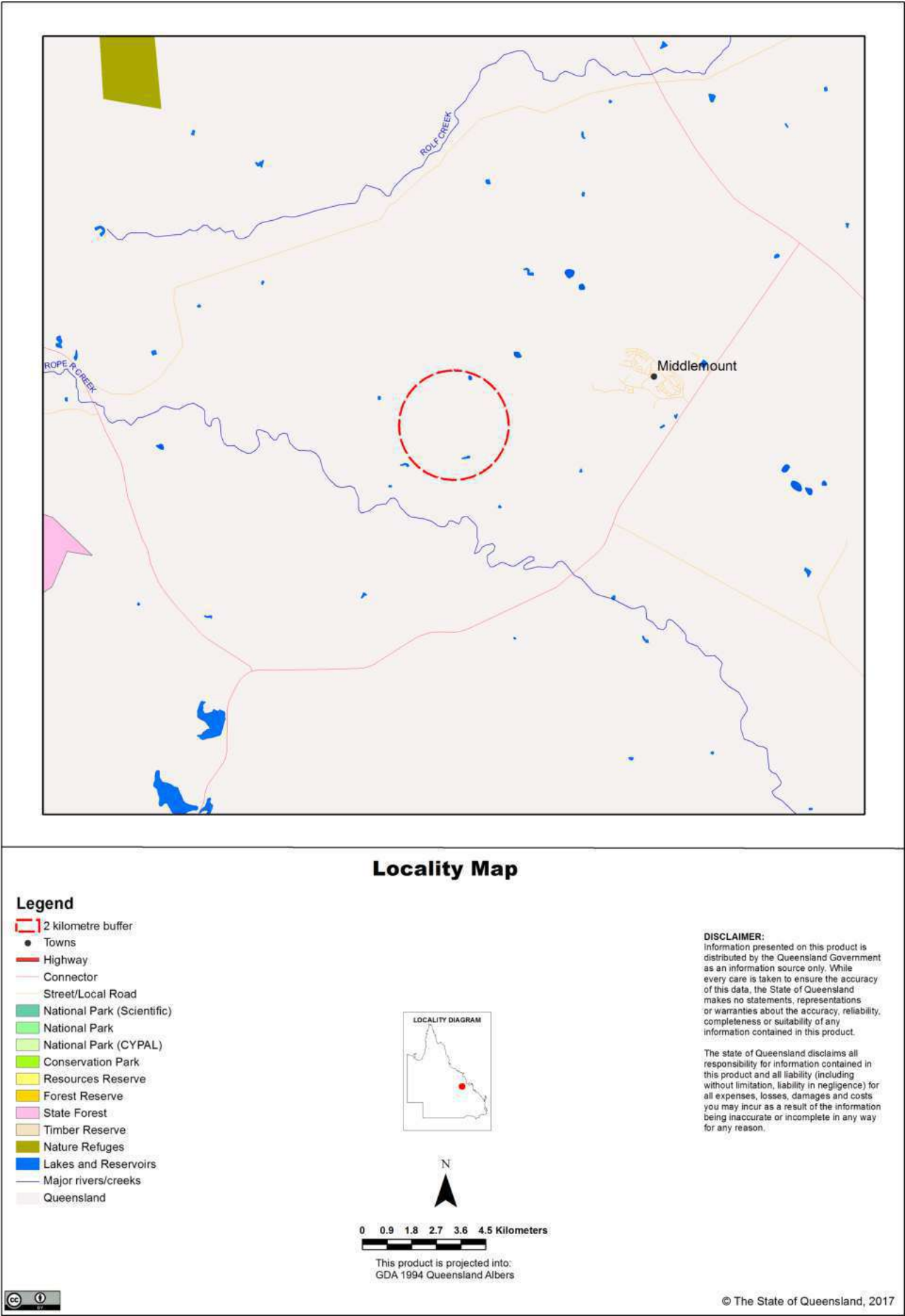
Criteria 5 - Offset Areas

5.1 Legally secured offset areas

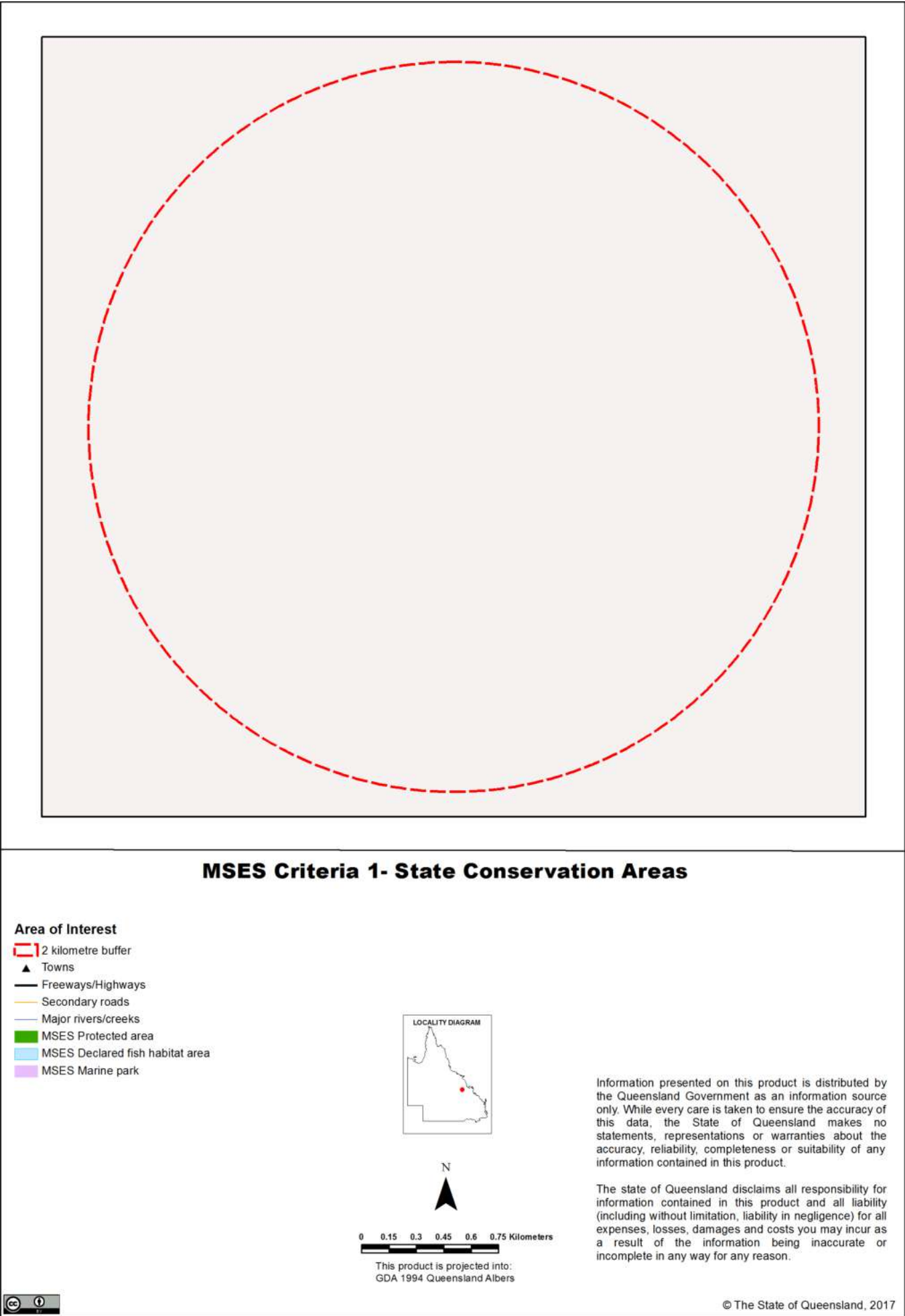
(no results)

Refer to **Map 6 - MSES Criteria 5 - Offset Areas** for an overview of the relevant MSES.

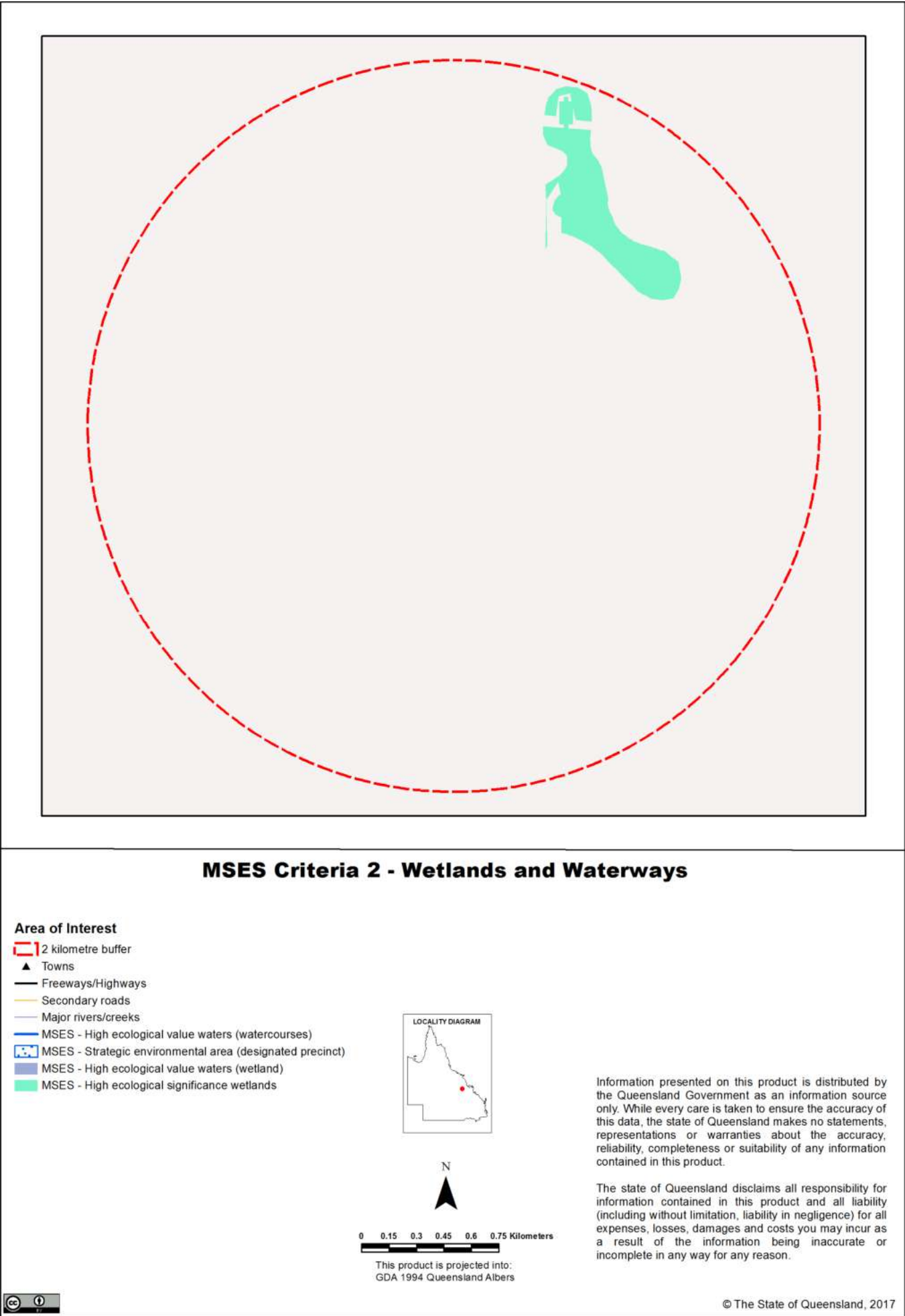
Maps
Map 1 - Location



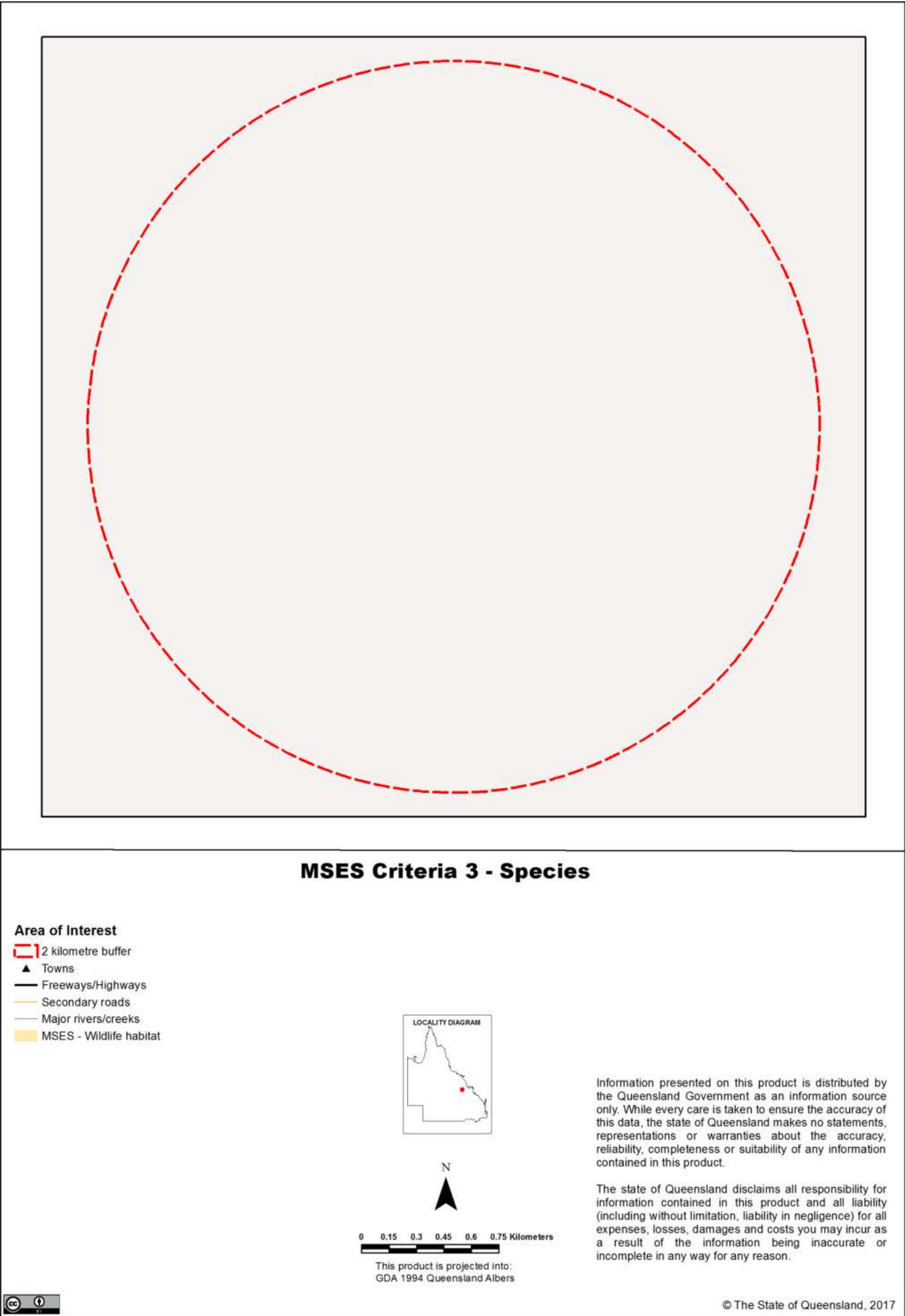
Map 2 - MSES Criteria 1 - State Conservation Areas



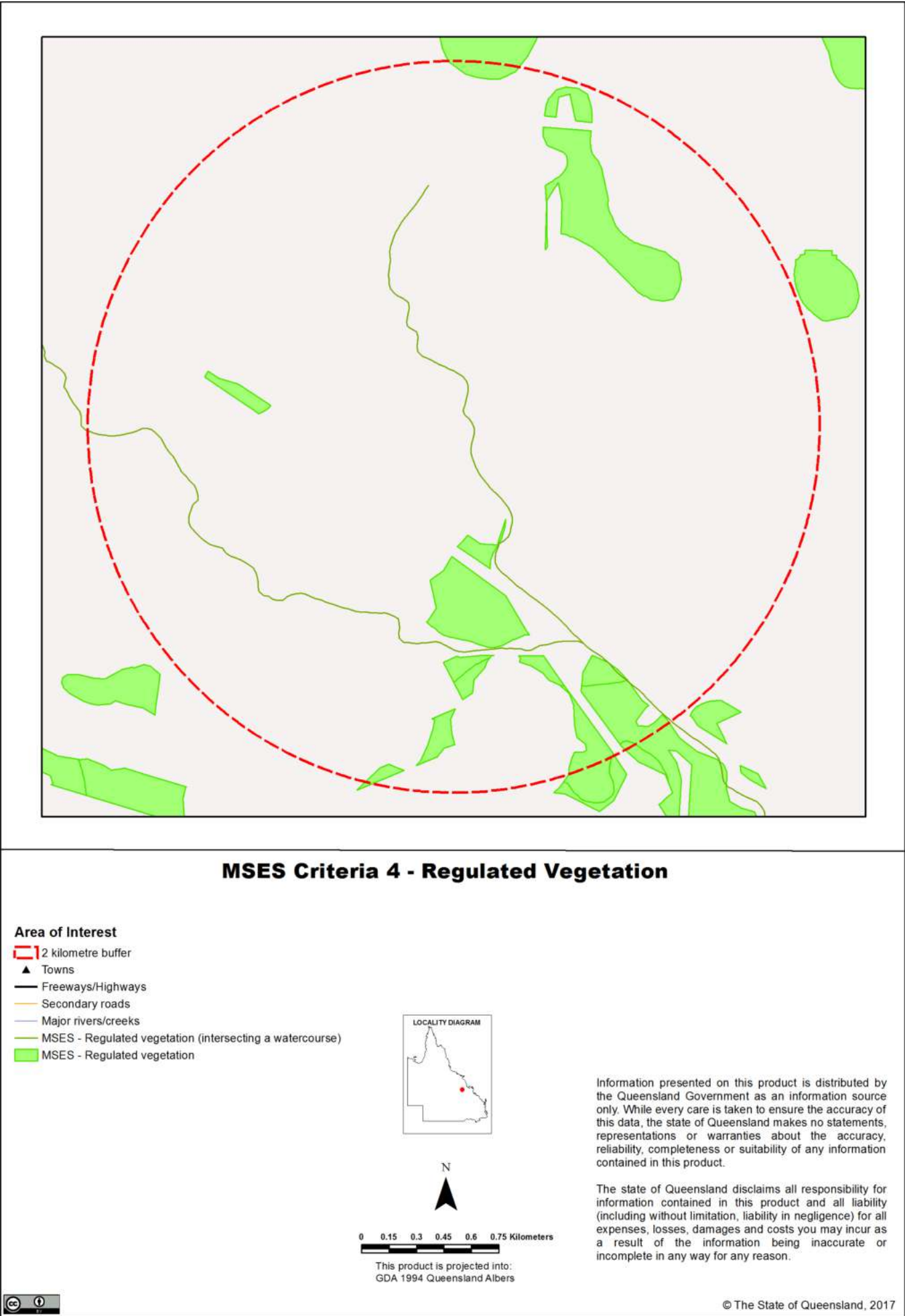
Map 3 - MSES Criteria 2 - Wetlands and Waterways



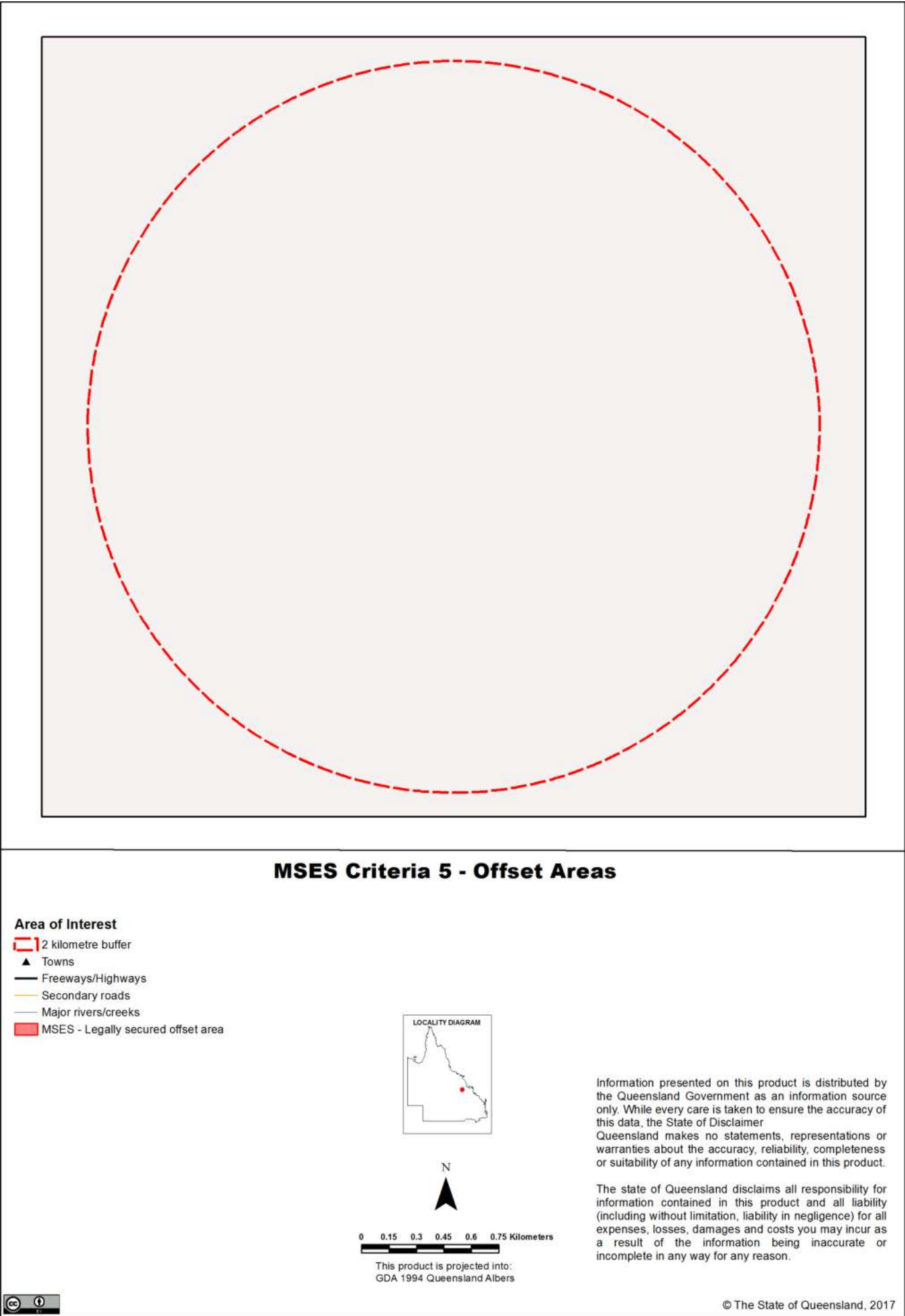
Map 4 - MSES Criteria 3 - Species



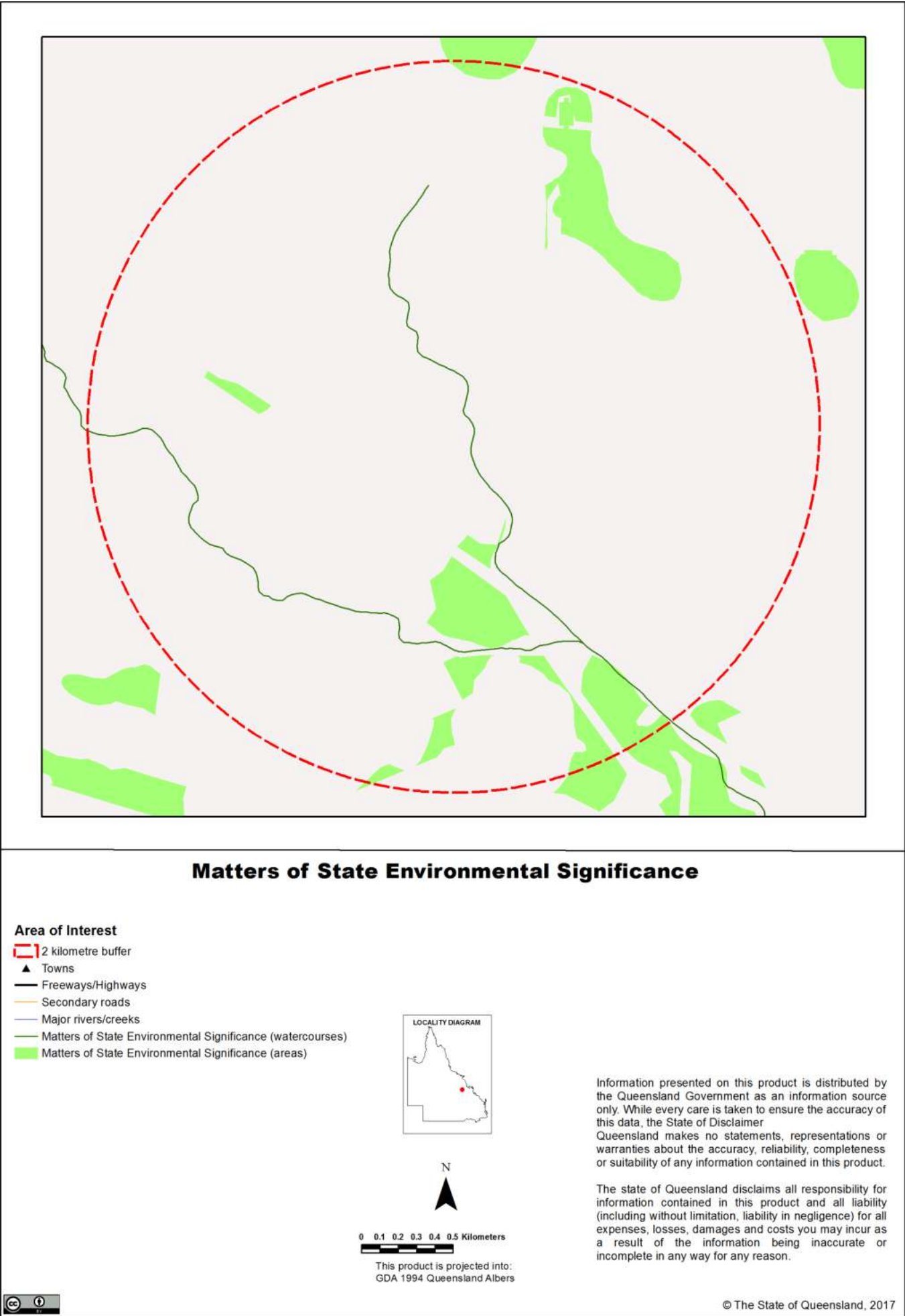
Map 5 - MSES Criteria 4 - Regulated Vegetation



Map 6 - MSES Criteria 5 - Offset Areas



Map 7 - Matters of State Environmental Significance



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) Criteria

Feature Name	Description
1.1 Protected Areas (NCA)	Protected areas under the <i>Nature Conservation Act 1992</i> , except coordinated conservation areas.
1.2 Marine Parks (MPA)	The following State marine parks zones under the <i>Marine Parks Act 2004</i> : - Marine National Park zone; - Marine Conservation Park zone; - Scientific Research zone; - Preservation zone; - Buffer zone.
1.3 Fish Habitat Areas (FA)	The following areas under the <i>Fisheries Act 1994</i> including: All fish habitat areas.
2.1 'High Ecological Significance' wetlands on the Map of Referable Wetlands	All natural wetlands that are 'High Ecological Significance' (HES) on the Map of Referable Wetlands. Exclude: any amendments to the Map of Referable Wetlands.
2.2 High Ecological Value (HEV) wetlands and waterways (EP Act)	Natural wetlands and waterways that occur in HEV (maintain) freshwater and estuarine areas under the Environmental Protection (Water) Policy.
2.3 Strategic Environmental Areas (RPI Act)	Designated precinct areas under the <i>Regional Planning Interests Act 2014</i> .
3.1 Threatened species and Iconic species (NCA)	Habitat for: Threatened wildlife under <i>Nature Conservation Act 1992</i> including: 'Endangered' and 'Vulnerable' species. Special least concern animals under the <i>Nature Conservation Act 1992</i> including: Koala (outside SEQ); Echidna and Platypus.
4.1 Vegetation Management Regional Ecosystem and Remnant Map (VMA)	Include VMA 'Endangered' and 'Of Concern' remnant (Category A and B) and high value regrowth (Category C) REs and Category R (GBR regrowth watercourse) areas from the Regulated Vegetation Management Map.
4.2 Vegetation Management Wetland Map (VMA)	Wetlands that are lakes and swamps shown on the Vegetation Management Wetlands Map.
4.3 Vegetation Management Watercourse and Drainage Feature Map (VMA)	Watercourses shown on the Vegetation Management Watercourse and Drainage Feature Map.
5.1 Legally secured offset areas (VMA, EP Act, SPA, TIA, EA)	Offset areas legally secured under a covenant, conservation agreement or development approval condition.

The Queensland Government's "Method for mapping - matters of state environmental significance for use in land use planning and development assessment" can be downloaded from:

<http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html>.

Appendix 2 - Source Data

The datasets listed below are available on request from:

<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page>

- Matters of State environmental significance
- Matters of State environmental significance drainage lines
- Boundaries of the Great Barrier Reef Marine Park

Note: MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). The compiled MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Underlying data sources used to develop individual releases of compiled MSES mapping include, but are not limited to:

- Regulated vegetation including:

- Regulated Regional Ecosystems and Regrowth
- Regulated Essential habitat
- Regulated Wetlands
- Regulated Watercourses and Drainage
- Former Regrowth

- Queensland Wetland Mapping (v3)

- Essential Habitat Mapping

- Protected Areas

- Marine Parks

- Fish Habitat Areas

- Strategic Environmental Areas

- The Map of Referable Wetlands:

- Wetland Protection Areas (HES wetlands in the GBR)
- Wetland Management Areas (contains other HES wetlands)

Datasets reflective of the above matters can be downloaded via the Queensland Spatial Catalogue:

<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page>

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
EHP	- Department of Environment and Heritage Protection
EP Act	- <i>Environmental Protection Act 1994</i>
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- <i>Nature Conservation Act 1992</i>
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- <i>Vegetation Management Act 1999</i>



Queensland Government

Department of Environment and Heritage Protection

Environmental Reports

Matters of State Environmental Significance

Area of Interest: Longitude: 148.674 Latitude: -22.843

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@ehp.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government 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.



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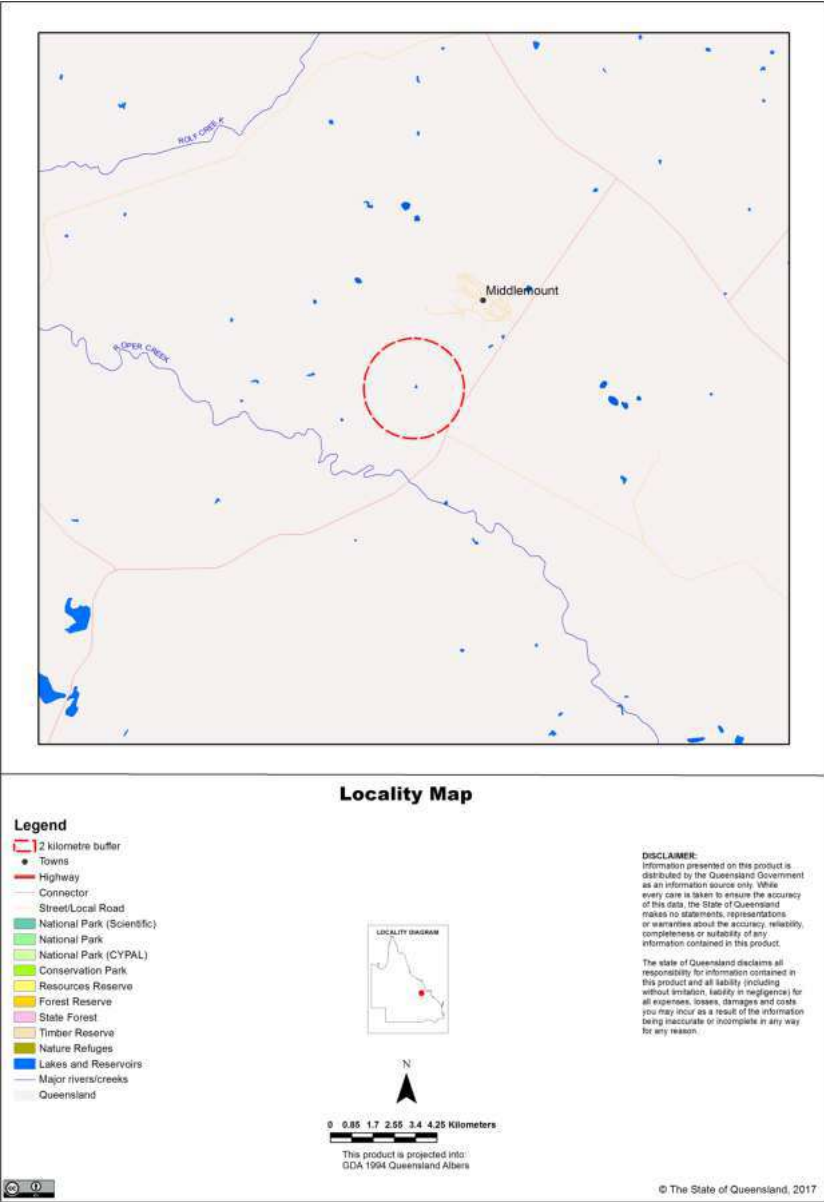
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI Longitude: 148.674 Latitude: -22.843

Size (ha)	1256.55
Local Government(s)	Isaac Regional
Bioregion(s)	Brigalow Belt
Subregion(s)	Isaac - Comet Downs
Catchment(s)	Fitzroy



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992*;
- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004*;
- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;
- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;
- Regulated vegetation under the *Vegetation Management Act 1999* that is:
 - Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;
 - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
 - Category R areas on the regulated vegetation management map;
 - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;
 - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;
- Strategic Environmental Areas under the *Regional Planning Interests Act 2014*;
- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Referable Wetlands under the Environmental Protection Regulation 2008;
- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;
- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	11.64 ha	0.9%
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7 Threatened species and Iconic species	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	10.52 ha	0.8%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0.0 ha	0.0 %
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0.0 ha	0.0 %
8d Regulated Vegetation - Essential habitat	0.0 ha	0.0 %
8e Regulated Vegetation - intersecting a watercourse **	4.9 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	54.56 ha	4.3%
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

Protected area (estates)

(no results)

Protected area (nature refuges)

(no results)

Marine park (highly protected)

(no results)

Declared fish habitat area (A and B areas)

(no results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

Strategic environmental area (designated precinct)

(no results)

High ecological significance wetlands

Natural wetlands that are 'High Ecological Significance' (HES) on the Map of Referable Wetlands are present.

HEV wetlands

(no results)

HEV watercourse

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

Wildlife habitat (threatened and special least concern animal)

(no results)

Threatened species habitat

(no results)

Note: The Threatened and Special Least Concern Animal (7) layer originates from the previous MSES version (4.1, dated at 2014). The layer does not represent all currently listed species and is subject to review.

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

To request a species list for an area, or search for a species profile, access Wildlife Online at:

<https://www.qld.gov.au/environment/plants-animals/species-list/>

Refer to **Map 3 - MSES - Species** for an overview of the relevant MSES.

MSES - Regulated Vegetation

category B

Regional ecosystem	Vegetation management polygon	Vegetation management status
11.4.9	E-dom	rem_end
11.4.9/11.4.8	E-dom	rem_end
11.3.2	O-dom	rem_oc

category C

Not applicable

For further information relating to regional ecosystems in general, go to:

<https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/>

For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:

<https://environment.ehp.qld.gov.au/regional-ecosystems/>

category R

Not applicable

essential habitat

Not applicable

Regulated vegetation intersecting a watercourse

A vegetation management watercourse is mapped as present

Regulated vegetation 100m from wetland

Regulated vegetation map category	Map number	RVM rule
B	8652	2

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

Legally secured offset area (offset register)

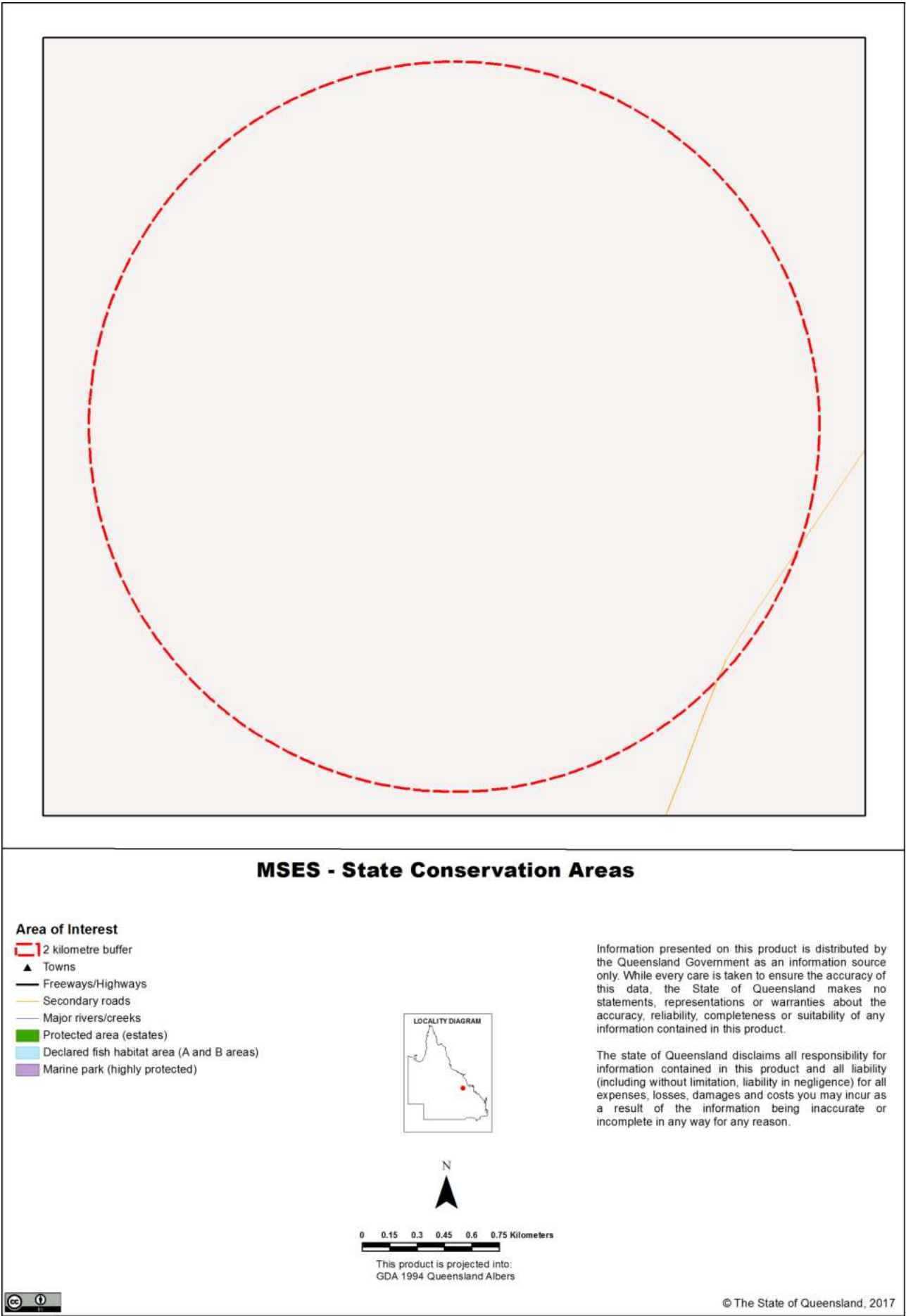
(no results)

Legally secured offset area (vegetation offsets)

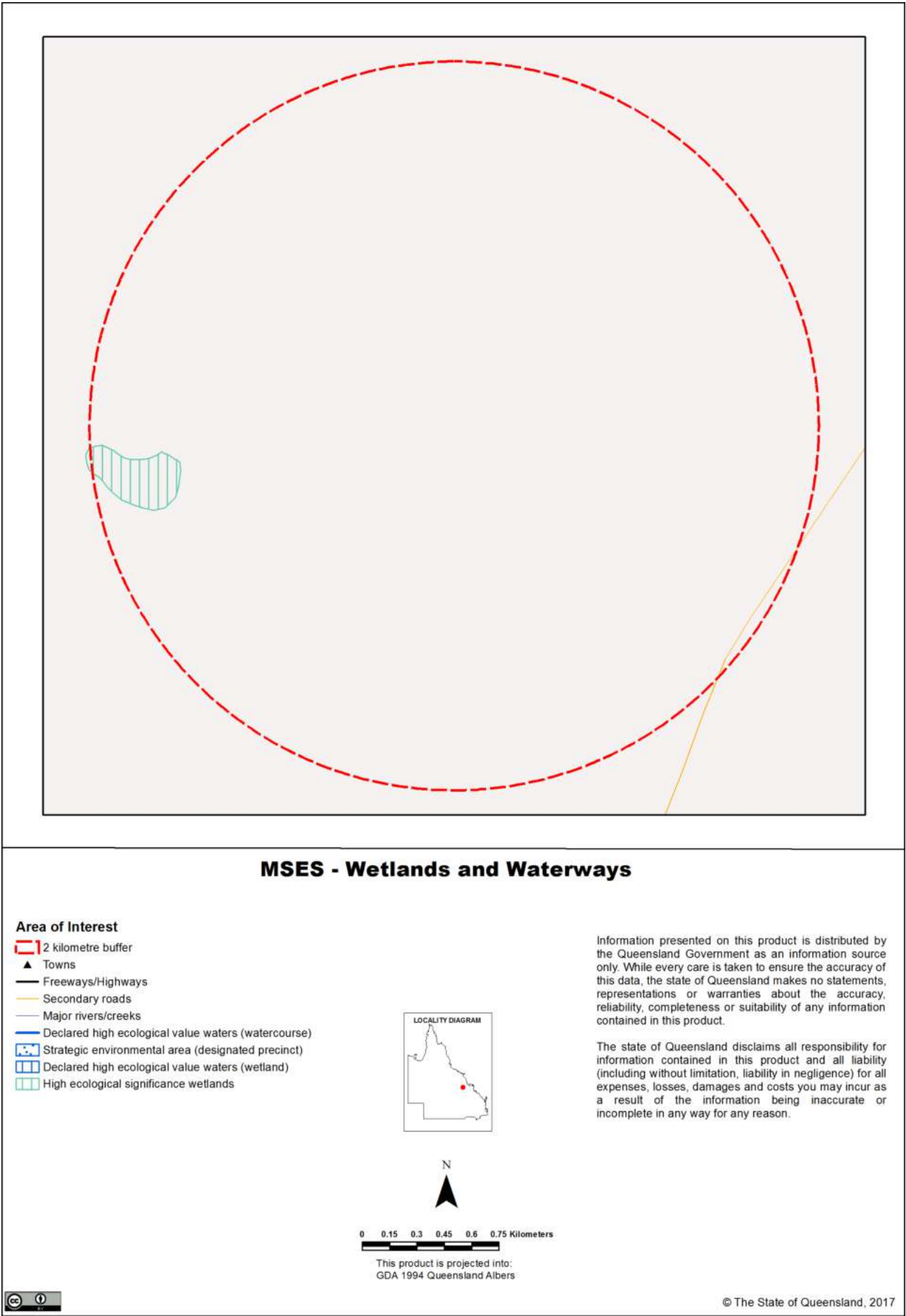
(no results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

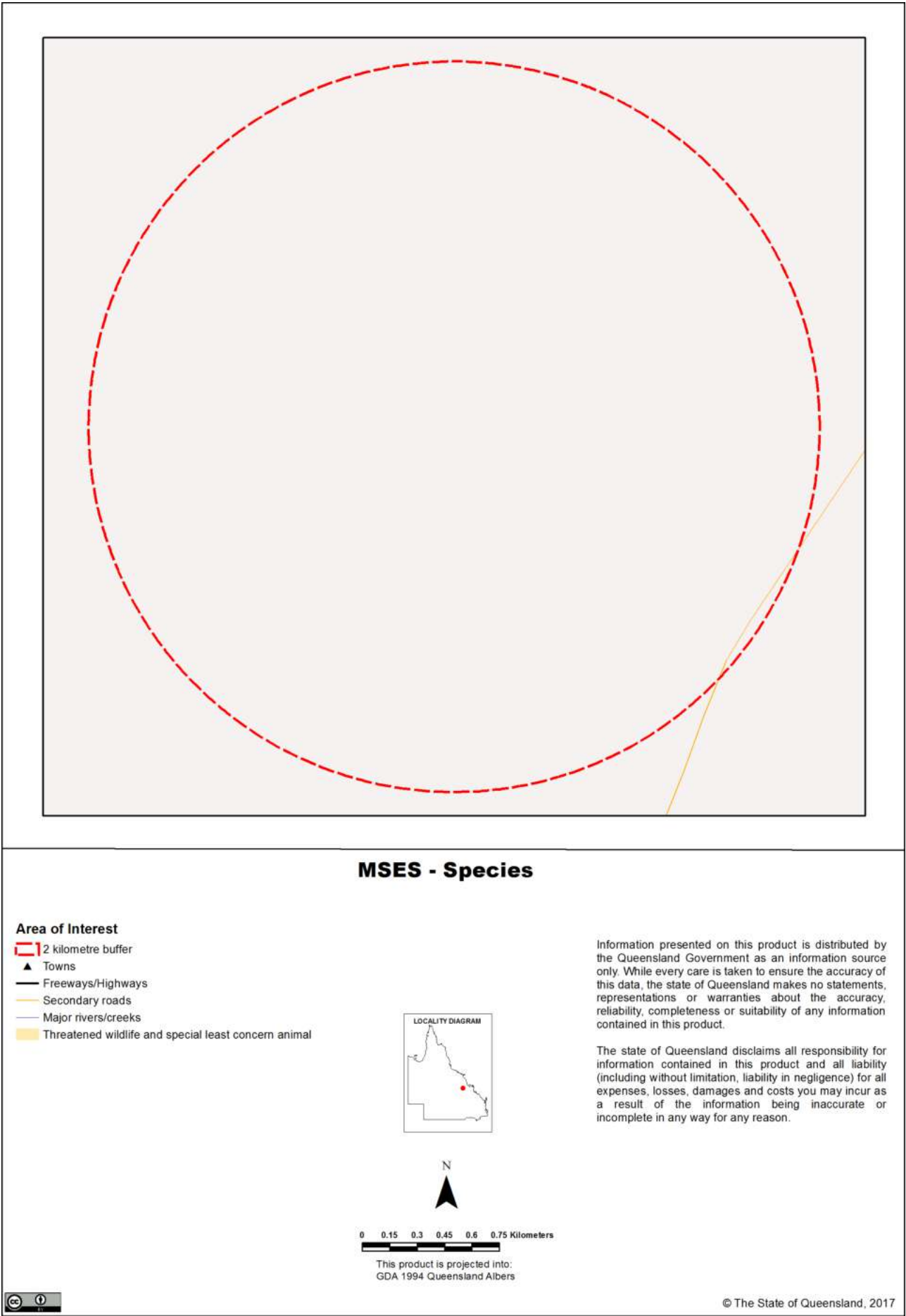
Map 1 - MSES - State Conservation Areas



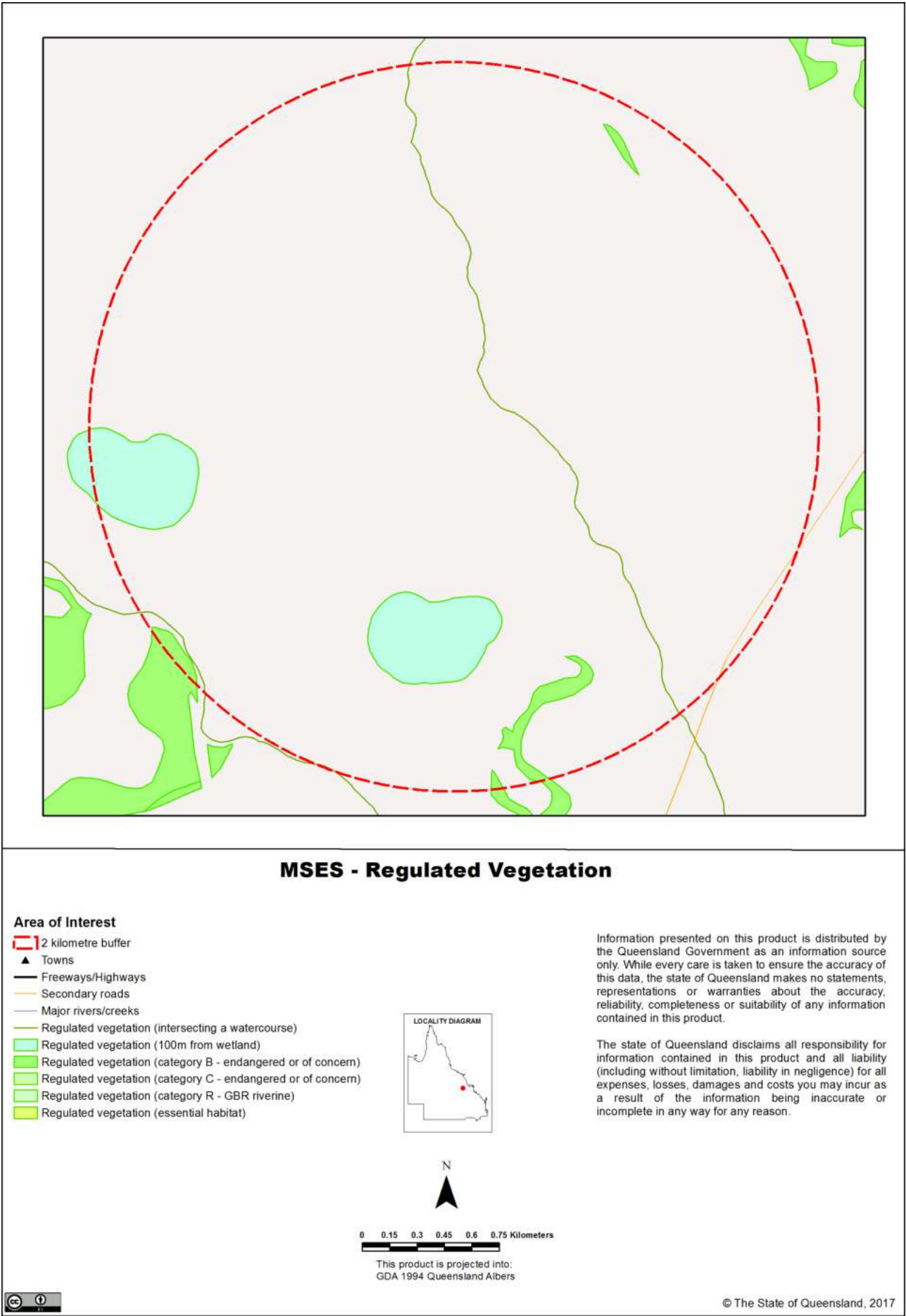
Map 2 - MSES - Wetlands and Waterways



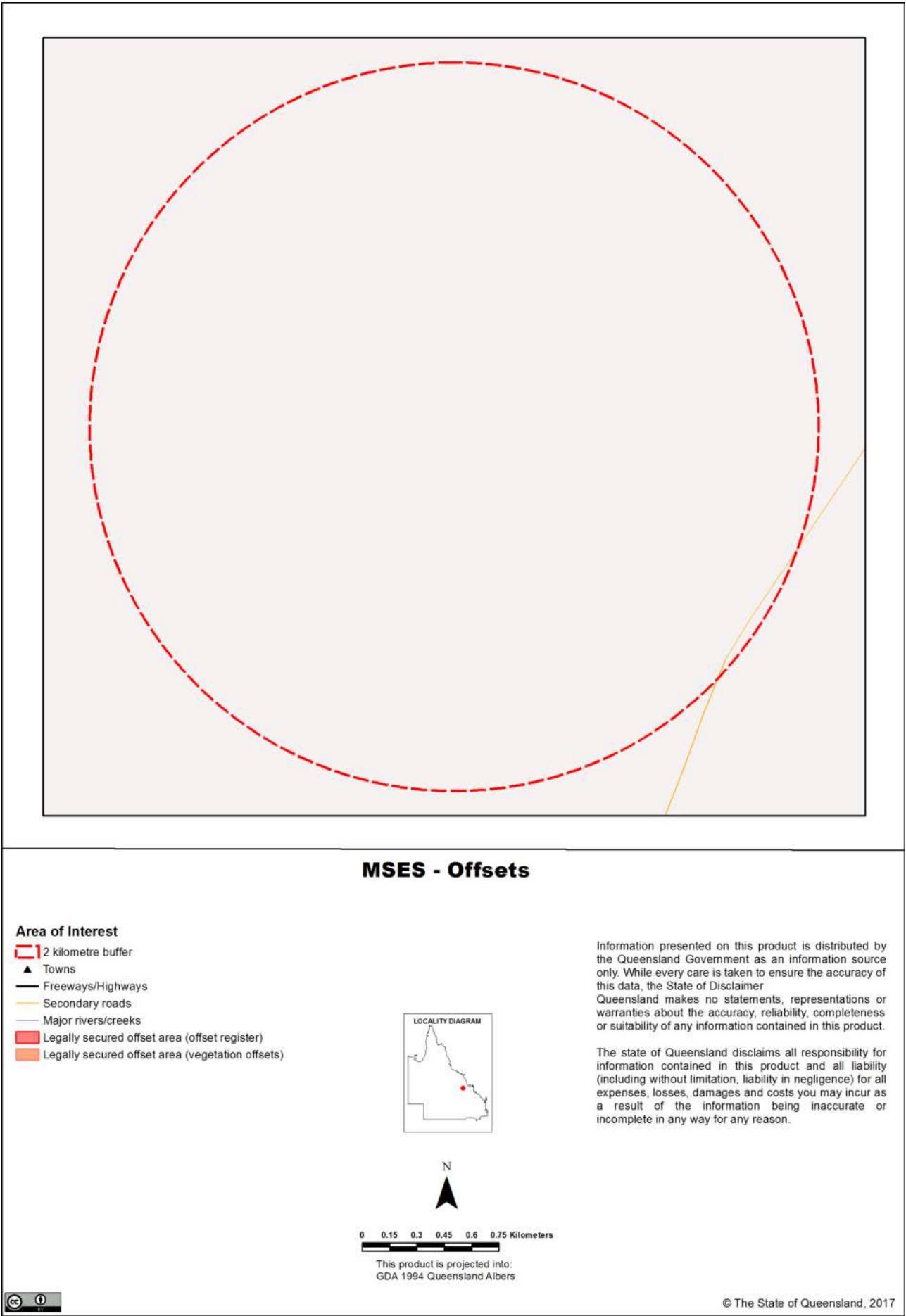
Map 3 - MSES - Species



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). The compiled MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The Queensland Government's "Method for mapping - matters of state environmental significance for use in land use planning and development assessment" can be downloaded from:

<http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html>.

Appendix 2 - Source Data

The datasets listed below are available on request from:

<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page>

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	current QSpatial data (http://qspatial.information.qld.gov.au)
Protected Areas-Estates and Nature Refuges	- Protected areas of Queensland - Nature Refuges - Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Referable Wetland - wetland layers: - Wetland management area wetlands - Wetland protection area wetlands
wetlands in HEV waters	HEV waters: - EPP Water (multiple locations) intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 4, 2015) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000) - latest version 1.4
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various)
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map - latest version 8.0
VMA Essential Habitat	Vegetation management - essential habitat map - latest version 4.41
VMA Wetlands	Vegetation management wetlands map - latest version 2.41
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact EHP
Regulated Vegetation Map	Vegetation management - regulated vegetation management map - latest version 1.41

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
EHP	- Department of Environment and Heritage Protection
EP Act	- <i>Environmental Protection Act 1994</i>
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- <i>Nature Conservation Act 1992</i>
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- <i>Vegetation Management Act 1999</i>



Appendix 7: Department of Environment and Heritage Protection Regional Ecosystem Report



Queensland Government

Department of Environment and Heritage Protection

Environmental Reports

Regional Ecosystems

Biodiversity Status

Area of Interest: Longitude: 148.62919 Latitude: -22.82804

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no matters of interest have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the status used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Natural Resources and Mines website

<https://www.dnrm.qld.gov.au/>

Please direct queries about these reports to: Queensland.Herbarium@dsitia.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government 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.



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Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Area of interest details

Area of Interest	148.62919,-22.82804 with 2 kilometre radius
Size (ha)	1256.6
Local Government(s)	ISAAC REGIONAL
Bioregion(s)	Brigalow Belt
Subregion(s)	Isaac - Comet Downs
Catchment(s)	Fitzroy

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	11.7	0.9
Of concern	109.5	8.7
No concern at present	404.1	32.2
Total remnant vegetation	525.4	41.8

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem is regularly reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and are usually distinguished by differences in dominant species, frequently in the shrub or ground layers and are denoted by a letter following the regional ecosystem code (e.g. a, b, c).

The Queensland Herbarium has developed a methodology for mapping regional ecosystems across Queensland. As new information is obtained, the descriptions and status of regional ecosystems is updated. Regional ecosystems and broad vegetation groups descriptions in the format of Sattler and Williams (1999) are maintained in the Regional Ecosystem Description Database (REDD). Vegetation communities and regional ecosystems are amalgamated into the higher level classification of broad vegetation groups (BVGs).

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of matters relevant to the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium's Regional Ecosystem Mapping, and not mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Natural Resources and Mines website.

<https://www.dnrm.qld.gov.au/>

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (1000 ha); or patch size (100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI, the associated short description, Biodiversity Status using the Queensland Herbarium's framework and the extent area present within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
11.3.1	Acacia harpophylla and/or Casuarina cristata open forest on alluvial plains	Endangered	9.4	0.8
11.3.2	Eucalyptus populnea woodland on alluvial plains	Of concern	31.7	2.5
11.3.25	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	Of concern	43.6	3.5
11.3.27	Freshwater wetlands	Of concern	30.5	2.4
11.3.7	Corymbia spp. woodland on alluvial plains	Of concern	3.8	0.3
11.4.9	Acacia harpophylla shrubby woodland with Terminalia oblongata on Cainozoic clay plains	Endangered	2.3	0.2
11.5.3	Eucalyptus populnea ± E. melanophloia ± Corymbia clarksoniana woodland on Cainozoic sand plains and/or remnant surfaces	No concern at present	404.1	32.2
non-rem	None	None	731.2	58.2

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before European settlement.

Table 4 provides further information in regards to the remnant regional ecosystems present within the site with respect to the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
11.3.1	In 2013, remnant extent was > 10,000 ha and 10-30% of the pre-clearing area remained	25a	None	Low
11.3.2	In 2013, remnant extent was > 10,000 ha and 10-30% of the pre-clearing area remained	17a	Contains palustrine wetland (e.g. in swales).	Low

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
11.3.25	In 2013, remnant extent was > 10,000 ha and >30% of the pre-clearing area remained	16a	Riverine wetland or fringing riverine wetland.	Low
11.3.27	In 2013, remnant extent was > 10,000 ha and >30% of the pre-clearing area remained	34d	Palustrine or Lacustrine wetland (e.g. vegetated swamp or lake).	Low
11.3.7	In 2013, remnant extent was > 10,000 ha and >30% of the pre-clearing area remained	9e	None	Low
11.4.9	In 2013, <10% of the pre-clearing area remained	25a	Contains palustrine wetland (e.g. in swales).	Low
11.5.3	In 2013, remnant extent was > 10,000 ha and >30% of the pre-clearing area remained	17a	None	Low
non-rem	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

Map 6 displays the distribution of mapped wetland systems within the area of interest.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
11.3.1	Habitat for threatened fauna species including painted honeyeater, <i>Grantiella picta</i> particularly in subregion 35 (Oliver et al. 2003).
11.3.2	Habitat for threatened flora species <i>Homopholis belsonii</i> .
11.3.25	Habitat for threatened flora species including <i>Eucalyptus raveretiana</i> . Shown to be associated with a high fauna species richness in the Taroom area (Venz et al. 2002). Within parts of the Fitzroy catchment, this RE is known habitat for the threatened freshwater turtle <i>Rheodytes leukops</i> . Known to be important habitat for other riparian freshwater turtle species.
11.3.27	Habitat for a diverse range of fauna species (Venz et al. 2002) particularly birds. <i>Hydrocharis dubia</i> is a vulnerable water plant that occasionally occurs in this RE. 11.3.27a: Provides wetland habitat for a flora and fauna.
11.3.7	Habitat of the endangered northern hairy-nosed wombat, <i>Lasiorhinus krefftii</i> .
11.4.9	None
11.5.3	None
non-rem	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional).

A comprehensive description of BVGs is available at:

<https://publications.qld.gov.au/dataset/vegetation-qld/resource/921fa786-e6d5-4a8a-9b0c-e532d2ce3f32>

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	731.2	58.2
16a	Open forest and woodlands dominated by <i>Eucalyptus camaldulensis</i> (river red gum) (or <i>E. tereticornis</i> (blue gum)) and/or <i>E. coolabah</i> (coolabah) (or <i>E. microtheca</i> (coolabah)) fringing drainage lines. Associated species may include <i>Melaleuca</i> spp., <i>Corymbia tessellaris</i> (carbeen), <i>Angophora</i> spp., <i>Casuarina cunninghamiana</i> (riveroak). Does not include alluvial areas dominated by herb and grasslands or alluvial plains that are not flooded. (land zone 3) (MGD, BRB, GUP, CHC, MUL, DEU, EIU, NWH, SEQ, [NET, WET]) (All bioregions except CYP and CQC)	43.6	3.5
17a	Woodlands dominated by <i>Eucalyptus populnea</i> (poplar box) (or <i>E. brownii</i> (Reid River box)) on alluvium, sand plains and footslopes of hills and ranges. (land zones 3, 5, 10, 9, 4, 11, 12, [8]) (BRB, MUL, DEU, MUL, EIU)	435.8	34.7
25a	Open forests to woodlands dominated by <i>Acacia harpophylla</i> (brigalow) sometimes with <i>Casuarina cristata</i> (belah) on heavy clay soils. Includes areas co-dominated with <i>A. cambagei</i> (gidgee) and/or emergent eucalypts (land zones 4, 9, 3, 11, 7, 12, [5, 8]) (BRB, MUL, MGD, DEU, [SEQ])	11.7	0.9
34d	Palustrine wetlands. Freshwater swamps/springs/billabongs on floodplains ranging from permanent and semi-permanent to ephemeral. (land zone 3) (GUP, EIU, BRB, CYP, CHC, [MGD])	30.5	2.4
9e	Open forests, woodlands and open woodlands dominated by <i>Corymbia clarksoniana</i> (grey bloodwood) (or <i>C. novoguineensis</i> or <i>C. intermedia</i> (pink bloodwood) or <i>C. polycarpa</i> (long-fruited bloodwood)) frequently with <i>Erythrophleum chlorostachys</i> (red ironwood) or <i>Eucalyptus platyphylla</i> (poplar gum) predominantly on coastal sandplains and alluvia. (land zones 3, 5, 2) (CYP, BRB, CQC, WET, EIU)	3.8	0.3

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See:

<http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/>

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant area (hectares) of each vegetation community derived from the regional ecosystem mapping (spatial) data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Quantitative site data from relatively undisturbed sites are extracted from CORVEG and summarized to provide information specific to each vegetation community.

Technical descriptions include the attributes: tree canopy height and cover and native plant species composition of the predominant layer, which are used to assess the remnant status of vegetation under the *Vegetation Management Act 1999*.

However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used where possible (Neldner et al. 2012 (PDF)* section 3.3.1 of:

<http://www.qld.gov.au/environment/assets/documents/plants-animals/herbarium/herbarium-mapping-methodology.pdf>

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community.

