Adani Mining Pty Ltd

NORTH GALILEE BASIN RAIL PROJECT

Additional information to the Environmental Impact Statement

Appendix C NGBR Project realignment report

April 2014

This North Galilee Basin Rail Project realignment report ("the Report") has been prepared by GHD Pty Ltd ("GHD") on behalf of and for Adani Mining Pty Ltd ("Adani") in accordance with an agreement between GHD and Adani.

The Report may only be used and relied on by Adani for the purpose of informing environmental assessments and planning approvals for the North Galilee Basin Rail Project ("the Purpose") and may not be used by, or relied on by any person other than Adani.

The services undertaken by GHD in connection with preparing the Report were limited to those specifically detailed in the Report.

The Report is based on conditions encountered and information reviewed, including assumptions made by GHD, at the time of preparing the Report. Assumptions made by GHD are contained through the Report, including (but not limited to) concept design and operations information provided by Adani.

To the maximum extent permitted by law GHD expressly disclaims responsibility for or liability arising from:

1. any error in, or omission in connection with assumptions, or
2. reliance on the Report by a third party, or use of the Report other than for the Purpose.

Table of contents

1. Introduction 9
   - 1.1 Project overview 9
   - 1.2 Purpose of this report 11
   - 1.3 Public consultation 11
2. Project description 12
   - 2.1 Purpose of this section 12
   - 2.2 Overview of the realignment 12
   - 2.3 Realignment corridor selection 12
   - 2.4 Key components 13
     - 2.4.1 Property and tenure 14
     - 2.4.2 Potential sensitive receptors 15
   - 2.5 Concept design 24
     - 2.5.1 Overview 24
     - 2.5.2 Passing loops 24
     - 2.5.3 Ancillary construction facilities 24
     - 2.5.4 Quarries and borrow areas 25
     - 2.5.5 Water supply infrastructure 27
     - 2.5.6 Haul roads and access roads 27
     - 2.5.7 Road Crossings 27
     - 2.5.8 Occupational and stock crossings 27
     - 2.5.9 Service crossings 28
     - 2.5.10 Rail network crossings 29
     - 2.5.11 Waterway crossings 29
3. Land use and tenure 30
   - 3.1 Purpose of section 30
   - 3.2 Methodology 30
     - 3.2.1 Study area 30
     - 3.2.2 Data sources 32
     - 3.2.3 Legislation 32
     - 3.2.4 Desktop assessment 33
   - 3.3 Existing environment 33
     - 3.3.1 Overview 33
     - 3.3.2 Tenure 33
     - 3.3.3 Land use 39
     - 3.3.4 Existing and proposed infrastructure 46
     - 3.3.5 Utilities 49
     - 3.3.6 Designated areas 51
     - 3.3.7 Native title 52
   - 3.4 Potential impacts and mitigation measures 55
     - 3.4.1 Overview 55
     - 3.4.2 Land use and accessibility 55
     - 3.4.3 Existing and proposed infrastructure 57
     - 3.4.4 Native title 59
   - 3.5 Conclusion 59

4. Scenic amenity and lighting 61
4.1 Purpose of section 61
4.2 Methodology 61
4.2.1 Study area 61
4.2.2 Legislation and guidelines 61
4.2.3 Data sources.... 62
4.2.4 Desktop assessment 62
4.2.5 Assessment of impacts.... 62
4.3 Existing environment....65
4.3.1 Landscape character 65
4.3.2 Viewing locations and sensitive visual receptors 68
4.3.3 Lighting 73
4.4 Potential impacts and mitigation measures 73
4.4.1 Construction.... 73
4.4.2 Operation 77
4.5 Conclusion 80
5. Topography, geology, soils and land contamination....81
5.1 Purpose of section 81
5.2 Methodology 81
5.2.1 Study area 81
5.2.2 Data sources.... 81
5.2.3 Legislation and guidelines 81
5.2.4 Desktop assessment 82
5.3 Existing environment....82
5.3.1 Topography.... 82
5.3.2 Geology 82
5.3.3 Soils 89
5.3.4 Good quality agricultural land 92
5.3.5 Strategic cropping land.... 95
5.3.6 Contaminated land 95
5.3.7 Acid sulfate soils 96
5.4 Potential impacts and mitigation measures 98
5.5 Conclusion 98
6. Nature conservation 99
6.1 Purpose of section 99
6.2 Methodology 99
6.2.1 Study area 99
6.2.2 Desktop assessment 100
6.3 Existing environment....103
6.3.1 Regional context.... 103
6.3.2 Regional ecosystems 112
6.3.3 Vegetation communities and habitat 124
6.3.4 Threatened ecological communities.... 129
6.3.5 Terrestrial flora.... 130
6.3.6 Terrestrial fauna 136
6.3.7 Threatened terrestrial fauna species likelihood of occurrence.... 139
6.3.8 Aquatic habitatsCattle egret 143
6.3.9 Aquatic fauna.... 148

6.3.10 Wetland protection areas and nationally important wetlands 150
6.3.11 Existing threatening processes 153

6.4 Potential impacts 154

6.4.1 Construction 154
6.4.2 Operation 164

6.5 Mitigation and management measures 168

6.6 Conclusion 169

7. MNES 171

7.1 Purpose of section 171

7.2 Methodology 171

7.2.1 Study area 172
7.2.2 Desktop assessment 174
7.2.3 Previous field surveys 181
7.2.4 Likelihood of occurrence assessment 181
7.2.5 Potential habitat mapping for threatened species 182
7.2.6 Assessment of potential impacts 182

7.3 Existing environment 182

7.4 Listed threatened species 182

7.4.1 Overview 182
7.4.2 Potential impacts and management measures 197
7.4.1 Bluegrass 197
7.4.2 Squatter pigeon (southern) 203
7.4.3 Ornamental snake 207
7.4.4 Black ironbox 210
7.4.5 Black-throated finch (southern) 214
7.4.6 Koala 217
7.4.7 King bluegrass 222
7.4.8 Summary 224

7.5 Threatened ecological communities 233

7.5.1 Overview 233
7.5.2 Brigalow 235
7.5.3 Semi-evergreen vine thicket 237
7.5.4 Natural grasslands 240
7.5.5 Summary 242

7.6 Listed migratory species 245

7.6.1 Overview 245
7.6.2 Rainbow bee-eater 249
7.6.3 Great egret 249
7.6.4 Cattle egret 250
7.6.5 Fork-tailed swift 250
7.6.6 White-bellied sea eagle 251
7.6.7 Barn swallow 252
7.6.8 Satin flycatcher 252
7.6.9 Latham's snipe 253
7.6.10 Potential impacts and avoidance, mitigation and management measures 253
7.6.11 Summary 259

7.7 Conclusion 262

8. Water resources 267

8.1 Purpose of section 267

8.2 Methodology 267

8.2.1 Study area ... 267
8.2.2 Data sources ... 267
8.2.3 Legislation and guidelines ... 268
8.2.4 Hydrology and hydraulics ... 270
8.2.5 Surface water quality ... 270
8.2.6 Waterway geomorphology ... 271
8.2.7 Groundwater ... 271
8.2.8 Hydrology and hydraulics ... 271

8.3 Existing environment ... 273

8.3.1 Catchment description ... 273
8.3.2 Climate ... 273
8.3.3 Geomorphology ... 273
8.3.4 Flooding ... 273
8.3.5 Groundwater ... 275
8.3.6 Surface water quality ... 277
8.3.7 Water supply infrastructure ... 277
8.3.8 Waterways ... 278

8.4 Potential impacts and mitigation measures ... 279

8.4.1 Construction ... 279
8.4.2 Operation ... 281
8.4.3 Summary of mitigation and management measures ... 283

8.5 Conclusion ... 283

9. Air quality ... 284

9.1 Purpose of section ... 284

9.2 Methodology ... 284

9.2.1 Study area ... 284
9.2.2 Data sources ... 286
9.2.3 Legislation and guidelines ... 286
9.2.4 Desktop assessment ... 288
9.2.5 Impact Assessment ... 289
9.2.6 Limitations ... 289

9.3 Existing environment ... 289

9.3.1 Sensitive receptors ... 289
9.3.2 Regional meteorology ... 290
9.3.3 Dispersion meteorology ... 292
9.3.4 Atmospheric stability ... 295
9.3.5 Mixing height ... 296
9.3.6 Background air quality ... 296