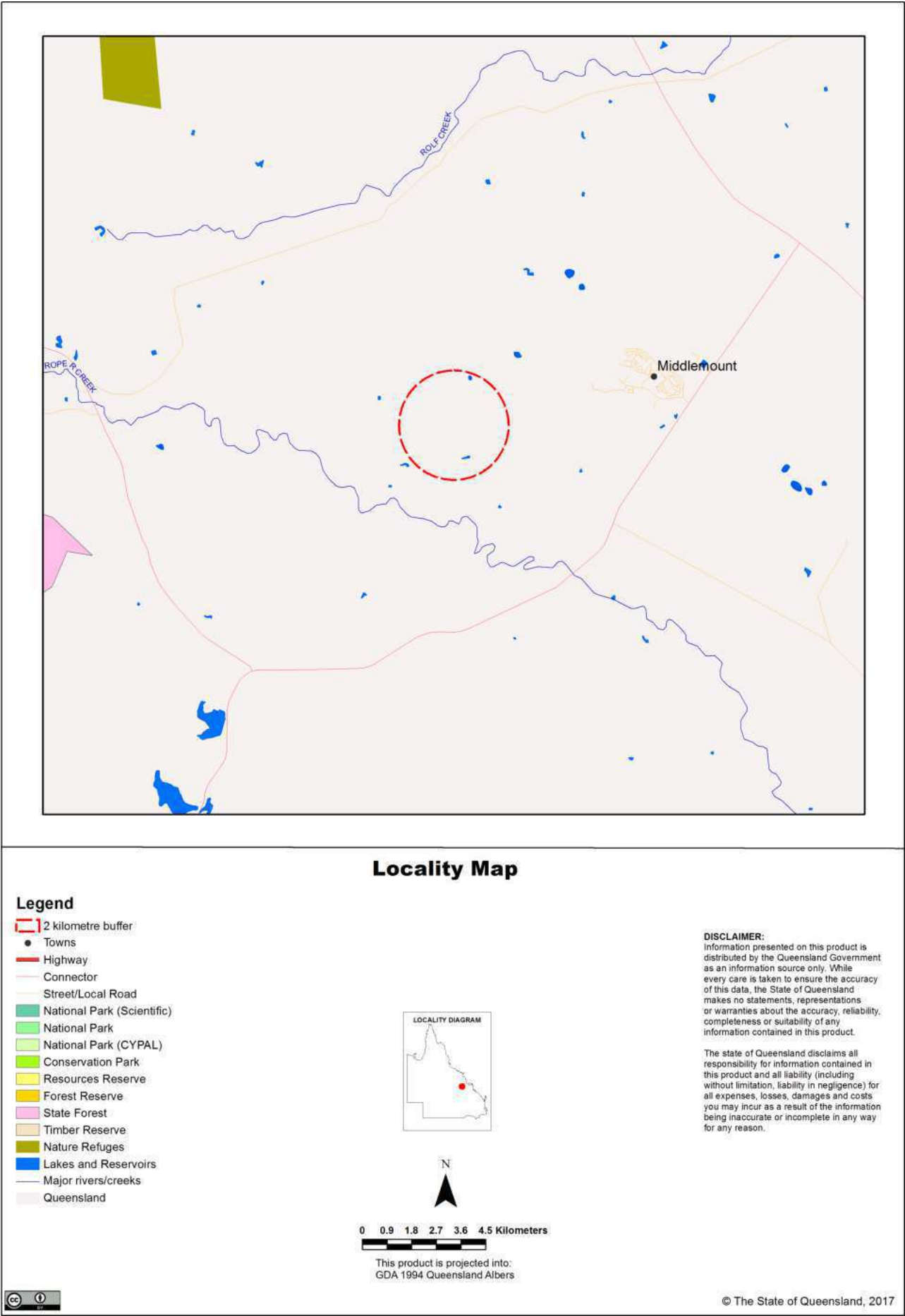
<http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/>

Benchmarks are subject to review based on additional data and expert opinion. Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

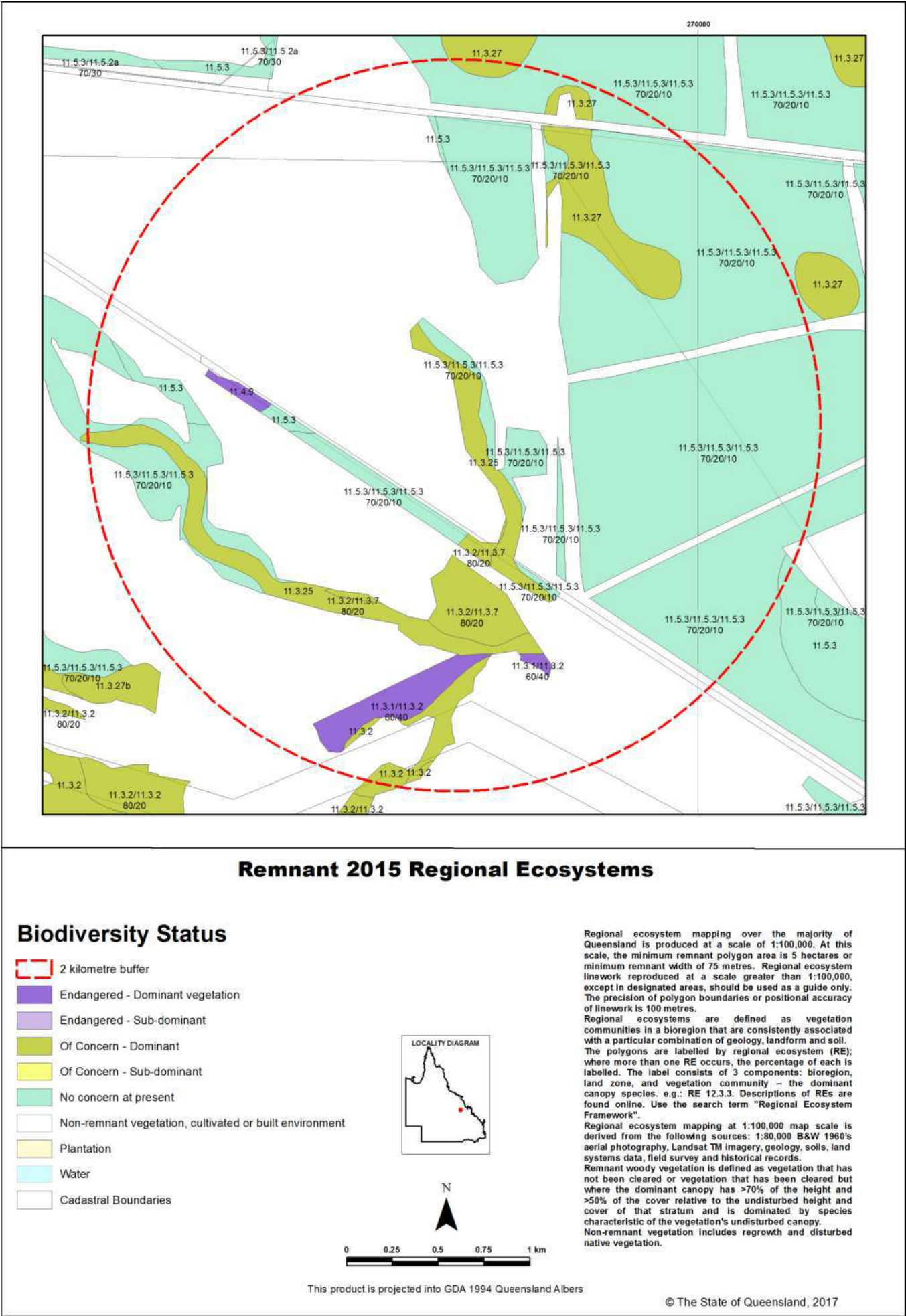
Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
11.3.1	Not currently available	Available
11.3.2	Not currently available	Available
11.3.25	Not currently available	Available
11.3.27	Not currently available	Not currently available
11.3.7	Not currently available	Not currently available
11.4.9	Not currently available	Not currently available
11.5.3	Not currently available	Not currently available
non-rem	Not currently available	Not currently available

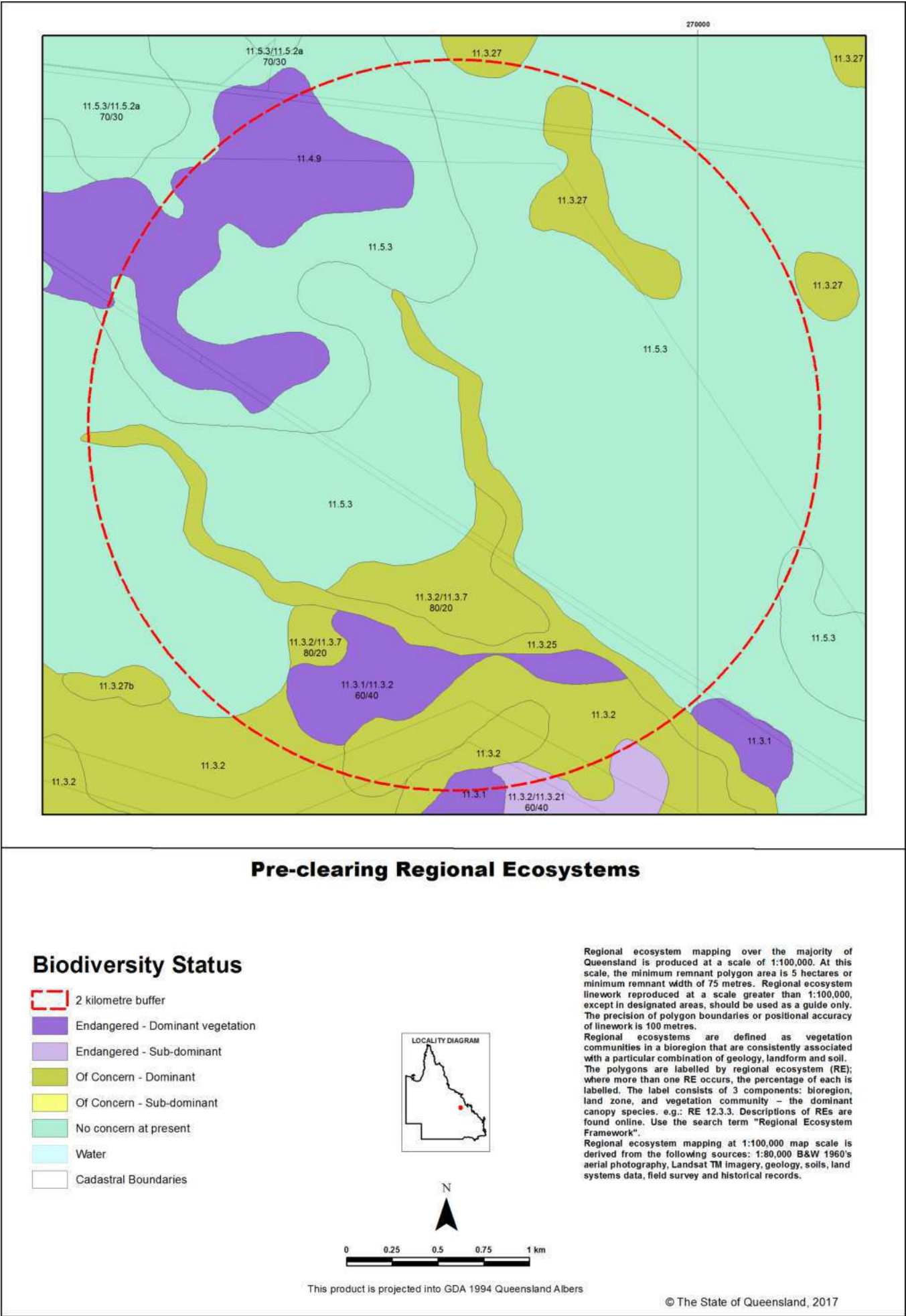
Maps
Map 1 - Location



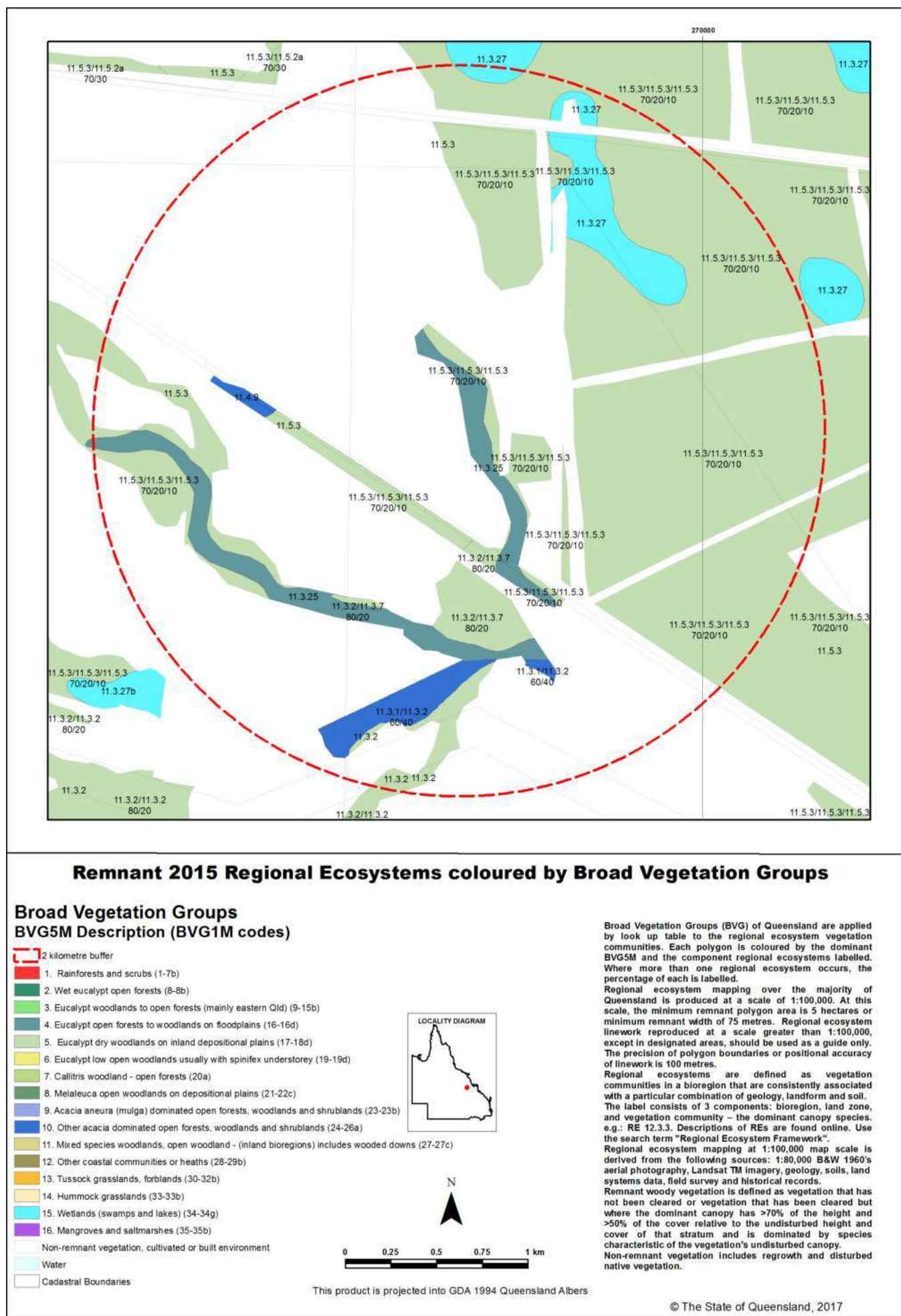
Map 2 - Remnant regional ecosystems



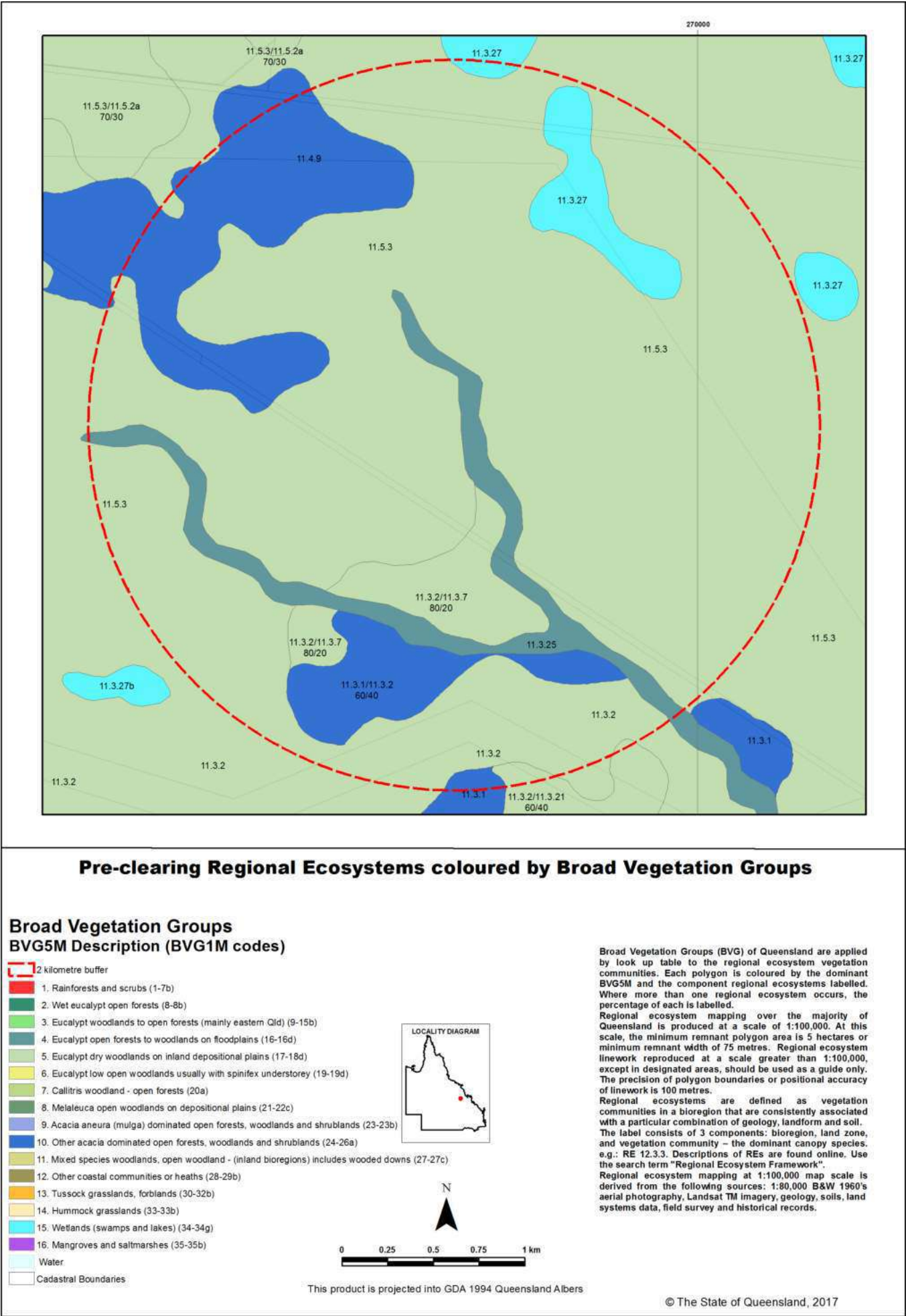
Map 3 - Pre-clearing remnant regional ecosystems



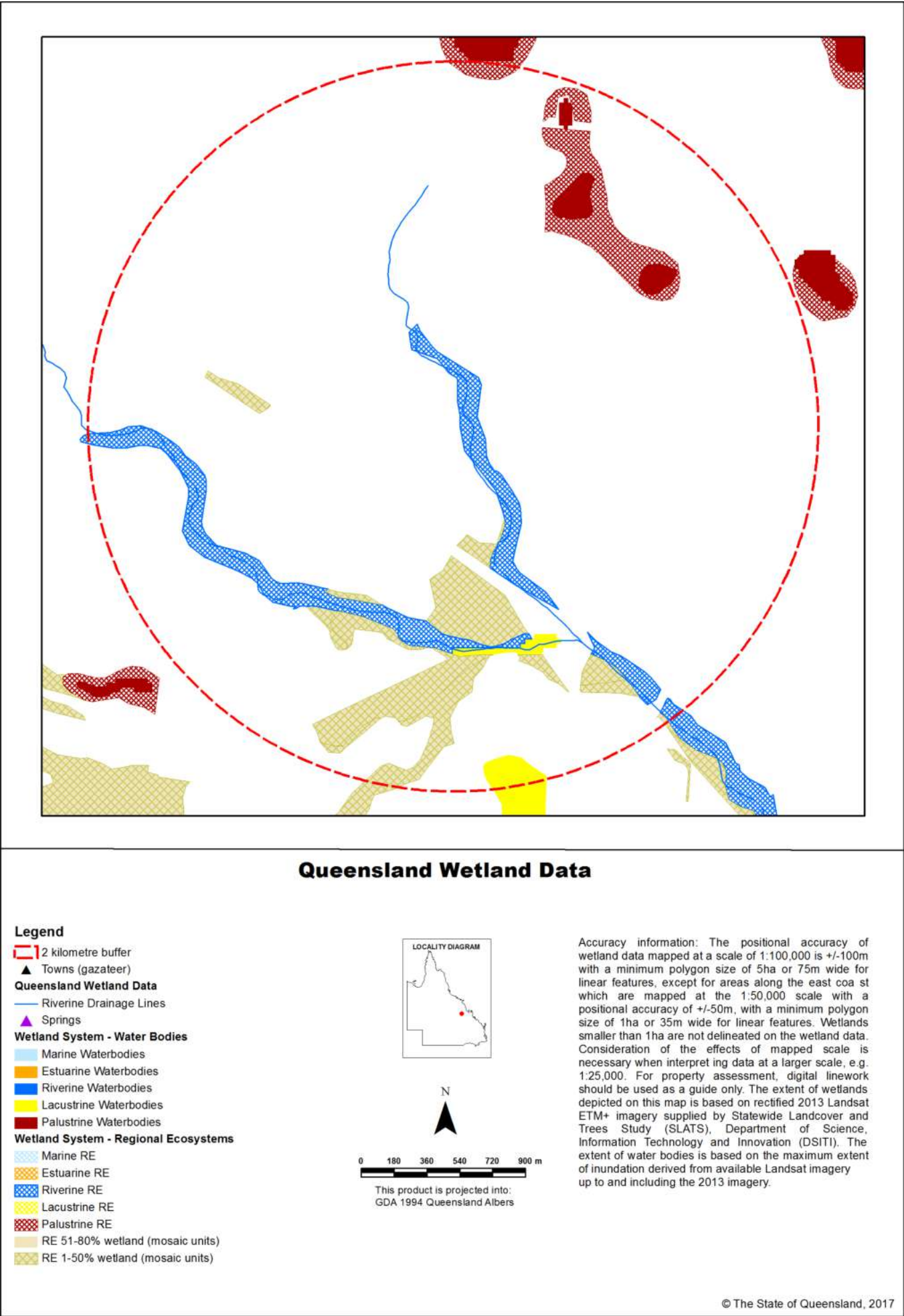
Page 13



Map 5 - Pre-clearing remnant regional ecosystems by BVG (5M)



Map 6 - Wetlands and waterways



Links and Other Information Sources

The Department of Environment and Heritage's Website -

<http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/>

provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from:

<https://publications.qld.gov.au/dataset/vegetation-qld/resource/921fa786-e6d5-4a8a-9b0c-e532d2ce3f32>

The methodology for mapping regional ecosystems can be downloaded from:

<http://www.qld.gov.au/environment/assets/documents/plants-animals/herbarium/herbarium-mapping-methodology.pdf>

Technical descriptions for regional ecosystems can be obtained from:

<http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/>

Benchmarks can be obtained from:

<http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/>

For further information associated with the remnant regional ecosystem dataset used by this report, such as the year at which the extent of remnant is reflective of, refer to the metadata associated with the relevant Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) and which is available through the Queensland Government Information System portal,

<http://dds.information.qld.gov.au/dds/>

The Queensland Globe is a mapping and data application implemented inside the Google Earth TM application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link:

<http://www.dnrm.qld.gov.au/mapping-data/queensland-globe>

References

Neldner, V.J., Wilson, B.A., Thompson, E.J., and Dillewaard, H.A. (2012). *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland*. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

<http://www.qld.gov.au/environment/assets/documents/plants-animals/herbarium/herbarium-mapping-methodology.pdf>

Neldner, V.J., Niehus R.E., Wilson, B.A. McDonald, W.J.F. and Ford, A.J. (2014). *The Vegetation of Queensland. Descriptions of Broad Vegetation Groups*. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

<https://publications.qld.gov.au/dataset/vegetation-qld/resource/921fa786-e6d5-4a8a-9b0c-e532d2ce3f32>

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1: Source Data

The dataset listed below is available for download from:

<http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/>

- Regional Ecosystem Description Database

The datasets listed below are available for download from:

<http://dds.information.qld.gov.au/dds/>

- Remnant Regional Ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
DNRM	- Department of Natural Resources and Mines
EHP	- Department of Environment and Heritage Protection
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
VMA	- <i>Vegetation Management Act 1999</i>



Appendix 8: Department of Natural Resources and Mines Regulated Vegetation Report

Veg Mapping

Veg Mapping

- Feature 1
- Feature 2
- Untitled Polygon

- Feature 1
- Feature 2
- Untitled Polygon

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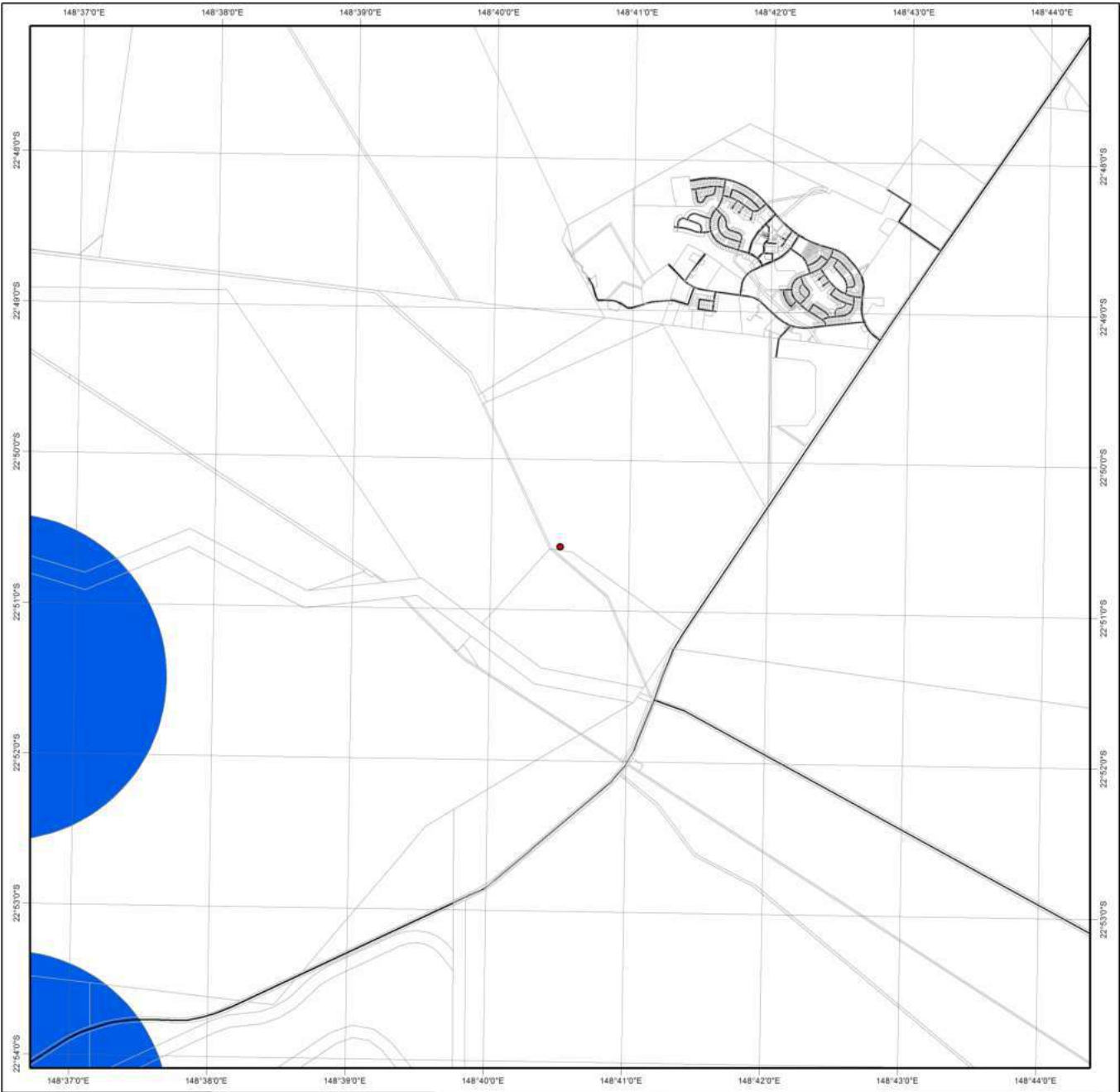
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AN

1.3.25 1 km



Appendix 9: High Risk Vegetation Trigger Report



Protected Plants Flora Survey Trigger Map

Legend

- Coordinates
- High risk area
- Cadastral line
- Property boundaries shown are provided as a locational aid only
- Freeways / motorways / highways
- Secondary roads / streets



0 490 980 1,470 1,960 2,450 m

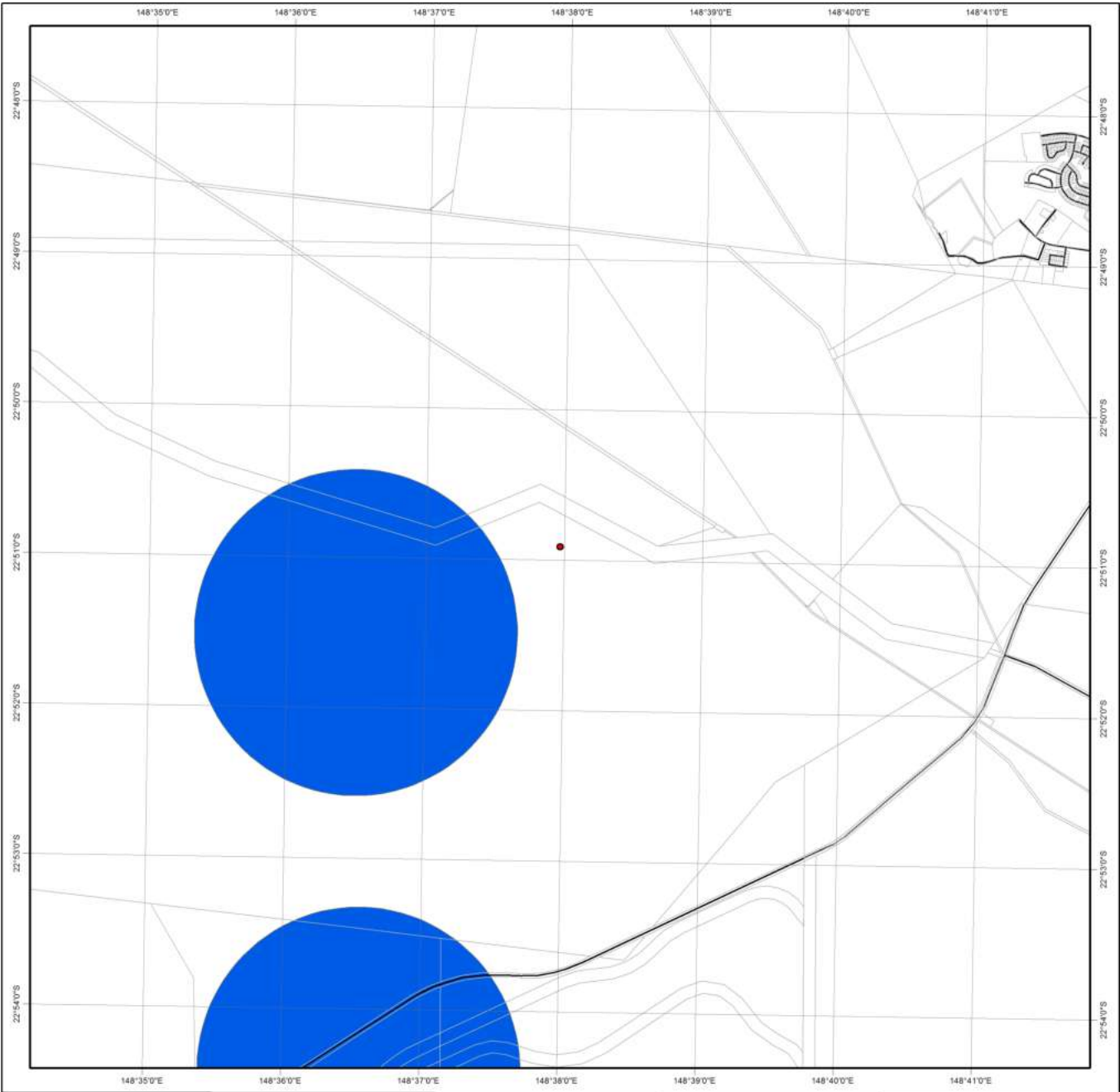
This product is projected into:
GDA 1994 Queensland Albers

This map shows areas where particular provisions of the Nature Conservation Act 1992 apply to the clearing of protected plants.

This map is produced at a scale relevant to the size of the area selected and should be printed as A4 size in portrait orientation.

For further information or assistance with interpretation of this product, please contact the Department of Environment and Heritage Protection at palm@ehp.qld.gov.au

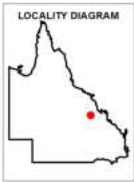
Disclaimer:
While every care is taken to ensure the accuracy of the data used to generate this product, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaim all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damages) and costs which might be incurred as a consequence of reliance on the data, or as a result of the data being inaccurate or incomplete in any way and for any reason.



Protected Plants Flora Survey Trigger Map

Legend

- Coordinates
- High risk area
- Cadastral line
- Property boundaries shown are provided as a locational aid only
- Freeways / motorways / highways
- Secondary roads / streets



0 490 980 1,470 1,960 2,450 m

This product is projected into:
GDA 1994 Queensland Albers

This map shows areas where particular provisions of the Nature Conservation Act 1992 apply to the clearing of protected plants.

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Appendix 10: Matters of National Environmental Significance Report



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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 16/05/17 12:17:36

[Summary](#)

[Details](#)

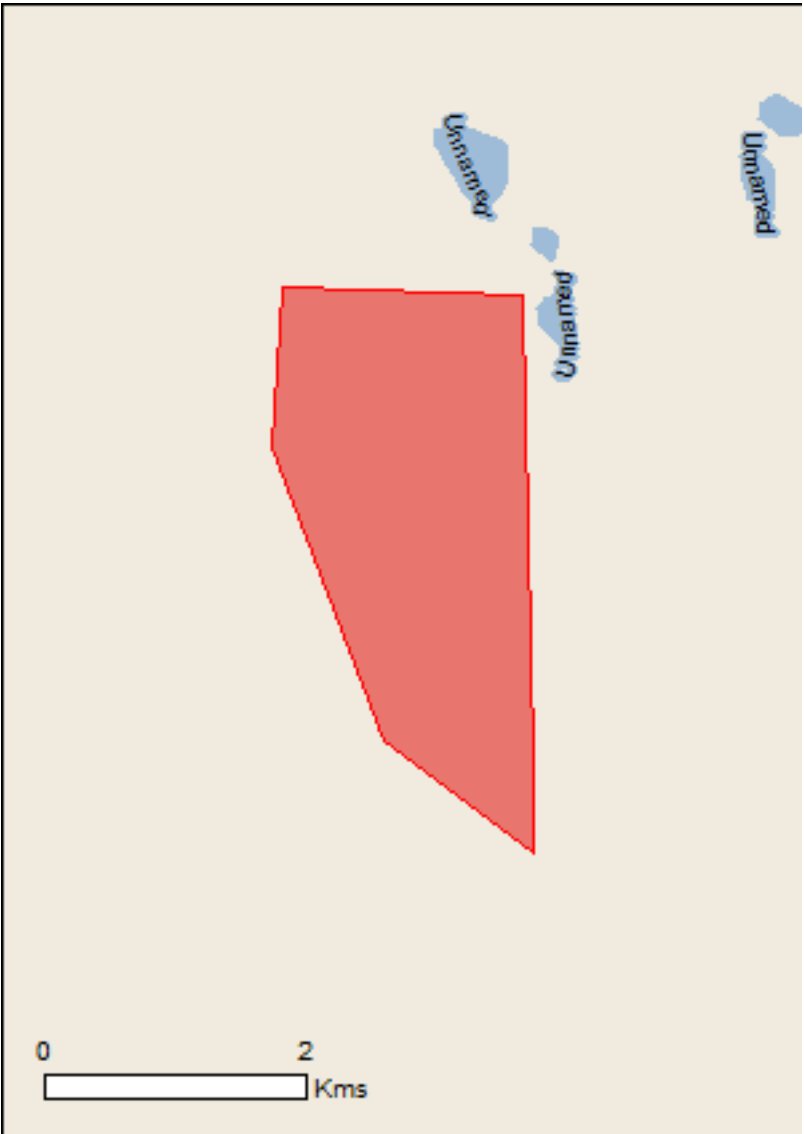
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

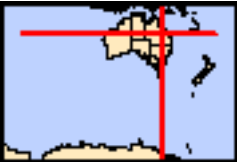
[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

[Buffer: 10.0Km](#)



Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	21
Listed Migratory Species:	12

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 environment anywhere.

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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	15
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

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.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythroriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [331]	Endangered	Species or species habitat may occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Plants		
Dichanthium queenslandicum		
King Blue-grass [5481]	Endangered	Species or species habitat may occur within area
Dichanthium setosum		
bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Delma torquata		
Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Denisonia maculata		
Ornamental Snake [1193]	Vulnerable	Species or species habitat likely to occur within area
Egernia rugosa		
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Elseya albagula		
Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Lerista allanae		
Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area
Rheodytes leukops		
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat likely to occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]	Endangered*	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]	Endangered*	Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]		Species or species habitat may occur within area

Extra Information

Invasive Species	[Resource Information]
------------------	--

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]	Endangered*	Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Frogs		
Rhinella marina		
Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus		
Domestic Cattle [16]		Species or species habitat likely to occur within area
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa		
Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica		
Prickly Acacia [6196]		Species or species habitat may occur within area
Jatropha gossypifolia		
Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp.		
Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

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

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-22.81402 148.617547,-22.814574 148.63394,-22.844397 148.634541,-22.849776 148.634627,-22.842736 148.624413,-22.824147 148.616688,-22.81402 148.617461,-22.81402 148.617547

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.



Appendix 11: Groundwater Dependent Ecosystems Database Report

Groundwater Dependent Ecosystem Map Report





Appendix 12: Landscape Fragmentation and Connectivity Tool Output

Department of Environment and Heritage Protection (DEHP)
Landscape Fragmentation and Connectivity (LFC) Tool version 1.4 LOGFILE
Process started at 26-02-2018 03:03:51 PM
Python version: 2.7.10 (default, May 23 2015, 09:40:32) [MSC v.1500 32 bit (Intel)]
Arcpy version: 10.4
Username: Libby

INPUT PARAMETERS

Output Workspace: H:\LFC Tool\Middlemount_WE_Rev4
Threshold lookup table: H:\LFC Tool\LFC_data.gdb\tbl_Regional_frag_local_threshold
Remnant cover layer: H:\LFC Tool\Qld Regulated Vegetation Map V1.48.gdb\Regulated_vegetation_management_map_EDITED
Remnant cover layer edited: True
Regional buffer extent: 20 kilometres
Local buffer extent: 5 kilometres
Impact layer: H:\LFC Tool\Middlemount_WE_Rev4\ProposedDisturbanceExtent.shp
layer projection: GDA_1994_MGA_Zone_56
Raster cell resolution for analysis: 10 metres
Edge Width: 50 metres
(The distance from non-remnant landscapes through to the core ecosystem - the edge of remnant ecosystems)
Default projection: H:\LFC Tool\scripts\QLD Albers Equal Area Conic.prj

15:03:51 Checking out the spatial analyst tool - required for LFC

15:03:51 _____BEGINNING LANDSCAPE FRAGMENTATION AND CONNECTIVITY ANALYSIS_____

15:03:51 This tool will categorise the landscape into:

{0: 'non-rem', 1: 'patch', 2: 'edge', 3: 'perforated', 4: 'core (< 100 hectares)', 5: 'core (100-500 hectares)', 6: 'core (> 500 hectares)'}

15:03:54 H:\LFC Tool\Middlemount_WE_Rev4\lyr_file does not exist, creating it now.

15:03:54 Copying across impact site feature(s) and calculating area in hectares (AreaHA)

15:03:55 Making a local copy of the impact site

15:03:55 Preparing remnant cover layer for analysis

15:03:56 Created regional scale buffer of 20 kilometres

15:03:56 Created local scale buffer of 5 kilometres

15:04:03 Clipped the remnant cover to the regional buffer extent

15:04:07 Unioned the pre impact remnant layer with the impact site

15:04:08 Attributed the impact area as non-remnant

15:04:08 Categorised the cover attributes in clip_remcover_pre.shp ready for raster conversion

15:04:20 Converted clip_remcover_pre.shp to raster

15:04:20 Categorised the cover attributes in clip_remcover_post.shp ready for raster conversion

15:04:32 Converted clip_remcover_post.shp to raster

15:04:32 Run Landscape fragmentation analysis on the pre impact regional landscape

NATURALLY VEGETATED AND CLEARED LAND BEING EXTRACTED FROM LAND COVER

IDENTIFICATION OF CORE, PATCH, EDGE AND PERFORATIONS

COMBINING FRAGMENTATION CLASSES

CLASSIFYING CORE FOREST PATCHES BY AREA

COMPOSING FINAL FRAGMENTATION MAP

COMPOSING FINAL FRAGMENTATION MAP

(FRAGMENTATION CALCULATION TIME WAS 4.3 MINUTES)

15:08:51 Run Landscape fragmentation analysis on the post impact regional landscape

NATURALLY VEGETATED AND CLEARED LAND BEING EXTRACTED FROM LAND COVER

IDENTIFICATION OF CORE, PATCH, EDGE AND PERFORATIONS

COMBINING FRAGMENTATION CLASSES

CLASSIFYING CORE FOREST PATCHES BY AREA

COMPOSING FINAL FRAGMENTATION MAP

COMPOSING FINAL FRAGMENTATION MAP

(FRAGMENTATION CALCULATION TIME WAS 4.2 MINUTES)

Extracting a local subset of lfc_regional_pre_impact

Extracting a local subset of lfc_regional_post_impact

Collating pre and post impact statistics and trigger assessment

15:13:14 Summarising area statistics for: lfc_localmsk_pre_impact

15:13:14 Summarising area statistics for: lfc_localmsk_post_impact

15:13:14 Summarising area statistics for: lfc_regional_pre_impact

15:13:14 Summarising patch count for lfc_localmsk_pre_impact

15:13:19 Summarising patch count for lfc_localmsk_post_impact

Analysing impact on Connectivity Areas

SIGNIFICANCE TEST ONE

The regional total area is 160953.94

The regional extent of core remnant is 40884.68

The regional extent of core remnant is 25.40 percent

This level of regional fragmentation sets a local impact threshold of: 5.0 percent

The table below lists the local impact thresholds for categories of regional core remnant extent:

REGIONAL CORE CATEGORY	LOCAL IMPACT THRESHOLD
< 10	2.0
10 - 30	5.0
30 - 50	10.0
50 - 70	20.0
70 - 90	30.0
>90	50.0

Area of core at the local scale (pre impact): 2965.24

Area of core at the local scale (post impact): 2874.12

Percent change of core at the local scale (post impact): 3.07

SIGNIFICANCE TEST TWO

The number of core remnant areas occurring on the site: 8

The number of core remnant areas remaining on the site post impact: 4

(Only core polygons greater than or equal to 1 hectare are included)

RESULT

15:13:30 This analysis has determined a SIGNIFICANT impact on connectivity areas

(A significant reduction in core remnant at the local scale is False OR a change from core to non-core remnant at the site scale is True)

The significance table has been written to: ..\main_output\lfc_significance_assessment.csv

The local scale summary table has been written to: ..\main_output\lfc_local_scale_summary.csv

The site scale summary table has been written to: ..\main_output\lfc_site_scale_summary.csv

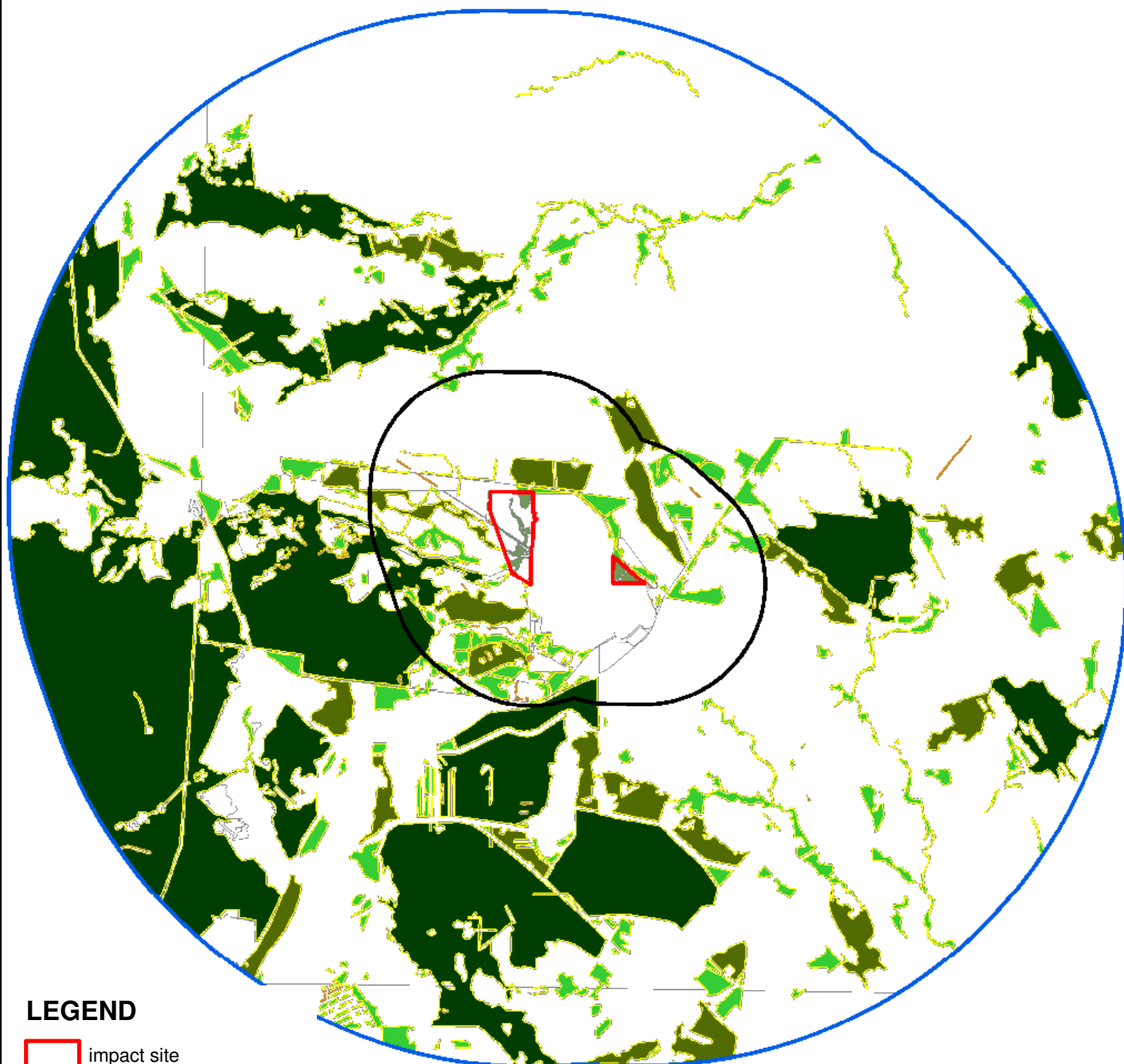
GIS layer files copied into folder \lyr_file within the project folder.

View layers in ArcMAP using..H:\LFC Tool\Middlemount_WE_Rev4\lyr_file\lyr_file\Connectivity Area Impact Assessment.lyr

Please scrutinise the output tables and spatial layers to confirm the desktop modelling of connectivity area impact

This analysis used an edited version of the Regulated Vegetation layer.

15:14:43 _____COMPLETED LANDSCAPE FRAGMENTATION AND CONNECTIVITY ANALYSIS_____



LEGEND

- impact site
- impact site local buffer
- impact site regional buffer
- patch
- edge
- perforated
- core (< 100 hectares)
- core (100-500 hectares)
- core (> 500 hectares)
- other

clip_remcover_pre

Cover

- remnant
- non-remnant

Middlemount Western Extension Project
Landscape Fragmentation and Connectivity (LFC)
Qld Regulated Vegetation Map V1.48



Appendix 13: Anabat Analysis Reports



Microbat Call Identification Report

Prepared for ("Client"):	Naturecall Environmental
Survey location/project name:	Middlemount – Impact Area
Survey dates:	28 April - 3 May 2017
Client project reference:	
Job no.:	NAT-1701a
Report date:	2 June 2017

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Methods

Data received

The data set received for analysis included 12 Anabat ZCA files, recorded over five consecutive nights (28th April – 2 May, 2017) using two Anabat Express detectors (Titley Scientific, Brisbane).

The ZCA files were converted to Anabat call sequence files (zero-crossing analysis format) using *AnalookW* (Corben 2015). This process yielded 5196 files for analysis; however, the majority of those files contained only non-bat background noise (e.g. from rain and/or wind and/or insects).

Call identification

All sequence files were viewed using *AnalookW* (Corben 2015) and a subset of files with representative samples of all call types recorded on each night by each detector was selected for detailed analysis. Species identification was achieved manually by comparing the call spectrograms of the selected calls with those of reference calls from south- and central-eastern Queensland and/or with published call descriptions (e.g. Reinhold *et al.* 2001; Pennay *et al.* 2004).

Species determination was also guided by considering probability of occurrence based on published distribution maps (e.g. Churchill 2008; van Dyck *et al.* 2013) and/or online databases (e.g. *Atlas of Living Australia* <http://www.ala.org.au>).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at <http://www.ausbats.org.au/>.

Species nomenclature follows Reardon *et al.* (2015).

Results & Discussion

Some 621 bat calls were identified, representing at least 15 and as many as 17 species (Table 1). Fourteen species were positively identified from at least one diagnostic call, while a number of call types had characteristics potentially attributable to two or more species. Such calls were allocated to species groups, with all group members considered possibly present unless they were reliably identified from other calls.

The unresolved species groups include (see Glossary for explanation of terms used):

- *Chalinolobus gouldii* / *Scotorepens balstoni* / *Mormopterus ridei*
 - Calls with predominantly curvilinear pulse shapes and characteristic frequency (Fc) in the range 30-34 kHz
 - *C. gouldii* positively identified where pulses were relatively steep and showed distinctive alternating frequency pattern
 - Calls with steep pulses at uniform frequency, and usually with more curved pulse-bodies than those attributed to *C. gouldii*, were allocated to *S. balstoni*
 - *M. ridei* identified from calls with flatter, broader pulses at uniform frequency
 - Many calls had mixed and/or intermediate pulse shapes and/or were fragmented and could have been from any of these three species

- *Chalinolobus morio* / *Vespadelus troughtoni*
 - Calls with steep, curvilinear (FM-qCF) pulses at Fc=49-54 kHz
 - *C. morio* differentiated on the basis of slanted pulse-body and down-sweeping tail
 - *V. troughtoni* positively identified if pulse bodies distinctly curved with up-swept tail (i.e. “hooked”)
 - Some calls too fragmented and/or brief to reliably determine these characteristics
- *Chalinolobus nigrogriseus* / *Scotorepens greyii*
 - Steep curvilinear pulses with uniform Fc around 37-39 kHz
 - Majority of relevant calls were allocated to *S. greyii* on the basis of relatively narrow (short-duration) pulses with distinctively hooked pulse bodies
 - A few calls with slightly longer-duration pulses and straighter pulse bodies could have been from *C. nigrogriseus*
- *Chalinolobus picatus* / *Vespadelus baverstocki* / *Scotorepens greyii*
 - Steep curvilinear pulses with Fc ~ 39-43 kHz
 - Calls with uniform Fc at <40 kHz and hooked pulse-body were allocated to *S. greyii*
 - *V. baverstocki* identified where pulses had hooked pulses with uniform Fc >41 kHz
 - Where alternating pulse frequency was clear and pulse shape generally lacking a clear hook in the body, calls were attributed to *C. picatus*
 - Many calls had intermediate pulse shapes and/or variable (but not distinctly alternating) frequency and could have been any of these species
- *Vespadelus baverstocki* / *Miniopterus orianae oceanensis*
 - Fc overlaps in the range 43-46 kHz
 - *V. baverstocki* identified where calls had relatively short duration pulses with distinctive hooked body
 - Calls with slanted pulse bodies of relatively longer duration allocated to *M. o. oceanensis*
 - A few calls too brief and/or fragmented to reliably differentiate
- *Nyctophilus* spp.
 - Readily distinguished from other bat calls due to steep, almost-linear pulse shape
 - two *Nyctophilus* spp. potentially occur in study area (*N. geoffroyi* & *N. gouldi*), but they cannot be differentiated using call characteristics
- *Taphozous troughtoni* / *Mormopterus lumsdenae*
 - Curvilinear pulses, usually of narrow band-width (qCF shape) in the frequency range 22-26 kHz
 - *M. lumsdenae* positively identified where pulse-shape varies within a call sequence, often including broader bandwidth pulses with down-swept tails (FM-qCF-FM)
 - Calls with almost-flat, uniform pulses of relatively shorter duration were allocated to *T. troughtoni*
 - Several calls too brief and/or fragmented to reliably differentiate

Table 1. Microbat species recorded in the Middlemount Impact Area, April-May 2017.

- ◆ = at least one call from the site was attributed unequivocally to the species
□ = calls similar to those of the species were recorded, but could not be reliably identified

Detector Date Total sequence files Number of calls identified	Impact area Unit 1					Impact Area Unit 2				
	28/4	29/4	30/4	1/5	2/5	28/4	29/4	30/4	1/5	2/5
	260	423	1581	359	469	180	90	513	975	386
	66	47	89	74	63	50	23	56	78	75
<i>Chalinolobus gouldii</i>	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
<i>Chalinolobus morio</i>	◆	◆	◆	◆	◆	◆	◆			
<i>Chalinolobus nigrogriseus</i>		□	□		□	□			□	
<i>Chalinolobus picatus</i>	□	◆	◆	◆	◆	◆	◆	□	□	◆
<i>Nyctophilus species</i>	◆	◆	◆			◆		◆	◆	◆
<i>Scotorepens balstoni</i>	◆	□	□	□				◆	□	◆
<i>Scotorepens greyii</i>	◆	◆	◆	◆	◆	□	◆	◆	◆	◆
<i>Vespadelus baverstocki</i>	□	□	□	◆	◆			◆	◆	◆
<i>Vespadelus troughtoni</i>			□	◆						
<i>Miniopterus orianae oceanensis</i>	◆	◆	◆	□		◆	◆		□	□
<i>Austronomus australis</i>	◆	◆	◆		◆		◆	◆		
<i>Chaerephon jobensis</i>	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
<i>Mormopterus lumsdenae</i>		◆	◆	◆	◆	◆		◆	◆	◆
<i>Mormopterus ridei</i>	◆	□	◆	□	□	◆	◆	□	◆	◆
<i>Saccolaimus flaviventris</i>	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
<i>Taphozous troughtoni</i>	◆							□		◆

References

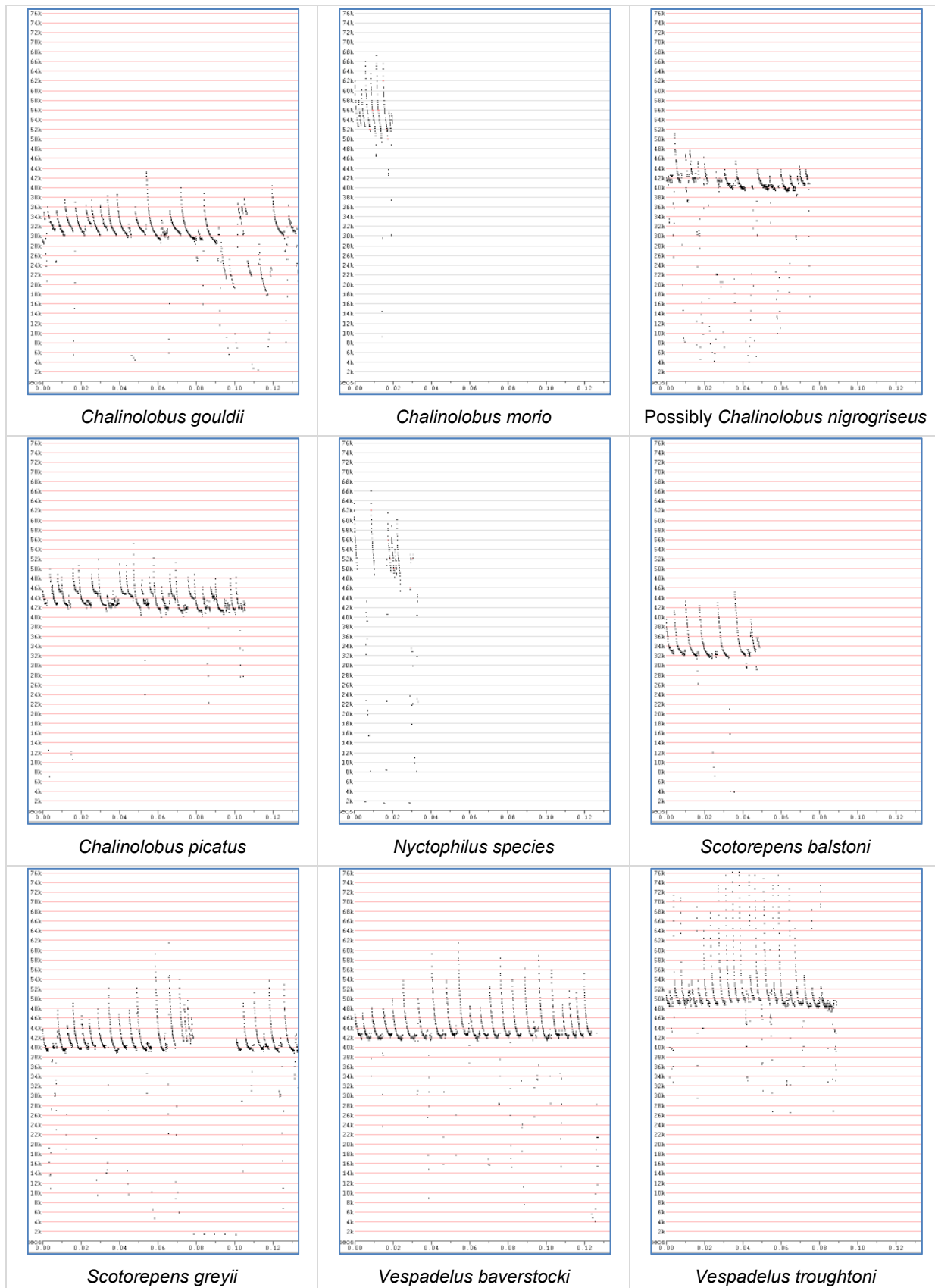
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Glossary

Technical terms used in this report are described in the following table.

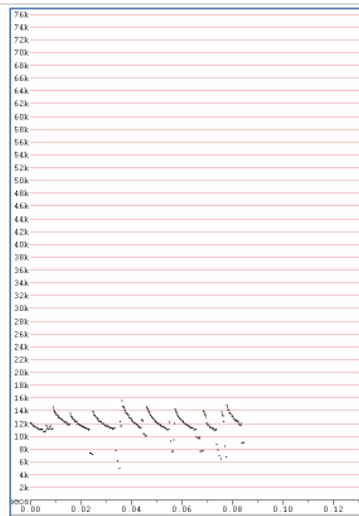
Approach phase	The part of a bat <i>call</i> emitted as the bat starts to home in on a detected prey item; a transitional series of <i>pulses</i> between the <i>search phase</i> and <i>feeding buzz</i> , that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound <i>pulses</i> in one or more <i>phases</i> (<i>search, approach, feeding buzz</i>).
CF (=Constant Frequency)	A type of <i>pulse</i> in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with <i>shape</i> appearing flat on the sonogram. Often also contains a brief <i>FM</i> component at the beginning and/or end of the CF component (<i>viz.</i> FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a <i>pulse</i> ; usually the lowest frequency reached in the <i>qCF</i> component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a <i>pulse</i> to the end of the pulse.
Feeding buzz	The terminal part of a <i>call</i> , following the <i>approach phase</i> , emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of <i>pulse</i> in which there is substantial change in frequency from beginning to end; <i>shape</i> ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the <i>characteristic frequency</i> section of <i>pulses</i> within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a <i>pulse</i> sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a <i>pulse</i> between the initial (usually steeper) frequency sweep and the <i>characteristic frequency</i> section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat <i>call</i> ; the <i>shape, duration</i> and <i>characteristic frequency</i> of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the <i>pulse</i> between the <i>knee</i> and <i>tail</i> and containing the <i>characteristic frequency</i> section.
Pulse shape	The general appearance of a <i>pulse</i> on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also <i>CF, qCF</i> and <i>FM</i> .
qCF (=quasi Constant Frequency)	A type of <i>pulse</i> in which there is very little change in frequency from beginning to end; <i>shape</i> appears to be almost flat. Some pulses also contain an <i>FM</i> component at the beginning and/or end of the qCF component (<i>viz.</i> FM-qCF).
Search phase	The part of a bat <i>call</i> generally required for reliable species diagnosis. A consistent series of <i>pulses</i> emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than <i>approach phase</i> and <i>feeding buzz</i> pulses.
Sequence	A sequence of <i>pulses</i> that may be from one or more bats; but generally refers to a <i>call</i> or part (e.g. <i>phase</i>) of a call.
Tail	The final component of a <i>pulse</i> , following the <i>characteristic frequency</i> section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

Appendix Representative call sequences recorded in the Middlemount Impact Area.
y-axis=frequency kHz; x-axis=time sec (time between pulses removed)

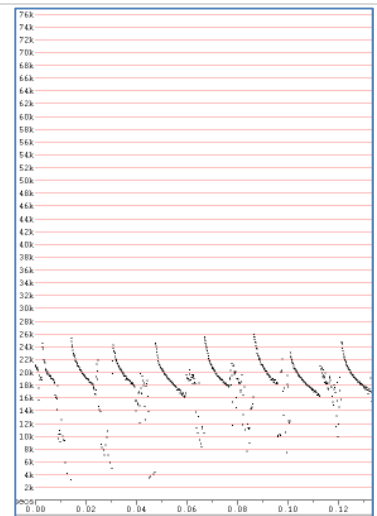




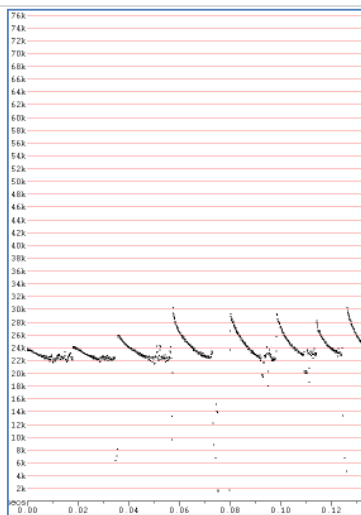
Miniopterus orianae oceanensis



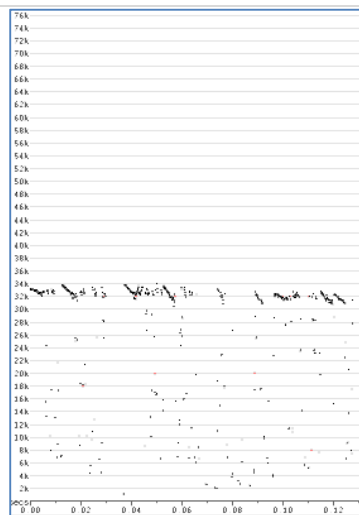
Austronomus australis



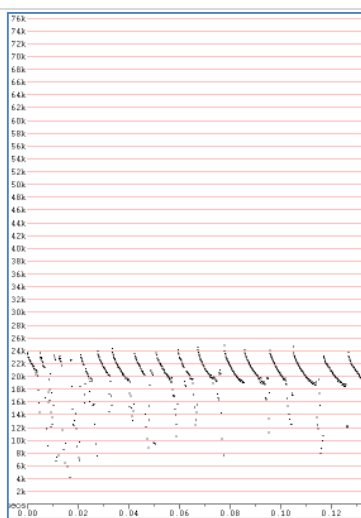
Chaerephon jobensis



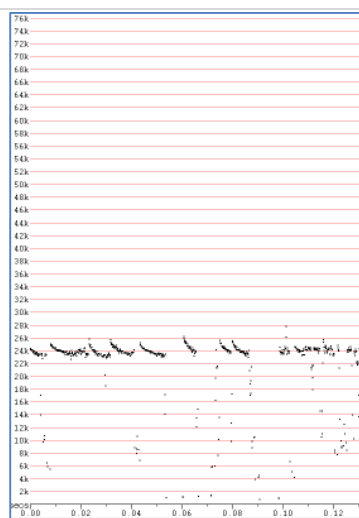
Mormopterus lumsdenae



Mormopterus ridei



Saccolaimus flaviventris



Taphozous troughoni



Microbat Call Identification Report

Prepared for ("Client"):	Naturecall Environmental
Survey location/project name:	Middlemount Area
Survey dates:	14-19 September 2017
Client project reference:	
Job no.:	NAT-1702
Report date:	4 October 2017

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Methods

Data received

The data set received for analysis included nine Anabat ZCA files, recorded by two Anabat Express detectors (Titley Scientific, Brisbane) between 14th and 19th September 2017, at four separate sites, south-west of Middelmount (Table 1).

The ZCA files were converted to Anabat call sequence files (zero-crossing analysis format) using *AnalogW* (Corben 2015). This process yielded 2345 sequence files for analysis.

Table 1. Anabat deployment details for the Middelmount survey, 14-19 September 2017.

Location	Latitude	Longitude	Detector	Date	Start time	Stop time
West-1	-22.8281	148.6299	Anabat1	14-Sep	17:30	06:30
				15-Sep	17:30	06:30
West-2	-22.8394	148.6289	Anabat1	16-Sep	17:30	06:30
				17-Sep	17:30	06:30
				18-Sep	17:30	06:30
East-1	-22.8428	148.6719	Anabat2	14-Sep	17:30	06:30
				15-Sep	17:30	06:30
East-2	-22.8468	148.6807	Anabat2	16-Sep	17:30	06:30
				17-Sep	17:30	01:34*

* Detector LOG file for Anabat2 shows "battery dead" at 01:34 AM on 18th September.

Call identification

All sequence files were viewed using *AnalogW* (Corben 2015) and a subset of files with representative samples of all call types recorded on each night by each detector was selected for detailed analysis. Species identification was achieved manually by comparing the call spectrograms of the selected calls with those of reference calls from eastern Queensland and/or with published call descriptions (e.g. Reinhold *et al.* 2001; Pennay *et al.* 2004).

Species determination was also guided by considering probability of occurrence based on published distribution maps (e.g. Churchill 2008; van Dyck *et al.* 2013) and/or online databases (e.g. *Atlas of Living Australia* <http://www.ala.org.au>).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at <http://www.ausbats.org.au/>.

Species nomenclature follows Reardon *et al.* (2015).

Results & Discussion

Most sequence files contained recognisable bats calls, although many were only brief and/or fragmented and of limited use for species identification. A total of 368 bat calls were identified, representing at least 11 and as many as 14 species (Table 2). Ten species were positively identified from at least one diagnostic call, while several call types had characteristics potentially attributable to two or more species. Such calls were allocated to species groups, with all group members considered possibly present unless they were reliably identified from other calls.

The unresolved species groups include (see Glossary for explanation of terms used):

- *Chalinolobus gouldii* / *Scotorepens balstoni* / *Mormopterus ridei*
 - Calls with predominantly curvilinear pulse shapes and characteristic frequency (Fc) in the range 29-34 kHz
 - *C. gouldii* positively identified where pulses were relatively steep and showed distinctive alternating frequency pattern
 - Calls with steep pulses at uniform frequency, and usually with more curved pulse-bodies than those attributed to *C. gouldii*, were allocated to *S. balstoni*
 - *M. ridei* was identified from calls with flatter, broader pulses at uniform frequency
 - Some calls had mixed and/or intermediate pulse shapes and/or were fragmented and could have been from any of these three species
- *Chalinolobus morio* / *Vespadelus troughtoni*
 - Calls with steep, curvilinear (FM-qCF) pulses at Fc=49-54 kHz
 - Two very brief calls were allocated to this group – one from East Location 1 and one from West Location 2
 - Each call had pulse characteristics most like *C. morio* (slanted pulse-body and down-sweeping tail), but with just one pulse per call it was not possible to reliably attribute to either species
- *Chalinolobus nigrogriseus* / *Scotorepens greyii*
 - Steep curvilinear pulses with uniform Fc around 37-39 kHz
 - Majority of relevant calls were positively attributed to *S. greyii* based on relatively narrow (short-duration) pulses with distinctively hooked pulse bodies
 - A few calls from each of the two “West” sites had slightly longer-duration pulses and straighter pulse bodies, so could have been from *C. nigrogriseus*
- *Chalinolobus picatus* / *Vespadelus baverstocki* / *Scotorepens greyii*
 - Steep curvilinear pulses with Fc ~ 39-43 kHz
 - Calls with uniform Fc at <40 kHz and hooked pulse-body were allocated to *S. greyii*
 - *V. baverstocki* identified where pulses had hooked pulses with uniform Fc >42 kHz
 - Where alternating pulse frequency was clear and pulse shape generally lacking a clear hook in the body, calls were attributed to *C. picatus*
 - Some calls had intermediate pulse shapes and/or variable (but not distinctly alternating) frequency and could have been from any of these species

- *Nyctophilus* spp.
 - Readily distinguished from other bat calls due to steep, almost-linear pulse shape
 - two *Nyctophilus* spp. potentially occur in study area (*N. geoffroyi* & *N. gouldi*), but they cannot be differentiated using call characteristics

Table 2. Microbat species recorded during the Middlemount Survey, September 2017.

◆ = at least one call from the site was attributed unequivocally to the species

□ = calls similar to those of the species were recorded, but could not be reliably identified

Detector: Location: Dates: Total sequence files: Number of calls identified:	Anabat 1 (west)		Anabat 2 (east)	
	West-1	West-2	East-1	East-2
	14-16 Sep	16-19 Sep	14-16 Sep	16-18 Sep
	1009	636	525	175
	78	168	77	45
<i>Chalinolobus gouldii</i>	◆	◆	◆	◆
<i>Chalinolobus morio</i>	□			□
<i>Chalinolobus nigrogriseus</i>	□	□		
<i>Chalinolobus picatus</i>	◆	◆	□	
<i>Nyctophilus</i> species	◆	◆	◆	
<i>Scotorepens balstoni</i>	◆	◆	□	
<i>Scotorepens greyii</i>	◆	◆	◆	◆
<i>Vespadelus baverstocki</i>	◆	◆	◆	
<i>Vespadelus troughtoni</i>	□			□
<i>Chaerephon jobensis</i>	◆	◆	◆	◆
<i>Mormopterus lumsdenae</i>	◆	◆	◆	◆
<i>Mormopterus ridei</i>	◆	◆	◆	◆
<i>Saccolaimus flaviventris</i>	◆	◆	◆	◆

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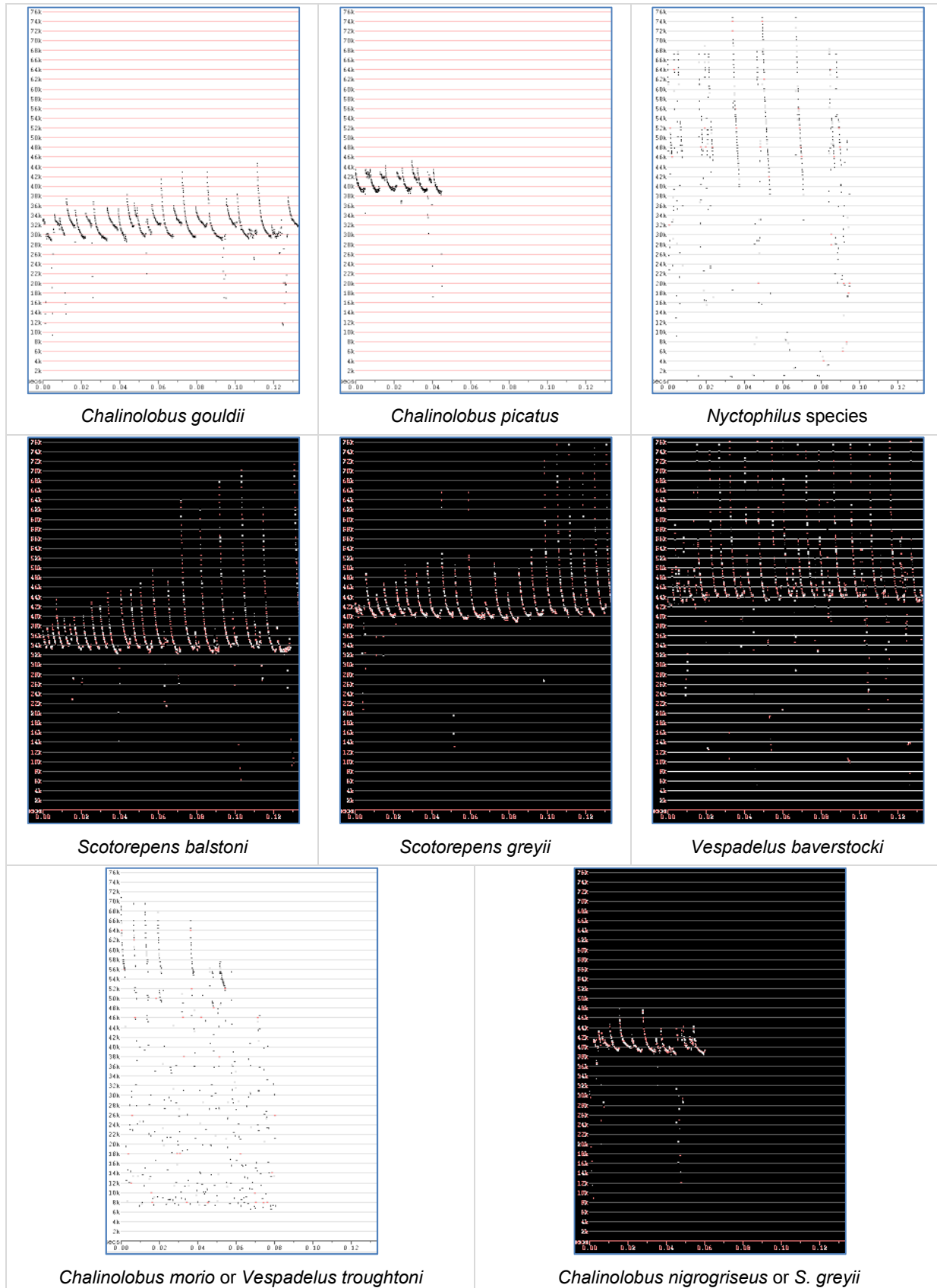
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- Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Department of Natural Resources and Mines, Brisbane.
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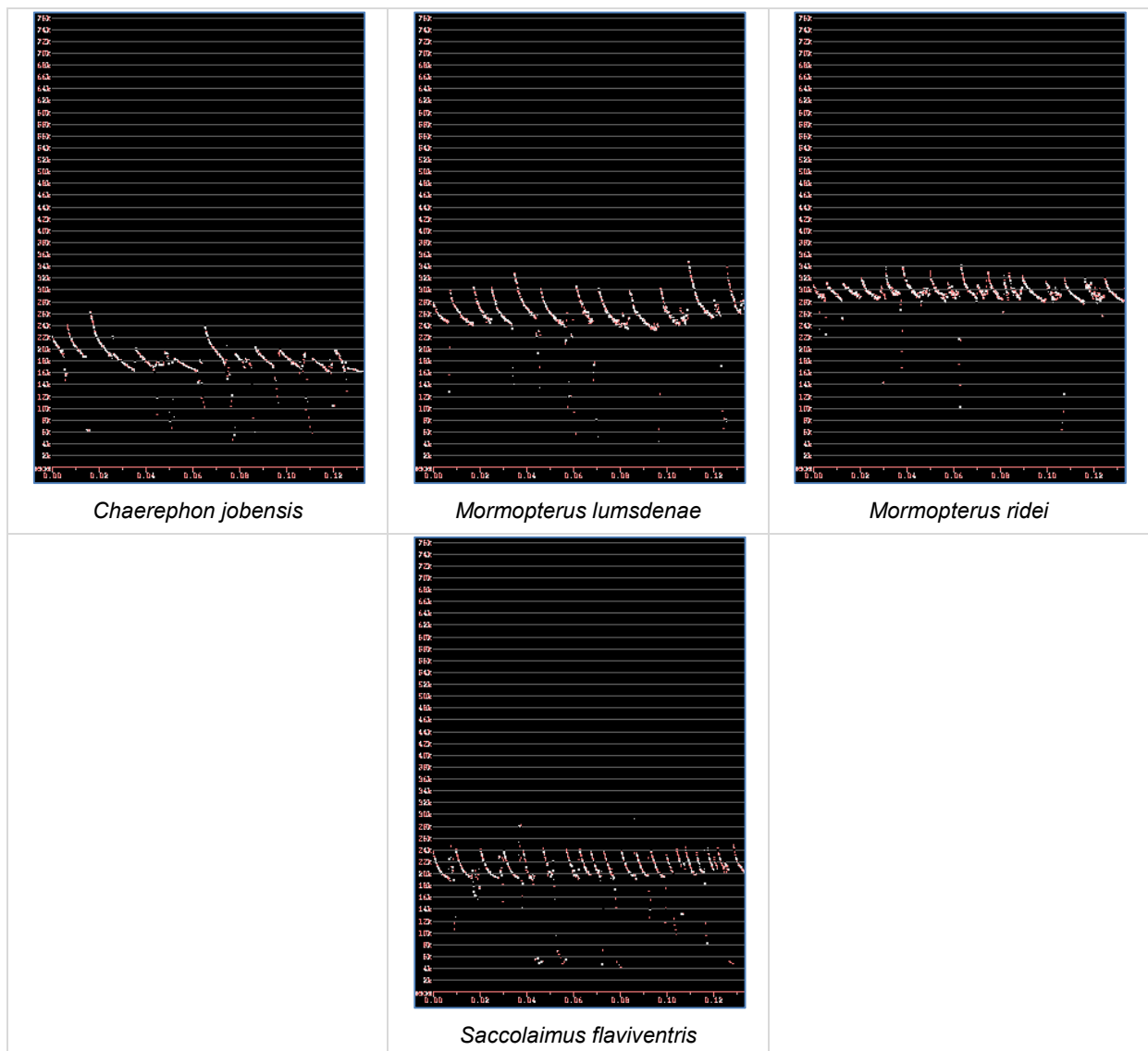
Glossary

Technical terms used in this report are described in the following table.

Approach phase	The part of a bat <i>call</i> emitted as the bat starts to home in on a detected prey item; a transitional series of <i>pulses</i> between the <i>search phase</i> and <i>feeding buzz</i> , that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound <i>pulses</i> in one or more <i>phases</i> (<i>search, approach, feeding buzz</i>).
CF (=Constant Frequency)	A type of <i>pulse</i> in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with <i>shape</i> appearing flat on the sonogram. Often also contains a brief <i>FM</i> component at the beginning and/or end of the CF component (<i>viz.</i> FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a <i>pulse</i> ; usually the lowest frequency reached in the <i>qCF</i> component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a <i>pulse</i> to the end of the pulse.
Feeding buzz	The terminal part of a <i>call</i> , following the <i>approach phase</i> , emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of <i>pulse</i> in which there is substantial change in frequency from beginning to end; <i>shape</i> ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the <i>characteristic frequency</i> section of <i>pulses</i> within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a <i>pulse</i> sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a <i>pulse</i> between the initial (usually steeper) frequency sweep and the <i>characteristic frequency</i> section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat <i>call</i> ; the <i>shape, duration</i> and <i>characteristic frequency</i> of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the <i>pulse</i> between the <i>knee</i> and <i>tail</i> and containing the <i>characteristic frequency</i> section.
Pulse shape	The general appearance of a <i>pulse</i> on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also <i>CF, qCF</i> and <i>FM</i> .
qCF (=quasi Constant Frequency)	A type of <i>pulse</i> in which there is very little change in frequency from beginning to end; <i>shape</i> appears to be almost flat. Some pulses also contain an <i>FM</i> component at the beginning and/or end of the qCF component (<i>viz.</i> FM-qCF).
Search phase	The part of a bat <i>call</i> generally required for reliable species diagnosis. A consistent series of <i>pulses</i> emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than <i>approach phase</i> and <i>feeding buzz</i> pulses.
Sequence	A sequence of <i>pulses</i> that may be from one or more bats; but generally refers to a <i>call</i> or part (e.g. <i>phase</i>) of a call.
Tail	The final component of a <i>pulse</i> , following the <i>characteristic frequency</i> section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

Appendix Representative call sequences recorded in the Middlemount survey, September 2017.
y-axis=frequency kHz; x-axis=time sec (time between pulses removed)







Appendix 14: Scat Analysis Results

Will Steggall

From: Mya Gaby
Sent: Tuesday, 3 October 2017 7:50 AM
To: Will Steggall; Karl Robertson
Subject: Fw: Scat analysis
Attachments: Invoice_280917-01.pdf

From: Trace Ecology <traceecology@gmail.com>
Sent: Thursday, September 28, 2017 4:29 PM
To: Mya Gaby
Subject: Scat analysis

Hi Mya,

I have taken a look at those scats for you. Results are as follows:

Site 1 (Drainage line): *Trichosurus vulpecula* (Common Brushtail Possum)

Site 2 (Next to road): *Phascolarctos cinereus* (Koala)

Please let me know if you require anything else.

Please find an invoice attached.

Kind regards,

Luke Foster
E: traceecology@gmail.com
M: 0423 501 384

TRACE ECOLOGY
Hair, Scat & Bone Analysis



Appendix 15: Offset Area Baseline Report

Western Extension Project

Offset Area Baseline Report

Client:

Middlemount Coal Pty Ltd

May 2018



Document Status

Version	Purpose	Author	Reviewed By	Approved By	Date
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Rev 1.0	Draft	Mya Gaby	Will Steggall	Will Steggall	19/03/2018
Rev 2.0	Final	Mya Gaby	Will Steggall	Will Steggall	03/05/2018

Document Control

Copy No.	Date	Type/Via	Issued to	Name	Purpose
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2	23/02/2018	Electronic/E-mail	Resource Strategies	Joe Fittell	Client Review
3	19/03/2018	Electronic	Naturecall Info	Clare Fitch	File Copy
4	19/03/2018	Electronic/E-mail	Resource Strategies	Joe Fittell	Client Review
5	03/05/2018	Electronic	Biodiversity Australia Info	Clare Fitch	File Copy
6	03/05/2018	Electronic/E-mail	Resource Strategies	Joe Fittell	Client Copy

Project Number: EC1687

Our Document Reference: EC1687-BEC-REPMCPLOffsetAreaBaselineReport-rev2.0

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Executive Summary

Biodiversity Australia Pty Ltd has been requested by Middlemount Coal Pty Ltd (MCPL) to undertake a baseline ecological assessment consisting of vegetation validation and terrestrial habitat quality assessments of four offset areas to be established for the Middlemount Coal Mine Western Extension Project (the Project).

The study sites are located approximately 270 kilometers (km) north-west of Rockhampton and 9 km south-west of the Middlemount Township and comprise the following areas:

1. Western Extension Commonwealth Offset Area (1) and (2)
2. Western Extension State Offset Area
3. Modified Stage 2 Commonwealth Offset Area (2) and (3)
4. Modified Rail Loop and Spur Offset Area (3a) and (3b)

Flora and fauna surveys were undertaken throughout the study sites from 18-21 July 2017 and 20-26 November 2017. Terrestrial habitat quality assessments were conducted in accordance with the *Guide to Determining Terrestrial Habitat Quality Version 1.2* at a total of 44 locations spread across the study sites. The fauna surveys comprised habitat suitability assessment, opportunistic surveys for threatened species, track, scat and secondary evidence searches, as well as, opportunistic fauna observations.

No threatened flora species were detected during the survey. Ecosystems were ground-truthed during the 2017 surveys and the Regional Ecosystem valuation process identified a total of fourteen distinct regional ecosystems across the study sites. Four of these are listed as Endangered (RE 11.3.1, RE 11.4.8, RE 11.4.9 and RE 11.4.9a) and three are listed as Of Concern (RE 11.3.2, RE 11.3.4 and RE 11.5.18) under the *Queensland Vegetation Management Act, 1999*.

The surveys also ground-truthed areas of the *Brigalow* (*Acacia harpophylla* dominant and co-dominant) threatened ecological community listed as Endangered under the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

Three threatened fauna species were recorded during the field surveys, namely the Koala, Greater Glider and Squatter Pigeon (southern). These species are listed as Vulnerable under the *Queensland Nature Conservation Act, 1992* [NC Act] and EPBC Act. A fourth threatened species, the Ornamental Snake, was also considered a potential occurrence in the study sites based on local records identified in the literature and database searches and presence of suitable habitat.

Species habitat index scores were calculated for the Squatter Pigeon (southern), Greater Glider, Koala and Ornamental Snake for each assessment unit within the Western Extension Commonwealth Offset Area. The overall Habitat Quality Scores for the four threatened fauna species within the study sites ranged between 5.90 and 7.41.



1.0 Introduction

Middlemount Coal Pty Ltd (MCPL) has lodged an amendment application to the Middlemount Coal Mine Environmental Authority (EA) EPML00716913 in accordance with section 224 of the Queensland (Qld) *Environmental Protection Act, 1994* (EP Act) to approve an extension of the Middlemount Coal Mine (Figure 1) (herein referred to as the Middlemount Coal Mine Western Extension Project [the Project]).

On 8 January 2018, the Project was referred under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (2016/7649). On 8 February 2018, a delegate of the Commonwealth Minister for the Environment declared the Action to be a 'controlled action' for the purpose of the EPBC Act due to potential adverse impacts on the following controlling provisions under Part 3 of the EPBC Act:

- sections 18 and 18A of the EPBC Act (listed threatened species and communities); and
- sections 24D and 24E of the EPBC Act (a water resource, in relation to coal seam gas development and large coal mining development).

Biodiversity Australia Pty Ltd (formerly trading as Naturecall Environmental) was commissioned by MCPL to validate vegetation and undertake terrestrial habitat quality assessments of four offset areas to be established for the Middlemount Coal Mine Western Extension Project (the Project).



2.0 Background Information

2.1. Location of the Study Sites

The study sites are located approximately 270 kilometres (km) north-west of Rockhampton and 3 km south-west of the Middlemount Township (Figure 1). They fall within in the Isaac-Comet Downs sub-region of the North Brigalow Belt Bioregion, and are within the Fitzroy catchment.

The study sites, as shown in Figure 2, comprise the following Offset Areas:

1. Western Extension Commonwealth Offset Area (1) and (2)
2. Western Extension State Offset Area
3. Modified Stage 2 Commonwealth Offset Area (2) and (3)
4. Modified Rail Loop and Spur Offset Area (3a) and (3b)

The Offset Areas are located on freehold land owned by MCPL and total approximately 1,843 hectares (ha) in area. The four Offset Areas include a combination of forested/woodland areas and cleared grazing land. The four Offset Areas are adjacent to three existing MCPL offset areas.

2.2. Study Objectives

The primary objectives of the Offset Baseline Report were to:

- ground truth Regional Ecosystems;
- providing written descriptions of the baseline health and quality of each Regional Ecosystem;
- characterise vegetation (remnant and non-remnant);
- identify and map the pre-clearing regional ecosystem of the study area (considering the Government pre-clear layer);
- identify and map any Matters of State Environmental Significance (MSES) and Matters of National Environmental Significance (MNES);
- apply the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (Department of Environment and Heritage Protection [DEHP] 2017a). to the Regional Ecosystems;
- apply the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a) to the Regional Ecosystems predicted to occur prior to clearing;
- map threatened ecological communities listed under the EPBC Act;
- map potential habitat for potentially occurring threatened species relevant to the Project (Ornamental Snake, Squatter Pigeon (southern), Koala and Greater Glider);
- apply the Habitat Quality Scoring Template to calculate the habitat quality score of the four Offset Areas; and



- undertake targeted surveys for threatened species relevant to the Project (Ornamental Snake, Squatter Pigeon (southern), Koala and Greater Glider).



Figure 1: Location of the Offset Areas

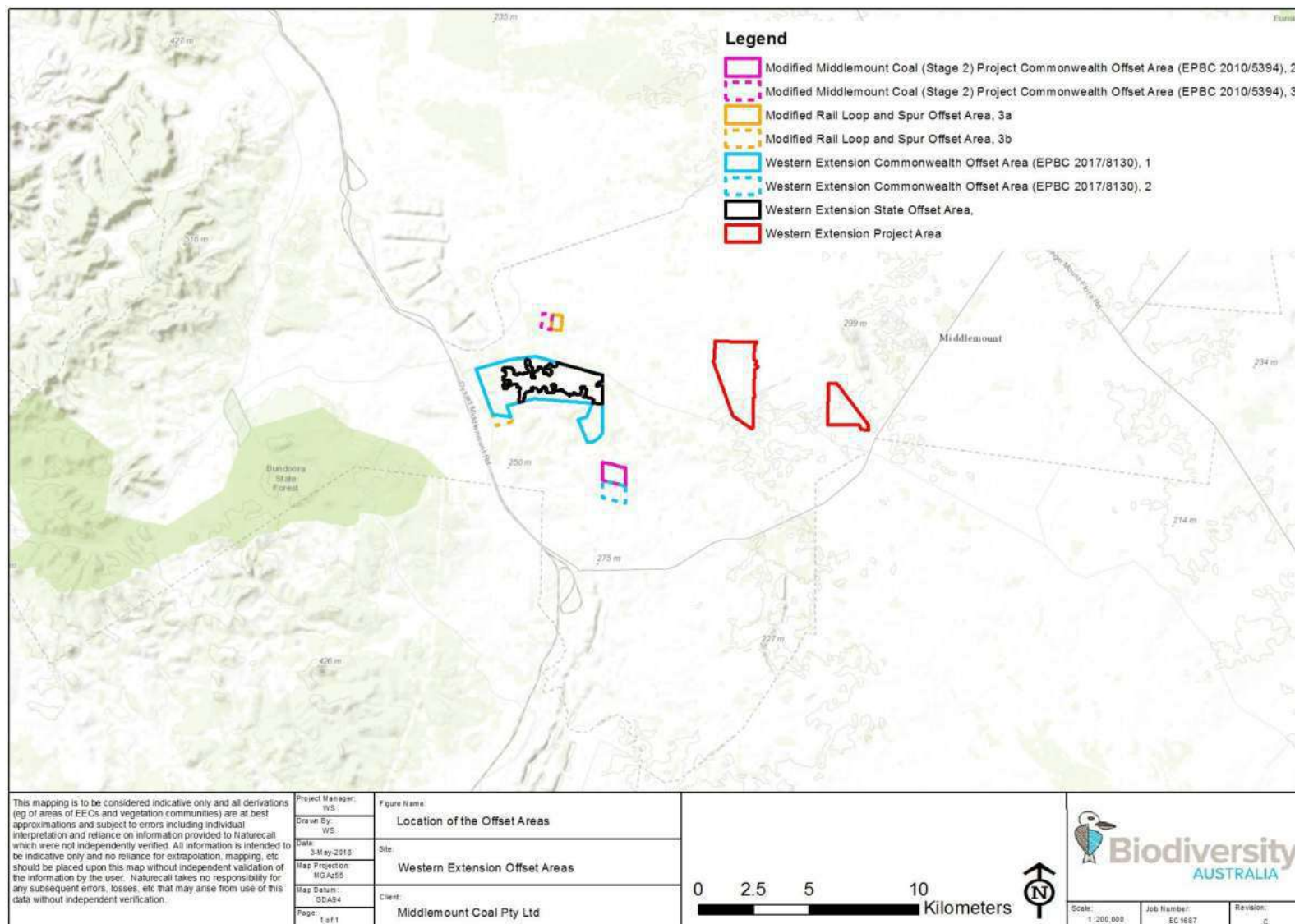
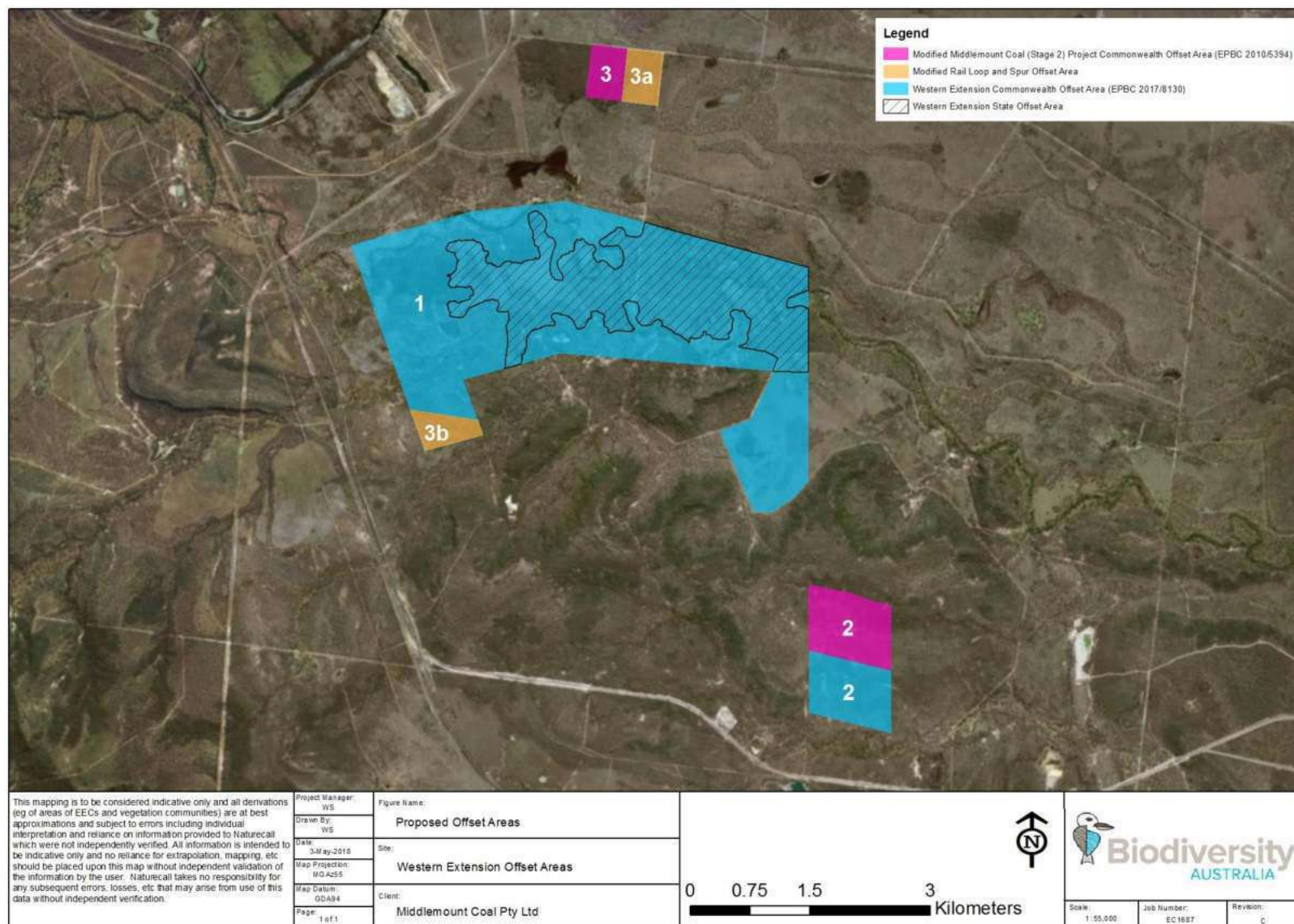




Figure 2: Offset Areas





3.0 Existing Environment

3.1. Soils, Topography and Geology

The study area comprises gently undulating lowlands with slopes ranging from <5 to 30 degrees. Elevated areas and scarp retreat zones are located in the Western Extension Commonwealth Offset Area (2) and the Modified Stage 2 Commonwealth Offset Area (2). Level and low lying areas occurring in the Modified Stage 2 Commonwealth Offset Area (3) and in the central and northern extent of the Western Extension Commonwealth Offset Area (1) along an alluvial plain associated with Roper Creek (Figure 3). The hydrological features of the study site and Roper Creek are discussed in Section 3.4.

Surface geology of the study area comprises several formations including alluvium associated with Roper Creek (clay, silt, sand and gravel), sedimentary rocks and felsites (lavas, clastics and high level intrusives) as shown in Figure 3. The dominant underlying geology is the Duaringa Formation which comprises sedimentary rocks including mudstone, sandstone, siltstone and conglomerate (Department of Natural Resources and Mines [DNRM] 2015).

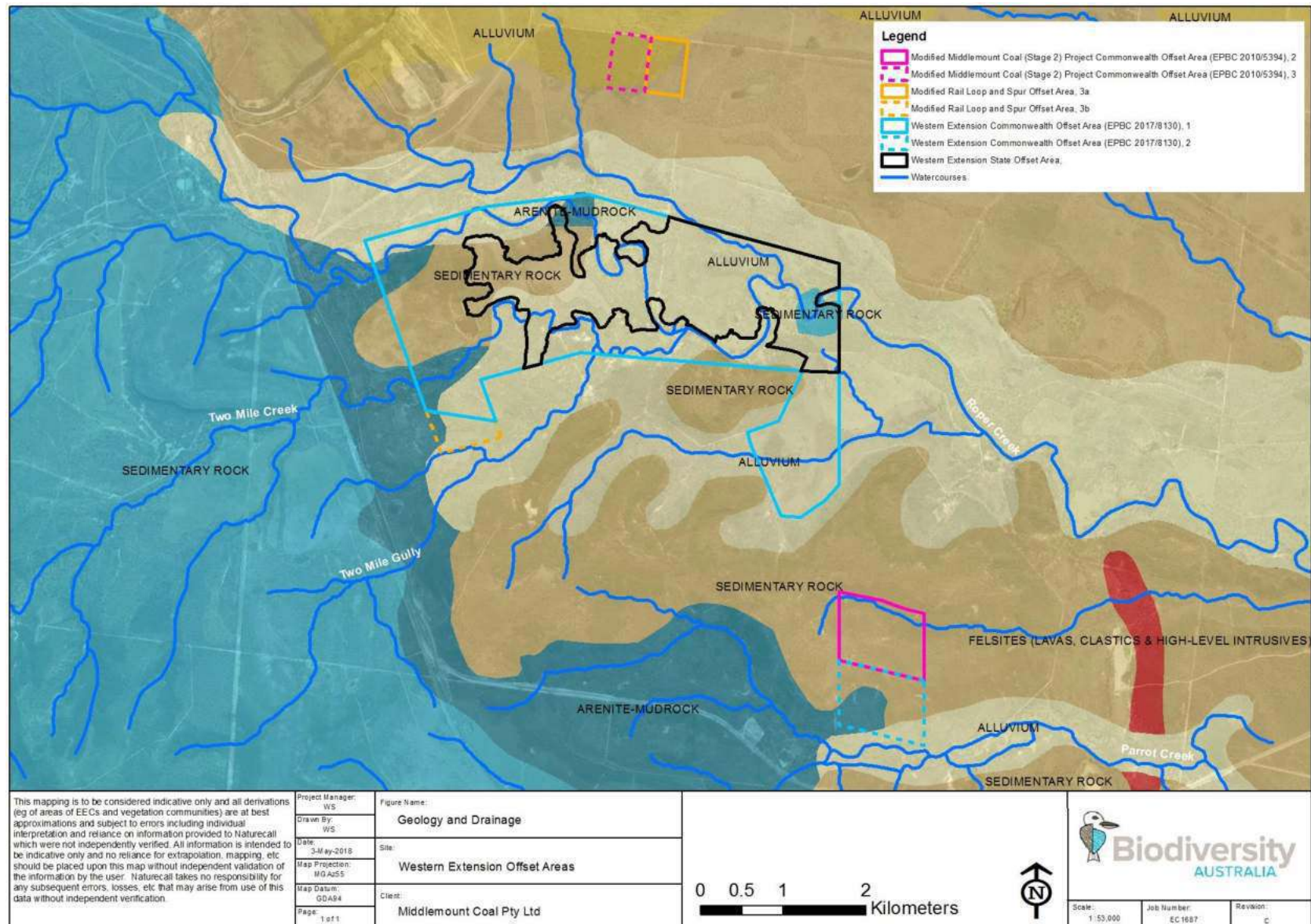
Soil types within the study sites vary widely depending on the topographic location and underlying geology. The most prevalent soil type within the study area comprise silty to sandy loams and clays.

A total of four land zones are mapped over the study sites (Wilson and Taylor 2012; Department of Science, Information Technology and Innovation [DSITI] 2017), comprising:

- Land Zone 3: Recent Quaternary alluvial systems.
- Land Zone 4: Tertiary-early Quaternary clay plains.
- Land Zone 5: Tertiary-early Quaternary loamy and sandy plains and plateaus.
- Land Zone 7: Cainozoic duricrusts.



Figure 3: Geology and Drainage





3.2. Regional Ecosystems

Existing DSITI (2017) Regional Ecosystem mapping of the Offset Areas indicates that 19 Regional Ecosystems are present (Table 1, Figure 4). This DSITI mapping was verified in the field by Biodiversity Australia in 2017.

3.3. Pre-clearing Regional Ecosystems

The Pre-clearing Regional Ecosystems digital data layer (DSITI 2017) of the non-remnant vegetation throughout the study sites indicate that 21 Regional Ecosystems formerly occurred in this area (Table 2; Figure 5). This layer was refined by Biodiversity Australia through field surveys.



Table 1: DSITI Mapped Regional Ecosystems within the study sites

Regional Ecosystem	Short Description	VMA Status	EPBC Status
11.10.12	<i>Eucalyptus populnea</i> woodland on medium to coarse-grained sedimentary rocks	LC	-
11.10.7	<i>Eucalyptus crebra</i> woodland on coarse-grained sedimentary rocks	LC	-
11.3.1/11.3.2	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains; and <i>Eucalyptus populnea</i> woodland on alluvial plains	E/OC	E
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	OC	-
11.3.2/11.3.27	<i>Eucalyptus populnea</i> woodland on alluvial plains and Freshwater wetlands	OC/LC	-
11.3.2/11.3.7	<i>Eucalyptus populnea</i> woodland on alluvial plains and <i>Corymbia spp.</i> woodland on alluvial plains	OC/LC	-
11.3.25	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	LC	-
11.3.4	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus spp.</i> woodland on alluvial plains	OC	-
11.3.4/11.3.7	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus spp.</i> woodland on alluvial plains; and <i>Corymbia spp.</i> woodland on alluvial plains	OC/LC	-
11.3.7	<i>Corymbia spp.</i> woodland on alluvial plains	LC	-
11.4.2	<i>Eucalyptus spp.</i> and/or <i>Corymbia spp.</i> grassy or shrubby woodland on Cainozoic clay plains	OC	-
11.4.8	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains	E	E
11.4.8/11.4.9	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains; and <i>Acacia harpophylla</i> shrubby woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains	E	E
11.4.9a	<i>Acacia harpophylla</i> , <i>Lysiphyllum carronii</i> +/- <i>Casuarina cristata</i> open forest to woodland.	E	E
11.5.2/11.5.2a	<i>Eucalyptus crebra</i> , <i>Corymbia spp.</i> , with <i>E. moluccana</i> on lower slopes of Cainozoic sand plains and/or remnant surfaces; and <i>Allocasuarina luehmannii</i> low tree layer with or without emergent woodland	LC	-
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	LC	-



Regional Ecosystem	Short Description	VMA Status	EPBC Status
11.5.9/11.5.3	<i>Eucalyptus crebra</i> and other <i>Eucalyptus spp.</i> and <i>Corymbia spp.</i> woodland on Cainozoic sand plains and/or remnant surfaces; and <i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	LC	-
11.7.2/11.5.18	<i>Acacia spp.</i> woodland on Cainozoic lateritic duricrust. Scarp retreat zone; and <i>Micromyrtus capricornia</i> shrubland on Cainozoic sand plains and/or remnant surfaces	LC/OC	-
11.7.2/11.7.4	<i>Acacia spp.</i> woodland on Cainozoic lateritic duricrust. Scarp retreat zone; and <i>Eucalyptus decorticans</i> and/or <i>Eucalyptus spp.</i> , <i>Corymbia spp.</i> , <i>Acacia spp.</i> , <i>Lysicarpus angustifolius</i> woodland on Cainozoic lateritic duricrust	LC	-

E – Endangered, OC – Of Concern, NC – No Concern at present, LC – Least Concern, VMA – Vegetation Management Act, EPBC –Environmental Protection and Biodiversity Conservation Act, BD Status –Biodiversity Status (according to the Queensland Government).

Source: DEHP 2017b

Table 2: Pre-clearing Regional Ecosystems mapped by DSITI within the study sites

Regional Ecosystem	Short Description	VMA Status	EPBC Status
11.10.12	<i>Eucalyptus populnea</i> woodland on medium to coarse-grained sedimentary rocks	LC	-
11.10.7/11.10.12	<i>Eucalyptus crebra</i> woodland on coarse-grained sedimentary rocks; and <i>Eucalyptus populnea</i> woodland on medium to coarse-grained sedimentary rocks	LC	-
11.3.1/11.3.2	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open-forest on alluvial plains; and <i>Eucalyptus populnea</i> woodland on alluvial plains	E/OC	-
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	OC	-
11.3.2/11.3.21	<i>Eucalyptus populnea</i> woodland on alluvial plains; and <i>Dichanthium sericeum</i> and/or <i>Astrebla spp.</i> grassland on alluvial plains. Cracking clay soils	OC/E	E
11.3.2/11.3.27	<i>Eucalyptus populnea</i> woodland on alluvial plains; and Freshwater wetlands	OC/LC	-
11.3.2/11.3.7	<i>Eucalyptus populnea</i> woodland on alluvial plains; and <i>Corymbia spp.</i> woodland on alluvial plains	OC/LC	-
11.3.25	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	LC	-
11.3.4	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus spp.</i> woodland on alluvial plains	OC	-



Regional Ecosystem	Short Description	VMA Status	EPBC Status
11.3.4/11.3.7	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus</i> spp. woodland on alluvial plains; and <i>Corymbia</i> spp. woodland on alluvial plains	OC/LC	-
11.3.7	<i>Corymbia</i> spp. woodland on alluvial plains	LC	-
11.4.2	<i>Eucalyptus</i> spp. and/or <i>Corymbia</i> spp. grassy or shrubby woodland on Cainozoic clay plains	OC	-
11.4.8	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains	E	E
11.4.8/11.4.9	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains; and <i>Acacia harpophylla</i> shrubby woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains	E	E
11.4.9a	<i>Acacia harpophylla</i> , <i>Lysiphyllum carronii</i> +/- <i>Casuarina cristata</i> open forest to woodland	E	E
11.5.2/11.5.2a	<i>Eucalyptus crebra</i> , <i>Corymbia</i> spp., with <i>E. moluccana</i> on lower slopes of Cainozoic sand plains/remnant surfaces; and <i>Allocasuarina luehmannii</i> low tree layer with or without emergent woodland	LC	-
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	LC	-
11.5.3/11.5.2a	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces; and <i>Allocasuarina luehmannii</i> low tree layer with or without emergent woodland	LC	-
11.5.9/11.5.3	<i>Eucalyptus crebra</i> and other <i>Eucalyptus</i> spp. and <i>Corymbia</i> spp. woodland on Cainozoic sand plains and/or remnant surfaces; and <i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	LC	-
11.7.2/11.5.18	<i>Acacia</i> spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone; and <i>Micromyrtus capricornia</i> shrubland on Cainozoic sand plains and/or remnant surfaces	LC/OC	-
11.7.2/11.7.4	<i>Acacia</i> spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone; and <i>Eucalyptus decorticans</i> and/or <i>Eucalyptus</i> spp., <i>Corymbia</i> spp., <i>Acacia</i> spp., <i>Lysicarpus angustifolius</i> woodland on Cainozoic lateritic duricrust	LC	-

E – Endangered, OC – Of Concern, NC – No Concern at present, LC – Least Concern, VMA – Vegetation Management Act, EPBC –Environmental Protection and Biodiversity Conservation Act, BD Status –Biodiversity Status (according to the Queensland Government).

Source: DEHP 2017b



Figure 4: DSITI Mapped Regional Ecosystems

Source: DSITI 2017

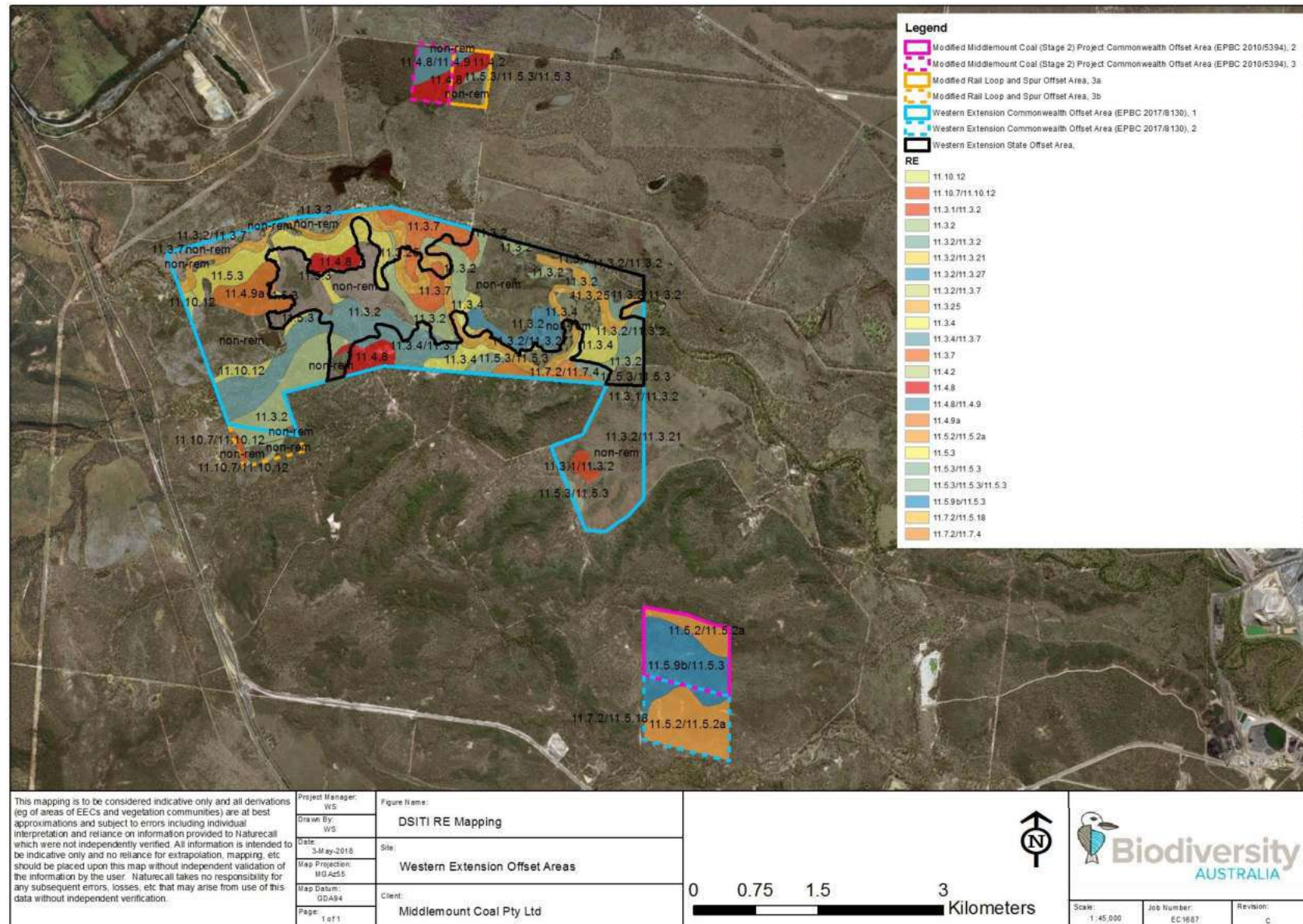
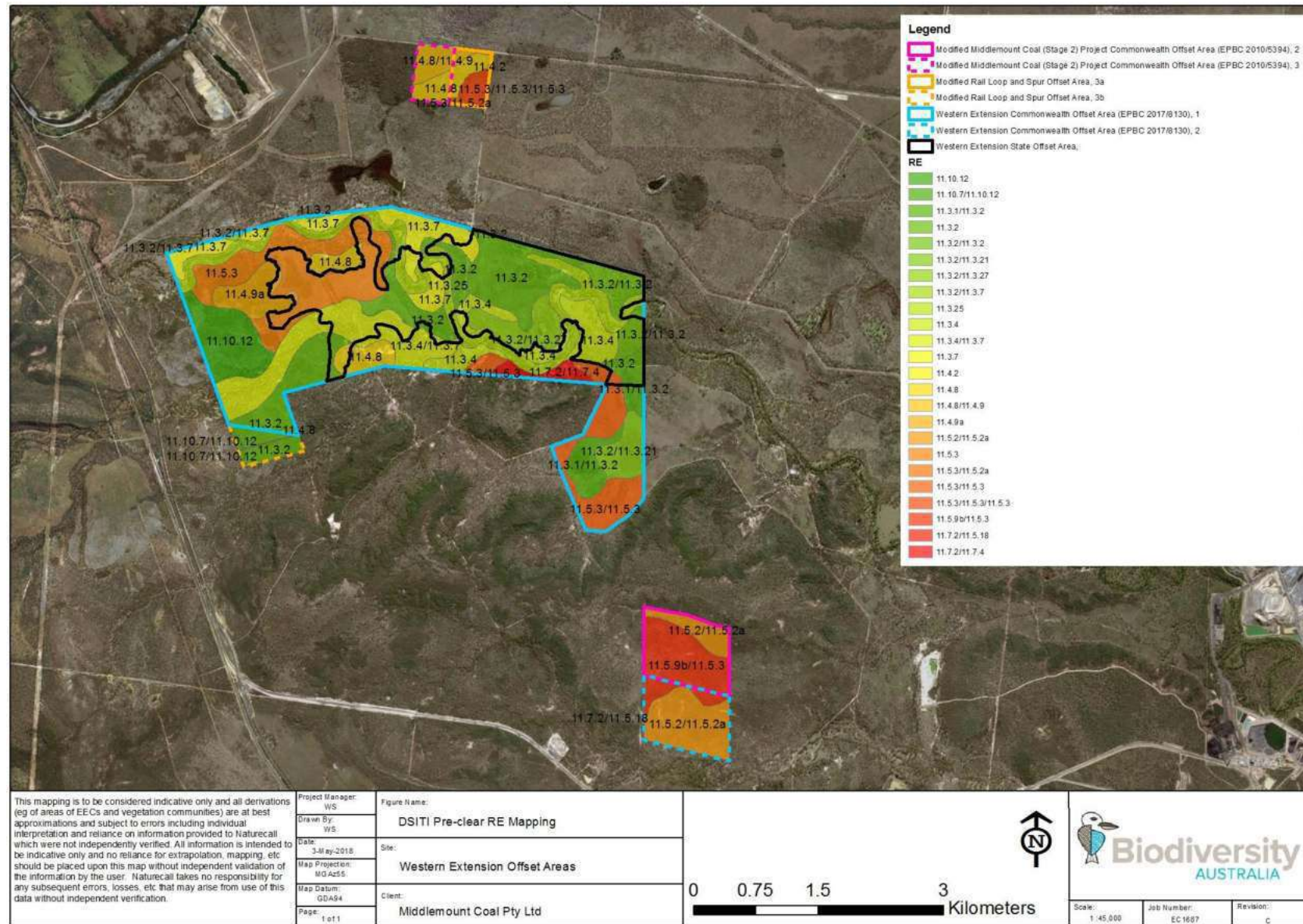




Figure 5: Mapped Pre-clearing Regional Ecosystems





3.4. Drainage Features

The study site is located in the Fitzroy River Basin which drains an area of approximately 150,000km² (DNRM 2015). The main drainage feature of the study site is Roper Creek which passes through the Western Extension Commonwealth Offset Area (1) (Figure 3). Roper Creek was found to be largely dry during the field surveys (Photo 1), however some pools remained. A number of other smaller tributaries and drainage lines flow through the Offset Areas into Roper Creek.

These watercourses are all ephemeral (i.e. flow is restricted to periods after rainfall). Whilst these watercourses were not flowing during the field surveys, recent rainfall events resulted in a number of temporary waterholes within the watercourses.

Only the Western Extension Commonwealth Offset Area (1) contains a permanent water source, comprising a large dam in the western extent of the area (Photo 2) and several smaller dams. These water sources would provide a permanent water source for native fauna and habitat for a range of bird species.

Photo 1: Section of Roper Creek





Photo 2: Permanent dam in Offset Area



3.5. Landuse and Disturbance History

The study sites do not contain any developed areas such as dwellings or farm infrastructure. The primary current landuse for the study site is beef cattle grazing, which mostly occurs along Roper Creek and other cleared areas of the Western Commonwealth Extension Offset Area (1). No other agricultural activities are conducted within the study site.

Historically, the main disturbance activities within the locality were related to land clearing associated with cattle grazing, which has occurred extensively in low-lying areas including creek flats, and clay plains. Grazing and trampling by cattle has suppressed regeneration over some cleared areas, however natural regeneration is occurring extensively throughout the study sites.

The Modified Rail Loop and Spur and Modified Stage 2 Commonwealth Offset Areas show few signs of disturbance and largely comprise remnant vegetation.

3.6. Summary of Previous Threatened Species Recorded

A number of flora and fauna surveys have been undertaken on lands surrounding the study site (Parsons Brinckerhoff [PB] 2010; Ecology and Heritage Partners [EHP] 2012, 2013a, 2013b, 2013c; Naturecall, 2013, 2014a, 2014b, 2014c, 2015, 2016, 2017a, 2017b; GHD 2012). These surveys have resulted in the detection of a number of flora and fauna species listed under the *Nature Conservation Act, 1992* (NC Act) and/or EPBC Act which include:



- *Cerbera dumicola* which is listed as 'Near Threatened' under the NC Act (PB 2010; EHP 2012; Naturecall 2016).
- Koala (*Phascolarctos cinereus*), which is listed as 'Vulnerable' under the NC Act and EPBC Act (PB 2010; Naturecall 2014b, 2016, 2017a; EHP 2012).
- Greater Glider (*Petauroides volans*), which is listed as 'Vulnerable' under the NC Act and EPBC Act (Naturecall 2014b, 2017a, 2017b).
- Squatter Pigeon (southern) (*Geophaps scripta scripta*), which is listed as 'Vulnerable' under the NC Act and EPBC Act (PB 2010; EHP 2012; Naturecall 2013, 2014a, 2014c, 2017a).
- Ornamental Snake (*Denisonia maculata*), which is listed as 'Vulnerable' under the NC Act and EPBC Act (PB 2010).



4.0 Methodology

4.1. Desktop Study and Literature Review

A desktop study was completed prior to the field survey to gather relevant information and data. The following databases and Geographic Information System (GIS) layers were searched/obtained:

- Department of the Environment and Energy (DEE) Protected Matters Search Tool (DEE 2017a) using a 2km search radius.
- DEHP Wildlife Online database (DEHP 2017c) using a 10km search radius.
- DSITI Regional Ecosystems Mapping digital data layer (DSITI 2017).
- DSITI Pre-clearing Regional Ecosystems digital data layer (DSITI 2017).

In addition to the desktop searches, the following literature was reviewed:

- *Ecological Investigations within the Offset Area for Stage 2 of the Middlemount Coal Mine, Queensland*(EHP 2012).
- *Vegetation Offsets for Middlemount Rail Spur and Loop* (EHP 2013a).
- *Vegetation Offsets for Parrot Quarry*(EHP 2013b).
- *Vegetation Offsets for Middlemount Coal Mine Thirteen Mile Gully Diversion* (EHP 2013c).
- *Middlemount Coal Mine Rail Loop and Spur Vegetation Offset Proposal* (MCPL 2013a).
- *Parrot Quarry Vegetation Offset Proposal* (MCPL 2103b).
- *Thirteen Mile Gully Diversion Vegetation Offset Proposa.* (MCPL 2013c).
- *Middlemount Coal Mine Offset Management Plan/Vegetation Management Plan* (MCPL 2013d).
- *Ecological Monitoring for Offset Area* (Naturecall 2013).
- *Ecological Assessment Report for Bingegang Pipeline Relocation, Middlemount Coal Mine* (Naturecall 2014a).
- *Ecological Monitoring for Offset Area: Use of the Offset Area by Fauna* (Naturecall 2014b).
- *Ecological Monitoring for Offset Area Year 2* (Naturecall 2014c).
- *Terrestrial Ecology Impact Assessment: Western Extension, Middlemount Coal Mine* (Naturecall 2015).
- *Vegetation Validation and Terrestrial Habitat Assessment, Middlemount Coal Mine* (Naturecall 2016).
- *Ecological Impact Assessment: Western Extension, Middlemount Coal Mine (in prep)* (Naturecall 2018).
- *Ecological Monitoring for Offset Area Year 4* (Naturecall 2017a).
- *North-eastern Extension Offset Area - Offset Baseline Report, Middlemount Coal Mine.*(Naturecall 2017b).
- *Middlemount Coal Project (Stage 2) Terrestrial Ecological Impact Assessment*(PB 2010).

Existing DSITI Regional Ecosystem mapping of the study site (Section 3.2), as well as previous mapping on adjoining land (PB 2010; EHP 2012; Naturecall 2016) was obtained and used in



conjunction with satellite imagery to identify the broad vegetation types present. This preliminary mapping assisted with survey design and allowed comparison to the floristic data collected during the survey.

4.2. Field Surveys

Field surveys were undertaken across the study site to achieve the various project objectives (see Section 2.2). The different offset areas were subject to various survey methods and effort over two survey periods from 18-21 July and 20-26 November 2017.

Field surveys over the Modified Stage 2 Commonwealth Offset Area (2) and Western Extension Commonwealth Offset Area(2) study sites were also undertaken from 9-15 June 2016 as part of the Northeast Extension Offset Area project.

A detailed summary of the methods applied to the Offset Areas is provided in the following sections.

4.2.1. Vegetation and Habitat Quality Surveys

4.2.1.1. Regional Ecosystem and Non-remnant Vegetation Verification

Vegetation surveys were initially carried out over the study site to ground truth Regional Ecosystem mapping and Pre-clearing RE mapping. This was undertaken by Biodiversity Australia Ecologists from 18-21 July 2017. Further refinement of RE mapping was undertaken during the November survey period.

Field surveys were undertaken in accordance with the *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Neldner et al. 2017). A total of 15 quaternary survey sites were carried out across the study site (Figure 6). This allowed accurate mapping of Regional Ecosystems, and validation of vegetation status (i.e. remnant/non-remnant).

The following information was recorded at each quaternary survey site:

- Date.
- Structural Code.
- Ecologically Dominant Layer (EDL)
Height.
- EDL Cover.
- Land Zone.
- Regional Ecosystem Map Unit.
- Collector/s.
- X/Y Coordinate.
- Remnant Vegetation Cover



The location of quaternary survey sites is shown in Figure 6.

4.2.1. Threatened Ecological Community Identification

Vegetation communities identified during the surveys were assessed for their conservation status under the EPBC Act, VM Act and DEHP Biodiversity Status. Brigalow communities were also assessed according to the Approved conservation advice for the Brigalow EEC (Department of the Environment, [DofE] 2013) and the Species Profile and Threats Database (DEE, 2018).

4.2.1.1. Habitat Quality Assessment

Habitat Quality Assessments were conducted throughout the study site in accordance with the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a). These surveys were carried out by Biodiversity Australia ecologists from 20-26 November 2017.

The following sections describe the procedures involved in the surveys.

Defining Assessment Units

Assessment units for the site condition assessments were defined according to the ground-truthed Regional Ecosystems. Each distinct RE was assigned as a single assessment unit as per the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a).

Sampling Sites

Based on a desktop assessment of the study site and minimum effort requirements described in the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a) a minimum of 49 plots/transects were suggested as shown in Table 3 below.

A total of 44 plots/transects were undertaken in November 2017. A geo-referenced map showing the location of survey sites is shown in Figure 6. Site selection was targeted to sample a representative coverage of the site vegetation.

As seen in Table 3 below, some assessment units had less than the suggested number of sites in the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a), yet the guidelines describe that site numbers can be reduced. This was due to the vegetation across the assessment unit being in very similar condition and not warranting additional condition assessments. In this circumstance, photographs were taken to demonstrate the similarity (streamlines sites) as allowed for in Section 4.4 of the guidelines (DEHP 2017a).

No field assessment of AU4 (RE 11.3.27d) was undertaken as it was not identified until after the field survey was carried out.


Table 3: Sampling Sites in all Offset areas

Assessment Unit	Regional Ecosystem	Area (ha)	Suggested no. of Sampling Sites	Sampling Sites Completed 2017
Western Extension Commonwealth Offset Area				
AU1	11.3.1	16.5	2	2
AU2	11.3.2	281	4	7
AU3	11.3.25	57	3	3
AU4	11.3.27d	4	2	0
AU5	11.3.4/11.3.4a	117.5	4	6
AU6	11.3.7	29	2	2
AU7	11.4.8	17	2	2
AU8	11.4.9/11.4.9a	42.5	2	4
AU9	11.5.18	4	2	1
AU10	11.5.2a	52.5	3	1
AU11	11.5.3	86.5	3	5
AU12	11.5.9	18.5	2	1
AU13	11.7.2	3	2	2
AU14	11.7.4	13.5	2	2
AU15 (Non-Rem)	11.3.1	32	2	2
AU16 (Non-Rem)	11.3.2	144	4	2
AU17 (Non-Rem)	11.3.4/11.3.4a	46	2	2
AU18 (Non-Rem)	11.3.7	13	2	1
AU19 (Non-Rem)	11.5.3	209	4	3
Western Extension State Offset Area				
AU1	11.3.1	8	2	1
AU2	11.3.2	185	4	4
AU3	11.3.25	17.5	2	1
AU4	11.3.27d	4	2	0
AU5	11.3.4/11.3.4a	17	2	2
AU6	11.5.3	8.5	2	1
AU7 (Non-Rem)	11.3.1	13.5	2	1
AU8 (Non-Rem)	11.3.2	105	4	2
AU9 (Non-Rem)	11.3.4/11.3.4a	12	2	1
AU10(Non-Rem)	11.5.3	83	3	2
Modified Commonwealth Stage 2 (a and b) Offset Area				



Assessment Unit	Regional Ecosystem	Area (ha)	Suggested no. of Sampling Sites	Sampling Sites Completed 2017
AU1	11.4.8	15.5	2	1
AU2	11.4.9	14	2	1
AU3	11.5.18	18	2	2
AU4	11.5.2a	7	2	1
AU5	11.5.3	12.5	2	1
AU6	11.5.9	47	2	2
Rail Loop and Spur (a and b) Offset Area				
AU1	11.3.2	10	2	2
AU2	11.4.8	7	2	1
AU3	11.4.9	9.0	2	1
AU4	11.5.3	6	2	2
AU5 (Non-Rem)	11.3.2	13	2	1
AU6 (Non-Rem)	11.5.3	11.5	2	2

Site Condition Assessment

The following information was recorded at each of the terrestrial habitat quality assessment sites using a combination of measured plots and transects:

- Observer, location and date.
- Regional Ecosystem (assessment unit).
- Photographic record of vegetation.
- Habitat description (e.g. presence of habitat resources for native fauna).
- Canopy and subcanopy height (measured using stick method).
- Canopy and subcanopy percentage cover.
- Native plant species richness (as a percentage) in each layer.
- Number of large trees located within a 100m x 50m plot.
- Recruitment of woody perennial species (i.e. proportion of dominant layer regenerating).
- Coarse woody debris within a 50m x 20m plot.
- Non-native plant cover percentage.
- Groundcover composition.

The values for each habitat quality attribute were recorded in the field on Biocondition data sheets (Eyre et al, 2015). This data was then added to the *Habitat Quality Scoring Template, Version 1.0* (DEHP 2014).

For Assessment Units that had multiple sampling sites the values for each attribute were totaled and then averaged in order to have one value for each attribute. This approach was confirmed



with DES. For each Assessment Unit the values recorded at the sampling sites were then compared against the relevant Regional Ecosystem benchmark data for each attribute to give an overall score for each attribute. Summing these scores determined the overall score for Site Condition for each Assessment Unit. This was all calculated through the Habitat Quality Scoring Template.

Site Context Assessment

Site context attributes were measured via desktop assessment using GIS mapping and spatial analysis as per the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a). ArcGIS Version 10.2.2 was used for all GIS mapping and spatial analysis.

This data was then added to the Habitat Quality Scoring Template which automatically compares the site context attributes to the Site Context Scoring sheet to determine the overall site context score for each Assessment Unit.

It is important to note that the “Distance to permanent watering point” was not calculated as this attribute is measured for intact Bioregions only and the Brigalow Belt Bioregion is fragmented (DEHP 2017a).

Fauna Species Habitat Assessment

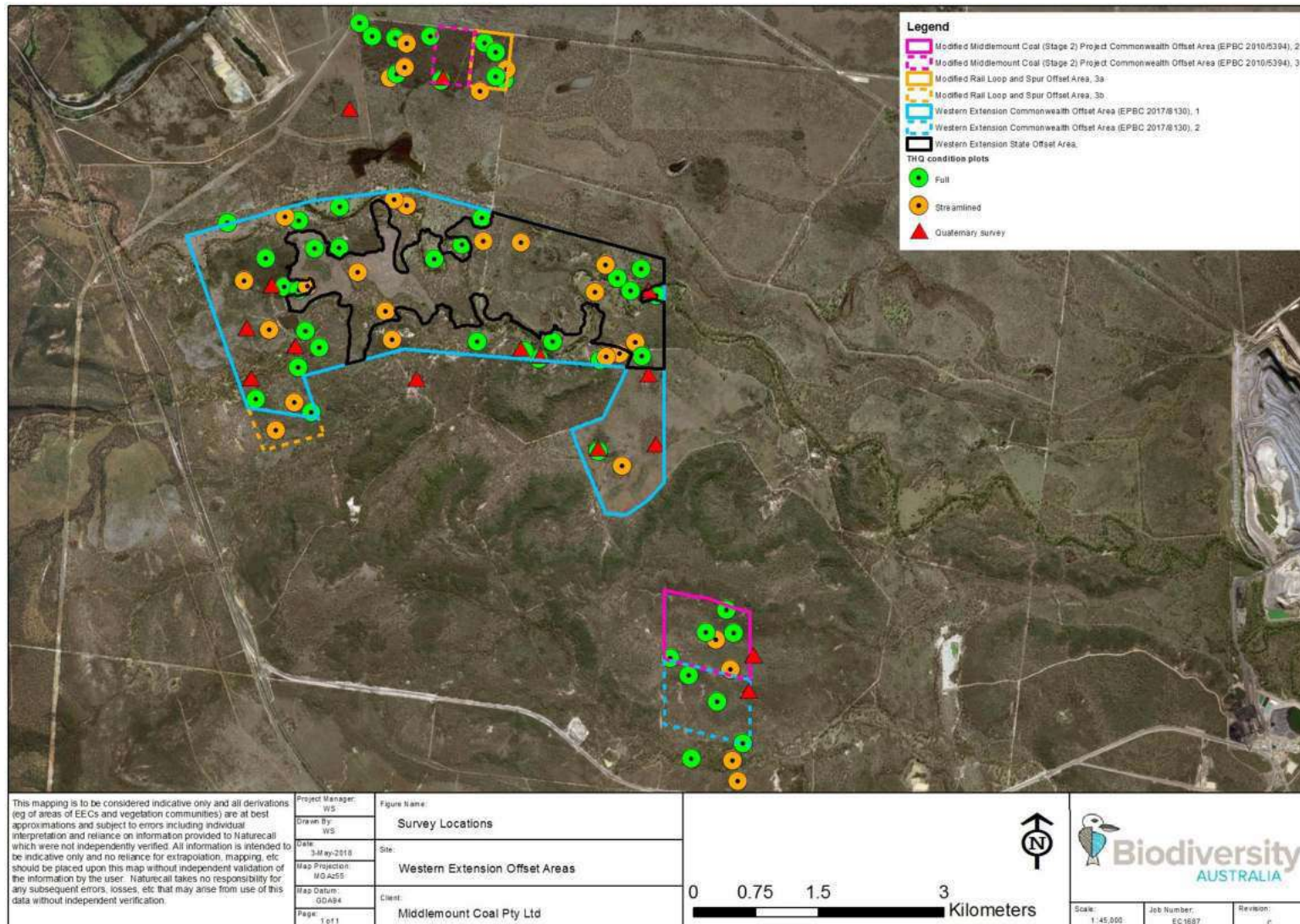
A desktop review was completed prior to the field survey to gather relevant information and data on the Squatter Pigeon (southern), Greater Glider, Koala and Ornamental Snake. Opportunistic surveys and habitat suitability assessment for the Squatter Pigeon (southern), Greater Glider, Koala and Ornamental Snake were then undertaken within the study site (See Section 4.2.2). Using the information gathered and expert knowledge of the general locality (based on previous field surveys), the Species Habitat Index scores were determined using the Species Habitat Index Scoring Guide as per the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017a).

Final Habitat Quality Score

The final Habitat Quality Score was automatically calculated within the Habitat Quality Scoring Template provided. Each of the above three indicators are scored then summed and translated to a final score out of 10, with a score of 10 representing a fully intact ecosystem and 1 representing a totally cleared area (DEHP 2017a).



Figure 6: Location of survey sites





4.2.2. Threatened Fauna Surveys

Opportunistic fauna surveys were carried out throughout the study sites during the November 2017 survey period. The surveys comprised the following:

- Habitat suitability assessment.
- Diurnal bird surveys.
- Track, scat, secondary evidence and physical habitat searches.
- Spotlighting transects
- Opportunistic fauna observations.

Further details are provided in the following sections.

4.2.2.1. Habitat Suitability Assessment

The condition and features (e.g. hollows, fallen logs, foraging resources and leaf litter) of the various habitat types within the study sites were recorded during the field surveys. Any permanent and non-permanent water sources were also recorded and photographed.

Detailed data on habitat parameters such as groundcover density and composition, vegetation structure, coarse woody debris and weed cover was collected as part of the site condition assessment described in Section 4.2.1.

4.2.2.2. Diurnal Bird Surveys

The diurnal bird surveys consisted of specific censuses of at least 30 minutes duration and were undertaken at a different location each morning during the survey period. Bird species were generally surveyed by detecting calls and searching with binoculars at specific points or along a walking transect. The surveys targeted permanent water sources, roads/tracks and other areas of suitable habitat for the Squatter Pigeon (southern).

4.2.2.3. Track, Scat ,Secondary Evidence and Physical Habitat Searches

Searches for scats and tracks were undertaken opportunistically throughout the study sites in conjunction with other surveys and when traversing between vegetation survey sites.