9.4 Potential impacts and mitigation measures ... 297

9.4.1 Construction ... 297
9.4.2 Operation ... 298
9.4.3 Summary of mitigation and management measures ... 317

9.5 Conclusion ... 318

10. Noise ... 319

10.1 Purpose of section ... 319

10.2 Methodology ... 319

10.2.1 Study area ... 319
10.2.2 Data sources ... 319
10.2.3 Legislation and guidelines ... 319
10.2.4 Desktop assessment ... 321

10.2.5 Limitations ... 324
10.3 Existing environment ... 324
10.3.1 Sensitive receptors ... 325
10.4 Potential impacts and mitigation measures ... 327
10.4.1 Construction ... 327
10.4.2 Operation ... 331
10.4.3 Summary of mitigation and management measures ... 332
10.5 Conclusion ... 332
11. Transport ... 334
11.1 Purpose of section ... 334
11.2 Methodology ... 334
11.2.1 Study area ... 334
11.2.2 Data sources ... 334
11.2.3 Legislation and guidelines ... 335
11.2.4 Desktop assessment ... 335
11.2.5 Road performance criteria ... 335
11.2.6 Intersection analysis ... 336
11.2.7 Crash analysis ... 337
11.2.8 General assumptions ... 337
11.3 Existing environment ... 337
11.3.1 Study road links ... 337
11.3.2 Road/rail crossings ... 338
11.3.3 Occupational and stock crossings ... 339
11.3.4 Study intersections ... 339
11.3.5 Traffic volumes and capacity of study road links ... 341
11.3.6 Heavy vehicle network ... 341
11.3.7 Crash analysis ... 342
11.4 Development traffic generation ... 343
11.4.1 Construction ... 343
11.4.1 Operation ... 348
11.5 Potential impacts and mitigation measures ... 349
11.5.1 Construction ... 349
11.5.2 Summary of mitigation and traffic management measures ... 355
11.6 Conclusion ... 355
12. Cultural heritage ... 356
12.1 Purpose of section ... 356
12.2 Methodology ... 356
12.2.1 Study area ... 356
12.2.2 Data sources ... 356
12.2.3 Legislation and guidelines ... 356
12.2.4 Desktop assessment ... 357
12.2.5 Stakeholder engagement ... 357
12.2.6 Limitations ... 360
12.3 Existing environment ... 360
12.3.1 Environmental context ... 360
12.3.2 Indigenous cultural heritage ... 360
12.3.3 Non-Indigenous cultural heritage ... 367
12.4 Potential impacts and mitigation measures ... 367

12.4.1 Construction 367
12.4.2 Operation 368
12.4.3 Summary of mitigation and management measures 368
12.5 Conclusion 368
13. Other matters 369
13.1 Coastal environment 369
13.2 Greenhouse gas 369
13.3 Waste 369
13.4 Social and economic impacts 369
13.5 Climate and natural hazards 370
13.6 Hazard, risk, health and safety 371
13.7 Cumulative impacts 372
14. Legislation and approvals 373
14.1 Purpose of section 373
14.2 Commonwealth legislation and policy 373
14.3 State legislation and policy 373
14.3.1 State Development and Public Works Organisation Act 1971 373
14.3.2 State planning policy 373
14.4 Local planning instruments 374
15. Conclusion and recommendations 375
15.1 Rationale for the NGBR Project realignment 375
15.2 Realignment impacts 375
15.3 Recommendation 376
16. References 378
16.1 Project description 378
16.2 Land use and tenure 378
16.3 Scenic amenity and lighting 379
16.4 Topography, geology, soils and land contamination 380
16.5 Nature conservation 380
16.6 Matters of national environmental significance 386
16.7 Water resources 388
16.8 Air quality 389
16.9 Greenhouse gas 389
16.10 Noise and vibration 390
16.11 Transport 390
16.12 Cultural heritage 391
16.13 Cumulative impacts 391
16.14 Other matters 391
16.15 Conclusions and recommendations 392