The sandy roads and dry creek beds within and around the study sites provided ideal locations for track searches, and any tracks found were photographed and identified using Triggs (1996) as a reference text.

Physical habitat searches of the site involved:

- Lifting of debris to search for reptiles and frogs.
- Inspection of dense vegetation for bird nests.
- Observation of likely basking sites for reptiles and frogs.



- Searching for scats, tracks, digging and scratches across the study site as they could indicate the presence of numerous native species (e.g. Koala).

4.2.2.4. Spotlighting Transects

Spotlighting was undertaken throughout the Western Extension Commonwealth Offset Area (1) over one night during the November survey period for a total of three hours.

This involved driving transects from a vehicle moving at walking pace along roads and tracks. Two hand held LED spotlights and a thermal imagery camera were utilised.

All habitat components (i.e. understory/canopy trees, dense vegetation, logs), were searched for terrestrial and arboreal fauna.



5.0 Results

5.1. Vegetation Survey Results

5.1.1. Floristics

The study sites were found to have reasonable floristic diversity, however weeds and naturalised pasture species such as Buffel Grass are present over large areas. The comprehensive flora list for the study sites is presented in Appendix 1.

A total of 115 flora species were recorded during the surveys, including 16 exotic species (Appendix 1). The highest diversity was found at less disturbed sites where an intact ground layer was present and there was less evidence of disturbance from cattle grazing.

5.1.2. Regional Ecosystems

The RE validation process identified a total of fourteen distinct regional ecosystems across the study sites. Approximately 66% of the Offset Areas (approximately 899ha) qualified as remnant vegetation¹, with the remaining 34% (approximately 469 ha) determined to be non-remnant. The following sections provide a detailed description of the ground-truthed RE mapping across the study sites.

5.1.2.1. Western Extension Commonwealth Offset Area

Table 4 details the RE's present in the Western Extension Commonwealth Offset Area (1 and 2) along with the area (in ha) and conservation status. A map of the RE's in the Western Extension Commonwealth Offset Area is provided in Figure 7.

¹ As defined by Neldner et al. (2017)


Table 4: Western Extension Commonwealth Offset Area Regional Ecosystems

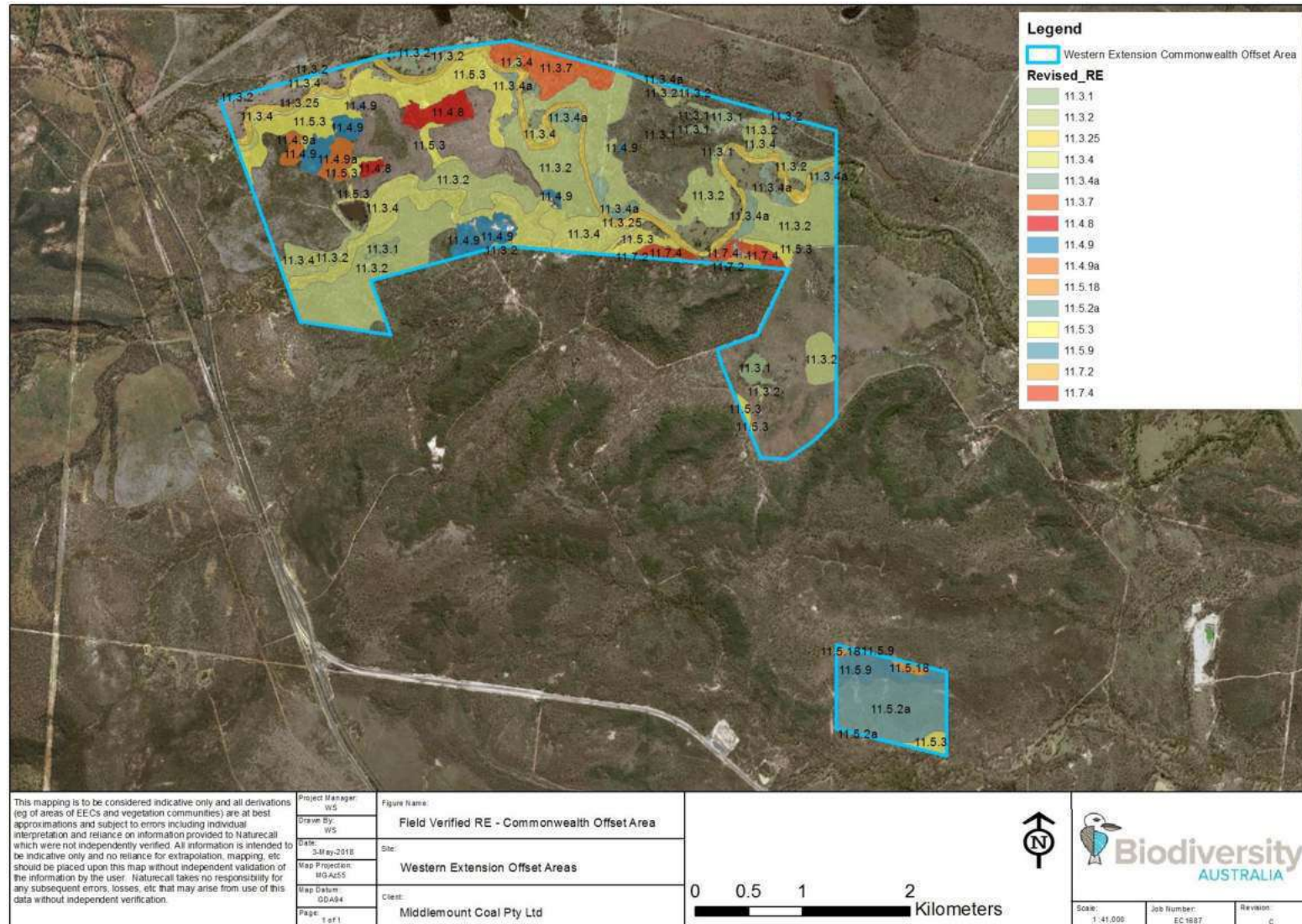
Regional Ecosystem	Short Description	Field Verified Area (ha)	VMA Status	EPBC Status
11.3.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains	16.5	E	E
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	281	OC	-
11.3.25	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	57	LC	-
11.3.27d	<i>Eucalyptus camaldulensis</i> and/or <i>E. tereticornis</i> woodland. A range of sedges and grasses occur in the ground layer including <i>Fimbristylis vagans</i> , <i>Myriophyllum striatum</i> , <i>Nitella pseudoflabellata</i> and <i>Pseudoraphis</i> sp. Occurs fringing large lakes. Palustrine wetland (e.g. vegetated swamp)	4	LC	-
11.3.4/11.3.4a	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus</i> spp. woodland on alluvial plains; and <i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	117.5	OC	-
11.3.7	<i>Corymbia</i> spp. woodland on alluvial plains	29	LC	-
11.4.8	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains	17	E	E
11.4.9/11.4.9a	<i>Acacia harpophylla</i> shrubby open forest to woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains; <i>Corymbia tessellaris</i> woodland. On alluvial sandridges to elevated levees and level terraces adjacent to larger stream channels which are irregularly flooded or possibly relict. Occurs on deep, loose neutral to alkaline red or pale uniform sand or non-sodic texture contrast soil. This unit has very low subsoil salinity in all profiles. Floodplain (other than floodplain wetlands)	42.5	E/ E	E/E
11.5.2a	<i>Allocasuarina luehmannii</i> low tree layer with or without emergent woodland	52.5	LC	-
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	86.5	LC	-
11.5.9	<i>Eucalyptus crebra</i> and other <i>Eucalyptus</i> spp. and <i>Corymbia</i> spp. woodland on Cainozoic sand plains and/or remnant surfaces	23.5	LC	-
11.5.18	<i>Micromyrtus capricornia</i> shrubland on Cainozoic sand plains and/or remnant surfaces	9	OC	-
11.7.2	<i>Acacia</i> spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	3	LC	-



Regional Ecosystem	Short Description	Field Verified Area (ha)	VMA Status	EPBC Status
11.7.4	<i>Eucalyptus decorticans</i> and/or <i>Eucalyptus spp.</i> , <i>Corymbia spp.</i> , <i>Acacia spp.</i> , <i>Lysicarpus angustifolius</i> woodland on Cainozoic lateritic duricrust	13.5	LC	-



Figure 7: Field verified Regional Ecosystems – Western Extension Commonwealth Offset Area





5.1.2.2. Western Extension State Offset Area

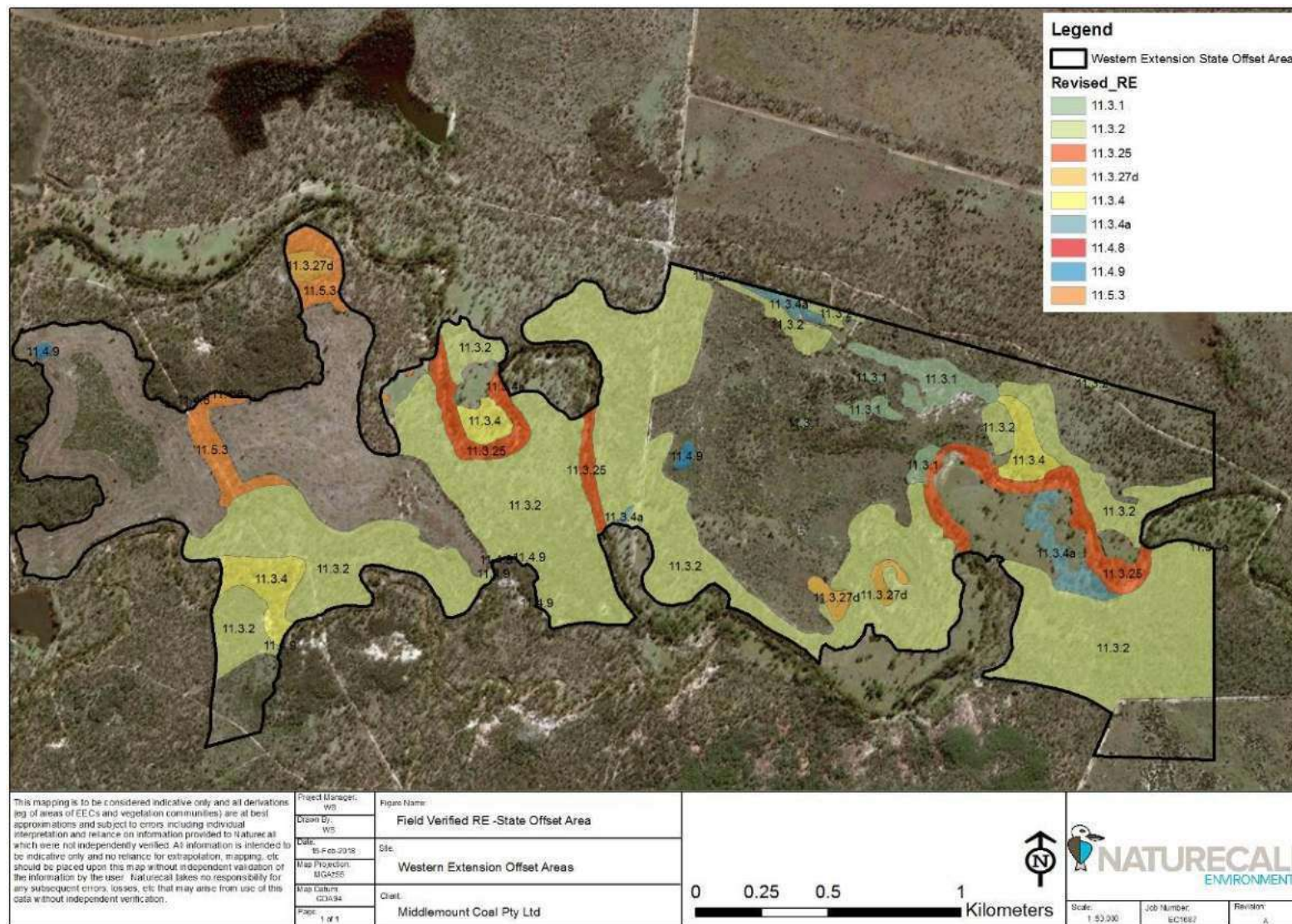
Table 5 details the RE's present in the Western Extension State Offset Area along with the area (in ha) and conservation status. A map of the RE's in the Western Extension State Offset Area is provided in Figure 8.

Table 5: Western Extension State Regional Ecosystems

Regional Ecosystem	Short Description	Field Verified Area (ha)	VMA Status	EPBC Status
11.3.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open-forest on alluvial plains	8	E	-
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	185	OC	-
11.3.25	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	17.5	LC	-
11.3.27d	<i>Eucalyptus camaldulensis</i> and/or <i>E. tereticornis</i> woodland. A range of sedges and grasses occur in the ground layer including <i>Fimbristylis vagans</i> , <i>Myriophyllum striatum</i> , <i>Nitella pseudoflabellata</i> and <i>Pseudoraphis</i> sp. Occurs fringing large lakes. Palustrine wetland (e.g. vegetated swamp).	4	LC	-
11.3.4/11.3.4a	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus</i> spp. woodland on alluvial plains; <i>Corymbia tessellaris</i> woodland. On alluvial sandridges to elevated levees and level terraces adjacent to larger stream channels which are irregularly flooded or possibly relict. Occurs on deep, loose neutral to alkaline red or pale uniform sand or non-sodic texture contrast soil. This unit has very low subsoil salinity in all profiles. Floodplain (other than floodplain wetlands)	17	OC	-
11.4.9	<i>Acacia harpophylla</i> shrubby open forest to woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains	0.5	E	E
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	8.5	LC	-



Figure 8: Field verified Regional Ecosystems – Western Extension State Offset Area





5.1.2.3. Modified Rail Loop and Spur Offset Area

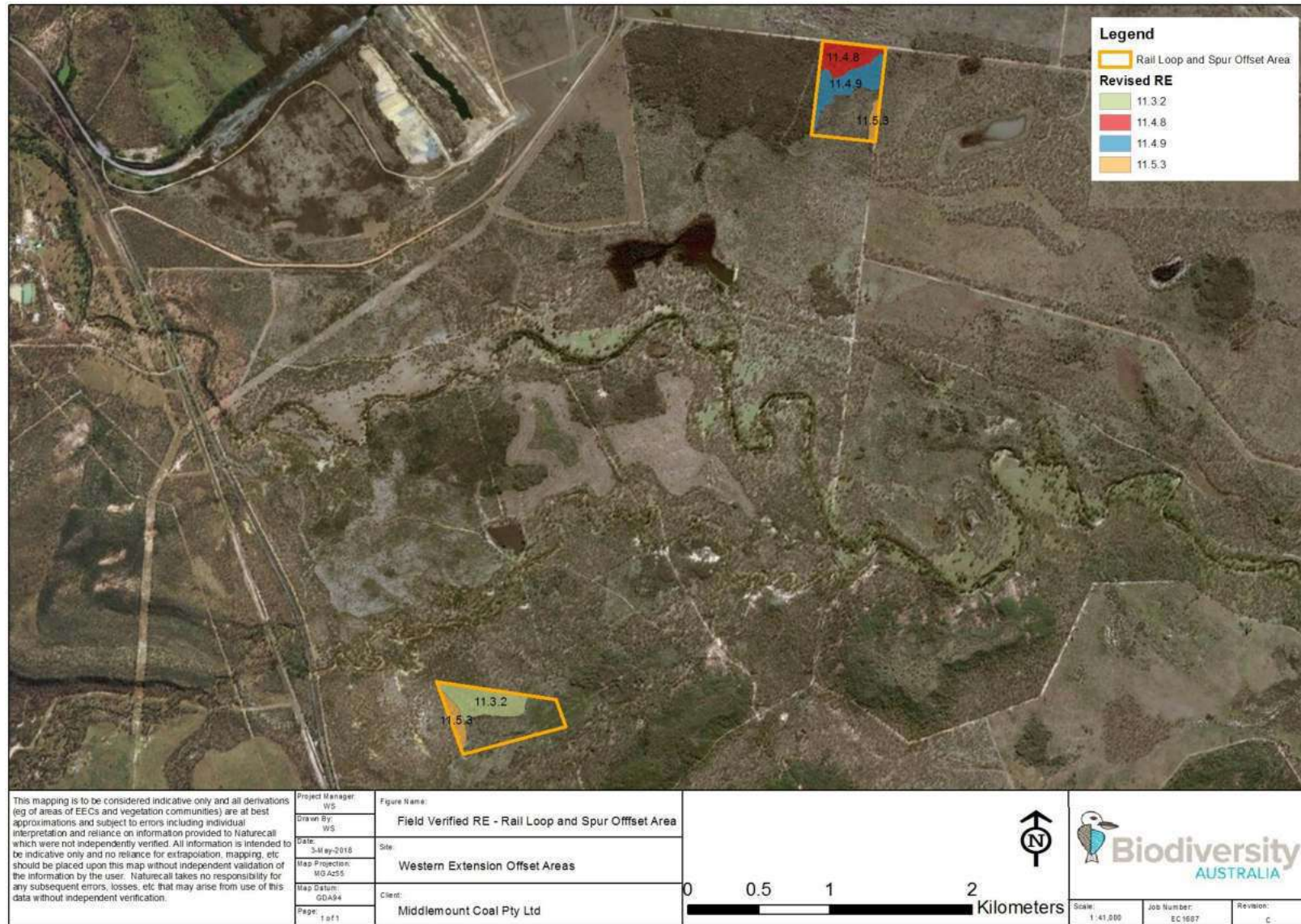
Table 6 details the RE's present in the Modified Rail Loop and Spur Offset Area (3a and 3b) along with the area and conservation status. A map of the RE's in this Offset Area is provided following the table.

Table 6: Rail Loop and Spur Offset Area Regional Ecosystems

Regional Ecosystem	Short Description	Field Verified Area (ha)	VMA Status	EPBC Status
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	10	OC	-
11.4.8	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains	7	E	E
11.4.9	<i>Acacia harpophylla</i> shrubby open forest to woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains; and <i>Acacia harpophylla</i> , <i>Lysiphyllum carronii</i> +/- <i>Casuarina cristata</i> open forest to woodland	9	E	E
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	6	LC	-



Figure 9: Field verified Regional Ecosystems – Rail Loop and Spur Offset Area





5.1.2.4. Modified Stage 2 Commonwealth Offset Area

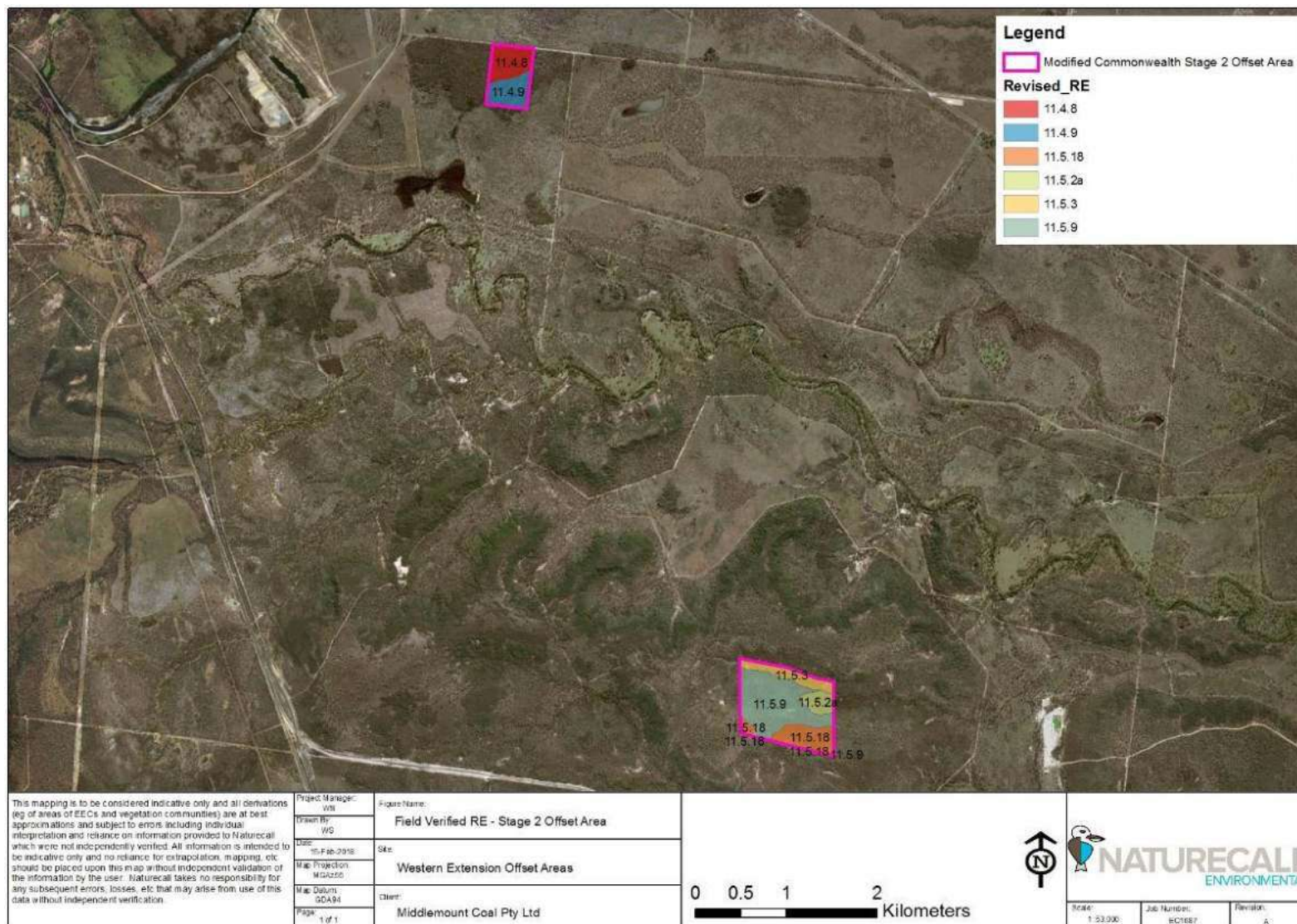
Table 7 details the RE's present in the Modified Stage 2 Commonwealth Offset Area (2 and 3) along with the area (in ha) and conservation status. A map of the RE's in the Modified Stage 2 Commonwealth Offset Area (2 and 3) is provided in Figure 10.

Table 7: Modified Stage 2 Commonwealth Offset Area Regional Ecosystems

Regional Ecosystem	Short Description	Field Verified Area (ha)	VMA Status	EPBC Status
11.4.8	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains	15.5	E	E
11.4.9	<i>Acacia harpophylla</i> shrubby open forest to woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains	14	E	E
11.5.18	<i>Micromyrtus capricornia</i> shrubland on Cainozoic sand plains and/or remnant surfaces	18	OC	-
11.5.2a	<i>Allocasuarina luehmannii</i> low tree layer with or without emergent woodland	7	LC	-
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	12.5	LC	-
11.5.9	<i>Eucalyptus crebra</i> and other <i>Eucalyptus spp.</i> and <i>Corymbia spp.</i> woodland on Cainozoic sand plains and/or remnant surfaces	47	LC	-



Figure 10: Field verified Regional Ecosystems – Modified Stage 2 Commonwealth Offset Area





5.1.3. Pre-clearing Regional Ecosystems

The Pre-clearing RE validation process refined the DSITI pre-clearing RE mapping for non-remnant areas. This identified five RE's likely to occur within non-remnant areas of the study sites which covered an area of approximately 469 ha.

The following sections identify and describe the Pre-clearing RE's identified per offset area.

5.1.3.1. Western Extension Commonwealth Offset Area

Table 8 details the Pre-clearing RE's present within non-remnant areas of the Western Extension Commonwealth Offset Area (1 and 2) along with the area (in ha) and conservation status. A map of the field verified Pre-clearing RE's in the Western Extension Commonwealth Offset Area is provided in Figure 11.

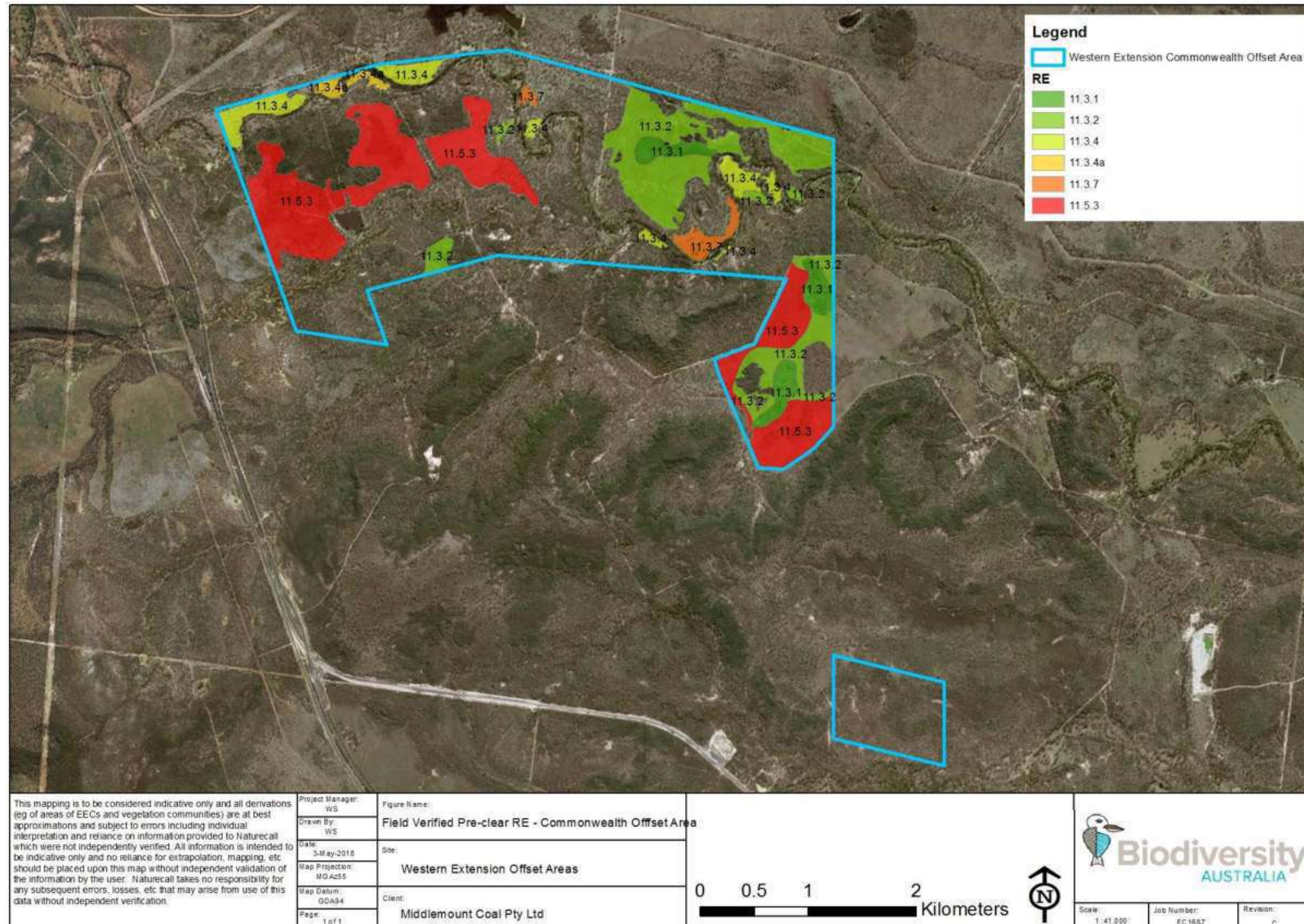


Table 8: Western Extension Commonwealth Offset Area Pre-clearing Regional Ecosystems

Regional Ecosystem (non-remnant)	Short Description	Field Verified Area (ha)	VMA Status	EPBC Status
11.3.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains	32	E	E
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	144	OC	-
11.3.4/11.3.4a	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus spp.</i> woodland on alluvial plains; <i>Corymbia tessellaris</i> woodland. On alluvial sandridges to elevated levees and level terraces adjacent to larger stream channels which are irregularly flooded or possibly relict. Occurs on deep, loose neutral to alkaline red or pale uniform sand or non-sodic texture contrast soil. This unit has very low subsoil salinity in all profiles . Floodplain (other than floodplain wetlands)	46	OC	-
11.3.7	<i>Corymbia spp.</i> woodland on alluvial plains	13	LC	-
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	209	LC	-



Figure 11: Field-verified Pre-clearing RE – Western Extension Commonwealth Offset Area





5.1.3.2. Western Extension State Offset Area

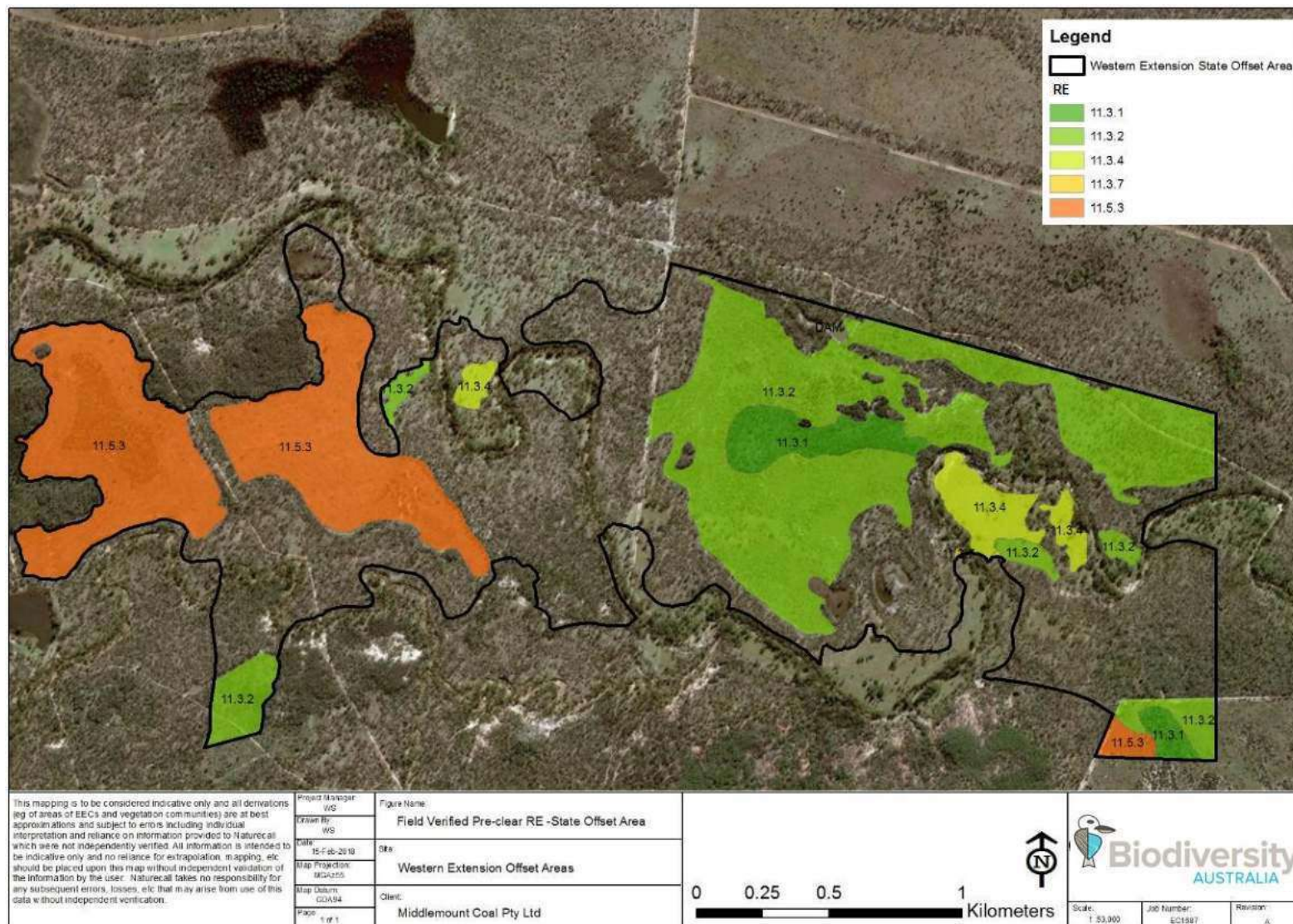
The following table (Table 9) details the Pre-clearing RE's present within non-remnant areas of the Western Extension State Offset Area along with the area (in ha) and conservation status. A map of the field verified Pre-clearing RE's in the Western Extension State Offset Area is provided in Figure 12.

Table 9: Western Extension State Offset Area Pre-clearing Regional Ecosystems

Regional Ecosystem (non-remnant)	Short Description	Field Verified Area (ha)	VMA Status	EPBC Status
11.3.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains	13.5	E	E
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	105	OC	-
11.3.4	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus spp.</i> woodland on alluvial plains	12	OC	-
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	83	LC	-



Figure 12: Field verified Pre-clearing RE – Western Extension State Offset Area





5.1.3.3. Modified Rail Loop and Spur Offset Area

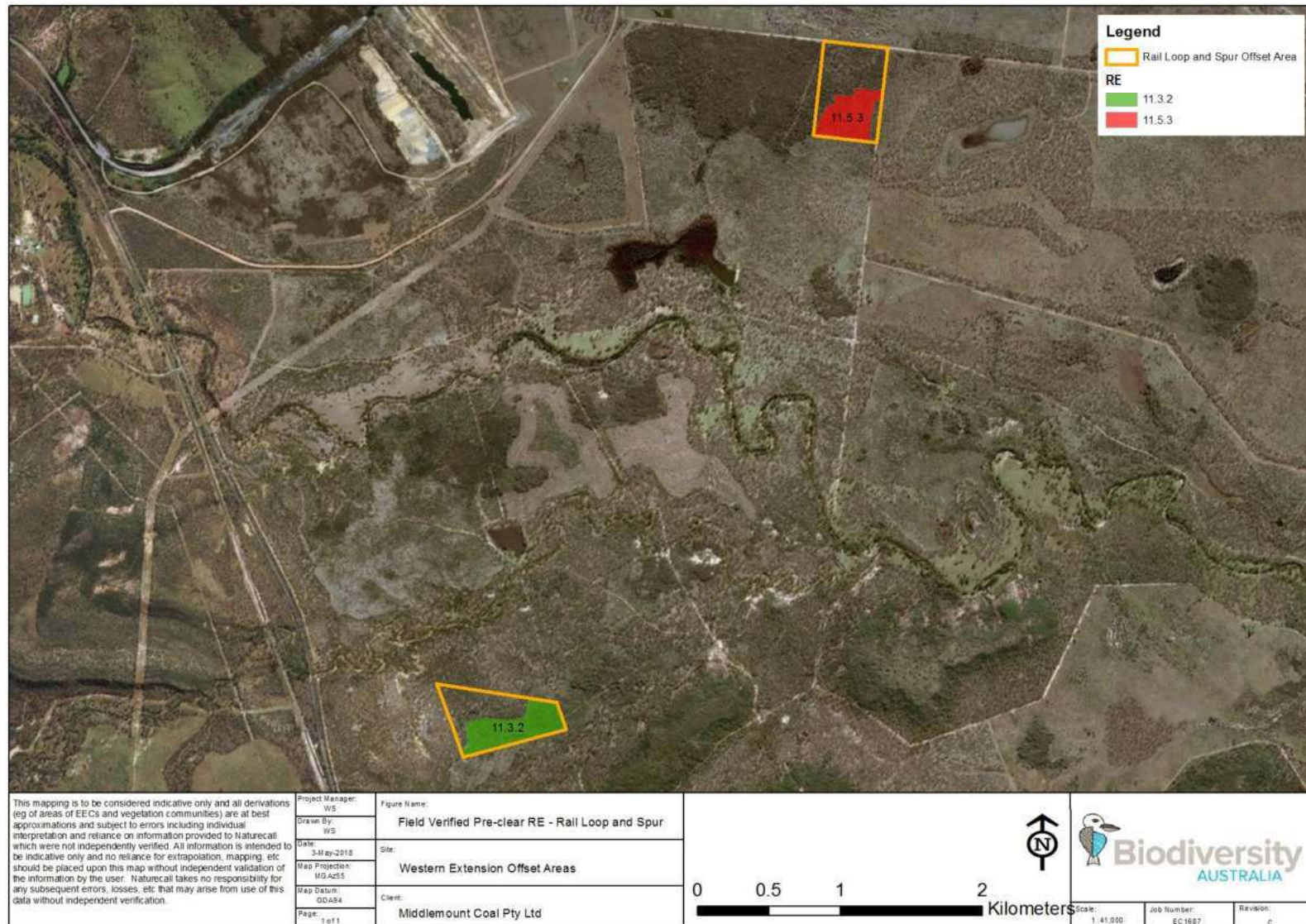
The following table (Table 10) details the Pre-clearing RE's present within non-remnant areas of the Modified Rail Loop and Spur Offset Area (3a and 3b) along with the area (in ha) and conservation status. A map of the field verified Pre-clearing RE's in the Modified Rail Loop and Spur Offset Area is provided in Figure 13.

Table 10: Rail Loop and Spur Offset Area Pre-clearing Regional Ecosystems

Regional Ecosystem (non-remnant)	Short Description	Field Verified Area (ha)	VMA Status	EPBC Status
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	13	OC	-
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	11.5	LC	-



Figure 13: Field-verified Pre-clearing RE – Modified Rail Loop and Spur Offset Area





5.1.4. Threatened Flora

The southern portions of the study sites comprising the Modified Stage 2 Commonwealth Offset Area (2) and Western Extension Commonwealth (2) Offset Areas contained potential habitat for *Cerbera dumicola*, however none were recorded during the surveys.

5.1.5. Endangered and Of Concern Regional Ecosystems

5.1.5.1. Queensland Vegetation Management Act Status

Under the VM Act, the following Endangered and Of Concern REs were identified and ground-truthed within the study sites:

Endangered Regional Ecosystems:

- RE 11.3.1 - *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.
- RE 11.4.8 - *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.
- RE 11.4.9 - *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.
- RE 11.4.9a - *Acacia harpophylla*, *Lysiphyllum carronii* +/- *Casuarina cristata* open forest to woodland.

Of Concern Regional Ecosystems:

- RE 11.3.2 - *Eucalyptus populnea* woodland on alluvial plains.
- RE 11.3.4 - *Eucalyptus tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plains.
- RE 11.5.18 - *Micromyrtus capricornia* shrubland on Cainozoic sand plains and/or remnant surfaces.

The area (in ha), of each of these communities is presented in Table 11 and their extent and location within the study sites is illustrated in Figure 14.

5.1.5.2. Environmental Protection and Biodiversity Conservation Act Status

Four Regional Ecosystems conforming to *Acacia harpophylla* dominant and co-dominant' listed as Endangered under the EPBC Act (Brigalow EEC) were identified and accurately ground-truthed during the survey. The type and area of these communities is shown in Table 11 and illustrated in Figure 15.

All of these RE types would qualify as the Brigalow EEC. There were a few small isolated patches of remnant vegetation that would not meet the minimum size threshold (<0.5ha) to qualify as the Brigalow EEC.

There are also some areas of non-remnant vegetation that have the potential to qualify as the Brigalow EEC, however these have not been mapped at this stage.


Table 11: Type and area of Brigalow EEC communities in the study sites

Revised RE	BD Status	VMA Status	EPBC Status	Area (ha)
Commonwealth				
11.3.1	Endangered	Endangered	Endangered	16.5
11.4.8	Endangered	Endangered	Endangered	17
11.4.9	Endangered	Endangered	Endangered	29
11.4.9a	Endangered	Endangered	Endangered	13.5
State				
11.3.1	Endangered	Endangered	Endangered	8
Modified Stage 2 Commonwealth (3)				
11.4.8	Endangered	Endangered	Endangered	15.5
11.4.9	Endangered	Endangered	Endangered	14
Rail Loop & Spur (3a)				
11.4.8	Endangered	Endangered	Endangered	7
11.4.9	Endangered	Endangered	Endangered	9



Figure 14: Endangered and Of Concern Regional Ecosystems Listed Under the VM Act

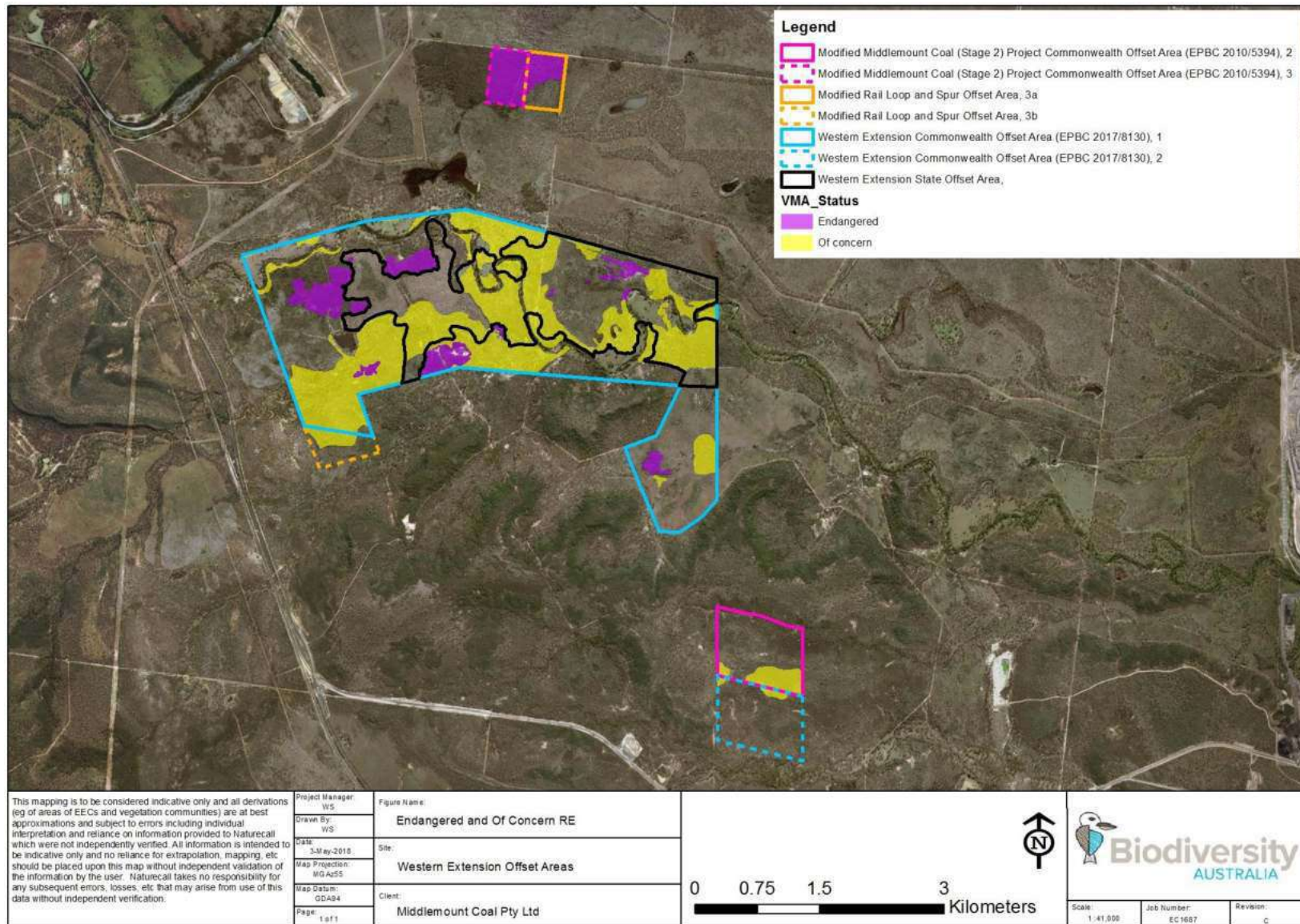
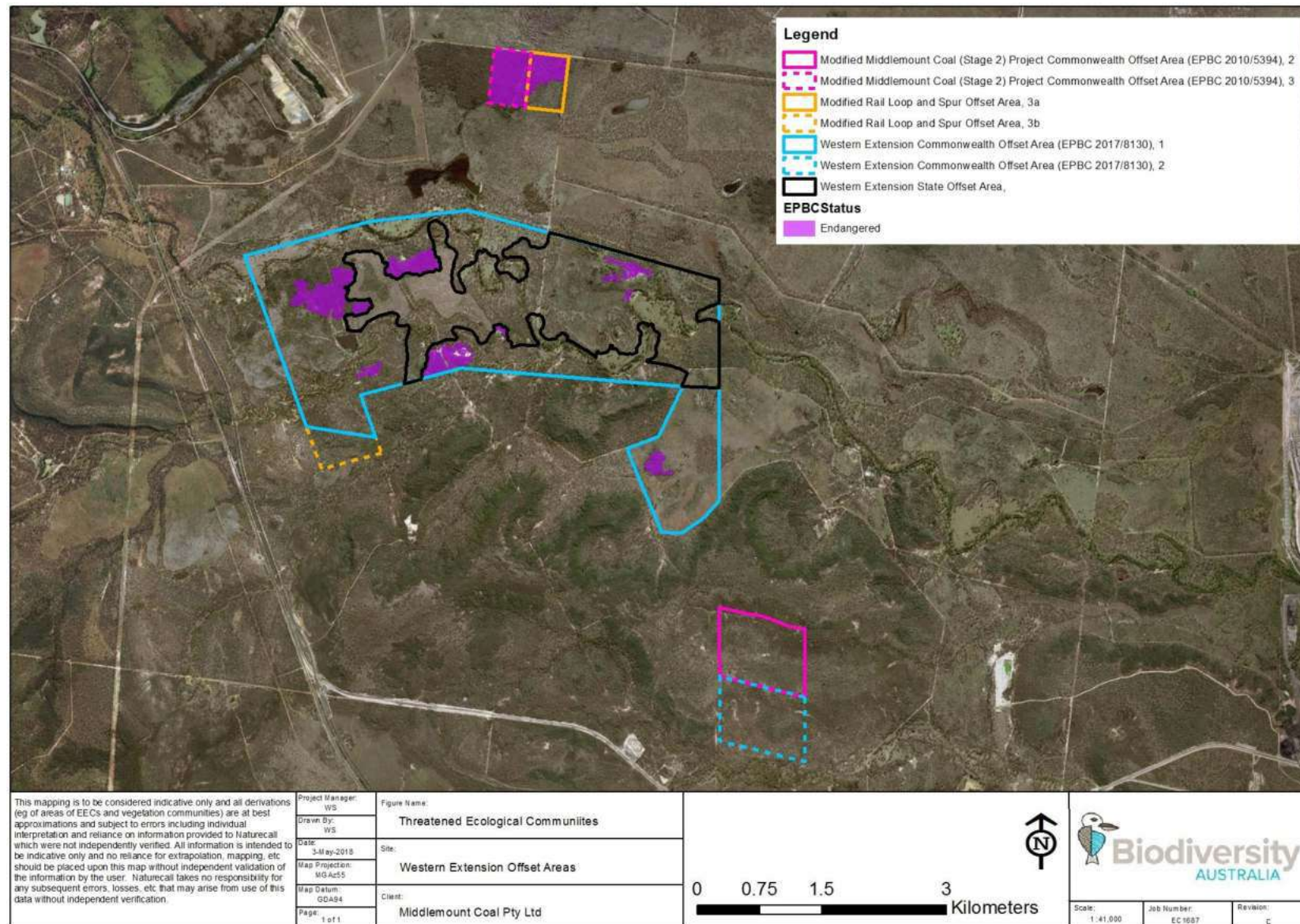




Figure 15: Threatened Ecological Communities Listed Under the EPBC Act





5.1.6. Exotic Flora Species

A total of 15 exotic flora species were recorded within the study sites. Weed invasion is common throughout, especially in disturbed areas, however it is largely limited to the groundcover stratum. Naturalised introduced pasture species such as Buffel Grass (*Cenchrus ciliaris*), Sabi Grass (*Urochloa mosambicensis*) and Red Natal Grass (*Melinis repens*) along with herbs including *Sida* spp., Cobblers Pegs (*Bidens pilosa*), Gomphrena Weed (*Gomphrena celosioides*) and Stylo (*Stylosanthes scabra*) were the main weeds encountered. These species dominated the ground layer in the derived grassland habitats, and incursion of these species into adjacent eucalypt woodlands was common.

Table 12 lists the noxious weeds declared under the *Biosecurity Act 2014* recorded within the study sites. Occasional Prickly Pear (*Opuntia elata*), Harrisia Cactus (*Harrisia martinii*) and Velvety Tree Pear (*Opuntia tomentosa*) were recorded. The noxious weed distribution of these species was patchy and these species are unlikely to pose a significant risk to the ecological integrity of the study sites due to their low density.

Table 12: Noxious Weeds Recorded Within the Study Sites

Scientific Name	Common name	Biosecurity Act Category	Weed of National Significance	Abundance
<i>Opuntia elata</i>	Prickly Pear	Class 2,3,4 and 5	Yes	Low
<i>Opuntia tomentosa</i>	Velvety Tree Pear	Class 3	Yes	Low
<i>Harrisia martinii</i>	Harrisia Cactus	Class 3	No	Low

5.1.7. Baseline Condition of Regional Ecosystems (Western Extension Commonwealth Offset Area (1 and 2) and Western Extension State Offset Area)

5.1.7.1. RE 11.3.1 – *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains

RE 11.3.1 within the Western Extension Commonwealth Offset Area (1) and Western Extension State Offset Area was dominated by *Acacia harpophylla*. Native forb species richness and number of large trees scored lower when compared to the benchmark values for this RE. Weed cover was also slightly higher than the benchmark value. However, overall the baseline health and quality of remnant RE 11.3.1 was high.

5.1.7.2. RE 11.3.2 – *Eucalyptus populnea* woodland on alluvial plains

RE 11.3.2 within the Western Extension Commonwealth Offset Area (1) and Western Extension State Offset Area was dominated by *Eucalyptus populnea*. Recruitment of woody perennial species, native grass and native forb species richness, native perennial grass cover and number of large trees all scored lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.3.2 was average.



5.1.7.3. RE 11.3.25 - *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines

Within the Western Extension Commonwealth Offset Area (1) and Western Extension State Offset Area *Eucalyptus tereticornis*, and *Casuarina cunninghamiana* dominated this RE. Roper Creek runs through part of the RE. Weed cover was high, particularly along drainage lines and this was reflected in the score for this attribute. Recruitment of woody perennial species, native shrub, grass and forb species richness, tree canopy cover, native perennial grass cover, organic litter and coarse woody debris scored lower than the benchmark values. Overall the baseline health and quality of RE 11.3.25 was average.

5.1.7.4. RE 11.3.27d - *Eucalyptus camaldulensis* and/or *E. tereticornis* woodland.

This RE comprises low lying land on a floodplain that would hold water for extended periods after rain. Tree and shrub cover is sparse and the groundcover composition is variable depending on the time of year.

A range of sedges and grasses occur in the ground layer including *Fimbristylis vagans*, *Cyperus gracilis*, *Juncus usitatus*, *Eragrostis* spp. and Swamp Ricegrass (*Leersia hexandra*). The ground layer was dry and grassy at the time of survey, however standing water and a variety of aquatic and semi-aquatic species would be present in the wet season. Weed cover was low and the main disturbance noted was trampling from cattle.

5.1.7.5. RE 11.3.4 and 11.3.4a - *Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains and *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines

RE 11.3.4 and 11.3.4a within the Western Extension Commonwealth Offset Area (1) and Western Extension State Offset Area was characterised by *Eucalyptus tereticornis* open woodlands on alluvial formations associated with Roper Creek. Previous clearing and thinning for grazing was evident in some areas. Recruitment of woody perennial species, native grass and forb species richness, tree canopy height, shrub canopy cover, native perennial grass cover and number of large trees scored lower than the benchmark values. Overall the baseline health and quality of RE 11.3.4/11.3.4a was average.

5.1.7.6. RE 11.3.7 – *Corymbia* spp. woodland on alluvial plains

RE 11.3.7 within the Western Extension Commonwealth Offset Area (1) and Western Extension State Offset Area was dominated by *Corymbia clarksoniana* and *Corymbia tessellaris*. The majority of attribute values scored slightly lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.3.7 was average.

5.1.7.7. RE 11.4.8 – *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains

Within the Western Extension Commonwealth Offset Area (1) and Western Extension State Offset Area *Acacia harpophylla* dominated this RE habitat. Weed cover was low throughout. Native forb species richness, shrub canopy cover and native perennial grass cover scored lower when



compared to the benchmark values for this RE. However, overall the baseline health and quality of RE 11.4.8 was high.

5.1.7.8. RE 11.4.9 and 11.4.9a – *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains; and *Acacia harpophylla*, *Lysiphyllum carronii* +/- *Casuarina cristata* open forest to woodland

RE 11.4.9 and 11.4.9a within the Western Extension Commonwealth Offset Area (1) and Western Extension State Offset Area was dominated by *Acacia harpophylla* and *Casuarina cristata*. Native shrub and forb species richness, tree canopy cover, shrub canopy cover and native perennial grass cover scored lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.4.9 and 11.4.9a was average.

5.1.7.9. RE 11.5.18 – *Micromyrtus capricornia* shrubland on Cainozoic sand plains and/or remnant surfaces

The shrub *Micromyrtus capricornia* was the dominant species in this RE. The groundcover comprises an intact layer of native grasses. Weed cover was very low throughout. The majority of attribute values scored slightly lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.5.18 was average.

5.1.7.10. RE 11.5.2a – *Allocasuarina luehmannii* low tree layer with or without emergent woodland

Allocasuarina luehmannii (Bull Oak) was the dominant species throughout this RE. The RE featured very low weed cover. Recruitment of woody perennial species, native tree and grass species richness, tree canopy cover, shrub canopy cover, native perennial grass cover and coarse woody debris scored lower than the benchmark values. Overall the baseline health and quality of RE 11.5.2a was average.

5.1.7.11. RE 11.5.3 - *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces

RE 11.5.3 within the Western Extension Commonwealth Offset Area (1 and 2) and Western Extension State Offset Area was dominated by *Eucalyptus populnea*. The remnant Poplar Box woodland was in good condition. Recruitment of woody perennial species, native shrub and forbs species richness, shrub canopy cover, native perennial grass cover and organic litter scored lower than the benchmark values in some areas. Overall the baseline health and quality of RE 11.5.3 was average when compared to the benchmark.

5.1.7.12. RE 11.5.9 - *Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces

Few weeds were present and a high number of tree species were recorded within RE 11.5.9. *Eucalyptus crebra* was the dominant canopy species within this RE. Recruitment of woody perennial species was significantly lower than the benchmark value. Overall the baseline health and quality of RE 11.5.9 was average which was reflected in the habitat quality scoring.



5.1.7.13. RE 11.7.2 - *Acacia* spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone

Within the Western Extension Commonwealth Offset Area (1), *Acacia shirleyi* (Lancewood) characterised this RE, with mono specific stands present throughout. Native shrub, grass and forbs species richness, tree canopy cover, shrub canopy cover, organic litter and coarse woody debris scored lower than the benchmark values. Overall the baseline health and quality of RE 11.7.2 was average.

5.1.7.14. RE 11.7.4 - *Eucalyptus decorticans* and/or *Eucalyptus* spp., *Corymbia* spp., *Acacia* spp., *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust

The remnant woodland within RE 11.7.4 was dominated by *Eucalyptus crebra*. Native tree species were diverse with 18 species recorded. Ground cover was dominated by grasses with low levels of coarse woody debris present. Overall the baseline health and quality of RE 11.7.4 was average.

5.1.7.15. Non-remnant Vegetation

According to Neldner et al. (2017):

“Woody vegetation is vegetation for which the predominant stratum is composed mainly of woody vegetation such as trees or shrubs. The Herbarium assesses and maps woody dominated vegetation as remnant if it meets the definition used in the Vegetation Management Act 1999, which is:

vegetation, part of which forms the predominant canopy of the vegetation—

(a) covering more than 50% of the undisturbed predominant canopy; and

(b) averaging more than 70% of the vegetation’s undisturbed height; and

(c) composed of species characteristic of the vegetation’s undisturbed predominant canopy.”

The field surveys indicated that approximately 444 ha of the Western Extension Commonwealth Offset Area (1) and approximately 213.5 ha of the Western Extension State Offset Area did not meet this definition and as such is mapped as non-remnant vegetation. These areas have been previously cleared, are grazed by cattle and displayed high levels of weed invasion, however the majority of weeds were naturalized pasture grasses.

Overall, regrowth Eucalypts and Acacias were the most common of these trees recorded in non-remnant area while *Corymbia* species were only occasionally present.

Despite this, it was noted that these areas displayed positive signs of natural regeneration.



5.1.8. Baseline Condition of Regional Ecosystems (Modified Stage 2 Commonwealth Offset Area 2 and 3)

5.1.8.1. RE 11.4.8 – *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains

Within the Modified Stage 2 Commonwealth Offset Area (3) *Acacia harpophylla* dominated RE 11.4.8. The majority of attributes for RE 11.4.8 scored lower when compared to the benchmark value. The overall baseline health and quality of RE 11.4.8 was average.

5.1.8.2. RE 11.4.9– *Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains

RE 11.4.9 within the Modified Stage 2 Commonwealth Offset Area (3) was dominated by *Acacia harpophylla* and *Casuarina cristata*. The majority of attributes for RE 11.4.9 scored lower when compared to the benchmark value. Overall the baseline health and quality of RE 11.4.9 was average.

5.1.8.3. RE 11.5.18 – *Micromyrtus capricornia* shrubland on Cainozoic sand plains and/or remnant surfaces

Within the Modified Stage 2 Commonwealth Offset Area (2) *Micromyrtus capricornia* dominated RE 11.5.18. Weed cover was very low throughout. The majority of attribute values scored slightly lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.5.18 was average.

5.1.8.4. RE 11.5.2a –*Allocasuarina luehmannii* low tree layer with or without emergent woodland

Allocasuarina luehmannii (Bull Oak) was the dominant species throughout RE 11.5.2a. The RE featured very low weed cover. Recruitment of woody perennial species, native tree and grass species richness, tree canopy cover, shrub canopy cover, native perennial grass cover and coarse woody debris scored lower than the benchmark values. Overall the baseline health and quality of RE 11.5.2a was average.

5.1.8.5. RE 11.5.3 - *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces

Few weeds were present and a high number of tree species were recorded within RE 11.5.3, with *Eucalyptus populnea* being the dominant species recorded. Recruitment of woody perennial species, native shrub, grass and forbs species richness, tree and shrub canopy cover and organic litter scored lower than the benchmark values. Overall the baseline health and quality of RE 11.5.3 was average when compared to the benchmark.



5.1.8.6. RE 11.5.9 - *Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces

Eucalyptus crebra was the dominant canopy species within RE 11.5.9. The majority of attribute values scored slightly lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.5.9 was average which was reflected in the habitat quality scoring.

5.1.9. Baseline Condition of Regional Ecosystems (Modified Rail Loop and Spur Offset Area 3a and 3b)

5.1.9.1. RE 11.3.2 – *Eucalyptus populnea* woodland on alluvial plains

RE 11.3.2 within the Modified Rail Loop and Spur Offset Area (3b) was dominated by *Eucalyptus populnea*. Recruitment of woody perennial species, native grass and native forb species richness, shrub canopy cover and native perennial grass cover all scored lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.3.2 was average.

5.1.9.2. RE 11.4.8 – *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains

Within the Modified Rail Loop and Spur Offset Area (3a), *Acacia harpophylla* dominated RE 11.4.8. Weed cover was low throughout. The majority of attribute values scored slightly lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.4.8 was average.

5.1.9.3. RE 11.4.9– *Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains

RE 11.4.9 within the Modified Rail Loop and Spur Offset Area (3a) was dominated by *Acacia harpophylla* and *Casuarina cristata*. Recruitment of woody perennial species, native shrub and forb species richness, tree and shrub canopy cover, native perennial grass cover and coarse woody debris all scored lower when compared to the benchmark values for this RE. Overall the baseline health and quality of RE 11.4.9 was average.

5.1.9.4. RE 11.5.3 - *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces

RE 11.5.3 within this study site was dominated by *Eucalyptus populnea*. Recruitment of woody perennial species, native shrub, grass and forbs species richness, tree and shrub canopy cover and native perennial grass cover scored lower than the benchmark values. Overall the baseline health and quality of RE 11.5.3 was average when compared to the benchmark.

5.1.9.5. Non-remnant Vegetation

According to Neldner et al. (2017):

“Woody vegetation is vegetation for which the predominant stratum is composed mainly of woody vegetation such as trees or shrubs. The Herbarium assesses and maps woody dominated



vegetation as remnant if it meets the definition used in the Vegetation Management Act 1999, which is:

vegetation, part of which forms the predominant canopy of the vegetation—

(a) covering more than 50% of the undisturbed predominant canopy; and

(b) averaging more than 70% of the vegetation's undisturbed height; and

(c) composed of species characteristic of the vegetation's undisturbed predominant canopy.”

The field surveys indicated that approximately 25 ha of the Rail Loop and Spur Offset Area (3a and 3b) did not meet this definition and as such is mapped as non-remnant vegetation. These areas have been previously cleared, are grazed by cattle and displayed high levels of weed invasion, however the majority of weeds were naturalized pasture grasses.

Overall, regrowth Eucalypts and Acacias were the most common of these trees recorded in non-remnant area while *Corymbia* species were only occasionally present.

Despite this, it was noted that these areas displayed positive signs of natural regeneration.

5.2. Habitat Quality Assessment (Western Extension Commonwealth Offset Area 1 and 2)

Site condition

The vegetation throughout the Western Extension Commonwealth Offset Area (1 and 2) is in good condition overall. The southern portion of the Western Extension Commonwealth Area as well as regional ecosystems 11.7.2 and 11.7.4 showed minimal signs of disturbance.

Remnant vegetation communities covered approximately 743 ha (63%) of the Western Extension Commonwealth Offset Area and non-remnant vegetation communities covered 444 ha (37%) of the Western Extension Commonwealth Offset Area.

The less disturbed remnant areas displayed attributes with similar values to the published benchmarks (DSITI 2017). Vegetation condition throughout the non-remnant areas varied but overall showed positive signs of natural regeneration. There are several areas that have been previously cleared and are grazed by cattle. These areas all displayed high levels of weed invasion, however the majority of weeds were naturalized pasture grasses. Many of these non-remnant areas recorded positive signs of native tree recruitment and natural regeneration.

Across the Western Extension Commonwealth Offset Area, assessment units (within remnant vegetation) scored between 45 and 63 (out of a possible 80) for overall site condition (Table 13). Remnant vegetation Assessment Unit 1 (RE 11.3.1) scored the highest and Assessment Unit 12 (RE 11.5.9) scored the lowest for overall site condition (Table 13).

Across the Western Extension Commonwealth Offset Area, assessment units (within non-remnant vegetation) scored between 33 and 46 (out of a possible 80) for overall site condition (Table 13). Assessment Unit 18 (RE 11.3.7) scored the highest and Assessment Unit 15 (RE 11.3.1) scored the lowest for overall site condition (Table 13).



Site context

Across the Western Extension Commonwealth Offset Area, assessment units scored between 22 and 26 (out of a possible 26) for site context (Table 13). Assessment Units 9, 10, 12, 16 and 19 all scored the maximum 26 for site context (Table 13).

Species habitat index

Species habitat index scores were calculated for the Squatter Pigeon (southern), Greater Glider, Koala and Ornamental Snake across the Western Extension Commonwealth Offset Area.

- Squatter Pigeon (southern): the species habitat index scored 38 for remnant AU's and 28 for non-remnant AU's (out of a possible 50).
- Greater Glider: the species habitat index scored 46 for remnant AU's and 14 for non-remnant AU's (out of a possible 50).
- Koala: the species habitat index scored 28 for remnant AU's and 17 for non-remnant AU's (out of a possible 50).
- Ornamental Snake: the species habitat index scored 46 for remnant AU's and 25 for non-remnant AU's (out of a possible 50).

Assessment Unit Habitat Quality Scores

Table 13 summarises the site condition, site context and species habitat index scores for each assessment unit using the Squatter Pigeon (southern), Greater Glider, Koala and Ornamental Snake species habitat index data.

Final Habitat Quality Scores

Tables 14, 15, 16 and 17 below summarise the final habitat quality scores for each assessment unit and for the Western Extension Commonwealth Offset Area overall, using the Squatter Pigeon (southern), Greater Glider, Koala and Ornamental Snake species habitat index data (Tables 14, 15, 16 and 17) respectively.

The final Total Habitat Quality Score for the Western Extension Commonwealth Offset Area is 7.15 for the Squatter Pigeon (southern), 7.11 for the Greater Glider, 6.46 for the Koala and 7.39 for the Ornamental Snake.

The results of these calculations have been used to support the input into the *EPBC Act Offsets Assessment Guide* (Department of Sustainability, Environment, Water, Population and Communities [SEWPaC], 2012) as detailed in Appendix 3.



Table 13: Habitat Quality Scores for Western Extension Commonwealth Offset Area

Assessment Unit	RE Type	Site Condition Score	Site Context Score	Species Habitat Index Score (Squatter Pigeon [southern])	Assessment Unit Habitat Quality Score (Squatter Pigeon [southern])	Species Habitat Index Score (Greater Glider)	Assessment Unit Habitat Quality Score (Greater Glider)	Species Habitat Index Score (Koala)	Assessment Unit Habitat Quality Score (Koala)	Species Habitat Index Score (Ornamental Snake)	Assessment Unit Habitat Quality Score (Ornamental Snake)
1	11.3.1	63	22	38	7.8	46	8.40	28	7.24	46	8.4
2	11.3.2	55	24	38	7.5	46	8.01	28	6.86	46	8.01
3	11.3.25	52.5	24	38	7.34	46	7.85	28	6.7	46	7.85
4	11.3.27d	-	-	-	-	-	-	-	-	-	-
5	11.3.4	52	24	38	7.31	46	7.82	28	6.67	46	7.82
6	11.3.7	47.5	25	38	7.32	46	7.85	28	6.66	46	7.85
7	11.4.8	62	22	38	7.82	46	8.33	28	7.18	46	8.33
8	11.4.9	55	22	38	7.37	46	7.88	28	6.73	46	7.88
9	11.5.18	46	26	38	7.05	46	7.56	28	6.41	46	7.56
10	11.5.2	51	26	38	7.37	46	7.88	28	6.73	46	7.88
11	11.5.3	53	25	38	7.44	46	7.95	28	6.79	46	7.95
12	11.5.9	45	26	38	7.73	46	8.30	28	7.02	46	8.3
13	11.7.2	53	25	38	7.68	46	8.21	28	7.02	46	8.21
14	11.7.4	55	25	38	7.56	46	8.08	28	6.92	46	8.08
15 (non rem)	11.3.1	33	25	28	6.56	14	5.50	17	5.73	25	6.34
16 (non rem)	11.3.2	43.5	26	28	6.6	14	5.53	17	5.73	25	6.26
17 (non rem)	11.3.4	45	25	28	6.28	14	5.38	17	5.58	25	6.09
18 (non rem)	11.3.7	46	25	28	6.56	14	5.63	17	5.58	25	6.36
19 (non rem)	11.5.3	41	26	28	6.99	14	5.96	17	6.18	25	6.76



Table 14: Final Habitat Quality Score for Western Extension Commonwealth Offset Area (Squatter Pigeon [southern])

(Squatter Pigeon (southern) Species Index Data)

Assessment Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15(NR)	16(NR)	17(NR)	18(NR)	19(NR)
RE	11.3.1	11.3.2	11.3.25	11.3.27d	11.3.4	11.3.7	11.4.8	11.4.9	11.5.18	11.5.2a	11.5.3	11.5.9	11.7.2	11.7.4	11.3.1	11.3.2	11.3.4	11.3.7	11.5.3
Habitat Quality Score (measured)	123	117	114.5	N/A	114	110.5	122	115	110	115	116	108	116	118	86.00	97.50	98.00	99.00	95.00
Habitat Quality Score (max)	156	156	156	N/A	156	151	156	156	156	156	156	141	151	156	131.00	151.00	156.00	151.00	136.00
Assessment Unit Area (ha)	16.43	291.02	57	4.20	117.92	29.10	17.20	42.9	4.26	52.57	95.73	18.36	3.30	13.70	32.20	143.91	46.03	13.23	209.20
Assessment Unit Habitat Quality Score	7.88	7.50	7.34	N/A	7.31	7.32	7.82	7.37	7.05	7.37	7.44	7.73	7.68	7.56	6.56	6.46	6.28	6.56	6.99
Size weighting	0.01	0.24	0.05	N/A	0.10	0.02	0.01	0.04	0.00	0.04	0.08	0.02	0.00	0.01	0.03	0.12	0.04	0.01	0.17
Weighted Assessment Unit Habitat Quality Score	0.11	1.81	0.35	N/A	0.71	0.18	0.11	0.26	0.02	0.32	0.59	0.12	0.02	0.09	0.17	0.77	0.24	0.07	1.21
FINAL TOTAL HABITAT QUALITY SCORE	7.15																		



Table 15: Final Habitat Quality Score for Western Extension Commonwealth Offset Area (Greater Glider)

(Greater Glider Species Index Data)

Assessment Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15(NR)	16(NR)	17(NR)	18(NR)	19(NR)
RE	11.3.1	11.3.2	11.3.25	11.3.27d	11.3.4	11.3.7	11.4.8	11.4.9	11.5.18	11.5.2a	11.5.3	11.5.9	11.7.2	11.7.4	11.3.1	11.3.2	11.3.4	11.3.7	11.5.3
Habitat Quality Score (measured)	131	125	123	N/A	122	119	130	123	118	123	124	117	124	126	72	84	84	85	81
Habitat Quality Score (max)	156	156	156	N/A	156	151	156	156	156	156	156	141	151	156	131	151	156	151	136
Assessment Unit Area (ha)	16.43	291.02	57.00	4.20	117.92	29.10	17.20	42.90	4.26	52.57	95.73	18.36	3.30	13.70	32.20	143.91	46.03	13.23	209.20
Assessment Unit Habitat Quality Score	8.40	8.01	7.85	N/A	7.82	7.85	8.33	7.88	7.56	7.88	7.95	8.30	8.21	8.08	5.50	5.53	5.38	5.63	5.96
Size weighting	0.01	0.24	0.05	N/A	0.10	0.02	0.01	0.04	0.00	0.04	0.08	0.02	0.00	0.01	0.03	0.12	0.04	0.01	0.17
Weighted Assessment Unit Habitat Quality Score	0.11	1.93	0.37	N/A	0.76	0.19	0.12	0.28	0.03	0.34	0.63	0.13	0.02	0.09	0.15	0.66	0.21	0.06	1.03
FINAL TOTAL HABITAT QUALITY SCORE	7.11																		



Table 16: Final Habitat Quality Score for Western Extension Commonwealth Offset Area (Koala)

(Koala Species Index Data)

Assessment Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15(NR)	16(NR)	17(NR)	18(NR)	19(NR)
RE	11.3.1	11.3.2	11.3.25	11.3.27d	11.3.4	11.3.7	11.4.8	11.4.9	11.5.18	11.5.2a	11.5.3	11.5.9	11.7.2	11.7.4	11.3.1	11.3.2	11.3.4	11.3.7	11.5.3
Habitat Quality Score (measured)	113	107	105	N/A	104	101	112	105	100	105	106	99	106	108	75	87	87	88	84
Habitat Quality Score (max)	156	156	156	N/A	156	151	156	156	156	156	156	141	151	156	131.00	151.00	156.00	151.00	136.00
Assessment Unit Area (ha)	16.43	291.02	57	4.20	117.92	29.10	17.20	42.9	4.26	52.57	95.73	18.36	3.30	13.70	32.20	143.91	46.03	13.23	209.20
Assessment Unit Habitat Quality Score	7.24	6.86	6.70	N/A	6.67	6.66	7.18	6.73	6.41	6.73	6.79	7.02	7.02	6.92	5.73	5.73	5.58	5.83	6.18
Size weighting	0.01	0.24	0.05	N/A	0.10	0.02	0.01	0.04	0.00	0.04	0.08	0.02	0.00	0.01	0.03	0.12	0.04	0.01	0.17
Weighted Assessment Unit Habitat Quality Score	0.10	1.65	0.32	N/A	0.65	0.16	0.10	0.24	0.02	0.29	0.54	0.11	0.02	0.08	0.15	0.68	0.21	0.06	1.07
FINAL TOTAL HABITAT QUALITY SCORE	6.46																		



Table 17: Final Habitat Quality Score for Western Extension Commonwealth Offset Area (Ornamental Snake)

(Ornamental Snake Species Index Data)

Assessment Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15(NR)	16(NR)	17(NR)	18(NR)	19(NR)
RE	11.3.1	11.3.2	11.3.25	11.3.27d	11.3.4	11.3.7	11.4.8	11.4.9	11.5.18	11.5.2a	11.5.3	11.5.9	11.7.2	11.7.4	11.3.1	11.3.2	11.3.4	11.3.7	11.5.3
Habitat Quality Score (measured)	131	125	123	N/A	122	119	130	123	118	123	124	117	124	126	83	95	95	96	92
Habitat Quality Score (max)	156	156	156	N/A	156	151	156	156	156	156	156	141	151	156	131.00	151.00	156.00	151.00	136.00
Assessment Unit Area (ha)	16.43	291.02	57	4.20	117.92	29.10	17.20	42.9	4.26	52.57	95.73	18.36	3.30	13.70	32.20	143.91	46.03	13.23	209.20
Assessment Unit Habitat Quality Score	8.40	8.01	7.85	N/A	7.82	7.85	8.33	7.88	7.56	7.88	7.95	8.30	8.21	8.08	6.34	6.26	6.09	6.36	6.76
Size weighting	0.01	0.24	0.05	N/A	0.10	0.02	0.01	0.04	0.00	0.04	0.08	0.02	0.00	0.01	0.03	0.12	0.04	0.01	0.17
Weighted Assessment Unit Habitat Quality Score	0.11	1.93	0.37	N/A	0.76	0.19	0.12	0.28	0.03	0.34	0.63	0.13	0.02	0.09	0.17	0.75	0.23	0.07	1.17
FINAL TOTAL HABITAT QUALITY SCORE	7.39																		



5.3. Habitat Quality Assessment (Western Extension State Offset Area)

Site condition

The vegetation throughout the Western Extension State Offset Area is in a good condition overall.

Remnant vegetation communities covered approximately 240.5 ha (53%) of the Western Extension State Offset Area while non-remnant vegetation communities covered approximately 213.5 ha (47%).

The less disturbed remnant areas displayed attributes with similar values to the published benchmarks (DSITI 2017). Vegetation condition throughout the non-remnant REs varied but overall showed positive signs of natural regeneration. There are several areas of the Western Extension State Offset Area that have been previously cleared and are grazed by cattle. These areas all displayed high levels of weed invasion, however the majority of weeds were naturalized pasture grasses. Many of these non-remnant areas recorded positive signs of native tree recruitment and natural regeneration.

Across the Western Extension State Offset Area, assessment units (within remnant vegetation) scored between 47 and 61 (out of a possible 80) for overall site condition (Table 18). Within remnant vegetation Assessment Unit 1 (RE 11.3.1) scored the highest and Assessment Unit 6 (RE 11.5.3) scored the lowest for overall site condition (Table 18).

Across the Western Extension State Offset Area, assessment units (within non-remnant vegetation) scored between 33 and 45 (out of a possible 80) for overall site condition (Table 18). Assessment Unit 9 (RE 11.3.4) scored the highest and Assessment Units 7 (RE 11.3.1) scored the lowest for overall site condition (Table 18).

Site context

Across the Western Extension State Offset Area, assessment units scored between 18 and 25 (out of a possible 26) for site context (Table 18). Assessment Units 3, 5 and 10 scored the highest for site context (Table 18).

Assessment Unit Habitat Quality Scores

Table 18 summarises the site condition and site context scores for each assessment unit.


Table 18: Habitat Quality Scores for Western Extension State Offset Area

Assessment Unit	RE	Site Condition Score	Site Context Score	Assessment Unit Habitat Quality Score
1	11.3.1	61	20	7.64
2	11.3.2	55	24	7.45
3	11.3.25	52.5	25	7.31
4	11.3.27d	-	-	-
5	11.3.4/11.3.4a	53	25	7.36
6	11.5.3	47	24	6.70
7 (non rem)	11.3.1	33	18	5.60
8 (non rem)	11.3.2	43.5	24	6.68
9 (non rem)	11.3.4	45	24	6.51
10 (non rem)	11.5.3	41	25	6.53

Final Habitat Quality Scores

The following table summarises the final habitat quality scores for each assessment unit. The overall Habitat Quality Score for the Western Extension State Offset Area is 6.94.

Table 19: Final Habitat Quality Score for Western Extension State Offset Area

Assessment Unit	1	2	3	4	5	6	7 (NR)	8 (NR)	9 (NR)	10 (NR)
RE	11.3.1	11.3.2	11.3.25	11.3.27d	11.3.4	11.5.3	11.3.1	11.3.2	11.3.4	11.5.3
Habitat Quality Score (measured)	81	79	77.5	N/A	78	71	51	67.5	69	66
Habitat Quality Score (max)	106	106	106	N/A	106	106	91	101	106	101
Assessment Unit Area (ha)	8.04	185.27	17.65	4.03	17.32	8.81	13.44	105.39	12.27	83.03
Assessment Unit Habitat Quality Score	7.64	7.45	7.31	N/A	7.36	6.70	5.60	6.68	6.51	6.53
Size weighting	0.02	0.41	0.04	N/A	0.04	0.02	0.03	0.23	0.03	0.18
Weighted Assessment Unit Habitat Quality Score	0.14	3.06	0.29	N/A	0.28	0.13	0.17	1.55	0.18	1.19
FINAL TOTAL HABITAT QUALITY SCORE	6.94									



5.4. Habitat Quality Assessment (Modified Stage 2 Commonwealth Offset Area 2 and 3)

Site condition

The vegetation throughout the Modified Stage 2 Commonwealth Offset Area is all remnant vegetation and in good condition overall. The southern portion of Modified Stage 2 Commonwealth Offset Area as well as REs showed minimal signs of disturbance.

The Modified Stage 2 Commonwealth Offset Area was made up of 114 ha of remnant vegetation communities and a further 0.5 ha of non-remnant vegetation. The less disturbed remnant areas displayed attributes with similar values to the published benchmarks (DSITI 2017).

Across the Modified Stage 2 Commonwealth Offset Area, assessment units scored between 40 and 54 (out of a possible 80) for overall site condition (Table 20). Assessment Unit 5 (RE 11.5.3) scored the highest and Assessment Unit 1 (RE 11.4.8) scored the lowest for overall site condition (Table 20).

Site context

Across the Modified Stage 2 Commonwealth Offset Area, assessment units scored between 15 and 26 (out of a possible 26) for site context (Table 20). Assessment Units 3, 4, 5 and 6 all scored the maximum 26 for site context (Table 20).

Species habitat index

Species habitat index scores were calculated for the Squatter Pigeon (southern) and Ornamental Snake across the Modified Stage 2 Commonwealth Offset Area.

- Squatter Pigeon (southern): the species habitat index scored 41 (out of a possible 50).
- Ornamental Snake: the species habitat index scored 46 (out of a possible 50).

Assessment Unit Habitat Quality Scores

Table 20 summarises the site condition, site context and species habitat index scores for each assessment unit using the Squatter Pigeon (southern) and Ornamental Snake species habitat index data.

Final Habitat Quality Scores

Tables 21 and 22 below summarise the final habitat quality scores for each assessment unit and for the Modified Stage 2 Commonwealth Offset Area, using the Squatter Pigeon (southern) and Ornamental Snake species habitat index data (Tables 21 and 22) respectively.

The final Total Habitat Quality Score for the Modified Stage 2 Commonwealth Offset Area is 7.09 for the Squatter Pigeon (southern) and 7.41 for the Ornamental Snake.

The results of these calculations have been used to support the input into the *EPBC Act Offsets Assessment Guide* (SEWPac 2012) as detailed in Appendix 3.


Table 20: Habitat Quality Scores for Modified Stage 2 Commonwealth Offset Area

Assessment Unit	RE Type	Site Condition Score	Site Context Score	Species Habitat Index Score (Squatter Pigeon [southern])	Assessment Unit Habitat Quality Score (Squatter Pigeon [southern])	Species Habitat Index Score (Ornamental Snake)	Assessment Unit Habitat Quality Score (Ornamental Snake)
1	11.4.8	40	15	41	6.15	46	6.47
2	11.4.9	51	16	41	6.92	46	7.24
3	11.5.18	46	26	41	7.24	46	7.56
4	11.5.2a	48	26	41	7.37	46	7.69
5	11.5.3	54	26	41	7.76	46	8.08
6	11.5.9	45	26	41	7.18	46	7.50

Table 21: Final Habitat Quality Score for Modified Stage 2 Commonwealth Offset Area (Squatter Pigeons [southern])

(Squatter Pigeon (southern) Species Index Data)

Assessment Unit	1	2	3	4	5	6
RE	11.4.8	11.4.9	11.5.18	11.5.2a	11.5.3	11.5.9
Habitat Quality Score (measured)	96	108	113	115	121	112
Habitat Quality Score (max)	156	156	156	156	156	156
Assessment Unit Area (ha)	15.80	14.03	18.41	7.38	12.47	47.13
Assessment Unit Habitat Quality Score	6.15	6.92	7.24	7.37	7.76	7.18
Size weighting	0.14	0.12	0.16	0.06	0.11	0.41
Weighted Assessment Unit Habitat Quality Score	0.84	0.84	1.16	0.47	0.84	2.94
FINAL TOTAL HABITAT QUALITY SCORE	7.09					



Table 22: Final Habitat Quality Score for Modified Stage 2 Commonwealth Offset Area (Ornamental Snake)

(Ornamental Snake Species Index Data)

Assessment Unit	1	2	3	4	5	6
RE	11.4.8	11.4.9	11.5.18	11.5.2	11.5.3	11.5.9
Habitat Quality Score (measured)	101	113	118	126	126	117
Habitat Quality Score (max)	156	156	156	156	156	156
Assessment Unit Area (ha)	15.80	14.03	18.41	7.38	12.47	47.13
Assessment Unit Habitat Quality Score	6.47	7.24	7.56	7.69	8.08	7.50
Size weighting	0.14	0.12	0.16	0.06	0.11	0.41
Weighted Assessment Unit Habitat Quality Score	0.89	0.88	1.21	0.49	0.87	3.07
FINAL TOTAL HABITAT QUALITY SCORE	7.41					



5.5. Habitat Quality Assessment (Modified Rail Loop and Spur Offset Area 3a and 3b)

Site condition

The vegetation throughout the Modified Rail Loop and Spur Offset Area is in good condition overall. The Modified Rail Loop and Spur Offset Area was approximately 56.5 ha and made up of remnant and non-remnant vegetation communities. Remnant vegetation communities covered 32 ha (57%) while non-remnant vegetation communities covered 24.5 ha (43%) of the Modified Rail Loop and Spur Offset Area.

The less disturbed remnant areas displayed attributes with similar values to the published benchmarks (DSITI, 2017). Vegetation condition throughout the non-remnant REs varied but overall showed positive signs of natural regeneration. There are several areas within the Modified Rail Loop and Spur Offset Area that have been previously cleared and are grazed by cattle. These areas all displayed high levels of weed invasion, however the majority of weeds were naturalized pasture grasses. Many of these non-remnant areas recorded positive signs of native tree recruitment and natural regeneration.

Across the Modified Rail Loop and Spur Offset Area, assessment units (within remnant vegetation) scored between 40 and 56 (out of a possible 80) for overall site condition (Table 23). Within remnant vegetation, Assessment Unit 3 (RE 11.4.9) scored the highest and Assessment Unit 2 (RE 11.4.8) scored the lowest for overall site condition (Table 23).

Across the Modified Rail Loop and Spur Offset Area, assessment units (within non-remnant vegetation) scored between 37 and 43.5 (out of a possible 80) for overall site condition (Table 23). Assessment Unit 5 (11.3.2) scored the highest and Assessment Unit 6 (RE 11.5.3) scored the lowest for overall site condition (Table 23).

Site context

Across the Modified Rail Loop and Spur Offset Area, assessment units scored between 13 and 25 (out of a possible 26) for site context (Table 23). Assessment Units 1 and 5 scored the highest for site context (Table 23).

Species habitat index

Species habitat index scores were calculated for the Squatter Pigeon (southern) across the Modified Rail Loop and Spur Offset Area.

- Squatter Pigeon (southern): the species habitat index scored 28 for both remnant and non-remnant AU's (out of a possible 50).

Assessment Unit Habitat Quality Scores

Table 23 summarises the site condition, site context and species habitat index scores for each assessment unit using the Squatter Pigeon (southern) species habitat index data.



Final Habitat Quality Scores

Table 24 below summarises the final habitat quality scores for each assessment unit and for the Modified Rail Loop and Spur Offset Area overall, using the Squatter Pigeon (southern) species habitat index data.

The final Total Habitat Quality Score for the Approved Commonwealth Offset Area is 5.90.

Table 23: Habitat Quality Scores for Modified Rail Loop and Spur Offset Area

Assessment Unit	RE Type	Site Condition Score	Site Context Score	Species Habitat Index Score (Squatter Pigeon [southern])	Assessment Unit Habitat Quality Score (Squatter Pigeon [southern])
1	11.3.2	53	25	28	6.79
2	11.4.8	40	15	28	5.32
3	11.4.9	56	13	28	6.22
4	11.5.3	55	14	28	6.22
5 (non rem)	11.3.2	43.5	25	28	6.39
6 (non rem)	11.5.3	37	18	28	5.32

Table 24: Final Habitat Quality Score for Modified Rail Loop and Spur Offset Area (Squatter Pigeon [southern])

(Squatter Pigeon (southern) Species Index Data)

Assessment Unit	1	2	3	4	5	6
RE	11.3.2	11.4.8	11.4.9	11.5.3	11.3.2	11.5.3
Habitat Quality Score (measured)	106.00	83.00	97.00	97.00	96.50	83.00
Habitat Quality Score (max)	156.00	156.00	156.00	156.00	151.00	156.00
Assessment Unit Area (ha)	0.58	7.31	9.00	2.59	13.44	11.59
Assessment Unit Habitat Quality Score	6.79	5.32	6.22	6.22	6.39	5.32
Size weighting	0.01	0.16	0.20	0.06	0.30	0.26
Weighted Assessment Unit Habitat Quality Score	0.09	0.87	1.26	0.36	1.93	1.39
FINAL TOTAL HABITAT QUALITY SCORE	5.90					



5.6. Fauna Survey Results

5.6.1. Fauna Habitat Types

Broad fauna habitats within the study sites were categorized and mapped into seven broad habitat types using the same classifications as PB (2010) (Figure 16). The broad fauna habitat types include:

- Eucalypt woodland/forest.
- Micromyrtus shrubland.
- Riparian habitat.
- Wetlands (natural/artificial).
- *Acacia shirleyi* forest.
- *Acacia harpophylla* woodland/forest.
- Regrowth/derived grassland.

Table 25 details the regional ecosystems which make up each broad fauna habitat type along with the area (in ha) of each.

Table 25: Broad Fauna Habitat Types

Broad Fauna Habitat Type	Regional Ecosystem	Field Verified Area (ha)
Eucalypt Woodland	11.3.2	291
	11.3.4/11.3.4a	117.5
	11.3.7	29
	11.5.2a	59.5
	11.5.3	105
	11.5.9	65.5
	11.7.4	13.5
Subtotal (Eucalypt Woodland)		681
<i>Acacia harpophylla</i> woodland/forest	11.3.1	16.5
	11.4.8	39.5
	11.4.9/11.4.9a	65.5
Subtotal (<i>Acacia harpophylla</i>)		121.5
Riparian habitat	11.3.25	57
Wetlands	11.3.27d	4
<i>Acacia shirleyi</i> forest	11.7.2	3
Micromyrtus shrubland	11.5.18	22
Regrowth	-	469
TOTAL		1357.5

Table 26 describes the habitat values per category, with focus on habitat value and suitability for foraging, nesting, roosting, and breeding requirements for potentially occurring threatened species listed under the NC Act and EPBC Act.


Table 26: Fauna Habitat Assessment

Habitat Attribute / Category	Site Values					
	1. Eucalypt woodland/forest	2. Micromyrtus shrubland	3. Riparian habitat	4. <i>Acacia shirleyi</i> forest	5. <i>Acacia harpophylla</i> woodland/forest	6. Regrowth/derived grassland
Groundcover	Variable density and composition depending on disturbance history e.g. rotational grazing regime. Some areas feature a moderately dense cover of exotic grasses while some are more open and dominated by native grasses and shrubs. A number of native grass species provide a potential food resource for the Squatter Pigeon (southern). Some areas also have a mosaic of open sandy areas and native grasses which is preferred habitat for this species.	Comprises open grassy groundcover (mostly native grasses) and areas of bare ground. A number of native grass species provide potential food resources for the Squatter Pigeon (southern).	Generally a good cover of native grasses, sedges and herbs. Some areas dominated by Buffel Grass.	Sparse to open ground cover of native grasses, with areas of bare ground.	Sparse to open ground cover of mostly native grasses, with areas of bare ground. Provides potential shelter and prey habitat for threatened reptiles.	Dominant ground cover composition of exotic grasses with native grasses and herbs being less common. Areas with a higher percentage of native grass species would provide food resources for the Squatter Pigeon (southern).
Leaf Litter	High under canopy trees, and scattered throughout the mixed grass undergrowth.	Overall low density of leaf litter present due to the lack of canopy trees.	Generally thin leaf litter throughout due to open canopy.	Density of leaf litter was low overall with some small accumulations noted.	Mature Brigalow habitats contained dense accumulations of leaf litter which would provide shelter and prey habitat for a range of small reptiles.	Sparse leaf litter.
Logs and Debris	Reasonable abundance of hollow logs and debris present due to the nature of Eucalyptus shedding limbs. Larger logs provide shelter and prey habitat for ground dwelling reptiles.	Low density of coarse woody debris in the form of small fallen timber at the base of scattered canopy eucalypts. Marginal potential habitat values for threatened fauna overall.	Some accumulations of coarse woody debris and logs under canopy trees. Marginal potential habitat values for threatened fauna overall.	High density of coarse woody debris, which is typical of this habitat type.	High density of coarse woody debris, which is typical of this habitat type.	Very few logs observed. Some log and debris piles as a result of past clearing occur.
Rocky outcrops	Only some small to medium surface rock present.	Some small surface rock present.	Absent	Rocky outcrops are very common in this habitat type. Provide potential shelter, basking sites and prey habitat for a range of common reptiles and small mammals.	Absent	Absent



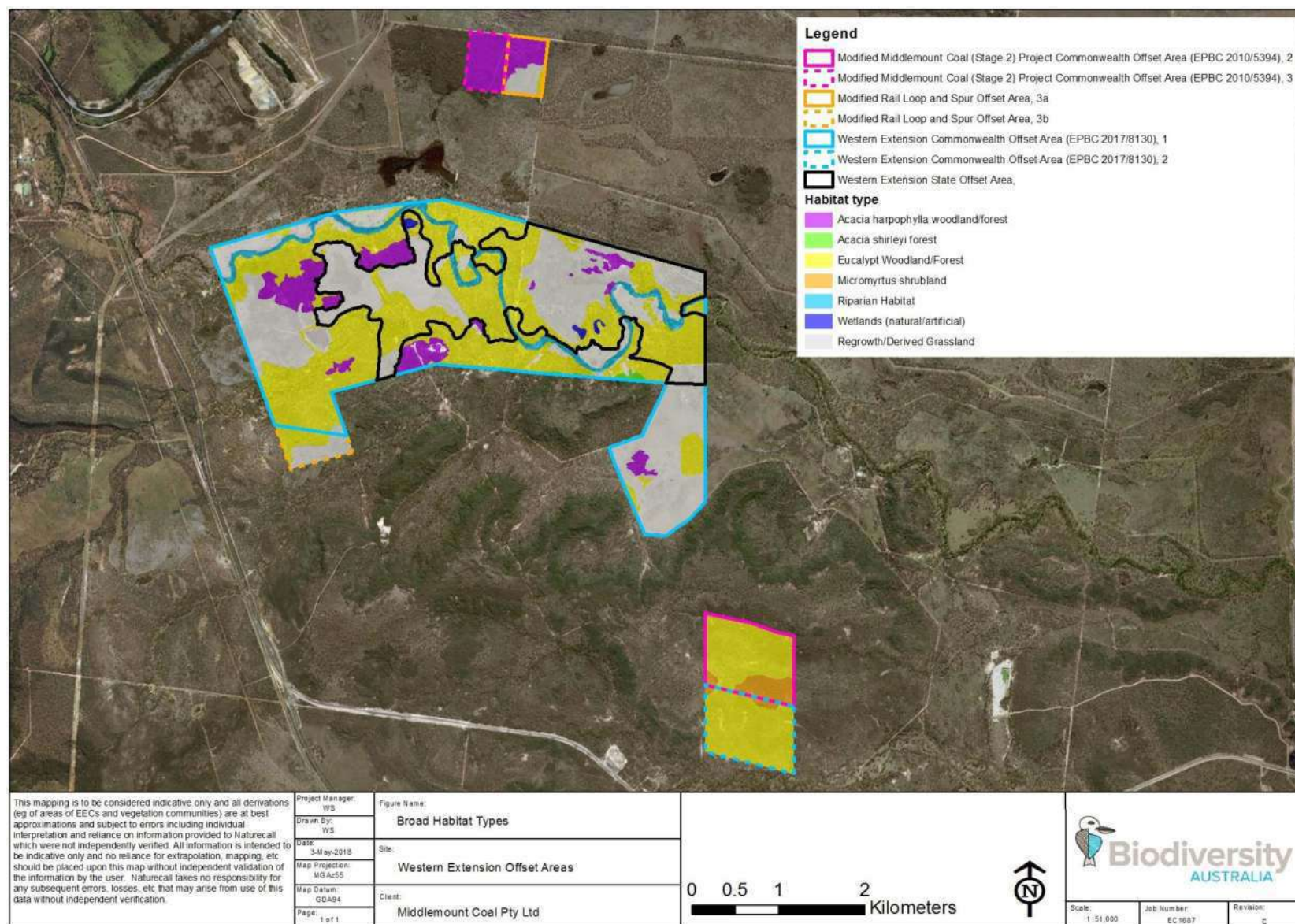
Habitat Attribute / Category	Site Values					
	1. Eucalypt woodland/forest	2. Micromyrtus shrubland	3. Riparian habitat	4. <i>Acacia shirleyi</i> forest	5. <i>Acacia harpophylla</i> woodland/forest	6. Regrowth/derived grassland
Aquatic habitat	Aquatic habitats in this habitat type were largely limited to small ephemeral creeks and soaks that would only hold water for short periods.	Absent	The ephemeral creeks and drainage lines were largely dry during the survey, however some had small pools of water remaining. Semi-permanent billabongs and pools in the creek bed would provide water sources for the Squatter Pigeon (southern).	Absent	Brigalow habitats contain small depressions and melon holes that would hold water during the wet season.	A few large dams were located within non-remnant areas. One large dam in the south of the site contained established aquatic vegetation. Dams on site attracted a range of wetland birds and provided permanent water sources for a range of fauna including the Squatter Pigeon (southern).
Hollows	Hollow-bearing trees and stags were common within this habitat type. A range of hollow-sizes are present i.e. <5cm to >20cm diameter cavities. Hollows provide nesting/denning/roosting habitat for a number of threatened fauna species such as the Greater Glider.	Scattered eucalyptus and corymbias in this habitat type contained hollows. Hollows that are present would provide potential roosting habitat for threatened fauna species.	Hollow-bearing trees were generally uncommon in this habitat type and would largely be occupied by common birds such as Galahs and Lorikeets.	Absent.	Low occurrence of tree hollows in occasional eucalyptus species present.	No hollow bearing trees present due to previous clearing history.
Nectar sources	Woodland habitats contain a range of nectar producing species e.g. eucalypts, acacias and grevilleas.	Low nectar source overall. Flowering <i>Micromyrtus</i> shrubs would be an insect attractant for Microbats.	Nectar sources in riparian habitats include eucalypts and Melaleucas, some of which were flowering during the survey.	<i>Acacia shirleyi</i> is the primary nectar source and would provide foraging resources for fauna when in flower.	<i>Acacia harpophylla</i> is the primary nectar source and would provide foraging resources for fauna when in flower.	This habitat type does not provide a significant nectar source due to the lack of mature trees.
Koala food trees	Moreton Bay Ash, Poplar Box and Narrow-leaved Ironbark are the main Koala browse species in this community (Department of the Environment [DotE] 2014). A Koala was recorded in this habitat type near Roper Creek (Photo 3).	Absent aside from a few Narrow-leaved Ironbark.	This community is dominated by Queensland Blue Gum which is a preferred browse species for Koalas.	Absent	<i>Eucalyptus cambageana</i> is located within this habitat type and, although a less common food source for the Koala, meets the definition of a Koala food tree (DotE 2014).	Absent aside from occasional areas of regrowth <i>Eucalypts</i> and <i>Corymbia spp.</i>



Habitat Attribute / Category	Site Values					
	1. Eucalypt woodland/forest	2. Micromyrtus shrubland	3. Riparian habitat	4. <i>Acacia shirleyi</i> forest	5. <i>Acacia harpophylla</i> woodland/forest	6. Regrowth/derived grassland
Connectivity values	Provides strong habitat links and connectivity values across the site, especially north-south connections with adjacent habitat in the east and west of the site. Some areas of woodland are fragmented by roads and cleared areas. This habitat type would benefit the local movements of a range of fauna species, including arboreal species such as the Koala.	The shrubland habitats would complement the connectivity values of other habitat types and provide shelter and cover for small terrestrial species and passerine birds.	Riparian habitats provide connectivity along Roper Creek. Due to the open nature of this habitat type, it is only likely to be used by mobile species capable of crossing open ground. Important connectivity values for the Koala.	This habitat type is generally surrounded by woodland habitats and would provide similar connectivity values. Rocky scarp habitats are likely to assist local movements of reptiles and small mammals.	The Brigalow habitats would contribute to the connectivity values of the other site habitats. Patches provide good 'stepping stone' habitats for birds.	Continued regeneration of non-remnant areas over time would help re-establish linkages for flora and fauna across the site and broader landscape.



Figure 16: Broad Fauna Habitat Types Present on the Study Site





5.6.2. Fauna Species Detected

A total of 87 fauna species were detected during the survey either opportunistically or during targeted surveys. A complete list of fauna species detected is provided in Appendix 2. Birds were the most common fauna group observed with a total of 72 species detected. Eleven mammals (including three introduced species) and four reptiles were also detected (Appendix 2).

The species assemblage on the study sites is considered typical for the area based on results of previous surveys on adjacent and nearby lands (e.g. PB 2010; EHP, 2012; Naturecall 2013, 2014b, 2015, 2016).

5.6.3. Threatened Fauna Species

The Koala (*Phascolarctos cinereus*), which is listed as Vulnerable under the NC Act and EPBC Act was observed at one location within the Western Extension Commonwealth Offset Area (1) during spotlighting surveys.

The Greater Glider (*Petauroides volans*) which is listed as Vulnerable under the NC Act and EPBC Act was observed during spotlighting surveys at five locations within the study sites, of which three records occur within the Western Extension Commonwealth Offset Area (1).

The Squatter Pigeon (southern) (*Geophaps scripta scripta*), which is listed as Vulnerable under the NC Act and EPBC Act was not observed within the study sites, but was observed on the Dysart Road to the southwest of the site.

Opportunistic surveys for the threatened Ornamental Snake (*Denisonia maculata*), which is listed as Vulnerable under the NC Act and EPBC Act, were carried out over the survey period, however it was not detected.

Further information on each of these species is provided below.

Koala (*Phascolarctos cinereus*)

An adult Koala was recorded just to the south of Roper Creek within the Western Extension Commonwealth Offset Area (1) during a spotlighting survey on 22 November 2018 (Photo 3, Figure 18). The Koala was recorded within a Queensland Blue Gum within vegetation equivalent to RE 11.3.4.

Koalas have also been recorded on adjacent land to the north by Ecology and Heritage Partners (2012) and adjacent to Parrot Quarry Road by Naturecall (2014b) (Figure 17).

Koala food trees (as defined in the *EPBC Act Referral Guidelines for the Vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)* [DotE 2014] and *Nature Conservation [Koala] Conservation Plan 2006 and Management Program 2006-2016* [EPA 2006]) are present within the study sites, in particular Queensland Blue Gum (identified as an important food species for the Koala [Van Dyck and Strahan 2008; Land for Wildlife 2014]), Moreton Bay Ash, Queensland Peppermint, Poplar Box and Narrow-leaved Ironbark.

A large portion of the Regional Ecosystems mapped within the offset areas would provide known and potential habitat for the Koala based on the occurrence of preferred Koala food trees (Figure



18). This includes RE 11.3.2, RE 11.3.4, RE 11.3.4a, RE 11.3.7, RE 11.3.25, RE 11.3.27d, RE 11.5.2a, RE 11.5.3, RE 11.5.9 and RE 11.7.4.

In addition, these areas would provide beneficial movement corridors (i.e. connectivity) for the Koala throughout the landscape, particularly along Parrot creek.

Photo 3: Koala recorded in the Offset Area

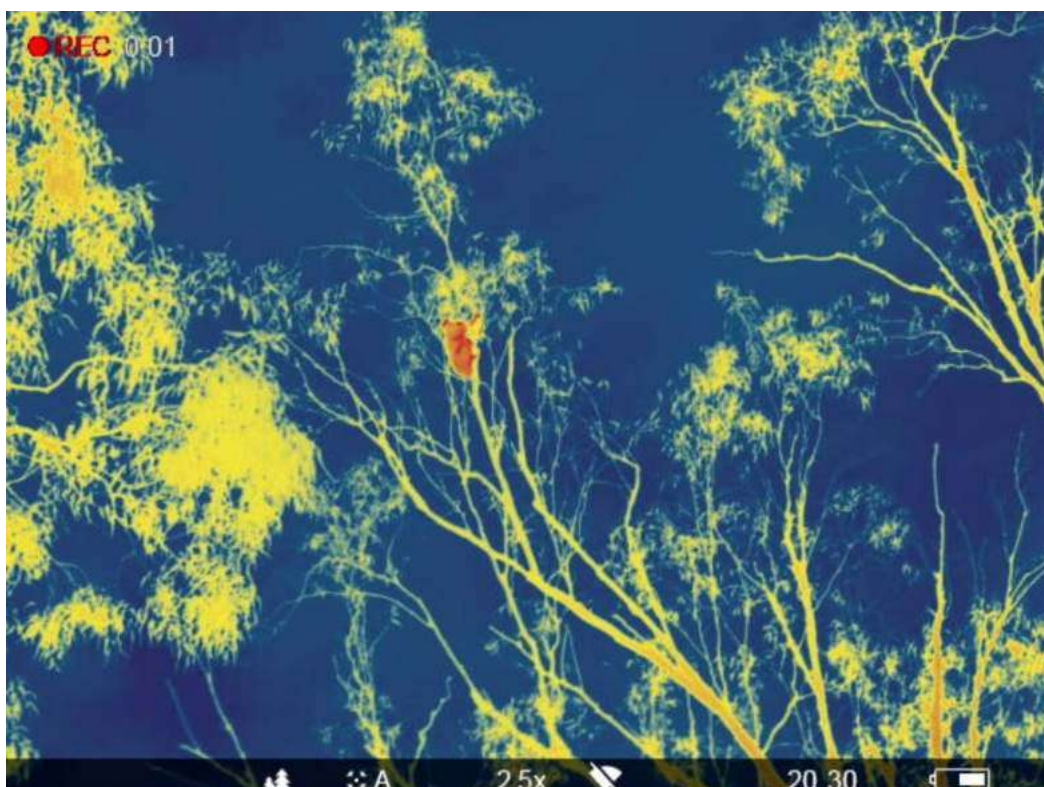
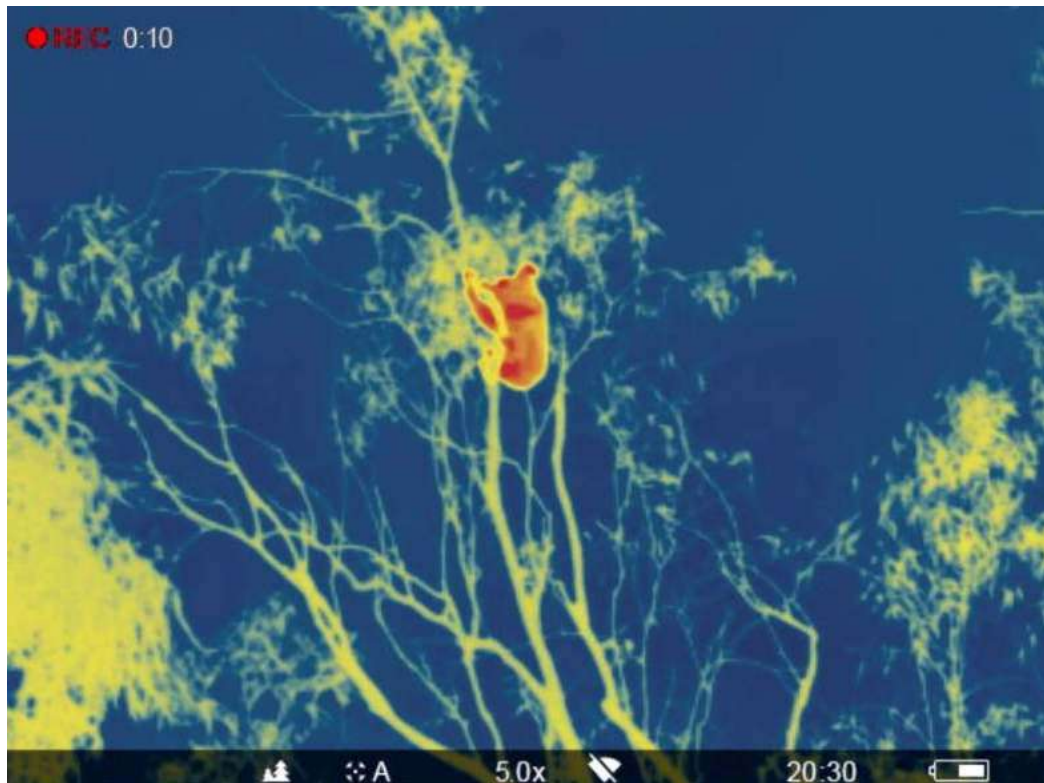




Figure 17: Previously recorded threatened species in the surrounding area

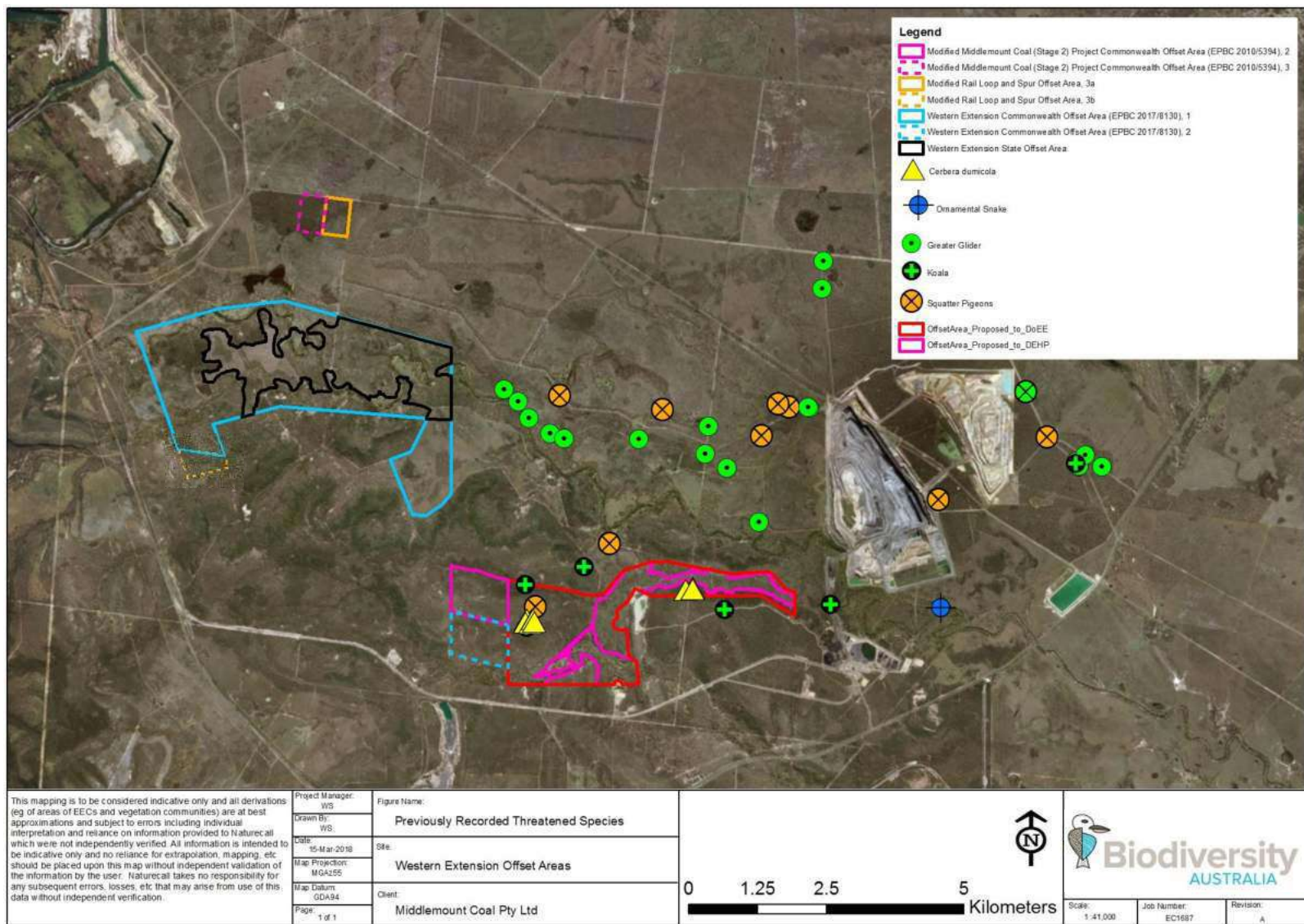
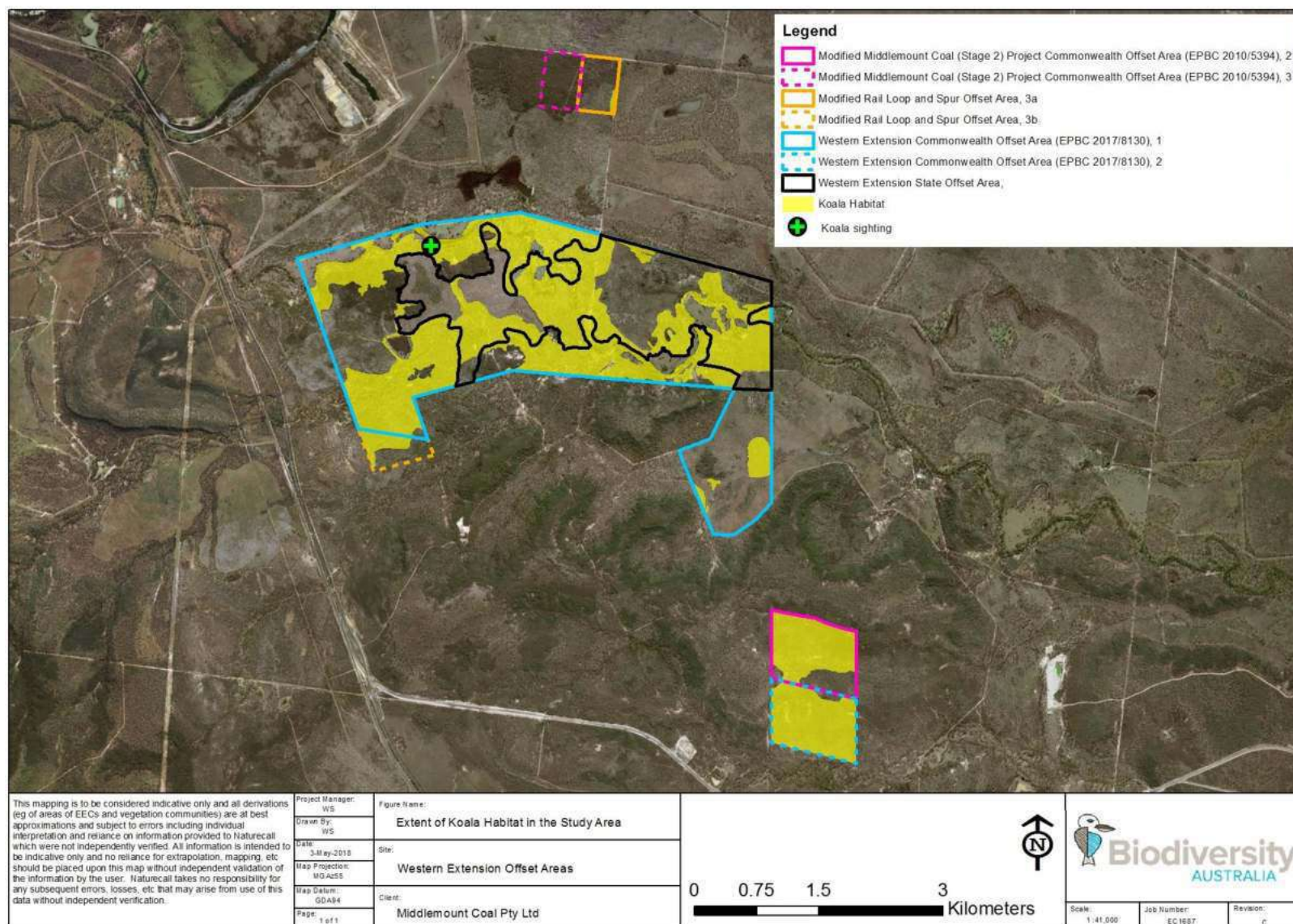




Figure 18: Koala habitat within each Offset Area





Greater Glider (Petauroides volans)

Four Greater Gliders were observed during a spotlighting survey on 22 November (Photo 4). Three were recorded within the north of the Western Extension Commonwealth Offset area (1) and one was recorded near the Dysart Road to the west. They were all recorded in open woodland habitats near Roper Creek equivalent to RE 11.5.3 and 11.3.7.

A fifth deceased Greater Glider was observed on 25th November to the south of the Western Extension Commonwealth Offset area (1) when en-route to vegetation survey plots. It was found entangled on a barbed wire fence, and was likely to have become entangled several weeks prior (Photo 5).

The Greater Glider occurs in forests and woodlands across eastern Australia where it forages on eucalypt leaves and occasionally flowers (Threatened Species Scientific Committee [TSSC] 2016). It requires large tracks of remnant forests which contain old growth trees containing hollows which it uses for denning (TSSC 2016).

Previous observations of this species on MCPL land (see Figure 17 above) have noted that it prefers woodland an open forest associated with major creeks and drainage lines, equivalent to RE types 11.3.25, 11.3.2, 11.3.4, 11.3.4a, 11.3.27d, 11.5.3 and 11.3.7. It has also been occasionally noted in Poplar Box woodland equivalent to RE 11.5.3. Preferred forage species appear to be Moreton Bay Ash, Silver-leaved Ironbark and Poplar Box.

The Western Extension Commonwealth Offset Area (1) contains extensive suitable habitat for the Greater Glider, and it has been demonstrated to occur here during the field surveys (Photos 4 & 5; Figure 19). Habitats that are known to support this species include woodland dominated by Blue Gum, Clarkson's Bloodwood, Silver-leaved Ironbark, Poplar Box and Moreton Bay Ash in riparian zones and creek flats associated with Roper Creek.



Photo 4: Greater Glider recorded

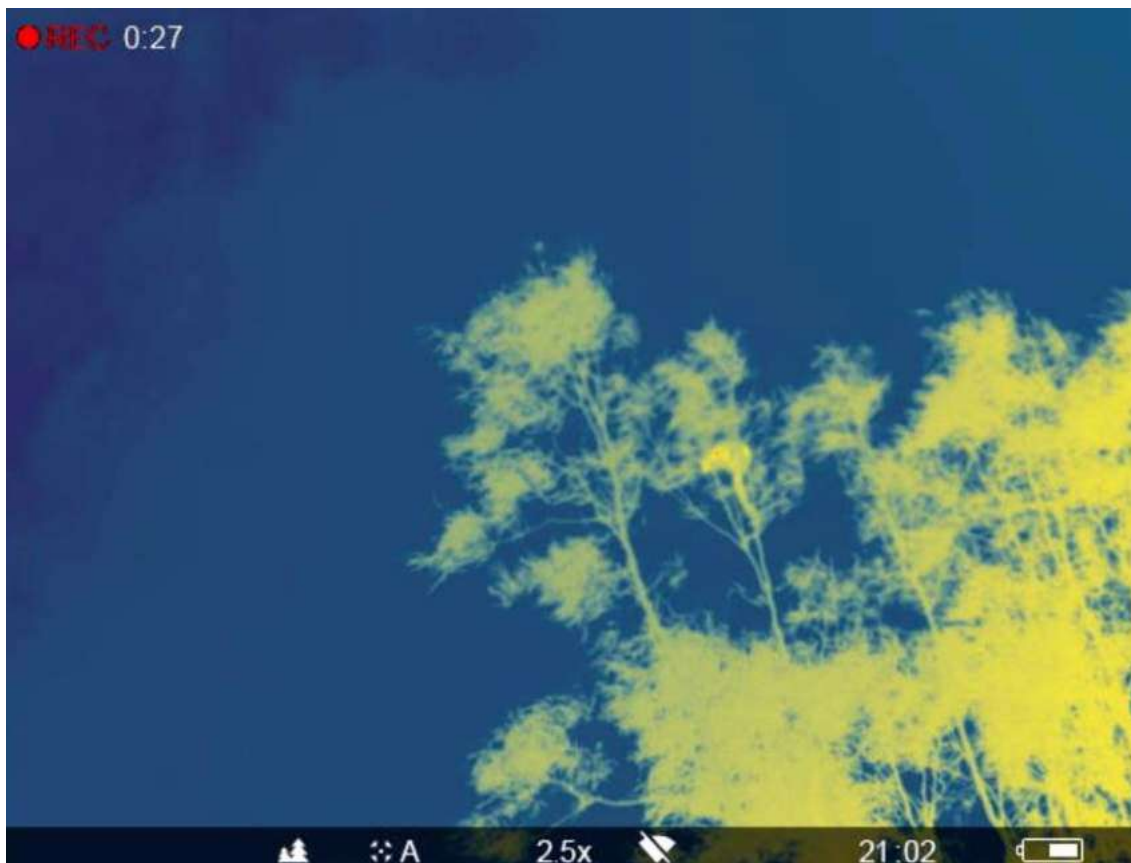


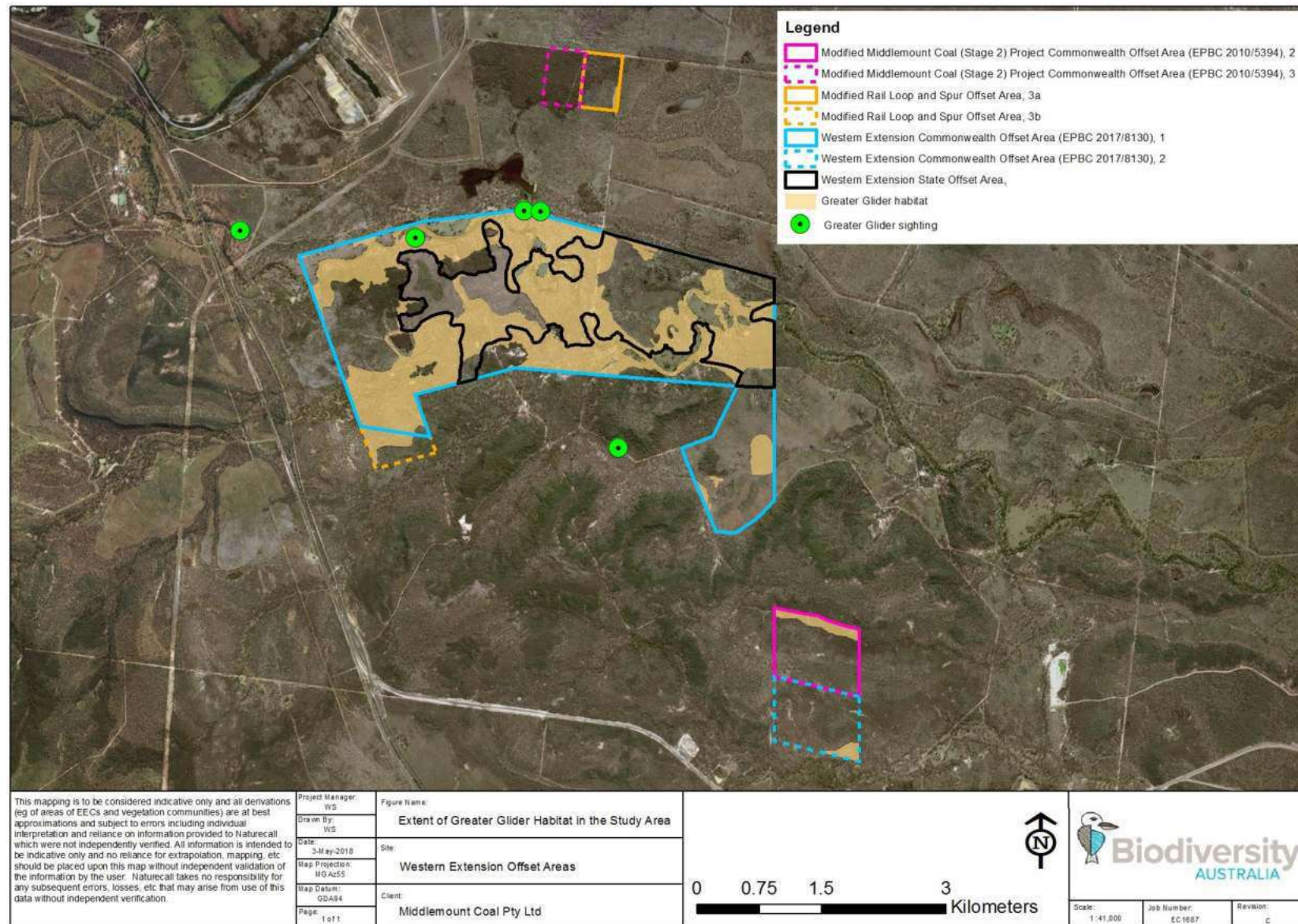


Photo 5: Greater Glider on barbed wire fence





Figure 19: Greater Glider habitat within the study sites





Squatter Pigeon (southern) (Geophaps scripta scripta)

The Squatter Pigeon (southern) was not recorded within the study sites during the field survey. One Squatter Pigeon (southern) was however opportunistically observed on the Dysart Road to the southwest of the study sites on 23 November. The location of this record is shown in Figure 22.

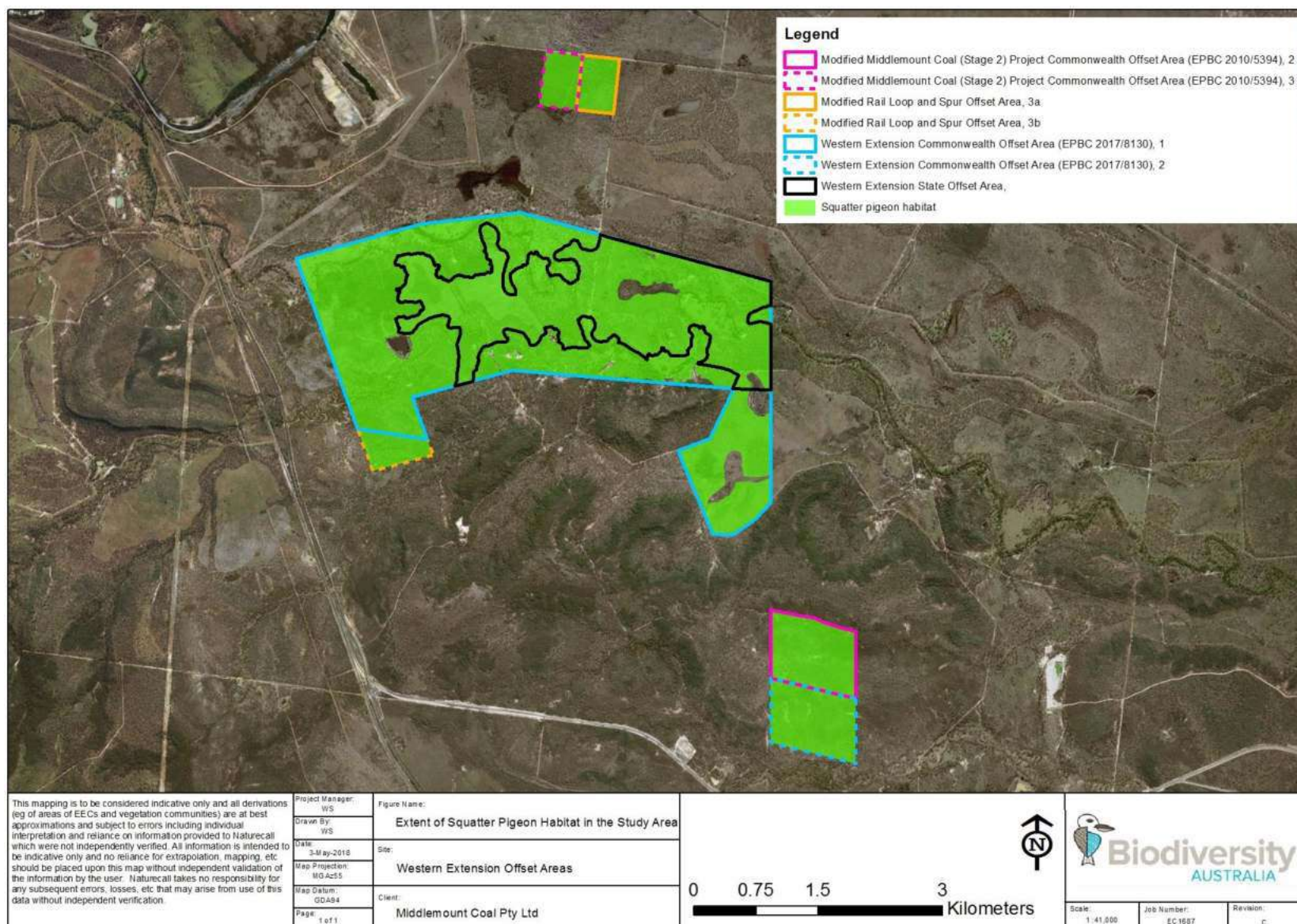
This species has also been previously recorded on MCPL lands to the east (see Figure 17). As identified in Table 26 a number of habitat attributes which would provide suitable habitat for the Squatter Pigeon (southern) are present throughout the study sites. These include a number of native grass species, permanent water resources and a mosaic of open sandy areas.

As identified by DEE (2017b), the Squatter Pigeon (southern) is known to utilize habitat located on land zones 3, 4, 5, 7 and 10. Within the study sites, this comprises most of the RE's (Figure 20).

These REs provide good quality habitat for the Squatter Pigeon (southern) as they contain a number of native grass species which would provide a potential food resource. In addition there a number of permanent water bodies within the study sites which would provide a suitable water source.



Figure 20: Squatter Pigeon (southern) habitat within the study sites





Ornamental Snake (Denisonia maculate)

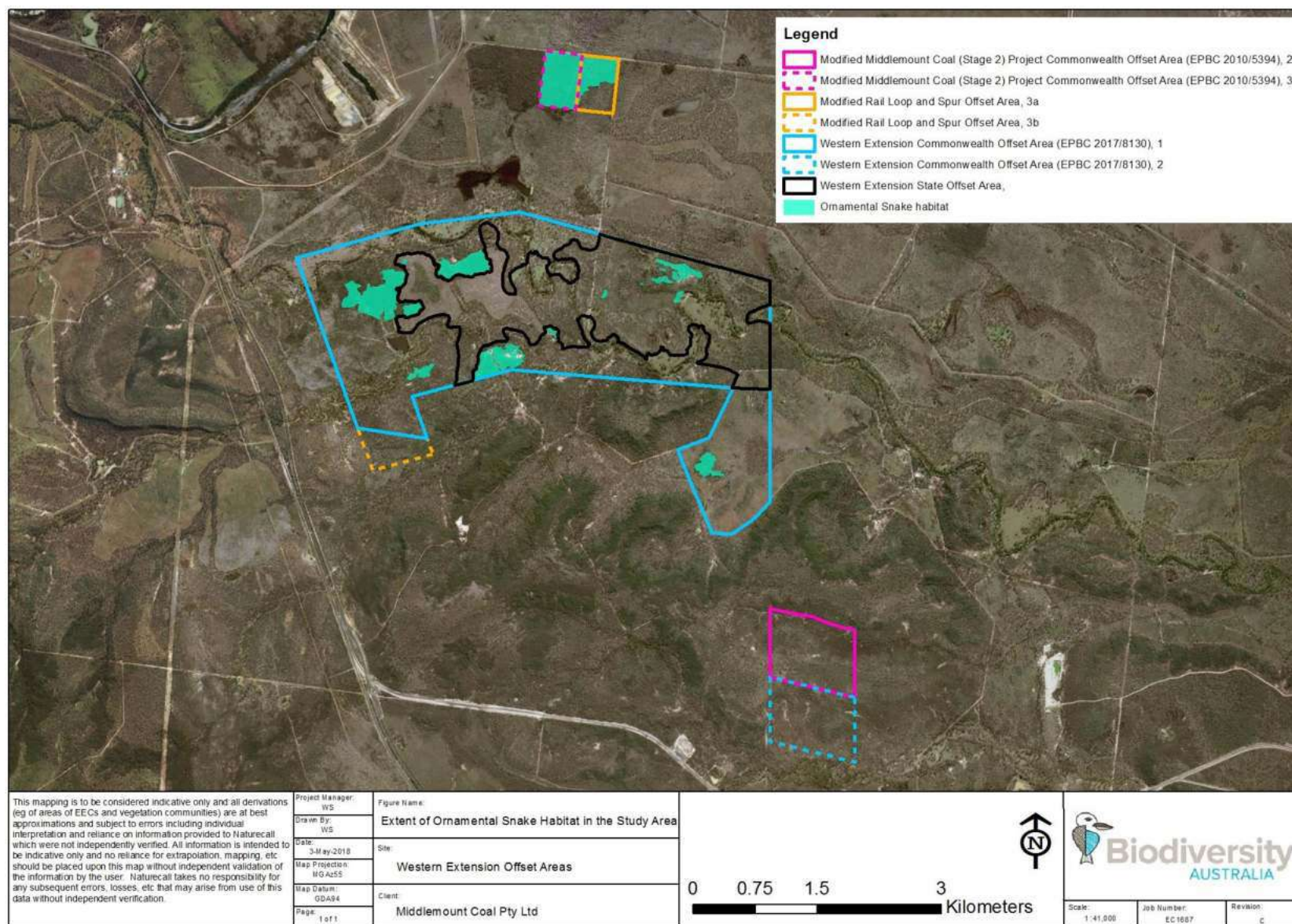
The Ornamental Snake prefers Brigalow, Gidgee, Blackwood or Coolabah dominated vegetation communities or grasslands associated with gilgais (DEE 2017c). It is often associated with wetlands and moist areas where preferred prey species (frogs) are common (DEE 2017c).

This species was recorded in the Stage 2 Project Area by PB (2010) in a degraded patch of Brigalow woodland that contained gilgai, thick leaf litter and abundant fallen timber (PB 2010; see Figure 17).

This species was not recorded during opportunistic herpetofauna surveys within the study sites, however suitable habitat for this species is present (Figure 21). The larger patches of remnant Brigalow (i.e. RE 11.3.1, RE 11.4.8, RE 11.4.9 and RE 11.4.9a) were found to be in good condition and contained the necessary microhabitat features for the Ornamental Snake, such as leaf litter, fallen timber, cracking clay soils and gilgai.



Figure 21: Ornamental Snake habitat within the study sites





Summary

Table 27 provides a summary of the extent of potential habitat for each of the above threatened species within each relevant offset area. Figure 22 also shows the location of threatened fauna species detected during the recent fauna surveys.