Table index

Table 2-1 Key components (construction phase) 13
Table 2-2 Key components (operational phase) 14
Table 2-3 Properties 14
Table 2-4 Potential sensitive receptors 15
Table 2-5 Passing loops 24
Table 2-6 Temporary construction infrastructure 25
Table 2-7 Road treatments 27
Table 2-8 Occupational and stock route crossings 28
Table 2-9 Service crossings 28
Table 2-10 Major waterways and crossing structures 29
Table 3-1 NGBR Project realignment property tenure 34
Table 3-2 Mining tenures 36
Table 3-3 Petroleum tenures 37
Table 3-4 Summary of potential sensitive receptors 44
Table 3-5 Significant recreational areas near the deviation corridor 46
Table 3-6 Road and stock route crossings 46
Table 3-7 Service crossings 49
Table 3-8 Ancillary features impact 56
Table 4-1 Visual modification definitions 63
Table 4-2 Visual sensitivity definitions 64
Table 4-3 Duration of impact 64
Table 4-4 Significance of impact 65
Table 4-5 Landscape character units 66
Table 4-6 Viewing locations 68
Table 4-7 Viewing locations with no anticipated impact during construction 74
Table 4-8 Viewing locations impacted during construction 75
Table 4-9 Viewing locations with no anticipated impact during operation 77
Table 4-10 Viewing locations impacted during operation 78
Table 5-1 Mapped geology within the NGBR Project realignment 85
Table 5-2 Soils within the NGBR Project realignment 89
Table 5-3 Agricultural land classes 92
Table 5-4 Good quality agricultural land intersected by the NGBR Project realignment 93

Table 5-5 Property details and EMR listing 96
Table 6-1 Regional ecosystems within the NGBR Project realignment footprint 113
Table 6-2 Broad vegetation communities and corresponding fauna habitats 124
Table 6-3 Broad vegetation communities identified within the NGBR Project realignment 125
Table 6-4 Declared weeds recorded along the NGBR Project realignment 134
Table 6-5 Terrestrial fauna species diversity – desktop assessment 136
Table 6-6 Terrestrial fauna species observed during surveys of Alpha Coal Project EIS and Drake Coal Project EIS within 1 km of NGBR Project realignment 137
Table 6-7 Vegetation clearing impacts on regional ecosystems 155
Table 6-8 Vegetation clearing impacts on high conservation status REs 155
Table 6-9 Loss of potential habitat for threatened fauna 159
Table 7-1 Data sources utilised 175
Table 7-2 Alpha Coal EIS sites relevant to NGBR Project realignment 181
Table 7-3 Likelihood of occurrence for threatened flora species 185
Table 7-4 Likelihood of occurrence for threatened fauna species 187
Table 7-5 Significance of residual impacts on bluegrass 202
Table 7-6 Significance of residual impacts on squatter pigeon 206
Table 7-7 Significance of residual impacts on ornamental snake 210
Table 7-8 Significance of residual impacts on black ironbox 212
Table 7-9 Significance of residual impacts on black-throated finch 216
Table 7-10 Significance of residual impacts on koala 219
Table 7-11 Summary of impacts, threats and mitigation measures for species 226
Table 7-12 Residual impacts on brigalow TEC 236
Table 7-13 Residual impacts on SEVT TEC 238
Table 7-14 Residual impacts on natural grasslands TEC 241
Table 7-15 Summary of potential direct and indirect impacts, proposed mitigation measures and residual impacts 243
Table 7-16 Likelihood of occurrence for migratory species 246
Table 7-17 Significance of residual impacts on migratory aerial bird species 255
Table 7-18 Significance of residual impacts on migratory woodland bird species 256
Table 7-19 Significance of residual impacts on migratory bird of prey species 257
Table 7-20 Significance of residual impacts on migratory wetland bird species 258
Table 7-21 Significance of residual impacts on migratory shorebird species 258
Table 7-22 Summary of potential impacts, mitigation measures and residual impacts – migratory species 260
Table 7-23 Impacts on MNES and whether an offset is required 263