Table 27: Area of potential habitat for threatened species within the Offset Areas

Species	Potential Habitat			
	Western Extension Commonwealth Offset Area	Western Extension State Offset Area	Modified Stage 2 Commonwealth Offset Area (a) and (b)	Modified Rail Loop and Spur Offset Area (a) and (b)
Ornamental Snake	76	N/A	29.5	N/A
Squatter Pigeon (southern)	1,134	N/A	114.5	N/A
Koala	683.5	N/A	N/A	N/A
Greater Glider	575	N/A	12.4	N/A

5.6.4. Migratory Fauna Species

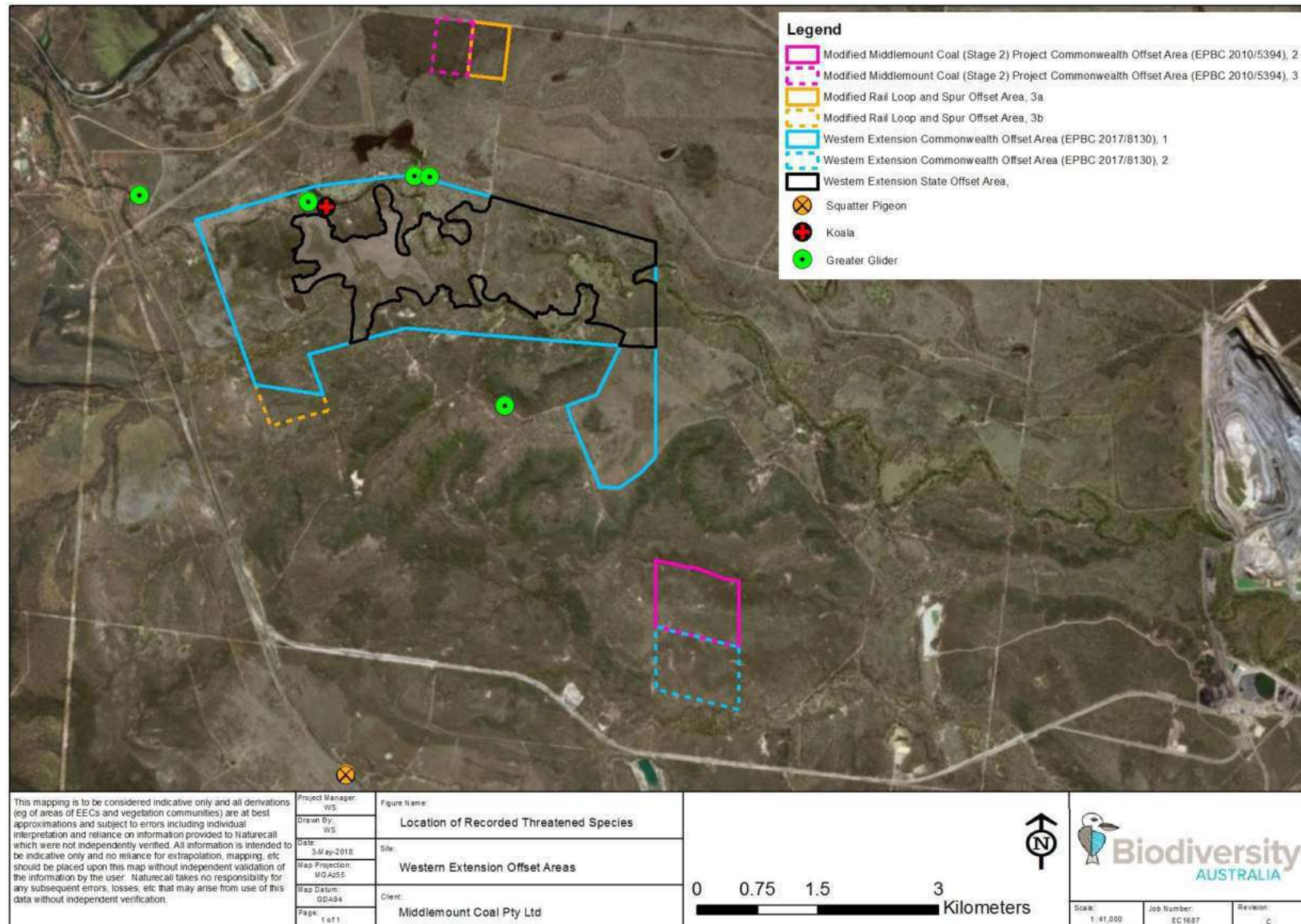
No migratory species were recorded during the field surveys.

5.6.5. Exotic Fauna Species

A feral cat was directly observed in the Western Extension Commonwealth Offset Area (1) during the spotlighting survey. Cat tracks were also occasionally observed on the surrounding roads and access tracks. No wild dogs were observed within the study sites, however dog tracks were recorded on access tracks and in dry creek beds. The only other exotic fauna species detected within the study sites was the European Rabbit.



Figure 22: Threatened fauna species detected during recent surveys





6.0 Summary and Conclusion

The study sites are located approximately 270 km north-west of Rockhampton and 3 km south-west of the Middlemount Township. The study sites comprise freehold land owned by MCPL and total approximately 1,843 ha in area. This includes a combination of forested/woodland areas along with cleared grazing land.

A desktop study (including comprehensive literature review) was carried out prior to the field survey to gather relevant information and data. Existing DSITI RE mapping of the study sites, as well as previous mapping on adjoining land was obtained and used in conjunction with satellite imagery to identify the broad vegetation types present within the study sites.

Flora and fauna surveys were undertaken throughout the study sites from 18-21 July 2017 and 20-26 November 2017. Terrestrial habitat quality assessments were completed at 44 locations spread across the four offset areas. The fauna surveys comprised habitat suitability assessment, opportunistic surveys for threatened species, track, scat and secondary evidence searches as well as opportunistic fauna observations.

The study sites was categorised into seven broad fauna habitat types (i.e. eucalypt woodland/forest, micromyrtus shrubland, riparian habitat, *acacia shirleyi* forest, wetlands, *acacia harpophylla* woodland/forest, and regrowth/derived grassland). Eucalypt woodland was the most common habitat type on the study sites. A number of habitat features were well represented in eucalypt woodlands such as hollow-bearing trees, coarse woody debris, nectar sources and native groundcover. It is considered that the various habitat types present on site would provide suitable habitat for a range of conservation significant fauna species including the Squatter Pigeon (southern), Greater Glider, Koala and Ornamental Snake.

No threatened flora species were detected during the survey. The less disturbed remnant areas displayed attributes with similar values to the published benchmarks. While non-remnant areas generally contained more weed species they showed positive signs of natural regeneration.

Three threatened fauna species were recorded during the field surveys, namely the Koala, Greater Glider and Squatter Pigeon (southern). These species are listed as Vulnerable under the NC Act and EPBC Act. A fourth threatened species, the Ornamental Snake, was also considered a potential occurrence in the study sites based on local records identified in the literature and database searches and presence of suitable habitat.

Species habitat index scores were calculated for the Squatter Pigeon (southern), Greater Glider, Koala and Ornamental Snake for each assessment unit within the Western Extension Commonwealth Offset Area. The overall Habitat Quality Scores for the four threatened fauna species within the study sites ranged between 5.90 and 7.41.



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Appendix 1: Site Flora Species List

Common name	Scientific name	NC Act Status
Canopy Trees		
Ironwood	<i>Acacia excelsa</i>	LC
Brigalow	<i>Acacia harpophylla</i>	LC
Inland Rosewood	<i>Acacia rhodoxylon</i>	LC
Lancewood	<i>Acacia shirleyi</i>	LC
Smooth-barked Apple	<i>Angophora leiocarpa</i>	LC
Clarkson's Bloodwood	<i>Corymbia clarksoniana</i>	LC
Dallachy's Gum	<i>Corymbia dallachiana</i>	LC
Moreton Bay Ash	<i>Corymbia tessellaris</i>	LC
Reid River Box	<i>Eucalyptus brownii</i>	LC
Dawson's Gum	<i>Eucalyptus cambageana</i>	LC
Narrow-leaved Ironbark	<i>Eucalyptus crebra</i>	LC
Peppermint	<i>Eucalyptus exserta</i>	LC
Silver-leaved Ironbark	<i>Eucalyptus melanophloia</i>	LC
Poplar Box	<i>Eucalyptus populnea</i>	LC
Queensland Blue Gum	<i>Eucalyptus tereticornis</i>	LC
Swamp Box	<i>Lophostemon suaveolens</i>	LC
Understorey Trees and Shrubs		
Bendee	<i>Acacia catenulata</i>	LC
-	<i>Acacia cretata</i>	LC
Black Wattle	<i>Acacia leiocalyx</i>	LC
Native Willow	<i>Acacia salicina</i>	LC
Bull Oak	<i>Allocasuarina luehmannii</i>	LC
Red Ash	<i>Alphitonia excelsa</i>	LC
Bitter bark	<i>Alstonia constricta</i>	LC
Whitewood	<i>Atalaya hemiglauca</i>	LC
Coffee Bush	<i>Breynia oblongifolia</i>	LC
Prickly Pine	<i>Bursaria incana</i>	LC
Wild Orange	<i>Capparis canescens</i>	LC
Narrowleaf bumle-tree	<i>Capparis loranthifolia</i>	LC
-	<i>Capparis mitchelli</i>	LC
Currant Bush	<i>Carissa ovata</i>	LC
Leichhardt Bean	<i>Cassia brewsteri</i>	LC
Belah	<i>Casuarina cristata</i>	LC
River Oak	<i>Casuarina cunninghamiana</i>	LC
Limebush	<i>Citrus glauca</i>	LC
-	<i>Denhamia cunninghamii</i>	LC
Native Ebony	<i>Diospyros humilis</i>	LC
Hop Bush	<i>Dodonaea viscosa</i>	LC



Common name	Scientific name	NC Act Status
Turkey Bush	<i>Eremophila deserti</i>	LC
Harrisia Cactus	<i>Harrisia martinii</i> *	LC
Batswing Coral Tree	<i>Erythrina vespertilio</i>	LC
False Sandalwood	<i>Eremophila mitchellii</i>	LC
Emu Bush	<i>Eremophila nivea</i>	LC
Cocaine Tree	<i>Erythroxylum australe</i>	LC
Native Guava	<i>Eupomatia laurina</i>	LC
Sandpaper Fig	<i>Ficus opposita</i>	LC
Scrub Leopardwood	<i>Flindersia dissosperma</i>	LC
Wilga	<i>Geijera parviflora</i>	LC
Beefwood	<i>Grevillea striata</i>	LC
Dysentery Bush	<i>Grewia latifolia</i>	LC
Bootlace Oak	<i>Hakea lorea</i>	LC
Red Bauhinia	<i>Lysiphyllum carronii</i> *	LC
Black Teatree	<i>Melaleuca bracteata</i>	LC
Fibre bark	<i>Melaleuca nervosa</i>	LC
-	<i>Micromyrtus capricornia</i>	LC
Boobialla	<i>Myoporum montanum</i>	LC
Native Olive	<i>Notelaea microcarpa</i>	LC
Prickly Pear	<i>Opuntia elata</i> *	LC
Velvety Tree Pear	<i>Opuntia tomentosa</i> *	
Gooya	<i>Owenia acidula</i>	LC
-	<i>Pittosporum sp.</i>	LC
Quinine Tree	<i>Petalostigma pubescens</i>	LC
-	<i>Psyrdrax attenuata</i>	LC
-	<i>Solanum parvifolium</i>	LC
Yellow-wood	<i>Terminalia oblongata</i>	LC
Vine Tree	<i>Ventilago viminalis</i>	LC
Grasses		
Kerosene Grass	<i>Aristida holathera</i>	LC
Feathertop Wiregrass	<i>Aristida latifolia</i>	LC
Buffel Grass	<i>Cenchrus ciliaris</i> *	LC
-	<i>Chloris sp.</i>	LC
Windmill Grass	<i>Chloris truncata</i>	LC
Cotton Panic Grass	<i>Digitaria brownii</i>	LC
-	<i>Eragrostis sp.</i>	LC
Black Speargrass	<i>Heteropogon contortus</i>	LC
Golden Weather-grass	<i>Hypoxis hygrometrica</i>	LC
Blady Grass	<i>Imperata cylindrica</i>	LC
Red Natal Grass	<i>Melinis repens</i> *	LC
Brigalow Grass	<i>Paspalidium caespitosum</i>	LC



Common name	Scientific name	NC Act Status
-	<i>Setaria sp.*</i>	LC
Fairy Grass	<i>Sporobolus caroli</i>	LC
Kangaroo Grass	<i>Themeda triandra</i>	LC
Sabi Grass	<i>Urochloa mosambicensis*</i>	LC
Groundcovers		
Chaff Flower	<i>Achyranthes aspera*</i>	LC
Mexican Poppy	<i>Argemone ochroleuca*</i>	LC
Creeping Saltbush	<i>Atriplex semibaccata</i>	LC
Cobbler's Pegs	<i>Bidens pilosa*</i>	LC
-	<i>Cassytha sp.</i>	LC
Rock Fern	<i>Cheilanthes sieberi</i>	LC
Lambs Quarter's	<i>Chenopodium album*</i>	LC
Yellow Buttons	<i>Chrysocephalum apiculatum</i>	LC
Flaxleaf Fleabane	<i>Conyza bonariensis*</i>	LC
Darling Lily	<i>Crinum flaccidum</i>	LC
Lance-leaved Rattlepod	<i>Crotalaria lanceolata*</i>	LC
Yellow Rattlepod	<i>Crotalaria mitchellii</i>	LC
Slender Flat-sedge	<i>Cyperus gracilis</i>	LC
Ruby Saltbush	<i>Enchylaena tomentosa</i>	LC
Winter Apple	<i>Eremophila debilis</i>	LC
Gomphrena Weed	<i>Gomphrena celsioides*</i>	LC
Parthenium	<i>Parthenium hysterophorus*</i>	LC
Pigweed	<i>Portulaca oleracea*</i>	LC
White root	<i>Pratia purpurascens*</i>	LC
Soft Roly-poly	<i>Salsola kali</i>	LC
Flannel Weed	<i>Sida hackettiana*</i>	LC
Spiked Sida	<i>Sida subspicata</i>	
Stylo	<i>Stylosanthes scabra*</i>	LC
Purple top	<i>Verbena bonariensis*</i>	LC
Bluebell	<i>Wahlenbergia gracilis</i>	LC
Spiny-headed Matrush	<i>Lomandra longifolia</i>	LC
Lianas, Scramblers and Twiners		
Nepine	<i>Capparis lasiantha</i>	LC
-	<i>Desmodium macrocarpum</i>	LC
-	<i>Glycine clandestina</i>	LC
Bush Banana	<i>Marsdenia viridiflora</i>	LC
Rough Silkpod	<i>Parsonsia lanceolata</i>	LC
Orchids and Epiphytes		
Tiger Orchid	<i>Cymbidium canaliculatum</i>	LC

* Denotes an introduced species



Appendix 2: Site Fauna Species List

Common Name	Scientific Name	Detection Method ¹
Birds		
Grey Teal	<i>Anas gracilis</i>	OBS
Pacific Black Duck	<i>Anas superciliosa</i>	OBS, HC
Australasian Darter	<i>Anhinga novaehollandiae</i>	OBS
Richards Pipit	<i>Anthus novaeseelandiae</i>	OBS
Red-winged Parrot	<i>Aprosmictus erythropterus</i>	OBS
Great Egret	<i>Ardea alba</i>	OBS
Cattle Egret	<i>Ardea ibis</i>	OBS
Australian Bustard	<i>Ardeotis australis</i>	OBS
Hardhead	<i>Aythya australis</i>	OBS
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	OBS, HC
Pheasant Coucal	<i>Centropus phasianinus</i>	OBS
Azure Kingfisher	<i>Ceyx azureus</i>	OBS
Red-capped Plover	<i>Charadrius ruficapillus</i>	OBS
Australian Wood Duck	<i>Chenonetta jubata</i>	OBS
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	OBS, HC
Australian Raven	<i>Corvus coronoides</i>	HC
Torresian Crow	<i>Corvus orru</i>	OBS, HC
Cicadabird	<i>Coracina tenuirostris</i>	OBS, HC
Pied Butcherbird	<i>Cracticus nigrogularis</i>	HC
Grey Butcherbird	<i>Cracticus torquatus</i>	OBS
Black Swan	<i>Cygnus atratus</i>	OBS
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	OBS, HC
Blue-winged Kookaburra	<i>Dacelo leachii</i>	OBS
Emu	<i>Dromaius novaehollandiae</i>	OBS
White-faced Heron	<i>Egretta novaehollandiae</i>	OBS
Black-fronted Dotterel	<i>Elsayornis melanops</i>	OBS
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>	OBS
Galah	<i>Eolophus roseicapilla</i>	OBS
Eastern Koel	<i>Eudynamys orientalis</i>	OBS
Dollarbird	<i>Eurystomus orientalis</i>	OBS
Australian Hobby	<i>Falco longipennis</i>	OBS
Eurasian Coot	<i>Fulica atra</i>	OBS
Bar-shouldered Dove	<i>Geopelia humeralis</i>	OBS
Peaceful Dove	<i>Geopelia placida</i>	OBS, HC
White-throated Gerygone	<i>Gerygone albogularis</i>	OBS, HC
Magpie-lark	<i>Grallina cyanoleuca</i>	OBS



Common Name	Scientific Name	Detection Method ¹
Brolga	<i>Grus rubicunda</i>	OBS
Australian Magpie	<i>Gymnorhina tibicen</i>	OBS, HC
Whistling Kite	<i>Haliastur sphenurus</i>	OBS, HC
Black-winged Stilt	<i>Himantopus himantopus</i>	OBS
Welcome Swallow	<i>Hirundo neoxena</i>	OBS
Red-backed Fairy-wren	<i>Malurus melanocephalus</i>	OBS
Noisy Miner	<i>Manorina melanocephala</i>	OBS, HC
Rainbow Bee-eater	<i>Merops ornatus</i>	HC
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>	OBS
Black Kite	<i>Milvus migrans</i>	OBS
Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>	OBS
Crested Pigeon	<i>Ocyphaps lophotes</i>	OBS
Olive-backed Oriole	<i>Oriolus sagittatus</i>	OBS
Striated Pardalote	<i>Pardalotus striatus</i>	OBS, HC
Australian Pelican	<i>Pelecanus conspicillatus</i>	OBS
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	OBS
Pied Cormorant	<i>Phalacrocorax varius</i>	OBS
Common Bronzewing	<i>Phaps chalcoptera</i>	OBS
Little Friarbird	<i>Philemon citreogularis</i>	OBS, HC
Noisy Friarbird	<i>Philemon corniculatus</i>	OBS, HC
Pale-headed Rosella	<i>Platycercus adscitus</i>	OBS, HC
Glossy Ibis	<i>Plegadis falcinellus</i>	OBS
Tawny Frogmouth	<i>Podargus strigoides</i>	OBS
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>	OBS
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>	OBS, HC
Willie Wagtail	<i>Rhipidura leucophrys</i>	OBS
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>	OBS
Apostlebird	<i>Struthidea cinerea</i>	OBS
Australian Grebe	<i>Tachybaptus novaehollandiae</i>	OBS
Double-barred Finch	<i>Taeniopygia bichenovii</i>	OBS
Australian White Ibis	<i>Threskiornis molucca</i>	OBS
Straw-necked Ibis	<i>Threskiornis spinicollis</i>	OBS
Forest Kingfisher	<i>Todiramphus macleayi</i>	OBS
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	HC
Masked Lapwing	<i>Vanellus miles</i>	OBS
Singing Honeyeater	<i>Lichenostomus virescens</i>	OBS, HC
Mammals		
Dog	<i>Canis lupus familiaris</i> *	TRA
Feral Cat	<i>Felis catus</i> *	OBS



Common Name	Scientific Name	Detection Method ¹
Eastern Grey Kangaroo	<i>Macropus giganteus</i>	OBS, SC, TRA
Common Wallaroo	<i>Macropus robustus</i>	OBS
Swamp Wallaby	<i>Wallabia bicolor</i>	OBS
Red-necked Wallaby	<i>Macropus rufogriseus</i>	OBS
Rufous Bettong	<i>Aepyprymnus rufescens</i>	OBS
European Rabbit	<i>Oryctolagus cuniculus</i> *	SC
Greater Glider ^{+,^}	<i>Petauroides volans</i>	OBS
Koala ^{+,^}	<i>Phascolarctos cinereus</i>	OBS
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	OBS
Reptiles		
Open Litter Rainbow Skink	<i>Carlia pectoralis</i>	OBS
Wall Skink	<i>Cryptoblepharus virgatus</i>	OBS
Copper-tailed Skink	<i>Ctenotus taeniolatus</i>	OBS
Bynoe's Gecko	<i>Heteronotia binoei</i>	OBS
¹ Codes: Direct Observation (OBS), Heard Call (HC), Tracks (TRA), Scat (SC) * Denotes exotic species ^ Vulnerable EPBC Act + Vulnerable NC Act # Migratory EPBC Act		



Appendix 3: EPBC Offset Calculator Justifications

JUSTIFICATION FOR THE INPUTS TO THE COMMONWEALTH OFFSET CALCULATOR

Table A-1
Calculator Inputs and Output – Squatter Pigeon (Southern) (Non-remnant Vegetation Offset)

Aspect	Input	Justification
Impact		
Species Status	Vulnerable	-
Area of Habitat to be Impacted	388.5 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	7	In consideration of the site condition and context, a quality value of 7 is considered appropriate for the Squatter Pigeon (southern) because: • this species has been recorded in a few locations within the Action area. • much of the potential habitat to be cleared has been subject to past disturbances (e.g. logging).
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Areas of habitat within the offset areas are considered to contain a number of native grass species which provide a potential food resource for the Squatter Pigeon (southern). Some areas also have a mosaic of open sandy areas and native grasses which is preferred habitat for this species. Natural regeneration is likely to further increase the extent of habitat over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of habitat for the Squatter Pigeon (southern). As a minimum, management of the offset areas would include: • weed control; • feral animal control; and • management of livestock grazing. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	395.5 ha	Area defined during field survey, consisting of 395.5 ha of woodland habitat mapped by Naturecall (2018).
Start Quality (0 to 10)	2	Dominant ground cover composition within the non-remnant vegetation is exotic grasses with native grasses and herbs being less common. The areas with a higher percentage of native grass species would provide some potential food resources for the Squatter Pigeon (southern).

Table A-1 (Continued)
Calculator Inputs and Output – Squatter Pigeon (Southern) (Non -remnant Vegetation Offset)

Aspect	Input	Justification
Risk of loss (%) without offset	0%	Within the next 20 years, without the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	0	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	5	An increase in quality is anticipated with protection of existing vegetation and implementation of weed control measures and active seeding/planting (as required).
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and management of livestock grazing) would effectively improve the habitat quality for the Squatter Pigeon (southern). MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the QLD <i>Vegetation Management Act, 1999</i>. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		57.59%

Table A-2
Calculator Inputs and Output – Squatter Pigeon (Southern) (Remnant Vegetation Offset)

Aspect	Input	Justification
Impact		
Species Status	Vulnerable	-
Area of Habitat to be Impacted	388.5 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	7	In consideration of the site condition and context, a quality value of 7 is considered appropriate for the Squatter Pigeon (southern) because: • this species has been recorded in one location within the Action area. • much of the potential habitat to be cleared has been subject to past disturbances (e.g. logging).
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Areas of habitat within the offset areas are considered to contain a number of native grass species which provide a potential food resource for the Squatter Pigeon (southern). Some areas also have a mosaic of open sandy areas and native grasses which is preferred habitat for this species. Natural regeneration is likely to further increase the extent of habitat over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of habitat for the Squatter Pigeon (southern). As a minimum, management of the offset areas would include: • weed control; • feral animal control; and • management of livestock. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	759.5 ha	Area defined during field survey, consisting of 759.5 ha of woodland habitat mapped by Naturecall (2018).
Start Quality (0 to 10)	7	Areas of habitat within the offset areas are considered to have a similar starting quality as the habitat in the impact area.

Table A-2 (Continued)
Calculator Inputs and Output – Squatter Pigeon (Southern) (Remnant Vegetation Offset)

Aspect	Input	Justification
Risk of loss (%) without offset	0%	Within the next 20 years, without the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	5	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	8	An increase in quality is anticipated with natural regeneration and protection of existing vegetation. A quality value of 8 is considered appropriate because: - the starting quality is 7; - weeds would be managed; - livestock would be managed; and - feral animals would be controlled.
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and management of livestock grazing) would effectively improve the habitat quality for the Squatter Pigeon (southern). MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the QLD Vegetation Management Act, 1999. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		66.36%

Table A-3
Calculator Inputs and Output – Koala (Remnant Vegetation Offset)

Aspect	Input	Justification
Impact		
Species Status	Vulnerable	-
Area of Habitat to be Impacted	175 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	7	In consideration of the site condition and context, a quality value of 7 is considered appropriate for the Koala because: • this species has been recorded in a few locations within the Action area. • much of the potential habitat to be cleared has been subject to past disturbances (e.g. logging). • no critical habitat would be disturbed by the Action; • important food species (Van Dyck and Strahan, 2008; Land for Wildlife, 2014) for the Koala are rare within the Action area.
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Areas of habitat within the offset areas contain important food trees for the Koala. Natural regeneration is likely to further increase the extent of potential habitat over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of habitat for the Koala. As a minimum, management of the offset areas would include: • weed control; • feral animal control; and • management of livestock grazing. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	683.5 ha	Area defined during field survey, consisting of 683.5 ha of woodland habitat mapped by Naturecall (2018).
Start Quality (0 to 10)	6	Areas of habitat within the offset areas are considered to have a similar starting quality as the habitat in the impact area.

Table A-3 (Continued)
Calculator Inputs and Output – Koala (Remnant Vegetation Offset)

Aspect	Input	Justification
Risk of loss (%) without offset	0%	Within the next 20 years, without the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	4	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	7	An increase in quality is anticipated with natural regeneration and protection of existing vegetation. A quality value of 7 is considered appropriate because: - the starting quality is 6; - livestock would be managed; - weeds would be managed; and - feral animals would be controlled.
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and management of livestock grazing) would effectively improve the habitat quality for the Koala. MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the <i>QLD Vegetation Management Act, 1999</i>. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		132.58%

Table A-4
Calculator Inputs and Output – Greater Glider (Remnant Vegetation Offset)

Aspect	Input	Justification
Impact		
Species Status	Vulnerable	-
Area of Habitat to be Impacted	175 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	7	In consideration of the site condition and context, a quality value of 7 is considered appropriate for the Greater Glider because: - this species has been recorded in a few locations within the Action area. - much of the potential habitat to be cleared has been subject to past disturbances (e.g. logging).
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Areas of habitat within the offset areas contain potential foraging and roosting habitat for the Greater Glider. Natural regeneration is likely to further increase the extent of potential habitat over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of habitat for the Greater Glider. As a minimum, management of the offset areas would include: - weed control; - feral animal control; and - management of livestock grazing. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	590 ha	Area defined during field survey, consisting of 590 ha of woodland habitat mapped by Naturecall (2016b).
Start Quality (0 to 10)	7	Areas of habitat within the offset areas are considered to have a similar starting quality as the habitat in the impact area.
Risk of loss (%) without offset	0%	Within the next 20 years, without the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	5	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).

Table A-4 (Continued)
Calculator Inputs and Output – Greater Glider (Remnant Vegetation Offset)

Aspect	Input	Justification
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	8	An increase in quality is anticipated with natural regeneration and protection of existing vegetation. A quality value of 8 is considered appropriate because: - the starting quality is 7; - livestock would be excluded (i.e. removal of grazing pressures); - weeds would be managed; and - feral animals would be controlled.
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and removal of livestock grazing) would effectively improve the habitat quality for the South-eastern Long-eared Bat. MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the <i>QLD Vegetation Management Act, 1999</i>. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		114.44%

Table A-5
Calculator Inputs and Output – Ornamental Snake (Remnant Vegetation Offset)

Aspect	Input	Justification
Impact		
Species Status	Vulnerable	-
Area of Habitat to be Impacted	15.5 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	6	In consideration of the site condition and context, a quality value of 6 is considered appropriate for the Ornamental Snake because: - this species has not been recorded within the Action area despite targeted survey work. - the Action area does not contain large areas of Gilgal habitat.
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Areas of habitat within the offset areas contain potential habitat for the Ornamental Snake. Natural regeneration is likely to further increase the extent of potential habitat over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of habitat for the Ornamental Snake. As a minimum, management of the offset areas would include: - weed control; - feral animal control; and - management of livestock grazing. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	76 ha	Area defined during field survey, consisting of 76 ha of woodland habitat mapped by Naturecall (2018).
Start Quality (0 to 10)	7	Areas of habitat within the offset areas are considered to have a similar starting quality as the habitat in the impact area, however the presence of permanent waterbodies increase the quality of habitat for this species based on the likely presence of prey species.
Risk of loss (%) without offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	6	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).

Table A-5 (Continued)
Calculator Inputs and Output – Ornamental Snake (Remnant Vegetation Offset)

Aspect	Input	Justification
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	8	An increase in quality is anticipated with natural regeneration and protection of existing vegetation. A quality value of 8 is considered appropriate because: - the starting quality is 7; - livestock would be excluded (i.e. removal of grazing pressures); - weeds would be managed; and - feral animals would be controlled.
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and removal of livestock grazing) would effectively improve the habitat quality for the South-eastern Long-eared Bat. MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the <i>QLD Vegetation Management Act, 1999</i>. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		129.45%

Table A-6
Calculator Inputs and Output – Brigalow (Remnant Vegetation Offset)

Aspect	Input	Justification
Impact		
Species Status	Endangered	-
Area of Habitat to be Impacted	22 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	6	In consideration of the site condition and context, a quality value of 6 is considered appropriate for Brigalow Woodland on-site because: • much of the Brigalow Woodland to be cleared has been subject to past disturbances. • approximately 5 ha of the Brigalow Woodland is comprised of non-remnant vegetation
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Natural regeneration is likely to further increase the extent of Brigalow Woodland over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of Brigalow Woodland. As a minimum, management of the offset areas would include: • weed control; • feral animal control; and • management of livestock grazing. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	70.5 ha	Area defined during field survey, consisting of 70.5 ha of woodland habitat mapped by Naturecall (2018).
Start Quality (0 to 10)	6	Areas of habitat within the offset areas are considered to have a similar starting quality as the habitat in the impact area.
Risk of loss (%) without offset	0%	Within the next 20 years, without the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	4	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).

Table A-6 (Continued)
Calculator Inputs and Output – Brigalow (Remnant Vegetation Offset)

Aspect	Input	Justification
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	7	An increase in quality is anticipated with natural regeneration and protection of existing vegetation. A quality value of 7 is considered appropriate because: - the starting quality is 6; - livestock would be excluded (i.e. removal of grazing pressures); - weeds would be managed; and - feral animals would be controlled.
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and removal of livestock grazing) would effectively improve the habitat quality for the South-eastern Long-eared Bat. MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the <i>QLD Vegetation Management Act, 1999</i>. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		120.98%

Table A-7
Calculator Inputs and Output – Stage 2 Commonwealth Offset (Brigalow)

Aspect	Input	Justification
Impact		
Species Status	Endangered	-
Area of Habitat to be Impacted	11 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	6	In consideration of the site condition and context, a quality value of 6 is considered appropriate for Brigalow Woodland on-site because: • much of the Brigalow Woodland to be cleared has been subject to past disturbances. • approximately 5 ha of the Brigalow Woodland is comprised of non-remnant vegetation
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Natural regeneration is likely to further increase the extent of Brigalow Woodland over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of Brigalow Woodland. As a minimum, management of the offset areas would include: • weed control; • feral animal control; and • management of livestock grazing. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	29.5 ha	Area defined during field survey, consisting of 29.5 ha of woodland habitat mapped by Naturecall (2018).
Start Quality (0 to 10)	6	Areas of habitat within the offset areas are considered to have a similar starting quality as the habitat in the impact area.
Risk of loss (%) without offset	0%	Within the next 20 years, without the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	4	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).

Table A-7 (Continued)
Calculator Inputs and Output – Stage 2 Commonwealth Offset (Brigalow)

Aspect	Input	Justification
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	7	An increase in quality is anticipated with natural regeneration and protection of existing vegetation. A quality value of 7 is considered appropriate because: - the starting quality is 6; - livestock would be excluded (i.e. removal of grazing pressures); - weeds would be managed; and - feral animals would be controlled.
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and removal of livestock grazing) would effectively improve the habitat quality for the South-eastern Long-eared Bat. MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the <i>QLD Vegetation Management Act, 1999</i>. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		101.06%

Table A-8
Calculator Inputs and Output – Stage 2 Commonwealth Offset (Squatter Pigeon)

Aspect	Input	Justification
Impact		
Species Status	Endangered	-
Area of Habitat to be Impacted	32 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	7	In consideration of the site condition and context, a quality value of 7 is considered appropriate for the Squatter Pigeon (southern) because: - this species has been recorded in one location within the Action area. - much of the potential habitat to be cleared has been subject to past disturbances (e.g. logging).
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Areas of habitat within the offset areas are considered to contain a number of native grass species which provide a potential food resource for the Squatter Pigeon (southern). Some areas also have a mosaic of open sandy areas and native grasses which is preferred habitat for this species. Natural regeneration is likely to further increase the extent of habitat over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of habitat for the Squatter Pigeon (southern). As a minimum, management of the offset areas would include: - weed control; - feral animal control; and - management of livestock. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	114 ha	Area defined during field survey, consisting of 114 ha of woodland habitat mapped by Naturecall (2018).
Start Quality (0 to 10)	6	Areas of habitat within the offset areas are considered to have a similar starting quality as the habitat in the impact area.
Risk of loss (%) without offset	0%	Within the next 20 years, without the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	4	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).

Table A-8 (Continued)
Calculator Inputs and Output – Stage 2 Commonwealth Offset (Squatter Pigeon)

Aspect	Input	Justification
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	7	An increase in quality is anticipated with natural regeneration and protection of existing vegetation. A quality value of 8 is considered appropriate because: - the starting quality is 7; - weeds would be managed; - livestock would be managed; and - feral animals would be controlled.
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and management of livestock grazing) would effectively improve the habitat quality for the Squatter Pigeon (southern). MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the QLD Vegetation Management Act, 1999. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		120.93%

Table A-9
Calculator Inputs and Output – Stage 2 Commonwealth Offset (Ornamental Snake)

Aspect	Input	Justification
Impact		
Species Status	Vulnerable	-
Area of Habitat to be Impacted	7 ha	Habitat area defined by Naturecall (2018) during field surveys.
Quality (0 to 10)	6	In consideration of the site condition and context, a quality value of 6 is considered appropriate for the Ornamental Snake because: - this species has not been recorded within the Action area despite targeted survey work. - the Action area does not contain large areas of Gilgal habitat.
Offset		
Time over which loss is averted (max. 20 years)	20 years	An arrangement would be made for the enduring protection and management of the offset area.
Time until ecological benefit	5 years	Areas of habitat within the offset areas contain potential habitat for the Ornamental Snake. Natural regeneration is likely to further increase the extent of potential habitat over time. Management of the offset areas is expected to improve the quality, composition and extent of patches of habitat for the Ornamental Snake. As a minimum, management of the offset areas would include: - weed control; - feral animal control; and - management of livestock grazing. It is considered that the ecological benefit is likely to conservatively occur within 5 years.
Start area (ha) (Size of the offset)	29.5 ha	Area defined during field survey, consisting of 29.5 ha of woodland habitat mapped by Naturecall (2018).
Start Quality (0 to 10)	7	Areas of habitat within the offset areas are considered to have a similar starting quality as the habitat in the impact area, however the presence of permanent waterbodies increase the quality of habitat for this species based on the likely presence of prey species.
Risk of loss (%) without offset	0%	Within the next 20 years, without the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality without offset (scale of 0-10)	6	A decrease in the quality is possible due to ongoing threatening processes (e.g. grazing, weeds, and feral animals) as there are no long-term conservation measures in place (which otherwise will be, as a result of the offset areas).

Table A-9 (Continued)
Calculator Inputs and Output – Stage 2 Commonwealth Offset (Ornamental Snake)

Aspect	Input	Justification
Risk of loss (%) with offset	0%	Within the next 20 years, with the offset, it is considered that there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	8	An increase in quality is anticipated with natural regeneration and protection of existing vegetation. A quality value of 8 is considered appropriate because: - the starting quality is 7; - livestock would be excluded (i.e. removal of grazing pressures); - weeds would be managed; and - feral animals would be controlled.
Confidence in the result	80%	There is a high level of confidence that loss of habitat values in the offset areas would be averted because an arrangement would be made for the enduring protection and management of the offset areas. There is a high level of confidence that the management measures (e.g. weed control, feral animal control and removal of livestock grazing) would effectively improve the habitat quality for the South-eastern Long-eared Bat. MCPL has a positive history in regards to meeting offsetting requirements. For example, in accordance with Conditions 1 and 2 of the Commonwealth Approval Decision (EPBC 2010/5394), appropriate long-term security for the Stage 2 Biodiversity Offset Area was established by securing a voluntary declaration of the area under the <i>QLD Vegetation Management Act, 1999</i>. Further, it is noted that the land on which the offset area is proposed is freehold land owned by MCPL and as a result, there is certainty regarding the restriction of vegetation clearance activities, the limitation and control of grazing activities and the general access and use of the land.
Calculator Output - % of Impact Offset		111.26%

APPENDIX E

AIR QUALITY IMPACT ASSESSMENT

Middlemount Coal Mine – Western Extension Project Air Quality and Greenhouse Gas Assessment

Prepared for:

Middlemount Coal Pty Ltd (MCPL)

May 2018

Final

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Glossary

Term	Definition
$\mu\text{g}/\text{m}^3$	micrograms per cubic metre
$^{\circ}\text{C}$	degrees Celsius
km	kilometre
m/s	metres per second
m^2	square metres
m^3	cubic metres
Nomenclature	Definition
CH_4	Methane
CO_2	carbon dioxide
$\text{CO}_2\text{-e}$	carbon dioxide equivalents
N_2O	nitrous oxide
PM_{10}	particulate matter with a diameter less than 10 micrometres
$\text{PM}_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
CH_4	methane
Abbreviations	Definition
Air EPP	<i>Environmental Protection (Air) Policy 2008</i>
EF	Emission factor
ERF	Emissions Reduction Fund
GHG	Greenhouse gases
MCM	Middlemount Coal Mine
MCPL	Middlemount Coal Pty Ltd
NGER	National Greenhouse and Energy Reporting
NPI	National Pollutant Inventory database
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by Middlemount Coal Pty Ltd (MCPL) to conduct an air quality and greenhouse gas assessment of a proposed extension of the Middlemount Coal Mine (MCM), herein referred to as the Western Extension Project.

The air quality and greenhouse gas assessment has included the following:

- Analysis of the existing environment at MCM.
- Preparation of dust emissions inventories for Year 2028 and 2032 of the MCM Western Extension Project.
- A comparison of the Western Extension Project dust emission inventories with the dust inventories previously developed and approved for the Stage 2 Middlemount Coal Project Environmental Impact Statement (EIS) (Year 14) and North-eastern Extension Project (Year 2029) and inference of potential air quality impacts.
- Calculation of greenhouse gas emissions for each operational year from 2018 up to and including 2037.

In summary, the air quality and greenhouse gas assessment for the Western Extension Project indicates the following:

- The dust emission rate estimated for the MCM Western Extension Project is lower than the equivalent year of the approved MCM operations. This is due to a reduction of between 12-33% in material (overburden) extraction rates and handling.
- Ground-level concentrations of air pollutants at sensitive receptors will, therefore, be lower than was anticipated by the Stage 2 Middlemount Coal Project EIS and what is currently occurring from MCM operations.
- Annual greenhouse emissions associated with the Project range from 227,581 tonnes of carbon dioxide equivalent (tCO₂-e) to 315,455 tCO₂-e with an average of 288,960 tCO₂-e.
- The majority of GHG emissions are associated with fugitive methane (60%) and diesel (34%).
- MCM will continue to have obligations under both the NGER scheme and the Safeguard Mechanism.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by Middlemount Coal Pty Ltd (MCPL) to conduct an air quality and greenhouse gas assessment of a proposed extension of the Middlemount Coal Mine (MCM), herein referred to as the Western Extension Project.

MCM is an open cut coal mine located in central Queensland, approximately 3 km southwest of the township of Middlemount. MCM has an approved run-of-mine (ROM) capacity of 5.7 million tonnes per annum (Mtpa).

In 2011, Katestone completed an air quality impact assessment as part of the Environmental Impact Statement (EIS) for the Stage 2 Middlemount Coal Project (Katestone, 2011) and in 2015, Katestone completed an air quality assessment for the MCM North-eastern Extension Project (Katestone, 2015).

MCPL received approval for the Stage 2 Middlemount Coal Project and the North-eastern Extension Project.

1.1 Project description

MCPL is now seeking approval for the Western Extension Project via an Environmental Authority (EA) amendment application for which air quality and greenhouse gas assessments are required. The main activities associated with the development of the Western Extension Project would include:

- Extension of the open cut pit within ML 70379 to the north-west;
- Continued extraction of ROM coal up to approximately 5.7 million tonnes per annum (Mtpa) using conventional open cut mining equipment;
- Placement of waste rock in existing emplacements, expanded emplacements (Eastern Dump) and within the mined-out void;
- Continued backfilling of coarse rejects into the pit within spoil, and temporary storage of fine rejects from coal crushing and washing in existing tailings storage facility cells for drying and reclaim for in-pit co-disposal;
- Progressive development of sediment dams, pipelines and other water management equipment and structures (including levees and realignment of an existing diversion structure);
- Progressive development of new haul roads and internal roads;
- Continued development of soil stockpiles, laydown areas and borrow areas;
- Continued use of existing and approved supporting mine infrastructure;
- Continued rail transport of coal products to the Dalrymple Bay Coal Terminal, Abbott Point Coal Terminal or Wiggins Island Coal Export Terminal for export;
- Extension of the approved mine life by approximately six years (to 2037); and
- A change to the final landform at the MCM for the end of the mine life to include two final voids.

1.1 Assessment Scope

The Western Extension Project represents a relatively small change to mining activities. If the Western Extension Project does not cause an increase in dust emissions compared to the air quality assessment that accompanied the Stage 2 Middlemount Coal Project EIS, the EIS's findings will remain valid and further quantitative assessment of the Western Extension Project is not necessary.

Accordingly, Katestone has quantified dust emissions from the Western Extension Project and compared those dust emissions to the emissions presented in the North-eastern Extension Project and Stage 2 Middlemount Coal Project EIS. This report also summarises ambient air quality monitoring conducted at the MCM.

Annual greenhouse gas emissions for the life of the Western Extension Project (2018-2037) have been estimated and summarised in Section 3 of this report.

2. AIR QUALITY ASSESSMENT

This section provides a qualitative air quality assessment for the Western Extension Project and includes:

- a summary of existing air environment including:
 - location of sensitive receptors; and
 - ambient monitoring conducted at the MCM.
- a description of assessment scenarios;
- quantification of dust emissions from the Western Extension Project; and
- comparisons of Western Extension Project dust emissions with the dust emissions presented in the North-eastern Extension Project air quality assessment (Katestone, 2015) and Stage 2 Middlemount Coal Project EIS air quality assessment (Katestone, 2010).

2.1 Existing Environment

The existing environment in the vicinity of MCM is described in the following sections and includes:

- identification of sensitive receptors;
- a summary of dust deposition monitoring; and
- a summary of meteorological monitoring.

2.1.1 Sensitive Receptor Locations

MCM is located in central Queensland, approximately 3 km southwest of the township of Middlemount. Sensitive receptors in proximity to MCM include the residential areas of Middlemount township along with isolated rural homesteads and properties in the region. A map showing the location of the sensitive receptors is provided in Figure 1.



Figure 1 Locations of sensitive receptors

2.1.2 Dust deposition

Dust deposition gauges have been operated on a monthly basis at five locations surrounding MCM from December 2013 to April 2016. The locations of the dust deposition gauges are shown in Figure 1.

The monthly dust deposition rates are summarised in Table 1 and Figure 2.

The monitoring results are generally below the guideline of 4 g/m²/month. On four occasions the dust deposition rate was greater than the guideline of 4 g/m²/month. In February 2014 sites DG1 and DG04 were greater than the guideline and in November 2015 sites DG03 and DG05 were greater than the guidelines. Overall, the measured dust deposition rates are indicative of inland regional areas of Queensland and do not suggest a significant contribution from mining activities.

Table 1 A summary of dust deposition rates measured at MCM

Date	Total insoluble matter (g/m2/month)					
	DG01	DG01a	DG02	DG03	DG04	DG05
December 2013	3.4	-	3.1	1.3	2.3	-
January 2014	1.2	-	2.8	-	2.0	-
February 2014	20.0	-	1.0	-	4.8	-
March 2014	1.3	-	-	2.6	0.6	-
June 2014	1.7	-	1.7	0.8	1.2	-
September 2014	0.9	-	1.2	0.6	0.8	-
October 2014	1.2	-	2.6	2.0	2.4	-
April 2015	-	3.6	-	1.2	2.1	0.5
May 2015	-	2.8	-	0.8	1.1	0.6
June 2015	-	1.4	-	0.6	0.7	0.6
July 2015	-	2.6	-	0.9	1.0	1.8
August 2015	-	3.8	-	1.6	1.9	2.6
September 2015	-	2.6	-	2.0	1.6	2.8
October 2015	-	3.5	-	1.7	1.7	2.2
November 2015	-	3.9	-	8.6	2.8	13.5
December 2015	-	1.5	-	0.8	0.4	-
January 2016	-	-	-	-	-	1.1
February 2016	-	1.8	-	0.7	1.4	1.4
March 2016	-	3.7	-	0.8	1	2
April 2016	-	0.6	-	3.6	1.1	0.8

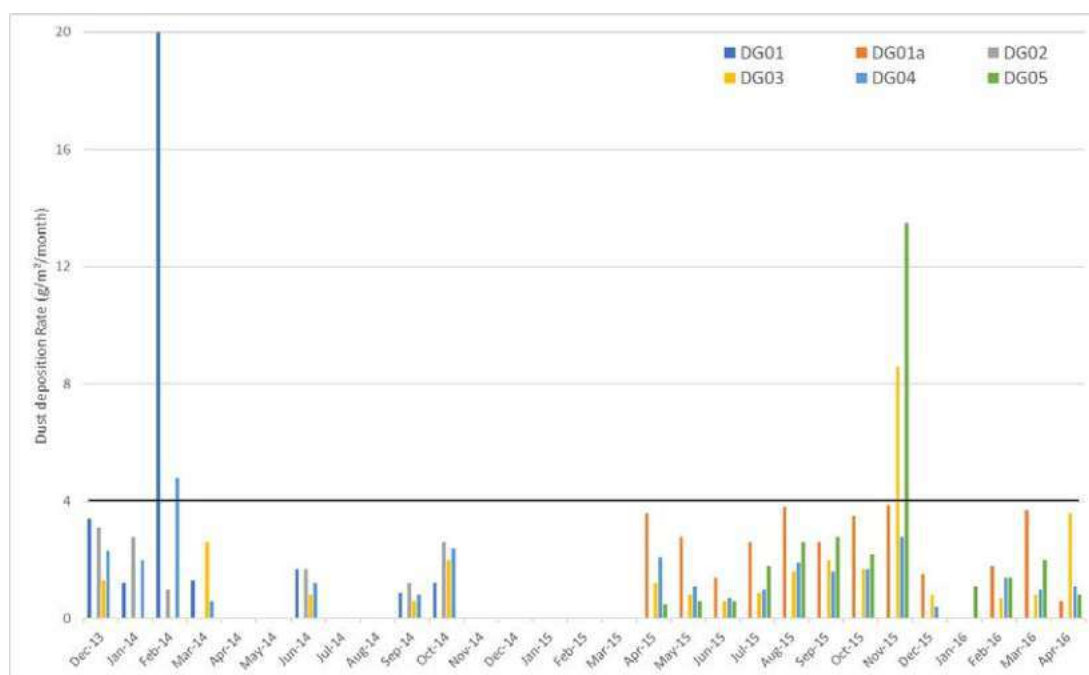


Figure 2 Time-series of measured dust deposition rates

2.1.3 Meteorology

MCPL operates a meteorological station south of the MCM ML 70379 boundary near the rail loop. Meteorological data from September 2013 to July 2017 has been provided as daily averages for the following parameters:

- Average wind speed
- Average wind direction
- Temperature (maximum, minimum and average)
- Total daily rainfall.

Summary statistics of meteorological data measured between September 2013 and July 2017 are provided in Table 2.

Table 2 Summary of daily temperature and rainfall data measured at MCM

Year	Data Capture	Maximum Daily Temperature (°C)		Average Daily Temperature (°C)		Rainfall Total (mm)	Daily maximum rainfall (mm)
		Highest	Average	Highest	Average		
2013	29%	42.9	34.1	33.9	25.5	95.0	29.6
2014	100%	43.9	29.6	35.3	22.2	825.2	105.2
2015	100%	39.7	30.1	31.2	22.5	530.0	104.0
2016	82%	41.2	29.2	32.4	22.0	514.6	87.4
2017	58%	43.3	29.8	34.2	22.5	469.8	82.8

Note: No meteorological data were available from 30 January 2016 to 5 April 2016.

An average daily wind rose for the monitoring period is shown in Figure 3. The average daily winds are predominantly from the southeast quadrant. The average daily winds are relatively light with an average speed of 1.68 m/s.

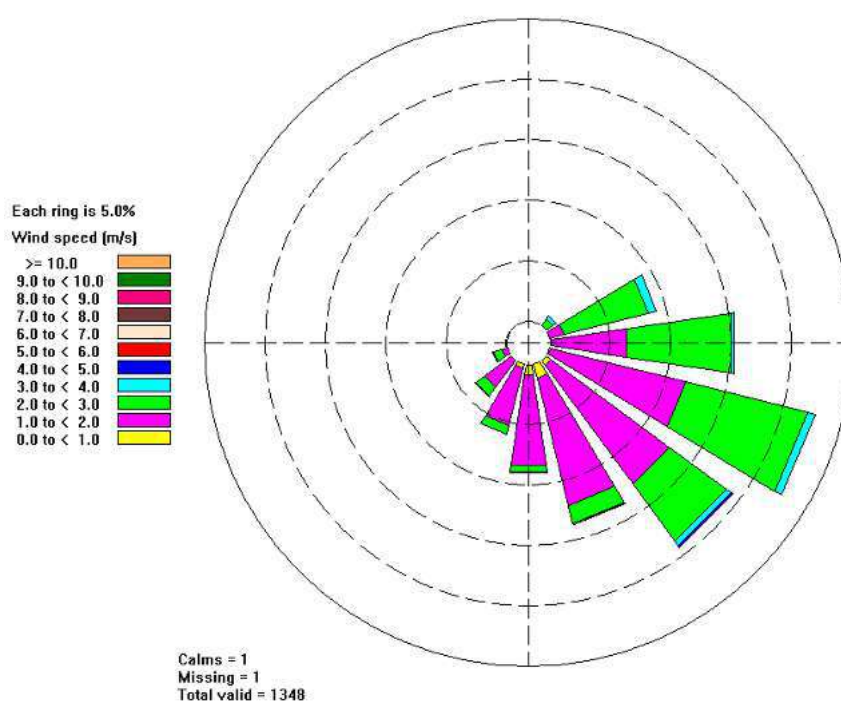


Figure 3 Daily average wind rose at MCM (September 2013 to July 2017)

Time series of daily average temperature and daily rainfall measured at MCM between 2013 to 2017 are shown in Figure 4 and Figure 5, respectively. The temperature profile shows typical central Queensland temperatures with daily average temperatures reaching 28 degrees Celsius (°C) in the summer months, dropping to 18°C in the winter months. The rainfall profile at MCM is indicative of the region with larger rainfall events during summer.



Figure 4 Time-series of daily average air temperature (°C) from September 2013 to July 2017

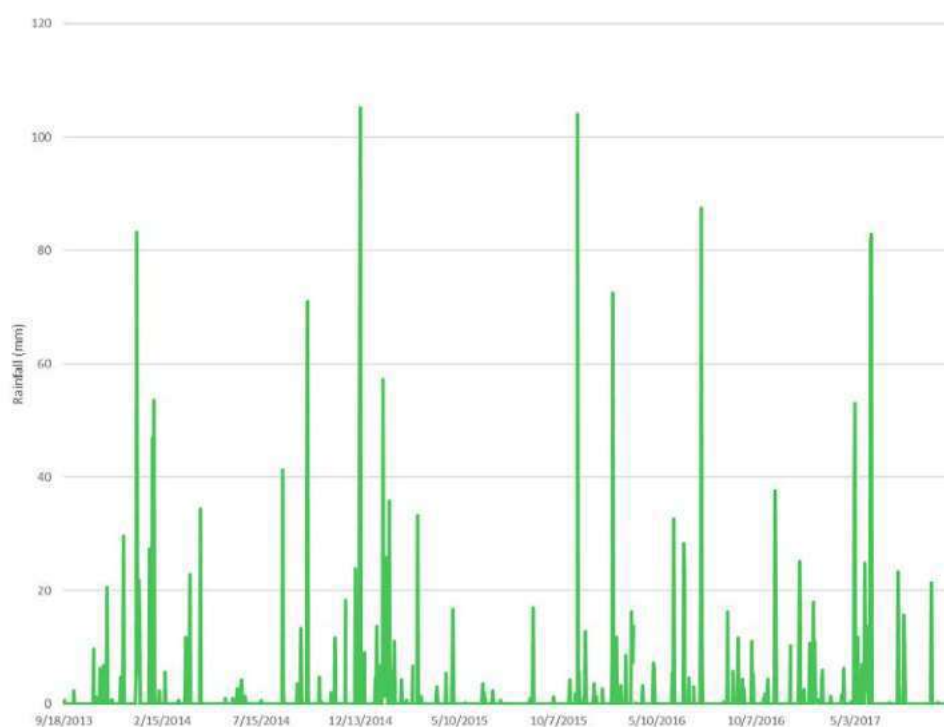


Figure 5 Time-series of daily rainfall (mm) from September 2013 to July 2017

2.2 Scenario Selection

Following review of the Western Extension Project mine plan, two years were selected for assessment purposes. The two years were selected based on material extraction/handling rates, proximity of mining activity to the closest sensitive receivers and other parameters relating to the potential for dust generation. The two selected years (Year 2028 and Year 2032) represent part and full use of the open-cut pit in the northwest and the East Dump waste rock emplacement area within ML 70417 and ML 700014.

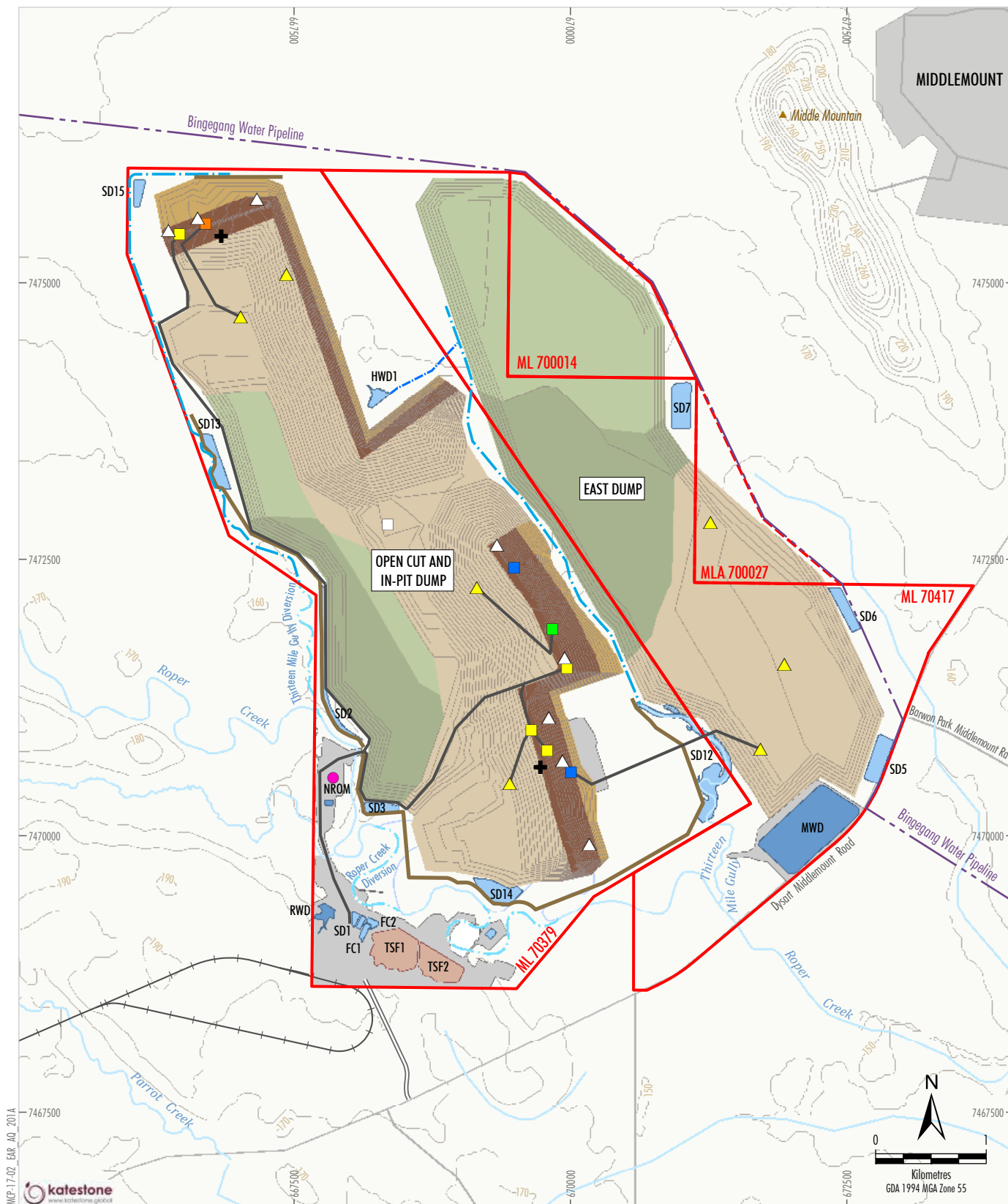
The location of MCM mining activities for Year 2028 and 2032 with the Western Extension Project are shown in Figure 6 and Figure 7, respectively.

The production schedule for the lifetime of the Western Extension Project has been provided by MCPL and details for Year 2028 and 2032 are provided in Table 3. For comparative purposes, Table 3 also includes the amounts of material extracted/handled for Year 14 of the Stage 2 Middlemount Coal Project EIS and Year 2029 of the North-eastern Extension Project, which correspond to Year 2032 of the Western Extension Project.

The production schedule shows that for both Year 2028 and Year 2032 of the Western Extension Project, the amount of overburden handling is significantly less than in Year 14 of the Stage 2 Middlemount Coal Project EIS with 23% and 33% less overburden handled, respectively.

Table 3 Western Extension Project Production Schedule

Material Handled	Amount of Material (tonnes)			
	Western Extension Project		North-Eastern Extension Project - Year 2029 (Katestone, 2015)	Stage 2 Middlemount Coal Project EIS Year 14 (Katestone, 2011)
	Year 2028	Year 2032		
Overburden	63,116,012	72,673,956	82,303,393	93,876,667
ROM	5,414,500	5,414,500	4,132,315	5,400,000
Product	3,945,000	3,730,500	3,181,355	4,000,000



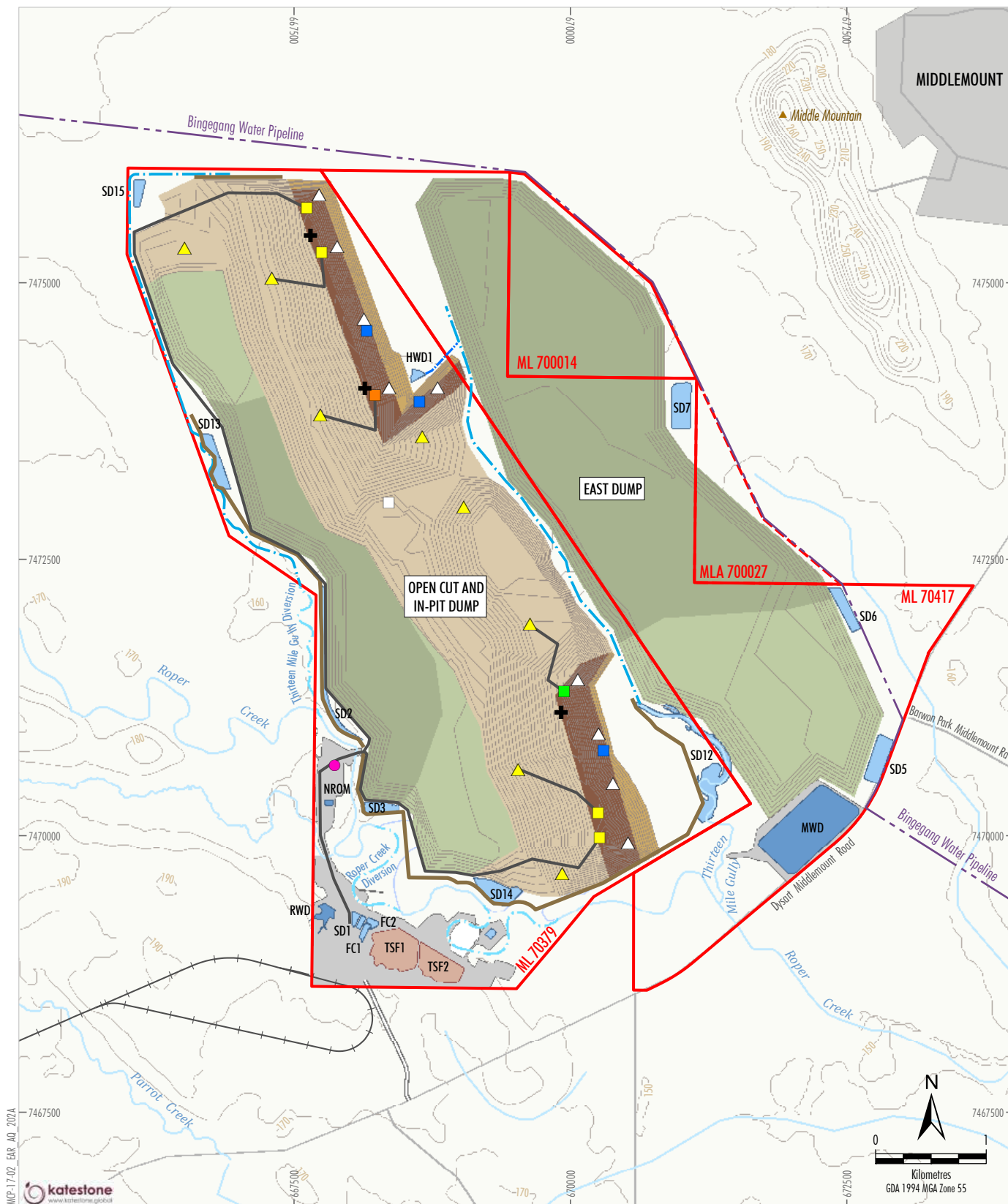
- LEGEND**
- Mining Lease Boundary (ML)
 - Mining Lease Application Boundary (MLA)
 - Topsoil Stripped
 - Active Open Cut Mining Area
 - Active Waste Rock Emplacement
 - Initial Rehabilitation
 - Established Rehabilitation
 - Mine Infrastructure Area
 - Tailings Storage Facility
 - Sediment Dam
 - Water Storage

- Water Transfer Pipeline
- Diversion Structure
- Levee
- Main Haul Road
- Mine Access Road
- Middlemount Rail Spur and Loop
- Noise Sources**
- + Drill
- △ D10 Dozer
- △ D11 Dozer
- EX1900 Excavator
- EX3600 Excavator
- EX5500 Excavator
- EX5600 Excavator
- R9968 Excavator
- CAT 992 Front End Loader

Source: MCPL (2018); Department of Natural Resources and Mines (2017)


WESTERN EXTENSION PROJECT
 Year 2028
 Activity Locations

Figure 6



WESTERN EXTENSION PROJECT
Year 2032
Activity Locations

Figure 7

2.3 Dust Emissions Inventory

The major source of dust emissions from MCM is the truck and shovel operations to remove coal and overburden from the open-cut pits. Other sources of dust at MCM include: the coal processing plant, rail loadout facility, wind-blown dust from stockpiles, pit dumps, bare-ground and areas undergoing rehabilitation.

A dust emissions inventory for the Western Extension Project has been prepared using the same methodology as the North-eastern Extension Project air quality assessment (Katestone, 2015) and the Stage 2 Middlemount Coal Project EIS air quality assessment (Katestone, 2011), where dust emissions were calculated using emission factors published by the US EPA in its Compilation of Air Pollution Emission Factors Volume 1 (AP-42) (US EPA, 1998, 2004, 2006a, 2006b) and by the Commonwealth Department of the Environment in its National Pollutant Inventory Handbooks (NPI, 2012).

Information on mining equipment, activity rates and mining locations for Year 2028 and 2032 of the Western Extension Project have been provided by MCPL as shown in Figure 6 and Figure 7.

A dust inventory has been estimated for Year 2028 and Year 2032 of the Western Extension Project.

Year 2032 represents the full extent of MCM with the Western Extension Project. The equivalent dust emissions inventory estimated in the North-eastern Extension Project was Year 2029 (Katestone, 2015) and Year 14 in the Stage 2 Middlemount Coal Project EIS (Katestone, 2011).

The dust emissions inventories for Year 2028 and Year 2032 of the Western Extension Project have been prepared for the following mining activities:

- Topsoil and overburden removal, handling, transport and dumping
- Drilling
- Blasting
- ROM coal handling in the open-cut pits
- Hauling ROM coal to processing area
- Handling of overburden and waste rock in the open-cut pits
- Hauling of overburden to emplacement areas
- Dumping and shaping of the waste rock emplacement areas
- Wind erosion from areas disturbed by mining activities
- Wind erosion of overburden emplacement areas
- Wind erosion, loading and unloading coal from ROM coal stockpiles
- ROM coal processing
- Wind erosion, loading and unloading coal from product coal stockpiles
- Loading rail wagons.

Dust control measures employed at the MCM (and that will be continued for the Western Extension Project) have been accounted for in the dust emissions inventory. The same dust controls and the level of control that was assumed in the dust inventory for the North-eastern Extension Project Year 2029 and Year 14 of the Stage 2 Middlemount Coal Project EIS have been applied to the Western Extension Project. These dust control measures are shown in Table 4.

Table 4 Dust Control Measures

Source	Control measure	Level of control	Reference
Haul roads	Watering	75%	NPI for Mining Version 2.3 (2001) – Level 2 watering assumed
Stockpiles (ROM and product coals)	Watering	50%	NPI for Mining Version 2.3 (2001)
Drilling	Dust collectors	70%	NSW Mineral Council (2000)
Material transfers in processing area	Watering	50%	NPI for Mining Version 2.3 (2001)
Exposed areas	Initial rehabilitation	30%	NPI for Mining Version 2.3 (2001)
Exposed areas	Established rehabilitation	99%	NPI for Mining Version 2.3 (2001)

A summary of total annual dust emissions for Year 2028 and Year 2032 of the Western Extension Project are shown in Table 5. For comparison, Table 5 also shows the total annual dust emissions that were estimated in the North-eastern Extension Project Year 2029 and the Stage 2 Middelmont Coal Project EIS for Year 14.