Table 8-1 Water quality sampling sites 270
Table 8-2 Stream gauge record 274
Table 8-3 Groundwater bores 275
Table 8-4 Alpha Coal Project EIS groundwater quality 277
Table 8-5 Major waterways and crossing structures 278
Table 9-1 Air quality objectives and assessment criteria 288
Table 9-2 Sensitive receptor locations 290
Table 9-3 TAPM configuration for the northern and southern prognostic meteorological model simulations 292
Table 9-4 Background concentrations and criteria for deposited dust and particles 296
Table 9-5 Proposed train consist configurations for the NGBR Project realignment and Newlands line 298
Table 9-6 Peak incremental deposited dust and particle predictions to the west of the NGBR Project realignment in vicinity of Homestead 16 306
Table 9-7 Peak incremental deposited dust and particle predictions to the east of the Newlands line in the vicinity of Homestead 16 307
Table 9-8 Predicted gaseous concentrations to the west of the NGBR Project realignment in the vicinity of Homestead 16 308
Table 9-9 Predicted gaseous concentrations to the east of the Newlands line in the vicinity of Homestead 16 309
Table 9-10 Peak incremental deposited dust and particle predictions to the west of the NGBR line in the vicinity of Homestead R2 313
Table 9-11 Peak incremental deposited dust and particle predictions to the east of the Newlands line in the vicinity of Homestead R2 314
Table 9-12 Predicted gaseous concentrations to the west of the NGBR Project realignment in the vicinity of Homestead R2 315
Table 9-13 Predicted gaseous concentrations to the east of the Newlands line in the vicinity of Homestead R2 316
Table 9-14 Maximum daily mean PM_{10} concentration at Homestead R3 317
Table 10-1 Noise and vibration criteria summary at sensitive receptors 320
Table 10-2 Summary of unattended noise monitoring (Location C) 324
Table 10-3 Summary of vibration monitoring (Location C) 324
Table 10-4 Potential sensitive receptors 325
Table 10-5 Estimated construction noise dB(A) L_{Aeq} (including +2.5dB façade correction) 327
Table 10-6 Study road links and nearest receptors 328
Table 10-7 Estimated construction vibration 329
Table 10-8 Estimated airblast overpressure and ground vibration from blasting within the NGBR Project realignment (based on 50 kg MIC) 329

Table 10-9 Estimated operation noise 331
Table 11-1 LOS for rural roads....335
Table 11-2 Maximum AADT (vehs/day/2-way) for various LOS on rural roads on level terrain 336
Table 11-3 Study road links....337
Table 11-4 Proposed road treatments 338
Table 11-5 Summary of study intersections....339
Table 11-6 Existing traffic volumes and LOS (2012)....341
Table 11-7 Percentage heavy vehicles on study road links....341
Table 11-8 Crash analysis....342
Table 11-9 Estimated monthly material supply truck traffic generation – return trips 344
Table 11-10 Estimated monthly construction vehicles (return trips) 346
Table 11-11 Estimated monthly construction traffic on study road links within the study area (single trips) 347
Table 11-12 Annual operation workforce 2016 to 2026 348
Table 11-13 Impact of construction traffic on study road links – 2015....350
Table 12-1 Indigenous cultural heritage database search results 361

Figure index

Figure 1-1 Project Location 10
Figure 2-1 Key features of the NGBR Project realignment 16
Figure 2-2 Potential quarry location 26
Figure 3-1 Land use study area 31
Figure 3-2 Local context and tenure 35
Figure 3-3 Mining and petroleum tenures 38
Figure 3-4 Study area land use 41
Figure 3-5 Good quality agricultural land 42
Figure 3-6 Strategic cropping land 43
Figure 3-7 Sensitive receptors 45
Figure 3-8 Transport infrastructure....48
Figure 3-9 Utilities 50
Figure 3-10 Designated areas....53
Figure 3-11 Native title claims....54
Figure 4-1 Landscape character units....67
Figure 4-2 View locations 72

Figure 5-1 Topography and landform 84
Figure 5-2 Mapped geology 87
Figure 5-3 Land systems and soils 91
Figure 5-4 Good quality agricultural land 94
Figure 5-5 Strategic cropping land within the NGBR Project realignment 97
Figure 6-1 Desktop assessment extent 102
Figure 6-2 Watercourses of relevance to the NGBR Project realignment 105
Figure 6-3 Regional context 108
Figure 6-4 Biodiversity Planning Assessment mapping – J Rating 109
Figure 6-5 Biodiversity Planning Assessment mapping – G Rating 110
Figure 6-6 Protected area estates 111
Figure 6-7 Certified regional ecosystem and regrowth mapping 123
Figure 6-8 Threatened ecological communities 132
Figure 6-9 Broad vegetation groups and fauna habitats 135
Figure 6-10 Threatened species records 142
Figure 6-11 Aquatic habitat relevant to the NGBR Project realignment 145
Figure 6-12 Wetland Protection Areas relevant to the NGBR Project realignment 151
Figure 6-13 Nationally important wetlands in or of relevance to the NGBR Project realignment 152
Figure 7-1 Project location 173
Figure 7-2 Threatened species records 184
Figure 7-3 Bluegrass potential habitat 200
Figure 7-4 Squatter pigeon potential habitat 205
Figure 7-5 Ornamental snake potential habitat 209
Figure 7-6 Black ironbox potential habitat 213
Figure 7-7 Black-throated finch potential habitat 215
Figure 7-8 Koala potential habitat 221
Figure 7-9 King bluegrass potential habitat 225
Figure 7-10 Threatened Ecological Communities 234
Figure 8-1 Study area and waterways 269
Figure 8-2 Field assessment sites 272
Figure 9-1 NGBR Project realignment and sensitive receptors 285
Figure 9-2 Monthly mean and decile maximum and minimum temperatures at Collinsville post office 290
Figure 9-3 Monthly mean 9 am and 3 pm relative humidity at Collinsville post office 291

Figure 9-4 Rainfall proportion by month Collinsville post office (033013) 292
Figure 9-5 Annual wind roses at Receptors H16 (LHS) and H18 (RHS) 293
Figure 9-6 Seasonal wind roses at Receptor H16 294
Figure 9-7 Pasquill-Gifford atmospheric stability classes at Receptor H16 295
Figure 9-8 Diurnal variation in mixing height at Receptor H16 296
Figure 9-9 High level overview of civil works sequencing during rail construction 297
Figure 9-10 Modelled track alignment for Receptor H16 300
Figure 9-11 Modelled track alignment for Receptor R2 301
Figure 9-12 Modelled track alignment for Receptor R3 302
Figure 9-13 Predicted annual mean deposited dust in the vicinity of Receptor H16 303
Figure 9-14 Predicted annual TSP concentrations in the vicinity of Receptor H16 304
Figure 9-15 Predicted maximum daily-mean PM_{10} concentrations in the vicinity of Receptor H16 304
Figure 9-16 Predicted maximum daily-mean $PM_{2.5}$ concentrations in the vicinity of Receptor H16 305
Figure 9-17 Predicted annual-mean $PM_{2.5}$ concentrations in the vicinity of Receptor Homestead 16 306
Figure 9-18 Predicted annual mean deposited dust in the vicinity of Homestead R2 310
Figure 9-19 Predicted annual TSP concentrations in the vicinity of Homestead R2 310
Figure 9-20 Predicted maximum daily-mean PM_{10} concentrations in the vicinity of Homestead R2 311
Figure 9-21 Predicted maximum daily-mean $PM_{2.5}$ concentrations in the vicinity of Homestead R2 311
Figure 9-22 Predicted annual-mean $PM_{2.5}$ concentrations in the vicinity of Homestead R2 312
Figure 9-23 Maximum daily mean PM_{10} concentration at Homestead R3 317
Figure 10-1 Sensitive receptors and monitoring locations 326
Figure 11-1 Study intersections 340
Figure 11-2 Bowen Developmental Road/Collinsville-Elphinstone Road treatment findings 353
Figure 11-3 Suttor Developmental Road/Collinsville-Elphinstone Road treatment findings 354
Figure 12-1 Native Title claims 359
Figure 12-2 Indigenous cultural heritage database search results 366

Appendices

Appendix A - Desktop assessment results

Appendix B - Likelihood of occurrence assessment

Appendix C - Threatened species habitat mapping

Appendix D - Potential fish community within the Suttor and Bowen River catchments

Appendix E - AUSROADS output file for the Homestead 16 simulation

Appendix F – Cultural heritage technical addendum

Terms and abbreviations

Terms and abbreviations	Definition
µg/m2	Micrograms per square metre
µg/m3	Micrograms per cubic metre
AADT	annual average daily traffic
ACA	Aquatic Conservation Assessment
Adani	Adani Mining Pty Ltd
AEIS	Additional Information to the Environmental Impact Statement
Airblast overpressure	The energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave is known as the peak air overpressure, generally measured in decibels using linear frequency weighting
Air EPP	Environmental Protection (Air) Policy 2008
Air NEPM	National Environment Protection (Ambient Air Quality) Measures
Air Toxics NEPM	National Environment Protection (Air Toxics) Measure
ALCAM	Australian Level Crossing Assessment Model
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASC	Australian Soil Classification
ASS	Acid sulfate soils
AquaBAMM	Aquatic Biodiversity Assessment and Mapping Method
AUL	Auxiliary left turn treatment
AUR	Auxiliary right turn treatment
AUSPLUME	Dispersion model to predict particle deposition rates
AUSROADS	Dispersion model to predict dispersion of particle and gaseous contaminants
BA	Birds Australia
BAL	Basic left turn treatment
BAR	Basic right turn treatment
Blasting	The use of explosives to fracture rock, coal or other materials for