Table 5 shows that the total estimated total suspended particulate matter (TSP), particulate matter with an aerodynamic diameter of equal to or less than 10 micrometres (PM₁₀) and particulate matter with an aerodynamic diameter of equal to or less than 2.5 micrometres (PM_{2.5}) emissions for the Western Extension Project Year 2032 are lower than the equivalent years for the North-eastern Extension Project (Year 2029) and the Stage 2 Middelmont Coal Project EIS (Year 14). TSP, PM₁₀ and PM_{2.5} emissions for the Western Extension Project Year 2028 are approximately 5% lower than 2032.

Table 5 Estimated total annual dust emission rates (tonnes/annum)

Operation Scenario		Total dust emission rate (tonnes/annum)		
		TSP	PM ₁₀	PM _{2.5}
Western Extension Project	Year 2028	7,099	2,709	396
	Year 2032	7,442	2,834	420
North-Eastern Extension Project	Year 2029	8,085	3,004	432
Stage 2 Middelmont Coal Project EIS	Year 14	10,664	3,730	497

A detailed breakdown of the dust emissions inventories for Year 2028 and Year 2032 of the Western Extension Project are shown in Table 6.

The detailed breakdown of the Western Extension Project dust emissions shows the following:

- Total dust emissions for the Western Extension Project are slightly higher during Year 2032 than Year 2028 due to the higher overburden mining rate in Year 2032 (see Table 3) and the longer coal haulage from pits to processing plant, which offset the lower haulage emissions and wind erosion due to completion of the Eastern Dump.
 - Dust emissions from the active pit and in-pit activities for Year 2032 are higher due to the higher rates of coal and overburden that is handled.
 - Dust emissions from the out-of-pit overburden haul activities are estimated to be lower for Year 2032 due to completion of the East Dump.
- Dust emissions from the out-of-pit dump are estimated to be marginally higher in Year 2028 as the East Dump is completed in Year 2032. Even though the area has increased in size in Year 2032 (hence there is a potential for more wind erosion), there is no material handling and increased rehabilitation.

- Dust emissions from the coal haul activities are estimated to be higher in Year 2032 as even though the ROM coal mining activity is predicted to be the same, the increased length of coal haul from pits to processing area in Year 2032 results in higher dust emissions.
- Dust emissions from the coal processing and loadout area are predicted to be similar for the two years.

Table 7 details the breakdown of dust emissions for the North-eastern Extension Project Year 2029 and the Stage 2 Middlemount Coal Project EIS for Year 14. Comparison with the Western Extension Project dust inventories (Table 6) shows the following:

- Total dust emissions for the Western Extension Project during Year 2028 and 2032 are estimated to be slightly lower than the North-eastern Extension Project Year 2029. This is primarily due to a reduction in annual overburden handling of 23% for Year 2028 and 12% for Year 2032 compared to the North-Eastern Extension Project Year 2029.
- Total dust emissions for the Western Extension Project during Year 2028 and 2032 are estimated to be significantly lower than Year 14 of the Stage 2 Middlemount Coal Project EIS. This is primarily due to a reduction in annual overburden handling volume of 33% for Year 2028 and 23% for Year 2032 compared to Year 14 of the Stage 2 Middlemount Coal Project EIS. Various aspects of the project have also been optimised since mining operations began which has also led to reductions in dust emissions.

Table 6 Western Extension Project estimated dust emission rates for each mining activity (g/s)

Activity	Western Extension Project					
	Year 2028			Year 2032		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Active Pits (Blasting, Drilling, Dozing)	72.1	30.4	4.2	79.7	33.9	4.7
In-Pit (Haul, Dump, Dozing, Wind Erosion)	84.8	31.0	5.4	93.6	33.8	6.0
Out-of-Pit Haul (Overburden to East Dump)	16.1	4.4	0.4	0.0	0.0	0.0
Out-of-Pit Dump (Dump, Dozing, Wind Erosion)	23.3	11.5	1.8	19.0	9.4	1.4
Coal Haul - Pit to Plant	21.3	5.8	0.6	36.6	10.0	1.0
Coal Processing and Loadout	7.2	2.7	0.2	7.1	2.7	0.2
TOTAL (g/s)	225	86	13	236	90	13
TOTAL (tonnes/annum)	7,099	2,709	396	7,442	2,834	420

Table 7 North-eastern Extension Project and Stage 2 EIS estimated dust emission rates for each mining activity (g/s)

Activity	North-Eastern Extension Project - Year 2029			Stage 2 Project EIS Year 14		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Active Pits (Blasting, Drilling, Dozing)	89.5	38.7	5.4	101.4	43.3	6.1
In-Pit (Haul, Dump, Dozing, Wind Erosion)	90.3	30.0	4.5	125.5	39.1	5.2
Out-of-Pit Haul (Overburden to East Dump)	27.3	7.5	0.9	52.3	14.3	1.4
Out-of-Pit Dump (Dump, Dozing, Wind Erosion)	33.1	14.2	2.5	29.4	12.8	2.2
Coal Haul - Pit to Plant	11.1	3.0	0.3	23.5	6.5	0.6
Coal Processing and Loadout	5.1	1.9	0.2	6.0	2.3	0.2
TOTAL (g/s)	256	95	14	338	118	16
TOTAL (tonnes/annum)	8,085	3,004	432	10,664	3,730	497

2.4 Summary of the Potential Air Quality Impacts from the Western Extension Project

The estimated dust emissions inventory for the Western Extension Project show that significantly lower dust emissions would occur compared to the equivalent year (Year 14) of the Stage 2 Middlemount Coal Project, which has been approved. The predicted lower estimated dust emissions for the Western Extension Project are a result of lower material (overburden) extraction rates (12-33% lower) and optimisation of the haulage fleet (larger trucks equal fewer trips) since operations began.

Further to this, estimated dust emissions inventories for the Western Extension Project Year 2028 and Year 2032 indicate that lower dust emissions would occur compared to the Year 2029 of the North-eastern Extension Project that was approved in 2016. Lower dust emissions are again a result of optimised mining extraction rates with less overburden material being handled and therefore less dust generation.

Quantification of air quality impacts from the Western Extension Project through dispersion modelling has not been explicitly conducted for this air quality assessment. Dispersion modelling was undertaken for the Stage 2 Middlemount Coal Project EIS air quality assessment (Katestone, 2010) and approved in 2010.

Due to the reduction in dust emissions expected from the Western Extension Project (as described above), inferred deposition rates and concentrations of annual average TSP, 24-hour average PM₁₀ (maximum and 6th highest) and 24-hour average and annual average PM_{2.5}, in the region surrounding MCM, can be expected to be less than was predicted for the Stage 2 Middlemount Coal Project EIS. Dust concentrations and deposition rates from the Western Extension Project can also be expected to be less than the existing dust concentrations and deposition rates resulting from current operations at MCM.

3. GREENHOUSE GAS ASSESSMENT

3.1 Introduction

The term greenhouse gases (GHG) comes from the 'greenhouse effect', which refers to the process whereby GHG in the atmosphere absorb the radiation released by the Earth's surface and then radiate some heat back towards the ground, increasing the surface temperature. Human activity, especially burning fossil fuels and deforestation, is increasing the concentration of GHG in the atmosphere and hence increasing the absorption of outgoing heat energy. Even a small increase in long-term average surface temperatures has numerous direct and indirect consequences for climate.

Australia is a signatory to United Nations Framework Convention on Climate Change (UNFCCC), the associated Kyoto Protocol signalling its commitment to reducing GHG emissions at a national level. Under the Paris Agreement, the most recent progression of the UNFCCC, Australia has set an ambitious target to reduce emissions by 26-28 per cent below 2005 levels by 2030, which builds on the 2020 target of reducing emissions by five per cent below 2000 levels.

The main GHG associated with the Project are carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). These gases vary in effect and longevity in the atmosphere, but scientists have devised a system named Global Warming Potential (GWP) to allow them to be described in equivalent terms to CO₂ (the most prevalent greenhouse gas) called carbon dioxide equivalents (CO₂-e). A unit of one tonne of CO₂-e is the basic unit used in carbon accounting. In simple terms an emissions inventory is calculated as the sum of the emission rate of each greenhouse gas multiplied by its associated GWP (denoted in squares). For example:

$$\text{tonnes CO}_2\text{-e} = \text{tonnes CO}_2 \times 1 + \text{tonnes CH}_4 \times 25 + \text{tonnes N}_2\text{O} \times 310$$

While few if any individual projects would make a noticeable change to the Earth's climate, the summation of human activities increasing the concentrations of GHG in the upper atmosphere does. Climate change is an environmental concern at a global level. Governments and the global scientific community have established conventions for accounting for GHG emissions to enable the transparent and verifiable assessment of GHG emissions among all global jurisdictions. This assessment employs these established conventions so that the relative impact of the Project can be assessed and understood.

3.2 National Policy

Australia will meet its targets through the Government's Direct Action Plan. The Emissions Reduction Fund (ERF) is a central component of the Direct Action policies that is made up of an element to credit emissions reductions, a fund to purchase emissions reductions, and a Safeguard Mechanism.

The Safeguard Mechanism has been put in place to ensure that emissions reductions purchased by the Government through the ERF are not offset by significant increases in emissions by large emitters elsewhere in the economy. The Safeguard Mechanism commenced on 1 July 2016 and requires Australia's largest emitters to keep emissions within baseline levels. It applies to around 140 large businesses that have facilities with direct emissions of more than 100,000 tonnes of carbon dioxide equivalent (tCO₂-e) a year and is expected to cover approximately half of Australia's emissions.

With current direct emissions of an estimated 250,000 tCO₂-e, MCPL is subject to the requirements of the Safeguard Mechanism.

3.3 National Greenhouse and Energy Reporting (NGER)

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) established a national framework for corporations to report GHG emissions and energy consumption.

The NGER Regulation recognises Scope 1 and Scope 2 emissions as follows:

- Scope 1 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility.
- Scope 2 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility.

Registration and reporting is mandatory for corporations that have energy production, energy use or GHG emissions that exceed specified thresholds. GHG emission threshold include Scope 1 and Scope 2 emissions. NGER reporting thresholds are summarised in Table 8.

Table 8 NGER reporting thresholds – greenhouse gas emissions and energy use

Threshold level	Threshold type	
	GHG (kt CO ₂ -e)	Energy consumption (TJ)
Facility	25	100
Corporate	50	200

With current direct emissions of an estimated 250,000 tCO₂-e, MCPL has existing reporting obligations under the NGER Scheme and is required to estimate and report their GHG emissions on an annual basis.

3.4 Emission sources

The main sources of GHG emissions associated with the Project, organised according to the scope of emissions, are:

- Scope 1 emissions:
 - Fugitive methane emissions that results from the open-cut mining of coal
 - Diesel usage for mining operations including earthmoving equipment, heavy machinery, haulage trucks and site vehicles
 - Explosive usage for blasting operations.
- Scope 2 emissions:
 - Electricity usage for mining operations including CHPP, mining equipment, lighting and amenities.

3.5 Emissions estimation

The methodologies used to estimate the GHG emissions resulting from the Project are consistent with:

- The NGER Determination
- The National Greenhouse Accounts Factors, July 2017 (DEE, 2017a)

The emission factors and energy content for each of the emissions sources that have been used in the assessment are summarised in Table 9.

Table 9 Emission factors and energy content for GHG emission sources

Emission source	Scope	Energy content	Units	Emission factor	Units
Diesel	1	38.6	GJ/kL	70.5	kgCO ₂ e/GJ
Fugitive methane (Qld - open cut)	1	-	-	0.02	tCO ₂ -e/tROM
Explosives (ANFO)	1	2.4	GJ/t	0.17	tCO ₂ -e/tANFO
Electricity (Queensland)	2	3.6	MJ/kWh	0.79	kgCO ₂ e/kWh

Sources: NGER Determination, National Greenhouse Accounts Factors (July 2017), NGA Workbook (January 2008)

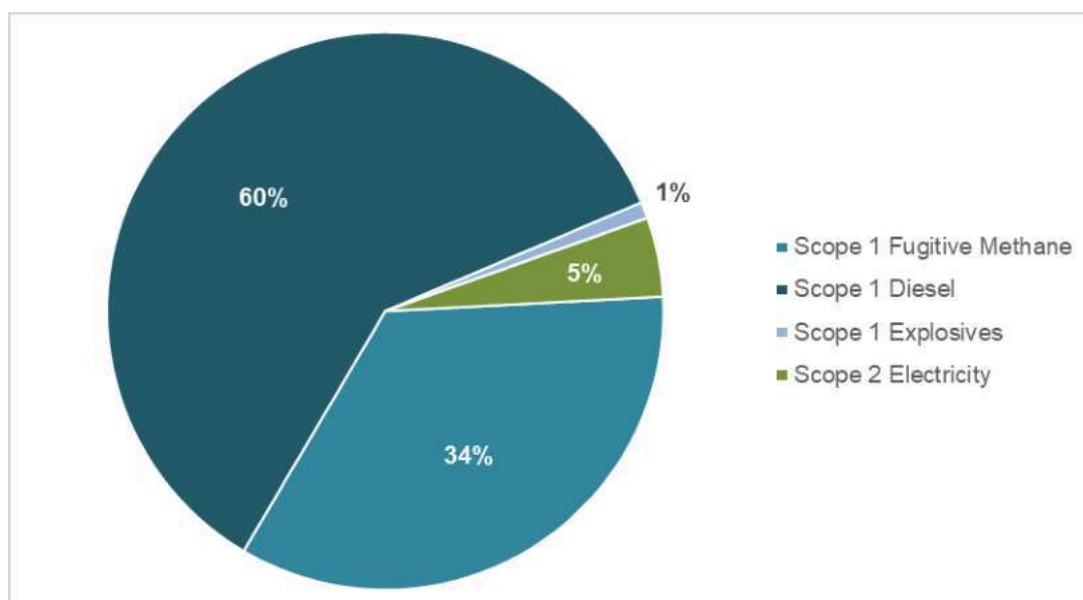
3.6 Greenhouse gas emissions

It is anticipated that the ongoing operation of the MCM will continue until 2037 with an average ROM production of 5,300,000 tonnes. The GHG emissions associated with the ongoing mining operations are summarised in Table 10.

Table 10 Summary of GHG emissions and energy use for the MCM incorporating the Western Extension Project

Annual emissions	Year	ROM (t/y)	Energy use (TJ)	GHG (tCO ₂ -e)
Average	-	5,287,326	2,474	288,960
Maximum	29	5,414,500	2,812	315,455
Minimum	2	4,749,912	1,766	227,581
TOTAL		230,400,000	45,040	8,221,600

The relative proportions of GHG emissions according to emissions scope and emissions source are illustrated in Figure 8.

**Figure 8 Project GHG emissions by scope and source**

By way of comparison, Australia's annual GHG emissions (excluding land use, land use change and forestry) were 534.7 million tonnes of carbon dioxide equivalent (MtCO₂-e) for the year ending 30 June 2016 (DEE, 2016), with the 2015 estimate of Queensland's GHG emissions being 133.1 MtCO₂-e (DEE, 2017b). On a national and state level, the maximum annual emissions of the Project would account for 0.06% and 0.24%, respectively.

3.7 Regulatory obligations – NGER and the Safeguard Mechanism

MCPL currently has NGER reporting obligations associated with the existing activities. In the 2016-17 reporting period GHG emissions for MCM operations were estimated to be 270,000 tCO₂-e (Scope 1 + Scope 2) with associated energy use of 2,148 TJ. GHG emissions and energy use/production associated with the Western Extension Project will need to be accounted for in ongoing annual NGER reporting associated with the existing mine in accordance with the *NGER Act 2007* and supporting legislation.

MCM will also be subject to the Safeguard Mechanism. Its responsibilities would include keeping net emissions at or below baseline emissions levels. The legislative framework for the Safeguard Mechanism is set out in the *National Greenhouse and Energy Reporting Act 2007* (the Act), through amendments included in the *Carbon Farming Initiative Amendment Act 2014*.

3.8 Greenhouse gas mitigation strategies

The following initiatives are proposed to help mitigate, reduce, control or manage GHG emissions through energy efficiency:

- Regular assessment, review and evaluation of GHG reduction opportunities
- Procurement policies that require the selection of energy efficient equipment and vehicles
- Monitoring and maintenance of equipment in accordance with manufacturer recommendations
- Optimisation of diesel consumption through logistics analysis and planning.

4. CONCLUSIONS

Katestone was commissioned by MCPL to conduct an air quality and greenhouse gas assessment of the Western Extension Project.

The air quality and greenhouse gas assessment has included the following:

- Analysis of the existing environment at MCM.
- Preparation of dust emissions inventories for Year 2028 and 2032 of the MCM Western Extension Project.
- A comparison of the Western Extension Project dust emission inventories with the dust inventories previously developed and approved for the EIS (Year 14) and North-eastern Extension Project (Year 2029) and inference of potential air quality impacts.
- Calculation of greenhouse gas emissions for each operational year from 2018 up to and including 2037.

In summary, the air quality and greenhouse gas assessment for the Western Extension Project indicates the following:

- The dust emission rate estimated for the MCM Western Extension Project is lower than the equivalent year of the approved MCM operations. This is due to a reduction of between 12-33% in material (overburden) extraction rates and handling.
- Ground-level concentrations of air pollutants at sensitive receptors will, therefore, be lower than was anticipated by the Stage 2 Middlemount Coal Project EIS and what is currently occurring from MCM operations.
- Annual greenhouse emissions associated with the Project range from 227 tCO₂-e to 315,455 tCO₂-e with an average of 288,960 tCO₂-e.
- The majority of GHG emissions are associated with fugitive methane (60%) and diesel (34%).

MCM will continue to have obligations under both the NGER scheme and the Safeguard Mechanism.

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APPENDIX F

NOISE IMPACT ASSESSMENT

MIDDLEMOUNT MINE

Western Extension Project Noise Impact Assessment for Proposed Mine Extension

16 April 2018

Middlemount Coal Pty Ltd

QB109-01F02 Noise Impact Assessment (r4)

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Important Disclaimer:

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We have derived data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination and re-evaluation of the data, findings, observations and conclusions expressed in this report.

We have prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

The information contained herein is for the purpose of acoustics only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of acoustics engineering including and not limited to structural integrity, fire rating, architectural buildability and fit-for-purpose, waterproofing and the like.

Supplementary professional advice should be sought in respect of these issues.

Executive Summary

Renzo Tonin Ron Rumble was engaged to prepare a noise impact assessment for the proposed Middlemount Coal Mine Western Extension Project. This report identifies and addresses the following items:

- Nearest residential neighbours potentially affected by operational noise;
- Existing noise environment at the nearest receptors;
- Applicable noise criteria at the nearest receptors;
- Types of mining activities and locations during key stages of mining operations;
- Predicted noise levels at the identified receptors; and
- Recommendations for suitable noise control measures.

The Middlemount Coal Mine site is located approximately 3 kilometres (km) south-west of the township of Middlemount in Central Queensland. The surrounding topography is relatively flat with the exception of a ridge rising between the site location and the township of Middlemount. Mining and processing activities will be undertaken within the existing Mining Leases (ML) 70379, ML 70417 and ML 700014 and operated in accordance with Environmental Authority EPML 00716913.

Two operational scenarios have been selected for the purpose of noise modelling, which are representative of operations in the selected years, 2028 and 2032. Fleet locations showing the haul truck and excavator/shovel locations were provided for the selected years by Middlemount Coal Pty Ltd (MCPL). Appendix C presents the proposed fleet locations in 2028 and 2032.

The Noise Criteria for the Western Extension Project was selected based on the relevant legislation and guidelines, and the background noise monitoring data presented in Section 3.1. A computer model was prepared for the Extension using CadnaA software. Operational noise levels were predicted with the use of maximum mining fleet and disturbance footprint (nominal Years 2028 and 2032) at each of these noise sensitive receptors.

One weather scenario was considered in modelling, namely adverse weather conditions (Stability Class F). Under adverse weather conditions (i.e. a temperature inversion), operational noise levels for Years 2028 and 2032 scenarios were determined to satisfy the noise objectives for daytime, evening and night time periods at the nearest noise sensitive receptors. One exception is the nearest receiver "Tralee 2", located approximately 3.5 km south-east of the mine, with possible noise exceedances up to 8dBA for modelling Year 2028. Note, the predicted noise levels are lower than previously approved at the Middlemount Coal Mine. Simple noise reduction strategies will be investigated such as limiting the use of the nearest haul routes and fixed plant items during night time periods in order to reduce noise levels at "Tralee 2".

Consistent with the approved Middlemount Coal Mine, noise monitoring would be conducted in the event of a complaint to validate the model predictions and inform the implementation of noise mitigation measures, if required. In this instance, additional noise mitigation measures would be investigated in consultation with the sensitive receptor, and could include modification of mine operations or at-receiver mitigation measures.

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1 Introduction

Renzo Tonin Ron Rumble was engaged to prepare a noise impact assessment for the Middlemount Coal Mine proposed Western Extension Project. This report identifies and addresses the following items:

- nearest residential neighbours potentially affected by operational noise;
- existing noise environment at the nearest receptors;
- applicable noise criteria at the nearest receptors;
- types of mining activities and locations during key stages of mining operations;
- predicted noise levels at the identified receptors; and
- recommendations for suitable noise control measures.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / New Zealand Standard ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Project & Site Description

2.1 Site Location

The Middlemount Coal Mine site is located approximately 3 kilometres (km) south-west of the township of Middlemount in Central Queensland (Appendix B). The surrounding topography is relatively flat with the exception of a ridge rising between the site location and the township of Middlemount (Appendix B).

Mining and processing activities will be undertaken within the existing Mining Leases (ML) 70379, ML 70417 and ML 700014 and operated in accordance with Environmental Authority EPML 00716913.

2.2 Project Description

Middlemount Coal Pty Ltd (MCPL) proposes to seek Queensland Government and Commonwealth Government approval for an extension to the Middlemount Coal Mine, herein referred to as the Western Extension Project. The main activities associated with the development of the Project would include:

- extension of the open cut pit within ML 70379 to the north-west (Appendix B);
- continued extraction of ROM coal up to approximately 5.7 million tonnes per annum (Mtpa) using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (Eastern Dump) and within the mined-out void (Appendix B);
- continued backfilling of coarse rejects into the pit within spoil, and temporary storage of fine rejects from coal crushing and washing in existing tailings storage facility cells for drying and reclaim for in-pit co-disposal;
- progressive development of sediment dams, pipelines and other water management equipment and structures (including levees and realignment of an existing diversion structure);
- progressive development of new haul roads and internal roads;
- continued development of soil stockpiles, laydown areas and borrow areas;
- continued use of existing and approved supporting mine infrastructure;
- continued rail transport of coal products to the Dalrymple Bay Coal Terminal, Abbott Point Coal Terminal or Wiggins Island Coal Export Terminal for export;
- extension of the approved mine life by approximately six years (to 2037); and
- a change to the final landform at the Middlemount Coal Mine for the end of the mine life to include two final voids.

Middlemount Coal Mine operates 24 hours a day, seven days a week. The mine will continue to utilise shovels/excavators and trucks for the removal of overburden and interburden. In general, the mining operation will continue to involve:

- vegetation clearing of selected mining operation areas;
- topsoil stripping;
- stripping of some overburden;

- blasting of overburden and inter-burden;
- removal of overburden and inter-burden using loading equipment and trucks;
- ROM coal mining;
- ROM coal transport;
- coal handling and processing; and
- site rehabilitation.

3 Noise Criteria

The relevant legislation and guidelines used to determine the noise criteria include the following:

- Environmental Protection (Noise) Policy 2008;
- Ecoaccess Guideline - Planning for Noise Control [Reference 3];
- Environmental Authority EPML 00716913 [Reference 4];
- Ecoaccess Draft Guideline Assessment of Low-frequency Noise [Reference 5]; and
- Model Mining Conditions Guideline (MMCG) (Department of Environment and Heritage Protection [DEHP], 2017a) [Reference 9].

3.1 Background Noise Monitoring

Background noise monitoring was conducted in March 2010 as part of the previous EIS noise impact assessment [Reference 1]. Monitoring consisted of attended and unattended noise monitoring at three locations around the project site. The following three locations were selected:

Site 1 - MAC Middlemount Village – (Easting: 55K 674101 Northing: 7475776)

Site 2 – Foxleigh property – (Easting: 55K 676259 Northing: 7475164)

Site 3 – Kokane property – (Easting: 55K 658113 Northing: 7479906)

Additional background noise monitoring was conducted in August 2013 as part of an independent report [Reference 7] commissioned by Middlemount Coal Mine. Monitoring consisted of attended and unattended noise monitoring at four locations around the project site. The following four locations were selected:

ML1 - MAC Camp – (Easting: 55K 674101 Northing: 7475776)

ML2 - 143 Centenary Drive North, Middlemount – (Easting: 55K 673724 Northing: 7477379)

ML3 - Foxleigh Residence (vacant) – (Easting: 55K 676259 Northing: 7475164)

ML4 - Hazelbrae Property – (Easting: 55K 668038 Northing: 7483466)

Table 1 presents a comparison of noise monitoring conducted in March 2010 and additional monitoring conducted in August 2013.

Table 1: Comparison of Background Noise Monitoring Results (March 2010 vs August 2013)

Monitoring Location	Month & Year	Sound Pressure Level dB(A)								
		L _{A10} , 15min			L _{Aeq} , 1 hr			Rating Background Level (RBL)		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Site 1 MAC Camp	March 2010	52	51	51	50	48	48	42	44	40
ML1 MAC Camp	August 2013	63	51	59	47	42	47	31	33	29
ML2: 143 Centenary Drive North	August 2013	61	55	56	47	42	40	33	27	20*
Site 2 – Foxleigh property	March 2010	43	48	43	41	45	41	33	36	33
ML3: Foxleigh Residence (vacant)	August 2013	52	48	53	41	37	41	28	27	23*
Site 3 – Kokane property	March 2010	42	51	44	41	50	43	30	36	31
ML4: Hazelbrae Property	August 2013	43	37	36	46	39	39	27	31	30

Note: *Where RBL is less than 25dBA, the RBL is set to 25dBA.

Table 1 shows the rating Background Levels or RBL's for August 2013 were lower than the March 2010 data. Only two sites can make a direct comparison between the data, namely Site 1 /ML1 and Site 2 / ML3. For Site 1 /ML1 MAC Camp the RBL's have reduced by around 11dB(A) during the day, evening and night time periods. For Site 2 / ML3 Foxleigh property the RBL's have reduced by around 5dB(A) to 10dB(A) during the day, evening and night time periods. There is no commentary in the March 2013 report explaining the reason for any differences between the March 2010 and August 2013 data at the same sites. The cumulative noise (summarised as L_{eq}) was fairly similar at both sites. The March 2013 is considered typical of many rural environments and conservative in nature. This report therefore uses the more conservative March 2013 noise data for assessment purposes.

3.2 Summary of Noise Criteria

Table 2 presents a summary of the noise criteria and the adopted Project Noise Criteria for dwellings and other noise sensitive receivers.

There are a number of conditions in Environmental Authority EPML00716913 relating to noise.

Table 2: Environmental Authority Conditions Relating to Noise

D1	Subject to conditions D2 and D3 noise from the mining activity must not cause an environmental nuisance at any noise sensitive or commercial place.
D2	When requested by the administering authority, noise monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within 14 days to the administering authority following completion of monitoring. Monitoring must include: a) LA10, adj, 15 mins (external); b) LA1, adj, 10 mins (internal – or a measured external noise level and calculation of corresponding internal noise level); c) The level and frequency of occurrence of impulsive or tonal noise; d) Atmospheric conditions including wind speed and direction; e) Effects due to extraneous factors such as traffic noise; and f) Location date and time of recording.
D3	If the environmental authority holder can provide evidence through monitoring that the limits defined in Table D1, are not being exceeded then the holder is not in breach of condition D1.
D4	If the monitoring indicates the noise component from the Project exceeds the limits in Table D1, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
D5	The method of measurement of noise monitoring must comply with the current edition of the administering authority's Noise Measurement Manual.

Table 3: Noise Limits from Table D1 in Environmental Authority EPML00716913

Noise level dB(A)	Monday to Sunday (including public holidays)		
	7 am – 6 pm	6 pm – 10 pm	10 pm – 7 am
Noise measured at a 'sensitive place' expressed as:			
$L_{Aeq, adj, 15 mins}^1$	$RBL^3 + 5$	$RBL^3 + 5$	$RBL^3 + 5$
$L_{A1, adj, 15 mins}^2$	40	40	40
Noise measured at a 'commercial place' expressed as:			
$L_{Aeq, adj, 15 mins}^1$	$RBL^3 + 10$	$RBL^3 + 10$	$RBL^3 + 10$
$L_{A1, adj, 15 mins}^2$	45	45	45

NOTE:

1: External noise limit

2: Internal noise limit

3: Rated Background Level (RBL) as defined in the administering authority's Coaches Guideline, Planning for Noise Control.

The Noise Criteria for the Western Extension Project was selected based on the relevant legislation and guidelines, and the background noise monitoring data presented in Section 3.1.

Table 4 presents the Project Criteria based on RBL results from March 2010 and August 2013.

Table 4: Project Criteria for Residential Receivers based on RBL Results (March 2010 vs August 2013)

Location	RBL (March 2010) (dB[A])			RBL (August 2013) (dB[A])			Project Criteria (dB[A])		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Site 1 / ML1 MAC Village	42	44	40	31	33	29	31 + 5 = 36	33 + 5 = 38	29 + 5 = 34
Site 2 / ML3 Foxleigh	33	36	33	28	27	25	33	32	30
Site 3 – Kokane	30	36	31	-	-	-	35	41	36
ML2 (Centenary Drive North	-	-	-	33	27	25	38	32	30
ML4 Hazelbrae	-	-	-	27	31	30	32	36	35

We note the Planning for Noise Control document [Reference 3] nominates the following for areas with low Rating Background Levels (RBLs):

It may not be possible to maintain background levels in very rural areas below 25dBA as developments occur. In such cases a threshold background level of 25dBA is to be used.

In direct comparison the more recent MMCG (DEHP, 2017a) document [Reference 9] nominates the following for areas with low RBLs:

In the event that measured background ($L_{A90, adj, 15 mins}$) is less than 30 dBA, then 30 dBA can be substituted for the measured background level.

For this extension project we have adopted the more conservative approach using the RBL data from August 2013 and minimum background noise levels of 25dBA as per the Planning for Noise Control document [Reference 3].

Table 5 presents the Project noise criteria for non-residential noise sensitive receivers based on Environmental Protection (Noise) Policy 2008 [Reference 2].

Table 5: Noise Criteria for Non-Residential Sensitive Receivers

Location	Period	Sound Pressure Level dB(A)			
		Planning for Noise Control	EPP Noise Policy (outdoor)	Existing Environmental Authority	Project Noise Criteria
Schools	Operating Hours	45	40*	47 (based on Site 1 daytime)	40
Parks^	Daytime	35	42 (Amenity based on Site 1 day RBL)	47 (based on Site 1 daytime)	42
Community Buildings#	Operating Hours	50	50*	52 (based on Site 1 daytime)	50

Location	Period	Sound Pressure Level dB(A)			
		Planning for Noise Control	EPP Noise Policy (outdoor)	Existing Environmental Authority	Project Noise Criteria

~ Sound pressure levels for the representative dwelling taken at Site 1, MAC Middlemount Village;

* Assuming an indoor/outdoor transmission loss of 5dB(A);

^ Due to higher measured background noise levels the amenity level has been adopted;

Assumed equivalent to commercial or retail receiver.

3.3 Noise Sensitive Receivers

The nearest noise sensitive receivers potentially affected by noise emissions from mining operations are listed in Table 6 below. The noise sensitive receivers were identified and provided by MCPL with the receiver IDs corresponding to the receiver IDs as per the Stage 2 EIS [Reference 1]. Table 6 also presents additional representative receivers not included in the Stage 2 EIS, namely properties described as Gundabah, Hazelbrae, Campion, Foxleigh, Tralee and Tralee2. Appendix D shows the location of the noise sensitive receivers.

Table 6: Noise Sensitive Receivers & Project Criteria

Receiver ID	Receiver	UTM Coordinates (Zone 55)		Noise Criteria dB(A)			Project Criteria based on?	Representative Receiver Point (described in Stage 2 EIS)
		Easting	Northing	Day	Evening	Night		
SR075	Accommodation Village 1	673899	7475861	36	38	34	RBL at ML1 (August 2013)	SR075
SR074	Accommodation Village 2	673860	7476113	36	38	34	RBL at ML1 (August 2013)	SR074
SR410	Accommodation Village 3	674176	7476028	36	38	34	RBL at ML1 (August 2013)	SR410
SR411	Accommodation Village 4	674171	7475738	36	38	34	RBL at ML1 (August 2013)	SR411
SR278-SR303	Alfred Quinn Drive Residences	673820	7476596	36	38	34	RBL at ML1 (August 2013)	SR288
SR619-SR725	Centenary Drive South Residences	675007	7475610	36	38	34	RBL at ML1 (August 2013)	SR725
SR069	Industrial Estate	673599	7475840	50	50	50	EPP Noise (2008)	SR075
SR409	Middlemount Community School	674416	7476301	40	40	40	EPP Noise (2008)	SR409
SR060	Norm Blache Oval	673473	7476213	50	50	50	EPP Noise (2008)	SR060
SR057	Treatment Plant	673263	7475790	50	50	50	EPP Noise (2008)	SR060
Gundabah	Gundabah	663948	7480703	32	36	35	RBL at ML4 (August 2013)	New receiver
Hazelbrae	Hazelbrae	668048	7483433	32	36	35	RBL at ML4 (August 2013)	New receiver
Campion	John Frederick Campion	676961	7475599	33	32	30	RBL at ML3 (August 2013)	New receiver
Foxleigh	Foxleigh	681585	7470645	33	32	30	RBL at ML3 (August 2013)	New receiver
Tralee	Tralee	681123	7467485	33	32	30	RBL at ML3 (August 2013)	New receiver
Tralee 2	Tralee 2	673175	7469070	33	32	30	RBL at ML3 (August 2013)	New receiver

4 Noise Impact Assessment

4.1 Calculation Methodology

Noise emissions were predicted by modelling the noise sources, receiver locations, topographical features of the intervening area, and possible noise control treatments using CadnaA (version 2018 161.4800) noise prediction computer program. CadnaA is an internationally recognised environmental noise prediction computer program that can be used to model transportation noise, construction noise and general industry noise. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

The noise prediction models take into account:

- location of noise sources and receiver locations;
- height of sources and receivers;
- separation distances between sources and receivers;
- ground type between sources and receivers;
- attenuation from barriers (natural and purpose built); and
- meteorological effects.

All predictions have been conducted in accordance with Internal Standard ISO 9613 (1996) *Acoustics – Attenuation of sound propagation outdoors* [Reference 8].

A number of 3D models were created for the site location and surrounding area using terrain contours at 10m intervals and more detailed on-site terrain elevations as provided by MCPL. All noise receivers were modelled as 2m above ground level and noise sources were modelled as point sources 2m above ground level.

4.2 Meteorological Effects

Certain meteorological conditions may increase noise levels by focusing sound-wave propagation paths at a single point. Such refraction of sound waves will occur during temperature inversions (atmospheric conditions where temperatures increase with height above ground level) and where there is a wind gradient (that is, wind velocities increasing with height) with wind direction from the source to the receiver.

Temperature inversions occurring within the lowest 50m to 100m of atmosphere can affect noise levels measured on the ground. Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of air in contact with the ground. This is especially prevalent on cloudless nights with little wind. Air that is somewhat removed from contact with the ground will not cool as much, resulting in warmer air aloft than near to the ground.

Similarly, when significant wind exists, the conditions can significantly affect noise levels at receptor points downwind of a noise source. This will depend however, on the particular direction and velocity of the wind at that time. It should also be noted that although wind can raise noise emission levels as perceived from a downstream assessment point, background noise also tends to increase as a result of increased wind activity. This often causes masking of potential increases in intrusive noise.

4.2.1 Wind Effects

Gradient wind differs from the drainage-flow wind associated with temperature inversions.

Drainage-flow wind is the localised drainage of cold air under the influence of the local topography, and travels in one direction only (direction of decreasing altitude). Gradient wind is the regional wind determined by synoptic factors (high and low-pressure systems), and may originate from any direction.

Unlike temperature inversions, gradient winds may cause impacts during any assessment period (day, evening or night), and not just the night period.

The Ecoaccess Guideline: Planning for Noise Control 2004 guideline [Department of Natural Resources and Mines] [Reference 3] specifies that the prevailing and worst case meteorological conditions (wind, temperature, humidity and temperature inversions) at the planned and receiver locations must be determined. Noise levels are calculated at the noise sensitive places for a range of typical operating scenarios and conditions that are representative of the proposed facility, including worst case meteorological conditions.

An Air Quality Assessment was prepared by Katestone Environmental Pty Ltd (December 2017) [Reference 6] for the Western Extension Project. Appendix G of this report presents wind rose extracts from the Katestone Environmental Pty Ltd report.

Our analysis of the wind roses concluded that wind effects were not a particular feature of the area blowing from the mine to the nearest receivers. That is, wind is not considered to be a feature where source to receiver wind speeds (at 10m height) of 3m/s or below occur for 30% of the time or more in any assessment period (day, evening, night) in any season as outlined in the Planning for Noise Control guideline [Reference 3]. For the Western Extension Project we have therefore not used the default wind effects parameter of 3m/s towards the receivers.

4.2.2 Temperature Inversions

An occurrence of 30% of the total night time period during winter (June, July and August) is selected by the Planning for Noise Control guideline [Reference 3] as representing a significant noise impact warranting further assessment.

For Middlemount Coal Mine we have used the default inversion parameters for modelling purposes:

- non-arid areas (annual average rainfall greater than 500mm);
- moderate (F-class stability category) inversions; and

- 3°/100m temperature inversion strength for all receivers plus a 2m/s source to receiver component drainage flow wind speed for those receivers where applicable.

4.3 Operational Noise Levels

4.3.1 Noise Modelling Years

Two operational scenarios have been selected for noise modelling purposes, years 2028 and 2032. These scenarios were selected in consideration of the scale of mining operations in each year of the Western Extension Project, number of major mobile equipment and proximity of operations to sensitive receivers. Fleet locations showing the haul truck and excavator/shovel locations were provided for the selected years by MCPL.

4.3.2 Fleet Locations & Numbers

Appendix C presents the proposed fleet locations in Year 2028 and Year 2032.

Table 7 presents fleet numbers for the proposed Western Extension Project Year 2028 and Year 2032.

Table 7: Fleet Numbers for the Proposed Western Extension Project Years 2028 and 2032

Plant Item	Western Extension Project Year 2028	Western Extension Project Year 2032
Drill	2	3
D10 Dozer	8	9
D11 Dozer	7	8
EX1900 Excavator	1	1
EX3600 Excavator	4	4
EX5500 Excavator	1	1
EX5600 Excavator	1	1
R996B Excavator	2	3
CAT992 Front End Loader	1	1

4.3.3 Haul Routes

Table 8 presents haul route fleet numbers for proposed Western Extension Project Year 2028.

Table 8: Haul Route Fleet Numbers for the Proposed Western Extension Project Year 2028

Plant Item	C1	C2	C3	W1	W2	W3	W4
	(North Anglo Strips/Terrace Pits)	(Central North/South Pits)	(South Strips/Terrace Pits)	(North Anglo Strips/Terrace Pits)	(Central North/South Pits)	(South Strips/Terrace Pits)	(East Dump)
T1 (140 t truck)	3	2	1	-	-	-	-
T1_Coal (CAT 789 190 t truck)	8	2	3	-	-	-	-
T2 (220 t truck)	-	-	-	6	6	5	8
CAT 24M grader	1	-	1	-	1	-	-
CAT 16H grader	-	1	-	1	-	1	1
CAT 777 water cart	1	0.5	0.5	1	0.5	0.5	1

Table 9 presents haul route fleet number for proposed Western Extension Project Year 2032.

Table 9: Haul route fleet numbers for the Proposed Western Extension Project Year 2032

Plant Item	C1	C2	C3	W1	W2	W3	W4
	(North Anglo Strips/Terrace Pits)	(Central North/South Pits)	(South Strips/Terrace Pits)	(North Anglo Strips/Terrace Pits)	(Central North/South Pits)	(South Strips/Terrace Pits)	(East Dump)
T1 (140 t truck)	4	2	-	-	-	-	-
T1_Coal (CAT 789 190 t truck)	9	4	-	-	-	-	-
T2 (220 t truck)	-	-	-	8	8	7	8
CAT 24M grader	1	-	-	1	-	1	-
CAT 16H grader	1	1	-	-	1	-	1
CAT 777 water cart	1	1	-	0.5	1	0.5	1

4.3.4 Sound Power Levels

Noise data for the excavators, front end loaders and trucks in the proposed fleet was sourced from the Stage 2 EIS [Reference 1] prepared by Parsons Brinckerhoff.

Table 10 presents noise data as an overall sound power level (in dB[A]) and octave band frequency data (in dBZ). This noise data applies to unmitigated trucks (i.e. standard trucks with no additional noise control treatment or hush kits applied).

Table 10: Sound Power Levels for Proposed Mining Fleet (Unmitigated Trucks)

Fleet	Plant Item	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
CHPP	CHPP	123	-	117	117	119	118	117	117	115	112
D1	D11 dozer	116	109	110	108	110	104	102	100	95	88
D2	D10 dozer	116	107	111	117	113	114	112	108	102	97
Drill	Drill	126	-	117	124	116	114	113	113	108	104
FEL	CAT 992 front end loader	112	102	106	121	104	106	108	103	97	89

Fleet	Plant Item	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
G1	CAT 24M grader	121	99	102	118	113	112	110	107	101	95
G2	CAT 16H grader	113	101	102	111	104	109	110	105	100	100
WC	CAT 777 water cart	112	113	118	116	112	109	106	104	97	90
E1	EX3600 excavator	115	103	111	105	100	100	111	111	106	98
E2	EX5500 Excavator	115	-	118	121	115	112	109	107	102	94
E3	EX5600 Excavator	115	-	118	121	115	112	109	107	102	94
E4	R996B Excavator	115	-	118	121	115	112	109	107	102	94
E5	EX1900 Excavator	115	-	118	121	115	112	109	107	102	94
T1	140 t truck	118	119	125	125	120	116	111	108	102	97
T1_Coal	CAT 789 190 t truck	118	119	125	125	120	116	111	108	102	97
T2	220 t truck	121	122	128	128	123	119	114	111	105	100

4.4 Predicted Operational Noise Levels

Predicted operational noise levels at each noise sensitive receiver are presented in Tables 11 and 12 for Years 2028 and 2032, respectively. Noise levels have been predicted and presented for both neutral weather (i.e. no wind) and adverse weather conditions.

Noise contour maps are also presented in Appendix E.

Table 11: Predicted Total Noise Levels for the Proposed Western Extension Project Year 2028 – Neutral & Adverse Weather Conditions

Receiver ID	Receiver	Year 2028 - Neutral Weather	Year 2028 - Adverse Weather	Noise Criteria dB(A)			Compliance?		
				Day	Evening	Night	Day	Evening	Night
SR075	Accommodation Village 1	24	31	36	38	34	Yes	Yes	Yes
SR074	Accommodation Village 2	24	31	36	38	34	Yes	Yes	Yes
SR410	Accommodation Village 3	24	31	36	38	34	Yes	Yes	Yes
SR411	Accommodation Village 4	24	31	36	38	34	Yes	Yes	Yes
SR278-SR303	Alfred Quinn Drive Residences	23	31	36	38	34	Yes	Yes	Yes
SR619-SR725	Centenary Drive South Residences	23	30	36	38	34	Yes	Yes	Yes
SR069	Industrial Estate	24	31	50	50	50	Yes	-	-
SR409	Middlemount Community School	23	30	40	40	40	Yes	-	-
SR060	Norm Blache Oval	24	31	50	50	50	Yes	-	-
SR057	Treatment Plant	24	32	50	50	50	Yes	-	-
Gundabah	Gundabah	22	29	32	36	35	Yes	Yes	Yes
Hazelbrae	Hazelbrae	19	26	32	36	35	Yes	Yes	Yes
Campion	John Frederick Campion	21	28	33	32	30	Yes	Yes	Yes
Foxleigh	Foxleigh	15	22	33	32	30	Yes	Yes	Yes
Tralee	Tralee	16	22	33	32	30	Yes	Yes	Yes
Tralee 2	Tralee 2	32	38	33	32	30	No	No	No

Table 11 shows operational noise levels for Year 2028 under neutral and adverse weather conditions are predicted to comply with the noise criteria for daytime, evening and night-time periods. The exception is the nearest receiver “Tralee 2” with a possible noise exceedance from 2dB(A) under neutral weather conditions to 8dB(A) under adverse weather conditions. This assumes the worst-case scenario with all plant operating simultaneously. Noise exceedances from plant items are discussed further in Section 5.

Table 12: Predicted Total Noise Levels for the Proposed Western Extension Project Year 2032 – Neutral & Adverse Weather Conditions

Receiver ID	Receiver	Year 2032 - Neutral Weather	Year 2032 - Adverse Weather	Noise Criteria dB(A)			Compliance?		
				Day	Evening	Night	Day	Evening	Night
SR075	Accommodation Village 1	23	30	36	38	34	Yes	Yes	Yes
SR074	Accommodation Village 2	23	30	36	38	34	Yes	Yes	Yes
SR410	Accommodation Village 3	23	30	36	38	34	Yes	Yes	Yes
SR411	Accommodation Village 4	23	30	36	38	34	Yes	Yes	Yes
SR278-SR303	Alfred Quinn Drive Residences	23	30	36	38	34	Yes	Yes	Yes
SR619-SR725	Centenary Drive South Residences	22	30	36	38	34	Yes	Yes	Yes
SR069	Industrial Estate	23	30	50	50	50	Yes	-	-
SR409	Middlemount Community School	22	29	40	40	40	Yes	-	-
SR060	Norm Blache Oval	23	30	50	50	50	Yes	-	-
SR057	Treatment Plant	23	30	50	50	50	Yes	-	-
Gundabah	Gundabah	22	29	32	36	35	Yes	Yes	Yes
Hazelbrae	Hazelbrae	19	26	32	36	35	Yes	Yes	Yes
Campion	John Frederick Campion	20	27	33	32	30	Yes	Yes	Yes
Foxleigh	Foxleigh	14	21	33	32	30	Yes	Yes	Yes
Tralee	Tralee	14	21	33	32	30	Yes	Yes	Yes
Tralee 2	Tralee 2	29	36	33	32	30	No	No	No

Table 12 shows operational noise levels for Year 2032 under neutral and adverse weather conditions are predicted to comply with the noise criteria for daytime, evening and night-time periods. The exception is the nearest receiver "Tralee 2" with a possible noise exceedance of 6dB(A) under adverse weather conditions. This assumes the worst-case scenario with all plant operating simultaneously. Noise exceedances from plant items are discussed further in Section 5.

5 Discussion on Noise Exceedances

The previous report section identified the nearest noise sensitive receiver "Tralee 2" as possible noise exceedances up to 8dB(A) under adverse weather conditions.

Our review of the EIS document [Reference 1] shows a number of noise contour maps based on the projected Stage 2 operation. Contours maps for Year 7, Year 14 and Year 22 of the mine have been extracted and presented in Appendix F of this report. Appendix F of this report also shows an indicative location of the nearest noise sensitive receiver "Tralee 2".

A comparison of the noise contour maps (C-4, C-5 and C-6) and location of Tralee 2 shows operational noise levels in the range of 40dBA to 44dBA at Tralee 2 (Appendix F). Similarly, a comparison of the contour maps (D-4, D-5 and D-6) and location of Tralee2 shows operations noise levels with some mitigation applied in the range of 37dB(A) to 40dB(A) at Tralee 2 (Appendix F).

In summary, the contour maps in the EIS document [Reference 1] predict noise levels ranging from 37dB(A) to 44dB(A) at Tralee 2 depending on the year and mitigation control (Appendix F). In comparison, noise predictions at Tralee 2 for the Western Extension Project indicate lower noise levels around 30dB(A) to 32dB(A) under neutral weather and 36dB(A) to 38dB(A) under adverse weather conditions. All predictions assume the worst-case scenario with all plant operating simultaneously.

Simple noise reduction strategies will be investigated such as limiting the use of the nearest haul routes and fixed plant items during night time periods.

Conditions D1 to D5 in the Environmental Authority EPML00716913 [Reference 4] relating to noise state the following (refer to previous Table 2 and repeated in Table 13 below):

Table 13: Environmental Authority Conditions Relating to Noise

D1	Subject to conditions D2 and D3 noise from the mining activity must not cause an environmental nuisance at any noise sensitive or commercial place.
D2	When requested by the administering authority, noise monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within 14 days to the administering authority following completion of monitoring. Monitoring must include: a) LAeq, adj, 15 mins (external); b) LA1, adj, 10 mins (internal – or a measured external noise level and calculation of corresponding internal noise level); c) The level and frequency of occurrence of impulsive or tonal noise; d) Atmospheric conditions including wind speed and direction; e) Effects due to extraneous factors such as traffic noise; and f) Location date and time of recording.
D3	If the environmental authority holder can provide evidence through monitoring that the limits defined in Table D1, are not being exceeded then the holder is not in breach of condition D1.
D4	If the monitoring indicates the noise component from the Project exceeds the limits in Table D1, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
D5	The method of measurement of noise monitoring must comply with the current edition of the administering authority's Noise Measurement Manual.

In the event of a noise-related complaint, EA Conditions D1 to D5 will be investigated. That is noise monitoring would be conducted to validate the model predictions and inform the implementation of noise mitigation measures, if required, where noise objectives are exceeded. In this instance, noise mitigation measures would be investigated in consultation with the noise sensitive receptor, and could include modification of mine operations or at-receiver mitigation measures.

6 Conclusion

Renzo Tonin Ron Rumble has completed a noise impact assessment for the proposed Middlemount Coal Mine Western Extension Project.

Under neutral and adverse weather conditions (i.e. a temperature inversion), operational noise levels for Years 2028 and 2032 scenarios were determined to satisfy the noise objectives for daytime, evening and night-time periods at the nearest noise sensitive receivers. The exception is the nearest receiver "Tralee 2" located approximately 3.5km south-east of the mine with possible noise exceedances up to 8dBA for modelling Year 2028. Simple noise reduction strategies will be investigated such as limiting the use of the nearest haul routes and fixed plant items during night time periods in order to reduce noise emissions to "Tralee 2".

In the event of a noise-related complaint, noise monitoring would be conducted to validate the model predictions and inform the implementation of noise mitigation measures, if required, where noise objectives are exceeded. In this instance, noise mitigation measures would be investigated in consultation with the sensitive receptor, and could include modification of mine operations or at-receiver mitigation measures.

References

1. Parsons Brinckerhoff (2010) Middlemount Coal Project, Stage 2 Noise Assessment Technical Report;
2. Environmental Protection (Noise) Policy 2008;
3. Ecoaccess Guideline - Planning for Noise;
4. Environmental Authority EPML 00716913;
5. Ecoaccess Draft Guideline Assessment of Low-frequency Noise;
6. Middlemount Coal Mine – Western Extension Project Air Quality and Greenhouse Gas Assessment dated 12 December 2017 [Reference D17009-3] and prepared by Katestone Environmental Pty Ltd;
7. Noise Monitoring Report Middlemount Coal Pty Ltd Dysart/Middlemount Road Middlemount QLD 4746 [Report 2546-1 R2 dated 29 January 2013 and prepared by NMS, and;
8. Internal Standard ISO 9613 (1996) *Acoustics – Attenuation of sound propagation outdoors*.
9. Model Mining Conditions Guideline (MMCG) (Department of Environment and Heritage Protection [DEHP], 2017a)

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L _{Max}	The maximum sound pressure level measured over a given period.
L _{Min}	The minimum sound pressure level measured over a given period.

L ₁	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L ₁₀	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L ₉₀	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L _{eq}	The “equivalent noise level” is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B **Mine Extension**

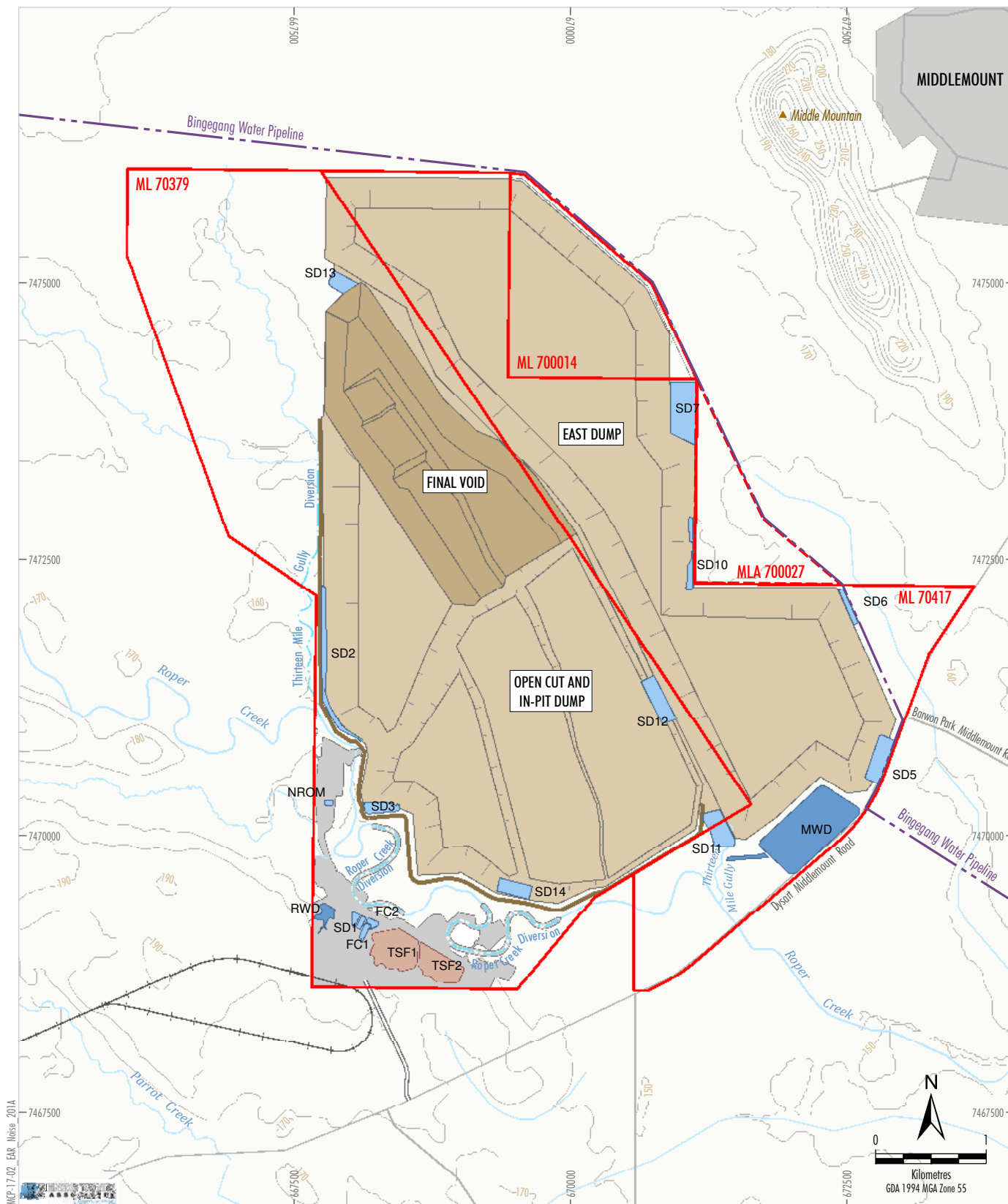
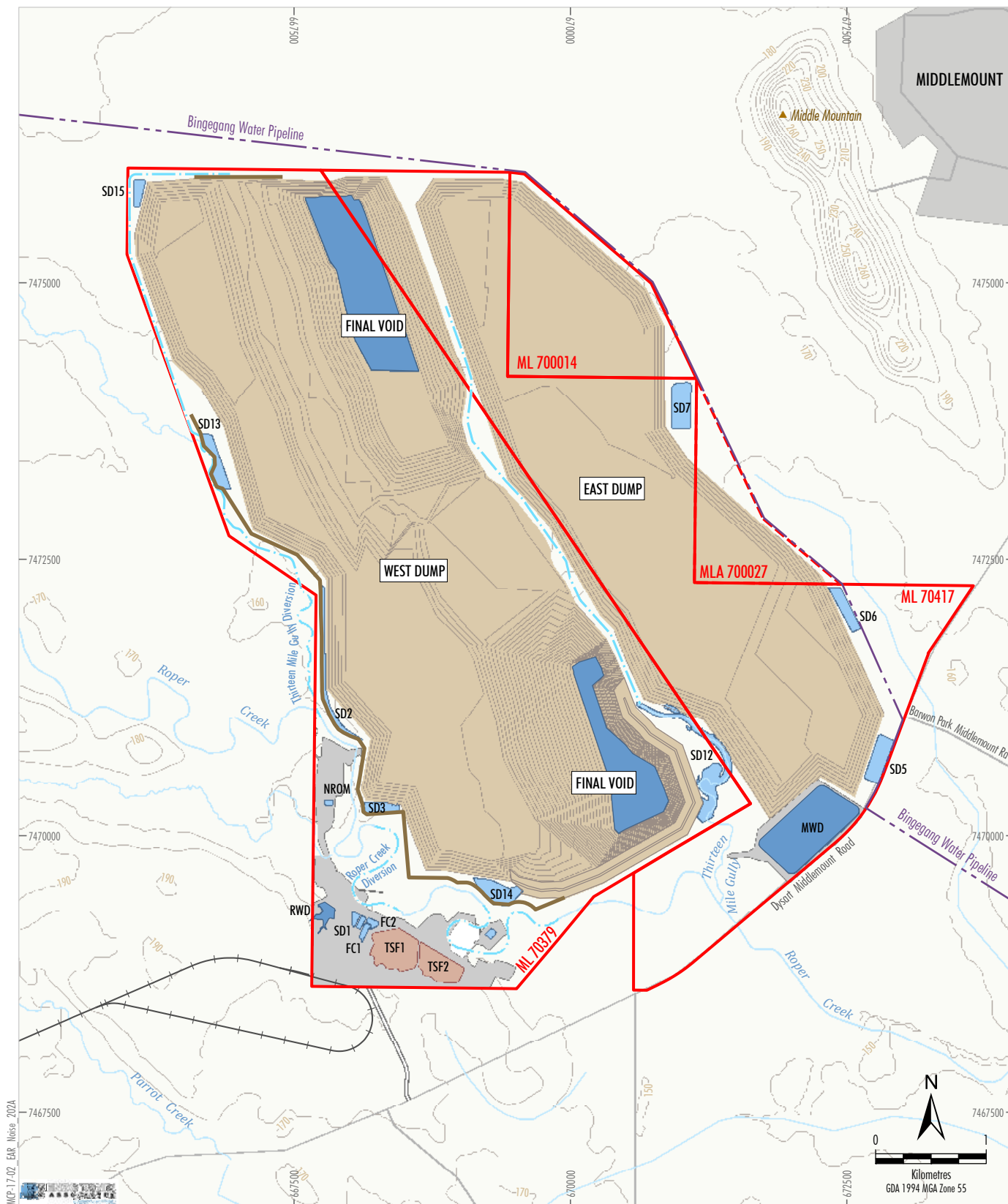


Figure B1



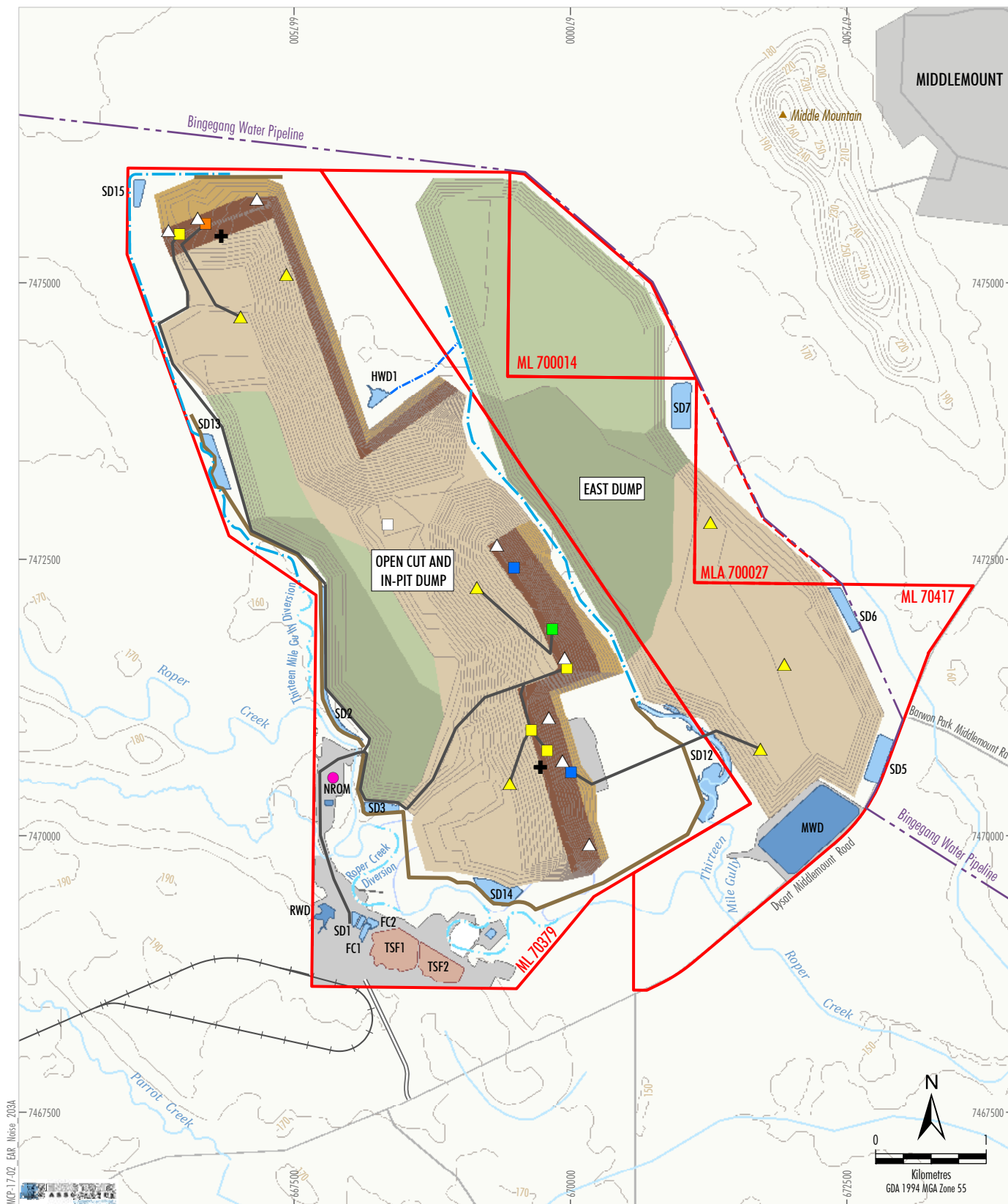
Source: MCPL (2018); Department of Natural Resources and Mines (2017)



WESTERN EXTENSION PROJECT
Project General Arrangement

Figure B2

APPENDIX C Fleet Locations

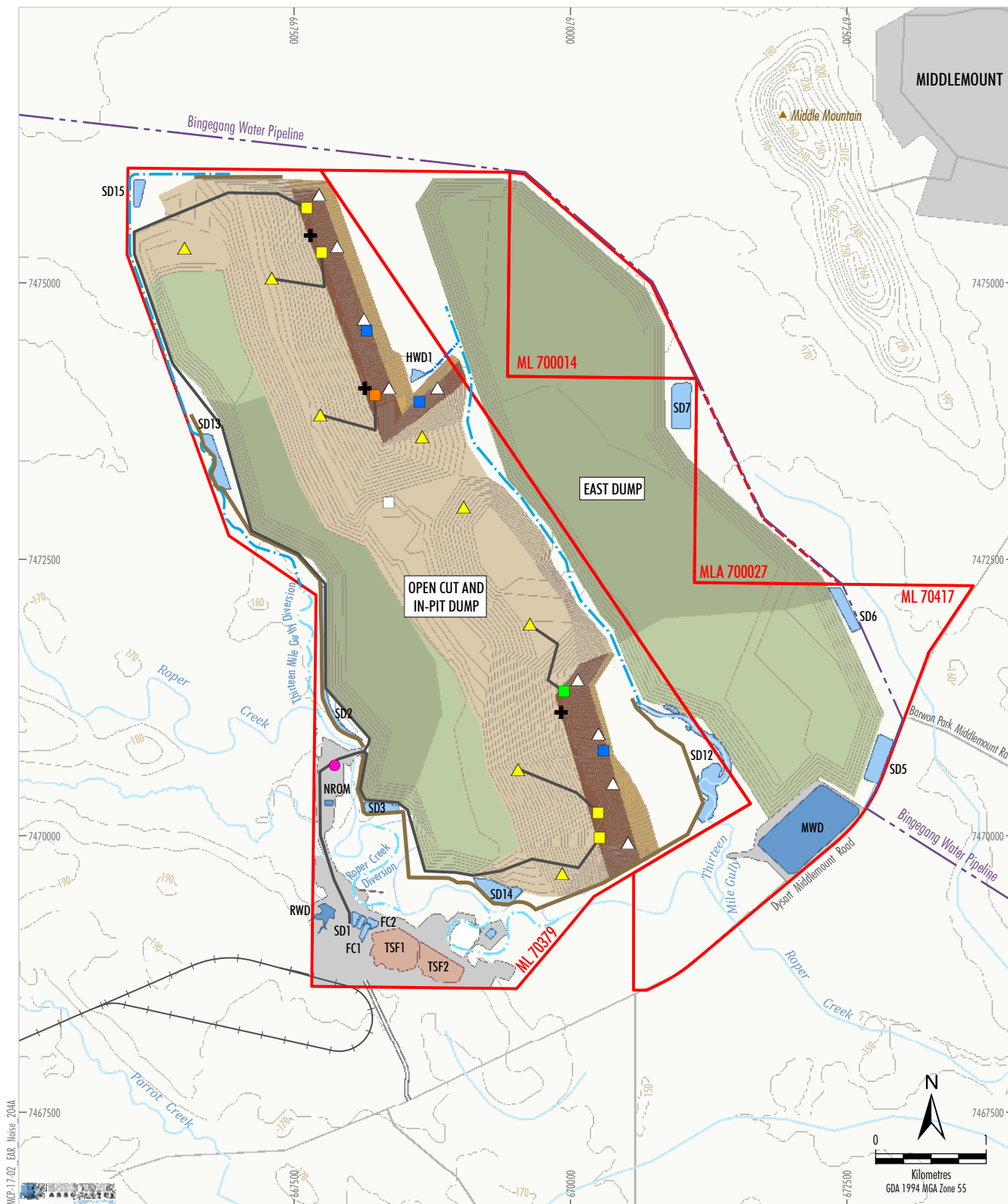


- LEGEND**
- Mining Lease Boundary (ML)
 - Mining Lease Application Boundary (MLA)
 - Topsoil Stripped
 - Active Open Cut Mining Area
 - Active Waste Rock Emplacement
 - Initial Rehabilitation
 - Established Rehabilitation
 - Mine Infrastructure Area
 - Tailings Storage Facility
 - Sediment Dam
 - Water Storage
 - Water Transfer Pipeline
 - Diversion Structure
 - Levee
 - Main Haul Road
 - Mine Access Road
 - Middlemount Rail Spur and Loop
 - Noise Sources**
 - + Drill
 - △ D10 Dozer
 - △ D11 Dozer
 - EX1900 Excavator
 - EX3600 Excavator
 - EX5500 Excavator
 - EX5600 Excavator
 - R9968 Excavator
 - CAT 992 Front End Loader

Source: MCPL (2018); Department of Natural Resources and Mines (2017)


WESTERN EXTENSION PROJECT
Noise Source Locations
2028

Figure C1



- LEGEND**
- Mining Lease Boundary (ML)
 - Mining Lease Application Boundary (MLA)
 - Topsoil Stripped
 - Active Open Cut Mining Area
 - Active Waste Rock Emplacement
 - Initial Rehabilitation
 - Established Rehabilitation
 - Mine Infrastructure Area
 - Tailings Storage Facility
 - Sediment Dam
 - Water Storage

- Water Transfer Pipeline
- Diversion Structure
- Levee
- Main Haul Road
- Mine Access Road
- Middlemount Rail Spur and Loop
- Noise Sources**
- + Drill
- ▲ D10 Dozer
- ▲ D11 Dozer
- EX1900 Excavator
- EX3600 Excavator
- EX5500 Excavator
- EX5600 Excavator
- R996B Excavator
- CAT 992 Front End Loader

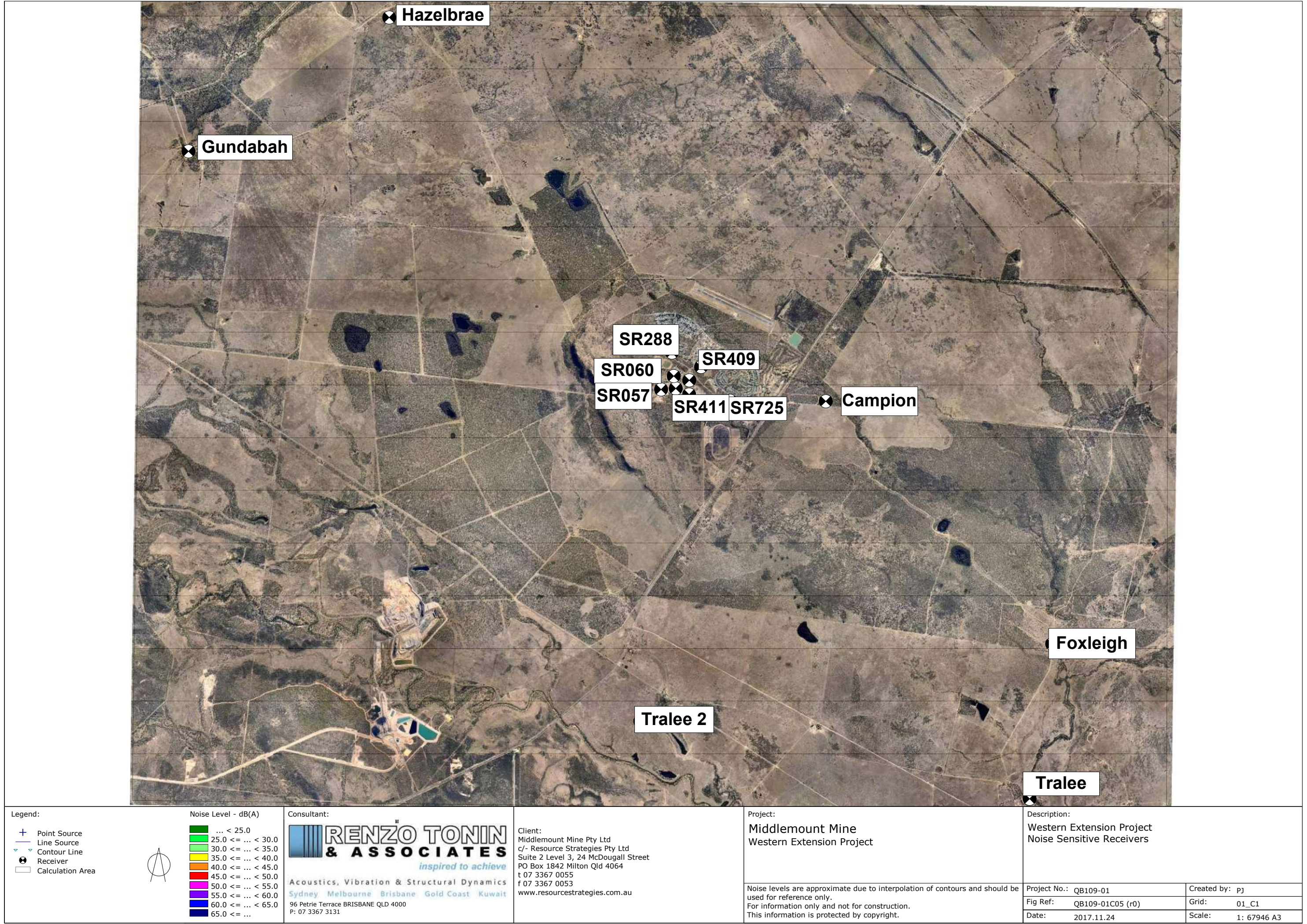
Source: MCPL (2018); Department of Natural Resources and Mines (2017)



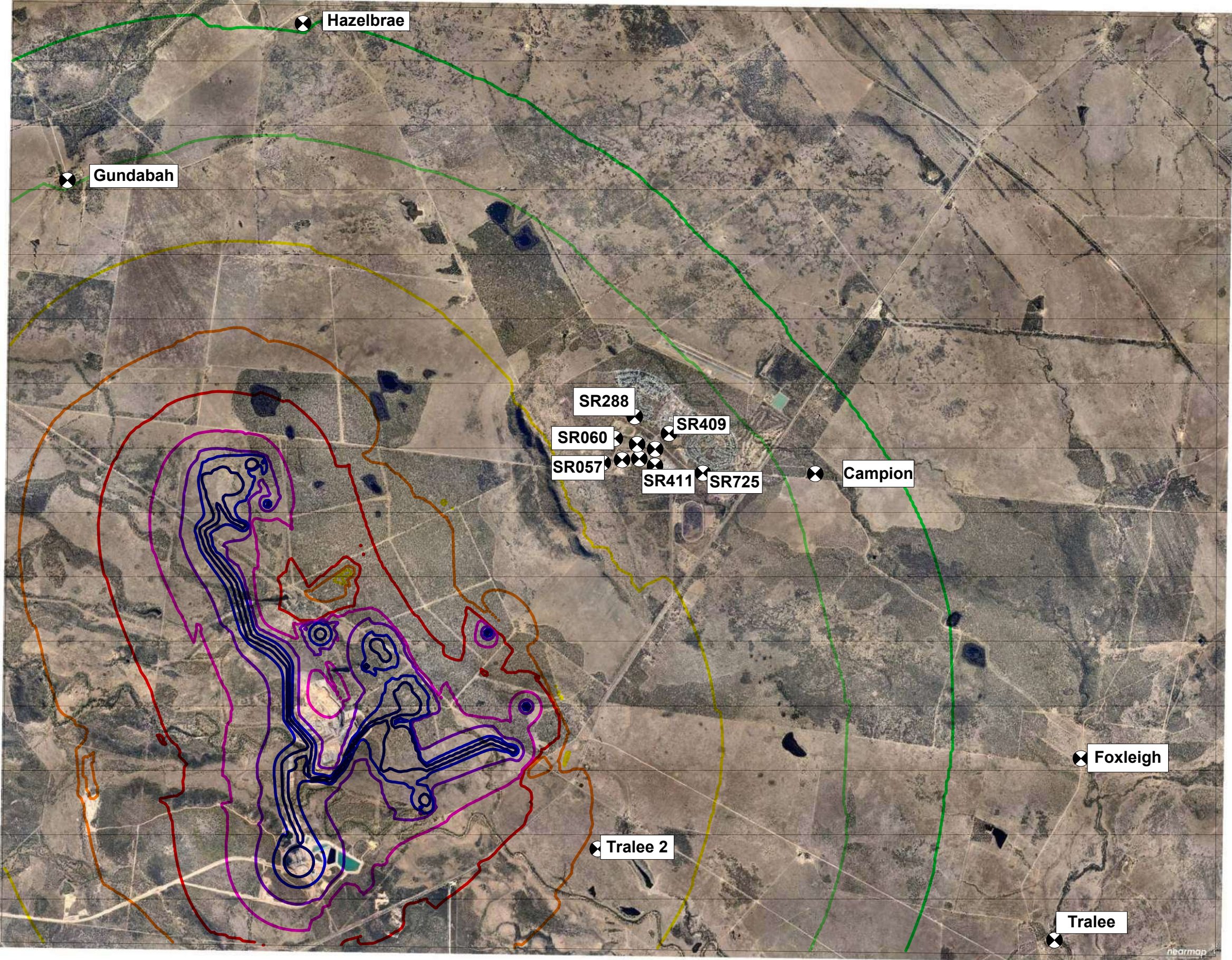
WESTERN EXTENSION PROJECT
Noise Source Locations
2032

Figure C2

APPENDIX D **Noise Sensitive Receiver Locations**



APPENDIX E Noise Contour Maps



- Legend:
- + Point Source
 - Line Source
 - Contour Line
 - ⊗ Receiver
 - Calculation Area



Noise Level - dB(A)	
	>= 20.0
	>= 25.0
	>= 30.0
	>= 35.0
	>= 40.0
	>= 45.0
	>= 50.0
	>= 55.0
	>= 60.0
	>= 65.0

Consultant:

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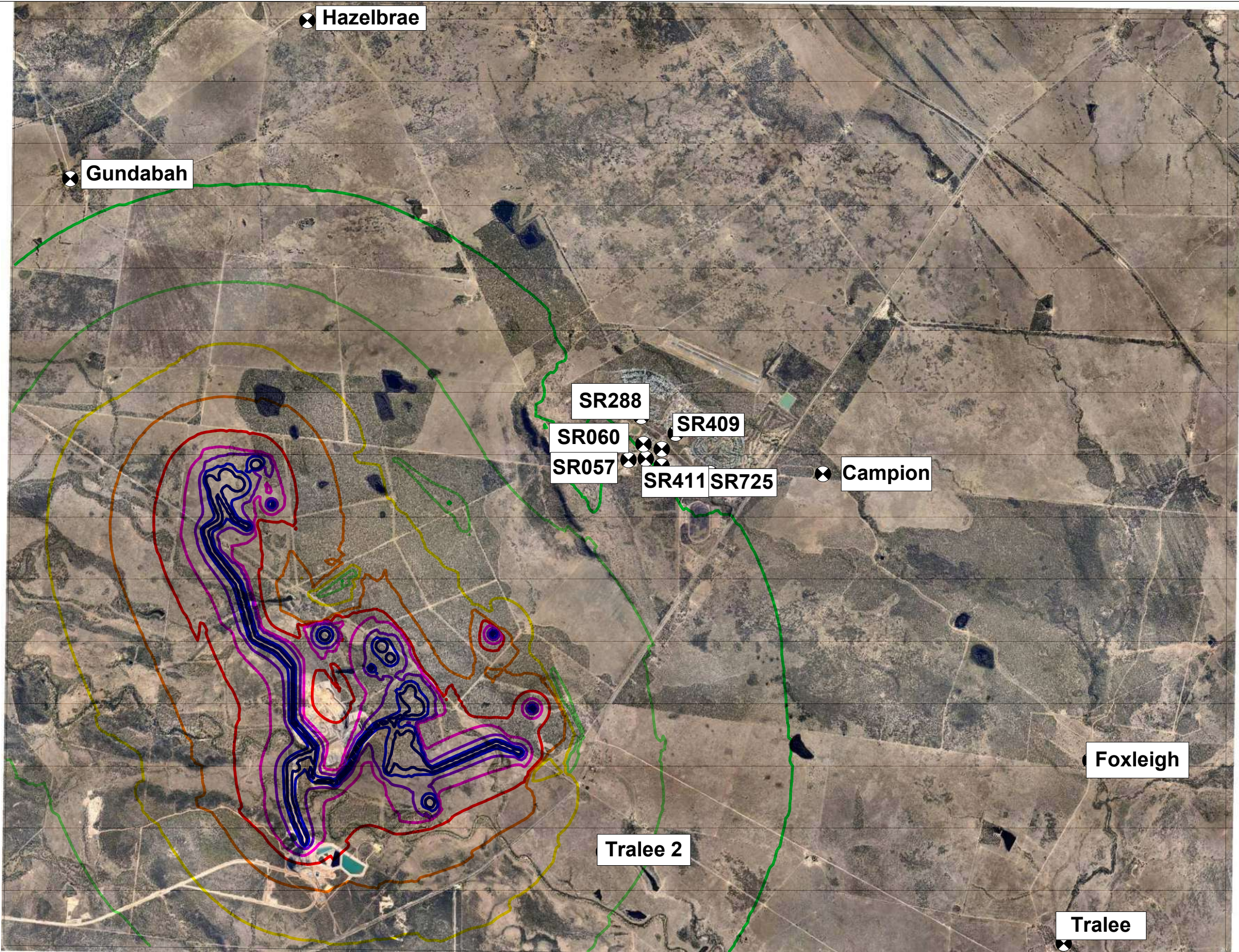
Project:
Middlemount Mine

Western Extension Project

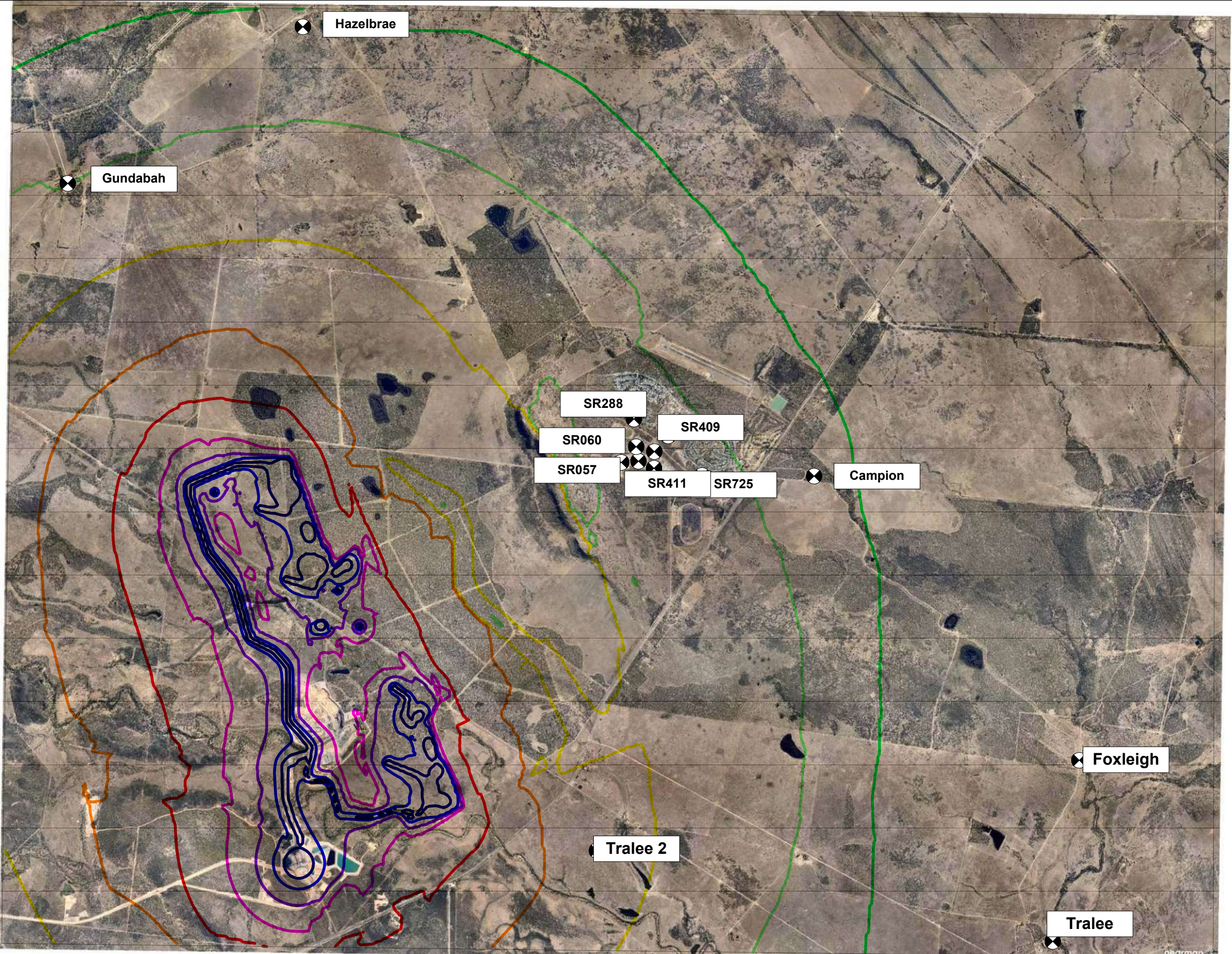
Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.
This information is protected by copyright.

Description:
Western Extension Project
Year 2028 - Adverse Weather
Conditions

Project No.:	QB109-01	Created by:	pj
Fig Ref:	QB109-01C02 (r0)	Grid:	01_C1
Date:	2017.11.24	Scale:	1: 69392 A3



Legend: + Point Source — Line Source — Contour Line ⊗ Receiver □ Calculation Area Noise Level - dB(A) >= 20.0 >= 25.0 >= 30.0 >= 35.0 >= 40.0 >= 45.0 >= 50.0 >= 55.0 >= 60.0 >= 65.0		Consultant: RENZO TONIN & ASSOCIATES inspired to achieve Acoustics, Vibration & Structural Dynamics Sydney Melbourne Brisbane Gold Coast Kuwait 96 Petrie Terrace BRISBANE QLD 4000 P: 07 3367 3131		Client: Middlemount Mine Pty Ltd c/- Resource Strategies Pty Ltd Suite 2 Level 3, 24 McDougall Street PO Box 1842 Milton Qld 4064 t 07 3367 0055 f 07 3367 0053 www.resourcestrategies.com.au		Project: Middlemount Mine Western Extension Project		Description: Western Extension Project Year 2032 - Neutral Weather Conditions	
		Noise levels are approximate due to interpolation of contours and should be used for reference only.		Project No.: QB109-01		Created by: pj			
		For information only and not for construction.		Fig Ref: QB109-01C05 (r0)		Grid: 01_C1			
		This information is protected by copyright.		Date: 2017.11.24		Scale: 1: 67946 A3			



Legend: Point Source Line Source Contour Line Receiver Calculation Area Noise Level - dB(A) >= 20.0 >= 25.0 >= 30.0 >= 35.0 >= 40.0 >= 45.0 >= 50.0 >= 55.0 >= 60.0 >= 65.0

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Project:

Middlemount Mine

Western Extension Project

Description:

Western Extension Project

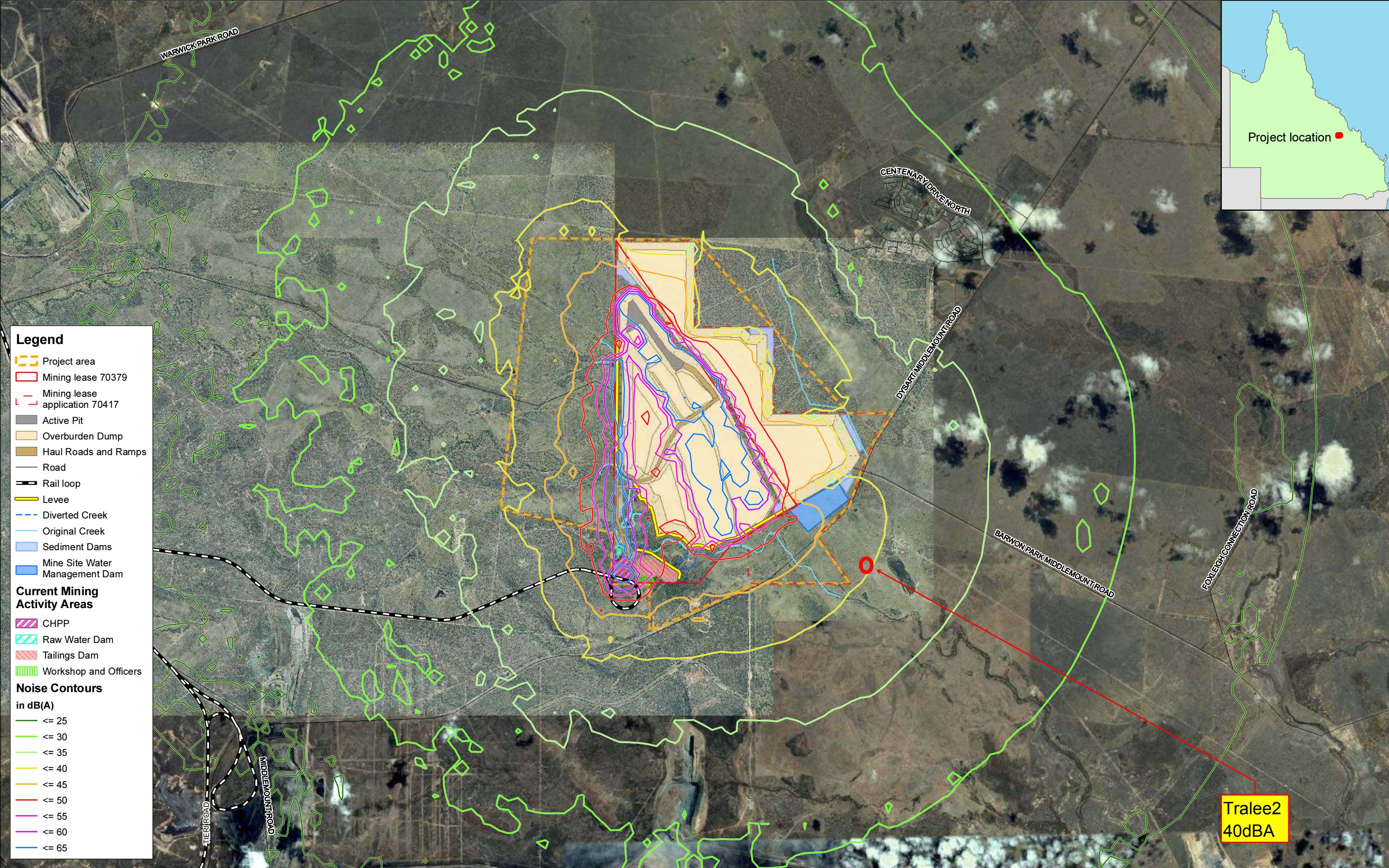
Year 2032 - Adverse Weather

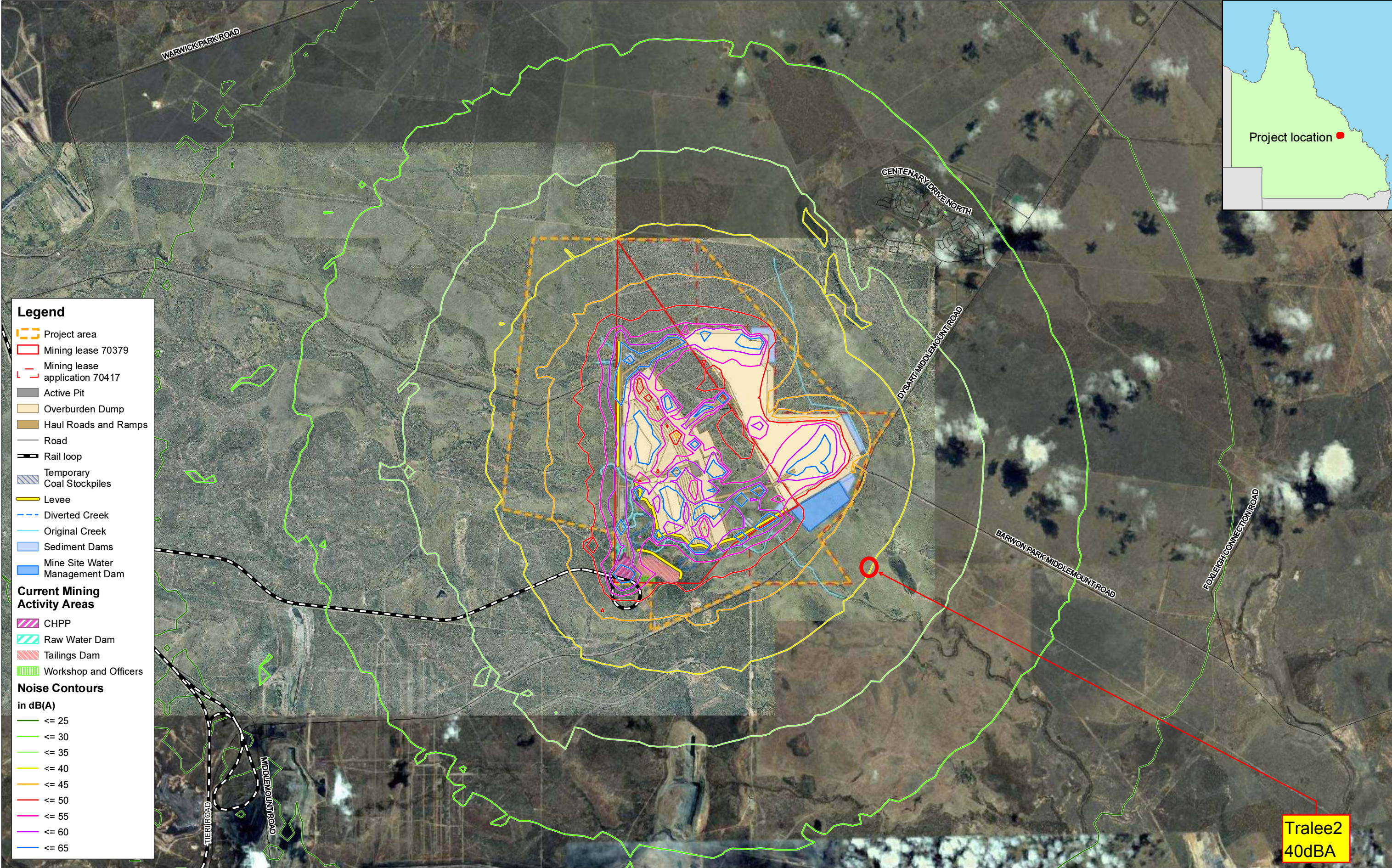
Conditions

APPENDIX F **Noise Contour Maps from EIS**













APPENDIX G Meteorological Data

An Air Quality Assessment has been prepared by Katestone Environmental Pty Ltd for the Western Extension Project. The report is titled *Middlemount Coal Mine – Western Extension Project Air Quality and Greenhouse Gas Assessment* and dated 12 December 2017 [Reference D17009-3].

The following text and figure is an extract from Page 6 of the report.

An average daily wind rose for the monitoring period is shown in Figure 3. The average daily winds are predominantly from the southeast quadrant. The average daily winds are relatively light with an average speed of 1.68 m/s.

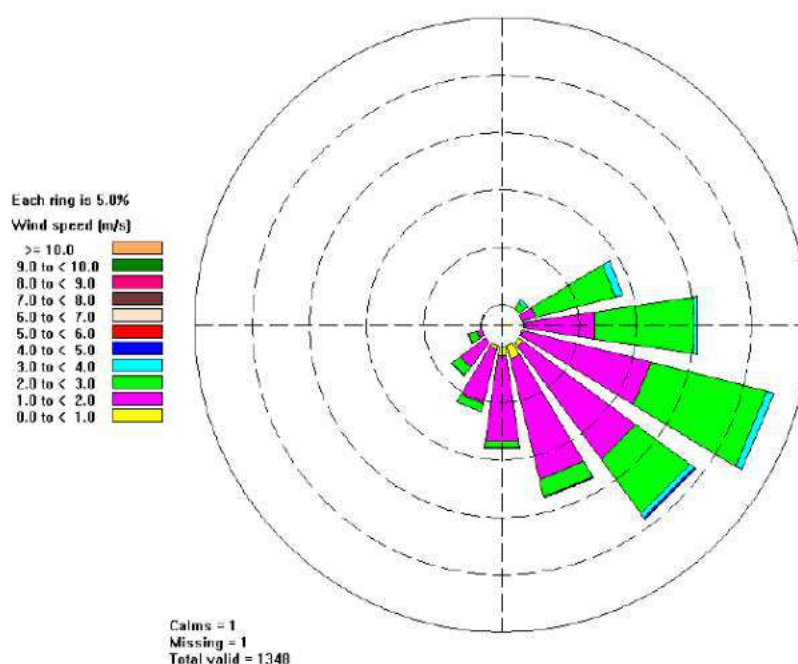


Figure 3 Daily average wind rose at MCM (September 2013 to July 2017)

Our analysis of the wind roses concluded that wind effects were not a particular feature of the area. That is wind is not considered to be a feature where source to receiver wind speeds (at 10 metre (m) height) of 3 metres per second (m/s) or below occur for 30% of the time or more in any assessment period (day, evening, night) in any season as outlined in the Planning for Noise Control. For the Western Extension Project we have therefore not used the default wind effects parameter of 3m/s.

APPENDIX G

REHABILITATION GOALS, OBJECTIVES, INDICATORS AND COMPLETION CRITERIA

Table G1
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
MIA, CHPP and roads (including haul roads)	Safe to humans and wildlife	- hazardous materials adequately managed - very low probability of subsidence or rock fails with serious consequences	contaminated land assessment	- hydrocarbon, heavy metal or other contamination levels are within allowable departmental limits - site added to the Environmental Management Register if required.
	Non-polluting	- polluted water contained on site or treated - ensure any residual water bodies have a low risk of environmental harm	upstream and downstream surface and ground water quality (e.g. sediment load, pH, heavy metal content, etc) meet EA conditions	receiving waters affected by surface water run-off have contaminant limits consistent with those specified in Table C5 of the EA, for a period of at least two years.
	Stable	- very low probability of subsidence or rock fails with serious consequences - very low probability of slope slippage with serious consequences - landform design achieves appropriate erosion rates - adequate vegetation cover established to minimise erosion	- slope angle, length and profile - erosion rates and gully formation - vegetation type, density and cover	- landform recontoured to be conducive to the adjacent landforms - all slopes are less than 5% - for slopes over 2%, continuous slope length does not exceed 70 m (i.e. engineered structures such as contour banks, cut-off drains etc are implemented on all slopes such that continuous slope length does not exceed 70 m) - erosion rates comparable to designated reference sites, for a period of at least five years - erosion maintenance requirements are comparable to designated reference sites, for a period of at least five years - a minimum of 70% vegetative cover is present and maintained - non-vegetation cover (stones, rock cover, litter, logs etc) does not cover greater than 30% of the total area - bare surface areas are not to exceed 20 m² in area, based on a five year average period - bare surface areas are not to exceed a length of 10 m along slope, based on a five year average period

Table G1 (Continued)
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
MIA, CHPP and roads (including haul roads) (cont.)	• Able to sustain an agreed post mining land use	• soil properties that support and will continue to support the desired final land use • establish specified self sustaining natural vegetation or habitat • establish land use with comparable management requirements to similarly used non-mining land	• ecosystem functionality, such as vegetation dynamics, habitat complexity and habitat quality • landscape function, such as rate of soil loss, erosion features, soil physical parameters, organic matter and nutrient content and cycling • rehabilitation progress and success rate • achievement of agreed final land use • ongoing sustainability of agreed final land use.	• vegetation established in accordance with post-mining land use given in Table F2 of the EA • water infiltration, aggregate stability and bulk density rates of rehabilitated areas are comparable to rates at designated reference sites which are representative of the post mining land use • nutrient cycling processes are comparable to designated references sites which are representative of the post mining land use • species in rehabilitated areas show evidence of flowering, viable seed setting, germination and emergence • evidence of generational succession of trees and shrubs is apparent in rehabilitated areas • vegetative material layer(s) (e.g. leaf litter) is evident and contributing to nutrient cycling and development of microbial mass • weeds do not dominate native species after disturbance or after rain • pests do not occur in substantial numbers or visibly affect the development of native plant species • for areas established to cattle grazing: - Cattle stocking rate is comparable to designated reference sites - land maintenance requirements are comparable to designated reference sites • for areas established to regional ecosystems: - densities of native tree, shrub and grass species are representative of the target Regional Ecosystems as determined through comparison with designated reference sites - community structure (groundcover, shrub and tree layers) are representative of the target Regional Ecosystems as determined through comparison with designated reference sites

Table G1 (Continued)
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
MIA, CHPP and roads (including haul roads) (cont.)				- non-native cover crop grass species constitute no more than 20% of the area of total vegetative cover - native tree, shrub and grass species which are representative of surrounding ecosystems and which will support the post-mine land use are to constitute 80% of the area of established vegetative cover
Final Voids below natural ground level All ramps	• Safe to humans and wildlife	• hazardous materials adequately managed • very low probability of subsidence or rock fails with serious consequences	• contaminated land assessment • safety assessment of dumps, voids and other slopes • slope angle, length and profile • Installation of safety barriers and human/wildlife exclusion fencing of final void if required following safety assessment	• safety assessment conducted and included in Post Closure Management Plan • fencing or other suitable barrier installed around the perimeter of the final void to restrict access • geotechnical stability of the high wall, low wall and end walls has been achieved and geotechnical investigations demonstrating this have been undertaken and reported • hydrocarbon, heavy metal or other contamination levels are within allowable departmental limits • no acid rock drainage occurring
	• Non-polluting	• polluted water contained on site or treated • ensure any residual water bodies have a low risk of environmental harm	• upstream and downstream surface and ground water quality (e.g. sediment load, pH, heavy metal content, etc) meet EA conditions	• the low, high and end walls drain internally to the final void • final void waters comply with specifications detailed in the Residual Void Water Quality Management Study • groundwater and monitoring bores has parameters consistent with those specified in Table C8 of the EA, for a period of at least five years.
	• Stable	• very low probability of subsidence or rock fails with serious consequences • very low probability of slope slippage with serious consequences • landform design achieves appropriate erosion rates	• safety assessment of dumps, voids and other slopes • slope angle, length and profile • erosion rates and gully formation	• as for “safe to human and wildlife” and “non-polluting”

Table G1 (Continued)
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
In-pit and out-of-pit overburden spoil dumps (slopes)	Safe to humans and wildlife	- hazardous materials adequately managed - very low probability of subsidence or rock fails with serious consequences	- safety assessment of dumps, voids and other slopes - slope angle, length and profile	- geotechnical stability has been achieved and geotechnical investigations demonstrating this have been undertaken and reported - slope angle does not exceed 18.5 degrees (other than spoil dump facing final void, which will be retained at angle of repose as per Final Void information above).
	Non-polluting	- polluted water contained on site or treated - ensure any residual water bodies have a low risk of environmental harm	- upstream and downstream surface and ground water quality (e.g. sediment load, pH, heavy metal content, etc) meet EA conditions - performance of capping	- groundwater monitoring bores have parameters consistent with those specified in Table C8 of the EA, for a period of at least five years. - receiving waters affected by surface water run-off have contaminant limits consistent with those specified in Table C5 of the EA, for a period of at least five years. - no leaching at the toe of dumps - no free water infiltrating into dispersive spoil.
	Stable	- very low probability of subsidence or rock fails with serious consequences - very low probability of slope slippage with serious consequences - landform design achieves appropriate erosion rates - adequate vegetation cover established to minimise erosion	- safety assessment of dumps, voids and other slopes - slope angle, length and profile - erosion rates and gully formation	- as for "safe to humans and wildlife" and "non-polluting" - rock mulch has 100% coverage of the overburden spoil dumps surface area (i.e. no bare areas exist), except for low wall spoil. - no active erosion for a period of at least five years
	Able to sustain an agreed post mining land use	- soil properties that support and will continue to support the desired final land use - establish specified self sustaining natural vegetation or habitat - establish land use with comparable management requirements to similarly used non-mining land	- ecosystem functionality, such as vegetation dynamics, habitat complexity and habitat quality - landscape function, such as rate of soil loss, erosion features, soil physical parameters, organic matter and nutrient content and cycling - rehabilitation progress and success rate	- vegetation established in accordance with post-mining land use given in Table F2 of the EA - species in rehabilitated areas show evidence of flowering, viable seed setting, germination and emergence - evidence of generational succession of trees and shrubs is apparent in rehabilitated areas - vegetative material layer(s) (e.g. leaf litter) is evident and contributing to nutrient cycling and development of microbial - mass

Table G1 (Continued)
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
In-pit and out-of-pit overburden spoil dumps (upper surface) (cont.)			- achievement of agreed final - land use - ongoing sustainability of agreed final land use.	- weeds do not dominate native species after disturbance or after rain - pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Safe to humans and wildlife	- hazardous materials adequately managed - very low probability of subsidence or rock fails with serious consequences	slope angle, length and profile	slope angle does not exceed 2%
	Non-polluting	- polluted water contained on site or treated - ensure any residual water bodies have a low risk of environmental harm	- upstream and downstream surface and ground water quality (e.g. sediment load, pH, heavy metal content, etc) meet EA conditions - Performance of capping	- groundwater monitoring bores have parameters consistent with those specified in Table C8 of the EA, for a period of at least five years. - receiving waters affected by surface water run-off have contaminant limits consistent with those specified in Table C5 of the EA, for a period of at least five years. - no free water infiltrating into dispersive spoil. - no long-term (>2 months) ponding of water on soil surface
	Stable	- very low probability of subsidence or rock fails with serious consequences - very low probability of slope slippage with serious consequences - landform design achieves appropriate erosion rates - adequate vegetation cover established to minimise erosion	- safety assessment of dumps, voids and other slopes - slope angle, length and profile - erosion rates and gully formation - vegetation type, density and cover	- as for "safe to humans and wildlife" and "non-polluting" - no free water infiltrating into dispersive spoil. - a minimum of 70% vegetative cover is present and maintained - non-vegetation cover (stones, rock cover, litter, logs etc) comprise not greater than 30% of the total area - bare surface areas do not exceed 5m² in area, over a five year average period - bare surface areas are not to exceed a length of 5 m along slope, over a five year average period

Table G1 (Continued)
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
In-pit and out-of-pit overburden spoil dumps (upper surface) (cont.)	• Able to sustain an agreed post mining land use	• soil properties that support and will continue to support the desired final land use • establish specified self sustaining natural vegetation or habitat • establish land use with comparable management requirements to similarly used non-mining land	• ecosystem functionality, such as vegetation dynamics, habitat complexity and habitat quality • landscape function, such as rate of soil loss, erosion features, soil physical parameters, organic matter and nutrient content and cycling • rehabilitation progress and success rate • achievement of agreed final land use • ongoing sustainability of agreed final land use.	• vegetation established in accordance with post-mining land use given in Table F2 of the EA • soil surface crusting occurs in less than 2% of the rehabilitated domain area • water infiltration, aggregate stability and bulk density rates of rehabilitated areas are comparable to rates at designated reference sites which are representative of the post mining land use • nutrient cycling processes are comparable to designated references sites which are representative of the post mining land use • species in rehabilitated areas show evidence of flowering, viable seed setting, germination and emergence • evidence of generational succession of trees and shrubs is apparent in rehabilitated areas • vegetative material layer(s) (e.g. leaf litter) is evident and contributing to nutrient cycling and development of microbial mass • weeds do not dominate native species after disturbance or after rain • pests do not occur in substantial numbers or visibly affect the development of native plant species • densities of native tree, shrub and grass species are representative of the target Regional Ecosystems as determined through comparison with designated reference sites • community structure (groundcover, shrub and tree layers) are representative of the target Regional Ecosystems as determined through comparison with designated reference sites • non-native cover crop grass species constitute no more than 20% of the area of total vegetative cover

Table G1 (Continued)
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
In-pit and out-of-pit overburden spoil dumps (upper surface) (cont.)				native tree, shrub and grass species which are representative of surrounding ecosystems and which will support the post-mine land use are to constitute 80% of the area of established vegetative cover.
Low wall spoil (above natural ground level)	Safe to humans and wildlife	- hazardous materials adequately managed - very low probability of subsidence or rock fails with serious consequences	- safety assessment of dumps, voids and other slopes - slope angle, length and profile	- geotechnical stability has been achieved and geotechnical investigations demonstrating this have been undertaken and reported. - slope angle will be retained at angle of repose.
	Non-polluting	- polluted water contained on site or treated - ensure any residual water bodies have a low risk of environmental harm	- upstream and downstream surface and ground water quality (e.g. sediment load, pH, heavy metal content, etc) meet EA conditions - performance of capping	- groundwater monitoring bores have parameters consistent with those specified in Table C8 of the EA, for a period of at least five years. - receiving waters affected by surface water run-off have contaminant limits consistent with those specified in Table C5 of the EA, for a period of at least five years. - no leaching at the toe of dumps - no free water infiltrating into dispersive spoil.
	Stable	- very low probability of subsidence or rock fails with serious consequences - very low probability of slope slippage with serious consequences - landform design achieves appropriate erosion rates	- safety assessment of dumps, voids and other slopes - slope angle, length and profile - erosion rates and gully formation	- as for "safe to humans and wildlife" and "non-polluting" - no active erosion for a period of at least five years
	Able to sustain an agreed post mining land use (benches within low wall spoil only)	- soil properties that support and will continue to support the desired final land use - establish specified self sustaining natural vegetation or habitat - establish land use with comparable management requirements to	- ecosystem functionality, such as vegetation dynamics, habitat complexity and habitat quality - landscape function, such as rate of soil loss, erosion features, soil physical parameters, organic matter and nutrient content and	- vegetation established in accordance with post-mining land use given in Table F2 of the EA on benches within low wall spoil - species in rehabilitated areas show evidence of flowering, viable seed setting, germination and emergence - evidence of generational succession of trees and shrubs is apparent in rehabilitated areas - vegetative material layer(s) (e.g. leaf litter) is evident and

Table G1 (Continued)
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
Low wall spoil (above natural ground level) (cont.)		similarly used non-mining land	- cycling - rehabilitation progress and success rate - achievement of agreed final land use - ongoing sustainability of agreed final land use.	- contributing to nutrient cycling and development of microbial mass - weeds do not dominate native species after disturbance or after rain - pests do not occur in substantial numbers or visibly affect the development of native plant species.
Water storage/ water management dams	Safe to humans and wildlife	- hazardous materials adequately managed - very low probability of subsidence or rock fails with serious consequences	Contaminated land assessment	- hydrocarbon, heavy metal or other contamination levels are within allowable departmental limits - site added to the Environmental Management Register if required.
	Non-polluting	- polluted water contained on site or treated - ensure any residual water bodies have a low risk of environmental harm	upstream and downstream surface and ground water quality (e.g. sediment load, pH, heavy metal content, etc) meet EA conditions	- receiving waters affected by surface water run-off have contaminant limits consistent with those specified in Table C5 of the EA, for a period of at least five years. - water quality in water storage and management dams which are retained for beneficial reuse comply with the limits detailed within ANZECC or ARMCANZ for that beneficial use, for a period of at least five years.
	Stable	- very low probability of subsidence or rock fails with serious consequences - very low probability of slope slippage with serious consequences - landform design achieves appropriate erosion rates - adequate vegetation cover established to minimise erosion	- safety assessment of dumps, voids and other slopes - slope angle, length and profile - erosion rates and gully formation - vegetation type, density and cover	- as for “safe to humans and wildlife” and “non-polluting” - a minimum of 70% vegetative cover is present and maintained - non-vegetation cover (stones, rock cover, litter, logs etc) comprise not greater than 30% of the total area - bare surface areas do not exceed 20 m² in area, over a five year average period - bare surface areas are not to exceed a length of 10 m along slope, over a five year average period

Table G1 (Continued)
Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
Water storage/ water management dams (cont.)	• Able to sustain an agreed post mining land use	• soil properties that support and will continue to support the desired final land use • establish specified self sustaining natural vegetation or habitat • establish land use with comparable management requirements to similarly used non-mining land	• ecosystem functionality, such as vegetation dynamics, habitat complexity and habitat quality • landscape function, such as rate of soil loss, erosion features, soil physical parameters, organic matter and nutrient content and cycling • rehabilitation progress and success rate • achievement of agreed final land use • ongoing sustainability of agreed final land use.	• vegetation established in accordance with post-mining land use given in Table F2 of the EA • soil surface crusting occurs in less than 5% of the rehabilitated domain area. • water infiltration, aggregate stability and bulk density rates of rehabilitated areas are comparable to rates at designated reference sites which are representative of the post mining land use • nutrient cycling processes are comparable to designated references sites which are representative of the post mining land use • species in rehabilitated areas show evidence of flowering, viable seed setting, germination and emergence • evidence of generational succession of trees and shrubs is apparent in rehabilitated areas • vegetative material layer(s) (e.g. leaf litter) is evident and contributing to nutrient cycling and development of microbial mass • weeds do not dominate native species after disturbance or after rain • pests do not occur in substantial numbers or visibly affect the development of native plant species • densities of native tree, shrub and grass species are representative of the target Regional Ecosystems as determined through comparison with designated reference sites • community structure (groundcover, shrub and tree layers) are representative of the target Regional Ecosystems as determined through comparison with designated reference sites • non-native cover crop grass species constitute no more than 20% of the area of total vegetative cover • native tree, shrub and grass species which are representative of surrounding ecosystems constitute at least 80% of the area of established vegetative cover.

Highlighted cells = the proposed changes to the approved criteria under EA EPML00716913.

ATTACHMENT A

GROUNDWATER ASSESSMENT PEER REVIEW LETTER



HydroAlgorithmics Pty Ltd • ABN 25 163 284 991
PO Box 241, Gerringong NSW 2534. Phone: (+61 2) 4234 3802

noel.merrick@hydroalgorithmics.com

DATE: 4 May 2018

TO: Shane Flint
Middlemount Coal Pty Limited
PO Box 24
Middlemount QLD 4756

FROM: Dr Noel Merrick

RE: Middlemount Coal Mine Western Extension Project – Groundwater
Assessment Peer Review

YOUR REF: Letter 00851920

OUR REF: HA2018/4

Introduction

This report is provided in response to a written request on 6 June 2017 from Resource Strategies Pty Ltd (RSPL), on behalf of Middlemount Coal Pty Ltd (MCPL), for conducting a peer review of the groundwater assessment (GA) for the Middlemount Coal Mine Western Extension Project in the Bowen Basin QLD. The GA has been done by Australasian Groundwater and Environmental Consultants (AGE) under the project management of RSPL.

The review has been conducted by Dr Noel Merrick in accordance with national groundwater modelling guidelines, with a focus on compliance with Queensland government requirements and the likely expectations of the Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development.

The GA has been reviewed progressively:

1. After conceptualisation, software selection and model design planning.
2. After model calibration, prediction, and issue of the draft GA report (v01.02).
3. After issue of the draft GA report (v01.04).
4. After issue of the finalised GA report (v01.05).

HydroAlgorithmics Report HA2017/3 documented the review after Stage 1, issued 22 October 2017. Responses by AGE were received 9 November 2017.

Documentation

The peer review has been based on this report:

1. AGE, 2018, *Middlemount Coal Mine Western Extension Project: Groundwater Assessment. Project No. G1840D report prepared for Middlemount Coal Pty Ltd. 99p + 6 Appendices (v01.05). 27 April 2018.*

Appendix F provides specific detail on the groundwater modelling component of the GA:

2. AGE, 2018, *Appendix F: Numerical Model Report*. 41p.

Other reports were provided, but these were not subject to review:

3. WRM, 2017, *Middlemount Mine - Estimate of Groundwater Inflows*. Letter report for Middlemount Coal Pty Ltd. 5 October 2017, 3p.
4. 4T Consultants Pty Ltd, 2017, *Middlemount Coal Mine Western Extension Project: Groundwater Bore Census*. Report prepared for Middlemount Coal Pty Ltd. 162p

The major sections in Document #1 are:

1. Introduction
2. Mining history
3. Queensland regulatory framework for groundwater
4. Environmental setting
5. Geology within the study area
6. Conceptual groundwater model
7. Environmental value of groundwater
8. Numerical modelling
9. Groundwater monitoring strategy / program
10. Conclusions
11. References

The appendices are:

- A. IESC Guidelines
- B. DNRM groundwater data base bores
- C. Bore census
- D. Monitoring bores
- E. Tertiary and Permian water quality data
- F. Numerical model report

The major and minor sections in Document #2 (Appendix F) are:

1. Introduction and objectives
 - Model confidence level classification
2. Model background
 - Previous modelling for Middlemount Coal Mine
 - Other nearby sites
 - Conceptual model
3. Model software
 - Code selection
4. Model design
 - Time discretisation - stress periods
 - Boundary conditions
 - Initial conditions
 - Hydraulic parameters
 - Timing - proposed mining run
 - Timing - post-mining
 - Mine drainage
 - Recharge
 - Water budget
5. Model calibration and verification
 - Calibration heads
6. Groundwater fate modelling
7. Uncertainty analysis
 - Methodology

Review Methodology

While there are no standard procedures for peer reviews of entire groundwater assessments, there are two accepted guides to the review of groundwater models: the Murray-Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline¹, issued in 2001, and the newer guidelines issued by the National Water Commission (NWC) in June 2012 (Barnett *et al.*, 2012²). Both guides also offer techniques for reviewing the non-modelling components of a groundwater assessment. As yet there are no firm guidelines on uncertainty analysis for groundwater models; however, a draft guide was issued by the IESC in February 2018³.

The 2012 NWC guide builds on the 2001 MDBC guide, with substantial consistency in model conceptualisation, design, construction and calibration principles, and the performance and review criteria, although there are differences in details. The new guide is almost silent on coal mine modelling and offers no direction on best practice methodology for such applications. There is, however, an expectation of more effort in uncertainty analysis, although the guide is not prescriptive as to which methodology should be adopted.

The groundwater assessment has been reviewed according to the 2-page Model Appraisal checklist⁴ in MDBC (2001). This checklist has questions on (1) The Report; (2) Data Analysis; (3) Conceptualisation; (4) Model Design; (5) Calibration; (6) Verification; (7) Prediction; (8) Sensitivity Analysis; and (9) Uncertainty Analysis. Non-modelling components of the groundwater impact assessment are addressed by the first three sections of the checklist.

It should be recognised that the effort put into the modelling component of a groundwater assessment is very dependent on possible timing and budgetary constraints that are generally not known to a reviewer.

A detailed assessment has been made in terms of the peer review checklists in **Table 1** and **Table 2**. Supplementary comments are offered in the following sections.

Report Matters

The GA report is a good quality document of about 200 pages length, including a number of appendices that contain more detail on Commonwealth requirements, field investigations, water quality, bore details, and numerical modelling. It is well structured, generally well written and the graphics are of high quality. The report serves well as a standalone document, with no undue dependence on earlier work.

Previous review comments after conceptualisation and model design stages have been addressed satisfactorily, except for a few instances that are explored further in following sections. Although some editorial corrections are warranted, they are not the focus of this review. Review comments on several draft reports have been addressed satisfactorily.

Overall, there are no significant matters of concern in the report as to structure or depth

¹ MDBC (2001). Groundwater flow modelling guideline. Murray-Darling Basin Commission. URL: www.mdbc.gov.au/nrm/water_management/groundwater/groundwater_guides

² Barnett, B, Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A. and Boronkay, A. (2012). *Australian Groundwater Modelling Guidelines*. Waterlines report 82, National Water Commission, Canberra.

³ IESC (2018). *Explanatory Note, Uncertainty Analysis in Groundwater Modelling*. Commonwealth of Australia, Draft February 2018.

⁴ The NWC guide includes a more detailed checklist with yes/no answers but without the graded assessments of the 2001 checklist, which this reviewer regards as less academic and more informative for readers.

of coverage. There is a clear focus on regulatory requirements.

The objectives are stated clearly at the outset (Section 1.1), and the text of the report and its Conclusion sufficiently address those objectives.

In Section 8.1, the report should provide a map of numerical model extent, or at least refer to Figure F 4.1 (in Appendix F), before any modelling results are presented.

Data Matters

The groundwater monitoring network is substantial, consisting of 10 Tertiary bores, nine Permian bores, and two destroyed bores (MW1, MW1P). There are no bores in alluvium. According to the bore hydrographs in Figures 6.3 and 6.4, measurements commenced in 2008 for Tertiary bores, and in 2012 for Permian bores. Some bores are always dry, hence of little use. The hydrographs are compared with weather trends indicated by the CRD curve. There is no convincing correlation of groundwater levels with rainfall, but many of the Permian bores show definite mining effects. The magnitude and polarity of vertical head differences between paired Tertiary and Permian sites have been examined.

A thorough examination has been undertaken to identify neighbouring bores within 10 km, by means of database interrogation and a field bore census. All groundwater users appear to be located 5-10 km to the north of the mining lease. There are no off-lease monitoring bores in this area to track groundwater responses as mining moves to the north-west. The proposed additional monitoring bores (in Figure 9.1) are suitably positioned for the future mining extent.

Separate groundwater level contour maps for Tertiary and Permian support general groundwater flow direction to the south-east, although there is a strong sink effect near existing mining.

Stream flow data, presented for a gauging station on upstream Roper Creek, indicate very infrequent flows. Losing conditions would be expected during times of flow. Given long periods of zero flow, the creek is not likely to ever have a gaining status.

There is a clear description, and good justification, for hydrogeological conceptualisation, as summarised in the conceptual model of Figure 6.8, during mining. The reviewer endorses this conceptualisation. No significant stresses have been omitted in the transition from the conceptual model to the numerical model. It is noted that evapotranspiration is in the conceptualisation, but not in the numerical implementation, due to substantial depths to the water table that would negate this process.

Model Matters

The model extent is shown clearly in Figure F 4.1 of Appendix F, but does not appear in the main report. Compared to the earlier (Stage 2 EIS) model, it extends farther to the north (13 km from the ML), not as far to the south (6 km), and has more logical arcuate eastern (8 km) and western (9 km) boundaries controlled by geology. The presence of neighbouring mines has been the main determinant of the boundary locations.

The model extent is approximately 30 km x 21 km. The broad extent of the model should minimise potential boundary effects. The Project-only drawdowns (Figures 8.2-8.5) show no edge effects.

Modelling methodology

The modelling methodology, which was reviewed initially in October 2017, is endorsed by the reviewer.

The model has been built with 17 layers. Due to dislocation of layer continuity by the Jellinbah Fault, about 67% of model cells have been pinched out.

The use of MODFLOW-USG (Beta) coupled with AlgoMesh software has allowed extra stratigraphic detail and better spatial resolution of surface features without compromising memory requirements or simulation runtime. The minimum cell size is 100 m. The total number of model cells is only about 109,000 which is remarkably concise for a model with so many layers. This illustrates the advantage of modelling with MODFLOW-USG.

The Bowen Gas Project has been included for cumulative effects.

Model calibration

Model calibration is satisfactory for transient conditions. The calibration performance (for groundwater levels) is about 8.6 %RMS in relative terms and about 7 mRMS in absolute terms, both of which are acceptable for coal mining models. Semi-quantitative calibration would have been possible to current pit inflows inferred by WRM (2017). This has not been mentioned, but the results are in good agreement for low-rainfall conditions (1-2 ML/day).

It is not possible for a reviewer to readily discern whether vertical head gradients are reproduced well as the hydrographs in Appendix F1 are displayed one by one, rather than as stacked curves for paired sites. The hydrograph matches are reasonably good overall.

No spatial map of average residuals is provided to allow an appreciation of where calibration is good and where it is poor.

Calibrated formation properties appear consistent with previous studies and site tests, with appropriate use of a depth decay function for coal permeabilities. The adopted Kh/Kv anisotropies appear mild and could be much greater in reality; this should reduce the predicted effects.

Model prediction

Three scenarios are defined for predictive analysis, although only two are mentioned. Their definitions could be clearer. Essentially, they comprise a Null run, a Cumulative run (for all mines and CSG), and a Project-only run (obtained by deactivating the Project, and differencing from the Cumulative run).

Another scenario consisted of particle tracking post-mining. The reviewer considers this an unnecessary undertaking as the groundwater level contours are sufficient to determine that the final voids are permanent sinks and therefore must capture all "particles".

The drawdown extents (modified by faults and coal seam truncation) and drawdown magnitudes are plausible.

A rigorous "*monte carlo*" style uncertainty analysis has been undertaken, incorporating uncertainty in transmissive, storage and recharge properties, based on about 300 effectively calibrated realisations. Uncertainty has been reported for mine inflow, drawdown extents per formation, and hydrographic responses at every bore (for percentiles 5, 20, 80 and 95). This work is commendable.

Conclusion

This reviewer finds that the model underpinning the groundwater assessment is "fit for purpose", where the primary purpose of the model is the prediction of potential environmental impacts as inferred from groundwater drawdown during mining.

The objectives have been addressed satisfactorily.

The proposed mitigation and monitoring measures are satisfactory. As all active landholder bores lie to the north, recommended monitoring between them and the mine extension is appropriate.

A very thorough and commendable analysis of the uncertainty in the estimates has been conducted.

Yours sincerely,

A handwritten signature in dark ink, appearing to read 'N Merrick', with a stylized flourish at the end.

Dr Noel Merrick

Table 1. MODEL APPRAISAL: Middlemount Model Preparation

Q.	QUESTION	Not Applicable or Unknown	Score 0	Score 1	Score 3	Score 5	Score	Max. Score (0, 3, 5)	COMMENT
1.0	THE REPORT								
1.1	Is there a clear statement of project objectives in the modelling report?		Missing	Deficient	Adequate	Very Good			Section F1. Appendix F.
1.2	Is the level of model complexity clear or acknowledged?		Missing	No	Yes				Section F1.1, Table F 1.1. Reference to 2012 national guidelines. Class 2 confidence classification, partly Class 3. Evidence is substantiated by ticking guideline attribute list. Equivalent to Impact Assessment Model, medium complexity (2001 guide).
1.3	Is a water or mass balance reported?		Missing	Deficient	Adequate	Very Good			Section F4.9: calibration & prediction periods. Mine inflow. No reported takes from alluvium and Roper Creek.
1.4	Has the modelling study satisfied project objectives?		Missing	Deficient	Adequate	Very Good			Stated objectives are predicted mine inflows and drawdown impacts. DEHP guide requirements are addressed (except alluvial / stream takes)
1.5	Are the model results of any practical use?			No	Maybe	Yes			
2.0	DATA ANALYSIS								
2.1	Has hydrogeology data been collected and analysed?		Missing	Deficient	Adequate	Very Good			Sections 5 & 6. Dipping geology truncated by major (Jellinbah) Fault. Detailed stratigraphy. Some historical measurements of physical properties - over-emphasis on textbook values. Good coverage of water quality in all formations.

2.2	Are groundwater contours or flow directions presented?		Missing	Deficient	Adequate	Very Good			Maps of flow directions should show locations of sample points – Figures 6.9, 6.10. There is sufficient data to infer flow towards the mine site from east and west, then regional flow to south-east, both in Tertiary and coal seams. Sections 6.5.3, 6.6.3 state alluvial and Tertiary groundwater flow to south-east. No steady-state head contours in modelling appendix F (other than particle tracking partial figure).
2.3	Have all potential recharge data been collected and analysed? (rainfall, streamflow, irrigation, floods, etc.)		Missing	Deficient	Adequate	Very Good			Primarily diffuse rainfall recharge. Expected losses through streambeds. Potential flood recharge not mentioned.
2.4	Have all potential discharge data been collected and analysed? (abstraction, evapotranspiration, drainage, springflow, etc.)		Missing	Deficient	Adequate	Very Good			Mine site drainages are ephemeral. Assessment of potential GDEs and stygofauna. Private groundwater usage estimated from bore census.
2.5	Have the recharge and discharge datasets been analysed for their groundwater response?		Missing	Deficient	Adequate	Very Good			Cumulative Rainfall Departure (residual mass) is compared with representative groundwater hydrographs to demonstrate active stresses - climate or mining effects. There is discussion on vertical head gradients. MW1 is said to be mining affected but the hydrograph shows rising heads before cessation - an explanation is offered.
2.6	Are groundwater hydrographs used for calibration?			No	Maybe	Yes			Sufficient monitoring network, and of long duration. Table 6.2 has 10 Tertiary sites and 9 Permian sites, with two destroyed (MW1, MW1P). Data from June 2008 (at most).

2.7	Have consistent data units and standard geometrical datums been used?			No	Yes				
3.0	CONCEPTUALISATION								
3.1	Is the conceptual model consistent with project objectives and the required model complexity?		Unknown	No	Maybe	Yes			
3.2	Is there a clear description of the conceptual model?		Missing	Deficient	Adequate	Very Good			Section 6.12.
3.3	Is there a graphical representation of the modeller's conceptualisation?		Missing	Deficient	Adequate	Very Good			Figure 6-6 E-W cross-sections during mining.
3.4	Is the conceptual model unnecessarily simple or unnecessarily complex?			Yes	No				Major processes are included, including fault truncation. Evapotranspiration not significant due the water depth (~10m). Stratigraphy is sufficiently represented by layer aggregation.
4.0	MODEL DESIGN								
4.1	Is the spatial extent of the model appropriate?			No	Maybe	Yes			Dimensions 30 km x 21 km. Unstructured grid of Voronoi cells. Minimum cell size 100m. 17 layers, about 20,000 cells per layer. Total cell count 108,552; 67% pinchouts.

4.2	Are the applied boundary conditions plausible and unrestrictive?		Missing	Deficient	Adequate	Very Good			Distances of mine lease to boundaries: North ~13 km; South 6 km; East ~8 km; West ~9 km. Reasonable no-flow boundaries (north & east). Drain cells on three edges represent neighbouring mines. DRN elevation of 30m above seam has been used for CSG. RIV is suitable for streams. RCH algorithm is %rainfall - suitable. No WEL extraction assumed by private bores - suitable. Initial heads pattern not shown.
4.3	Is the software appropriate for the objectives of the study?			No	Maybe	Yes			MODFLOW-USG Beta + AlgoMesh and custom Fortran/Python software.

Table 2. MODEL APPRAISAL: Middlemount Model Implementation

Q.	QUESTION	Not Applicable or Unknown	Score 0	Score 1	Score 3	Score 5	Score	Max. Score (0, 3, 5)	COMMENT
5.0	CALIBRATION								2011-2017: 7 years. First mining 2011. Warm-up 1974-2010 (27 years).
5.1	Is there sufficient evidence provided for model calibration?		Missing	Deficient	Adequate	Very Good			Sufficient for performance against groundwater levels. No mention of historical mine inflow agreement (1-2 ML/day). No indication of spatial distribution of residuals. Scattergram and performance statistics are given. Entire set of observed vs. simulated hydrographs.
5.2	Is the model sufficiently calibrated against spatial observations?		Missing	Deficient	Adequate	Very Good			Scattergram suggests uniform performance over all elevations. No residuals spatial map.
5.3	Is the model sufficiently calibrated against temporal observations?		Missing	Deficient	Adequate	Very Good			Hydrographs for all bores are presented for comparison in App.F1. Full range from poor to very good matches. Mine inflows of correct magnitude. Multi-level bores not shown together to see if vertical gradients are reproduced.
5.4	Are calibrated parameter distributions and ranges plausible?		Missing	No	Maybe	Yes			Table F4.1. Consistent with previous studies and site tests. Depth decay functions used for coal seam K. Kh/Kv anisotropy is mild and could be much greater.
5.5	Does the calibration statistic satisfy agreed performance criteria?		Missing	Deficient	Adequate	Very Good			8.6%RMS, 7mRMS at 26 calibration sites.

5.6	Are there good reasons for not meeting agreed performance criteria?	N/A	Missing	Deficient	Adequate	Very Good			
6.0	VERIFICATION								<i>Not a necessary step.</i>
6.1	Is there sufficient evidence provided for model verification?	N/A	Missing	Deficient	Adequate	Very Good			All data used for calibration.
6.2	Does the reserved dataset include stresses consistent with the prediction scenarios?	N/A	Unknown	No	Maybe	Yes			
6.3	Are there good reasons for an unsatisfactory verification?	N/A	Missing	Deficient	Adequate	Very Good			
7.0	PREDICTION								2018-2038: 21 years. Equilibrium post-mining by steady-state, not long-term transient recovery.
7.1	Have multiple scenarios been run for climate variability?		Missing	Deficient	Adequate	Very Good			A single average climate is assumed to have been used in accordance with standard practice.
7.2	Have multiple scenarios been run for operational /management alternatives?		Missing	Deficient	Adequate	Very Good			One proposed mine plan. Three scenarios: Null, Cumulative, Project only. ("Null" not stated?). Particle tracking for final voids.
7.3	Is the time horizon for prediction comparable with the length of the calibration / verification period?		Missing	No	Maybe	Yes			Transient calibration 7 years from 2011 to 2017. Prediction period is 21 years from 2018 to 2038. Hence 3x.
7.4	Are the model predictions plausible?			No	Maybe	Yes			Plausible mining drawdown magnitudes and drawdown extent.
8.0	SENSITIVITY ANALYSIS								
8.1	Is the sensitivity analysis sufficiently intensive for key parameters?	N/A	Missing	Deficient	Adequate	Very Good			Traditional perturbation analysis not done. Supplanted by thorough <i>monte carlo</i> uncertainty analysis.

8.2	Are sensitivity results used to qualify the reliability of model calibration?	N/A	Missing	Deficient	Adequate	Very Good			
8.3	Are sensitivity results used to qualify the accuracy of model prediction?	N/A	Missing	Deficient	Adequate	Very Good			
9.0	UNCERTAINTY ANALYSIS								
9.1	If required by the project brief, is uncertainty quantified in any way?		Missing	No	Maybe	Yes			Rigorous null-space <i>monte carlo</i> uncertainty analysis on K, S and RCH parameters. 304 effectively calibrated realisations, with 40% rejection rate (on 500 model runs) using 20% tolerance on objective function (sum-of-squares). Examination of effect on mine inflow, drawdown extents per formation, and hydrographic responses at every bore.