Terms and abbreviations	Definition
	later recovery
BPA	Biodiversity Planning Assessment
BOM	Bureau of Meteorology
BVC	Broad vegetation community
C	Listed as common under the NC Act
CAPEX	Capital expenditure
CH4	Methane
CHL	Channelised left turn treatment
CHMP	Cultural Heritage Management Plan
CHR	Channelised right turn treatment
CLR	Contaminated Land Register
CO	Carbon monoxide
CO2	Carbon dioxide
CO2-e	Carbon dioxide equivalent
DAFF	Department of Agriculture, Fisheries and Forestry
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics
dB(A)	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies
DCCEE	Department of Climate Change and Energy Efficiency
DCDB	Digital Cadastral Database
DEEDI	Department of Employment, Economic Development and Innovation
DEH	Former Department of Environment and Heritage
DEHP	Department of Environment and Heritage Protection
DEM	Digital Elevation Model
DEO	Desired environmental outcomes
DERM	Former Department of Environment and Resource Management

Terms and abbreviations	Definition
DIICCSTE	Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
DIWA	Directory of Important Wetlands in Australia
DEWHA	Former Department of Environment, Water, Heritage and the Arts
DIDO	Drive-in/Drive-out
DLGP	Former Department of Local Government and Planning
DNRM	Department of Natural Resources and Mines
DotE	Department of the Environment
DSDIP	Department of State Development, Infrastructure and Planning
DTMR	Department of Transport and Main Roads
E	Endangered
EH	Essential habitat
EIANZ	Environment Institute of Australia and New Zealand
EIS	Environment Impact Statement
ELA	Eco Logical Australia Pty Ltd
ELH	Environment Land Heritage
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Former Environmental Protection Agency (Qld)
EP Act	*Environmental Protection Act 1994*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPC	Exploration permits for coal
EPM	Exploration permit for minerals
EPP	Exploration permits for petroleum
EMR	Environmental Management Register
ERA	Environmentally relevant activity
FIFO	Fly-in/Fly-out
FullCAM	Full Carbon Accounting Model

Terms and abbreviations	Definition
g	Gram
GA	Geoscience Australia
GARID	Guidelines for the Assessment of Road Impacts of Developments
GBCIF	galilee basin coal infrastructure framework
GBR	Great Barrier Reef
GBSDA	Galilee Basin State Development Area
GDE	Groundwater Dependant Ecosystems
GHD	GHD Pty Ltd
GHG	Greenhouse gas
GHG Protocol	Greenhouse gas protocol
GIS	Geographic information system
GQAL	Good Quality Agricultural Land
g/VKT	Grams per vehicle-kilometre-travelled
h	Hour
ha	Hectare
HERBRECS	Queensland herbarium data storage project
HFC	Hydrofluorocarbon
HVR	High Value Regrowth
IBRA	Interim Biogeographic Regionalisation for Australia
IDAS	Integrated Development Assessment System
IRC	Isaac Regional Council
Jangga	Bulganunna Aboriginal Corporation
kg	Kilogram
km	Kilometre
KRA	Key Resource Area
kV	Kilovolt
LA90(period)	The sound pressure level that is exceeded for 90 per cent of the measurement period

Terms and abbreviations	Definition
LAeq(period)	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring
LAmax	The maximum sound level recorded during the measurement period
LCU	Landscape character unit
LGA	Local government areas
LHS	Left hand side
LOS	Level of Service
LP Act	Land Protection (Pest and Stock Route Management) Act 2002
m	Metre
m^2	Square metre
Ma	Listed as marine under the EPBC Act
mg	Milligram
Mi	Listed as migratory under the EPBC Act
MIC	Maximum instantaneous charge
ML	Mining lease
MLA	Mining lease application
MIWRP	Mackay, Isaac and Whitsunday Regional Plan 2011 – 2031
MNES	Matters of national environmental significance
mm/s	Millimetres per second
mtpa	Million tonnes per annum
NC Act	*Nature Conservation Act 1992*
NCAT	National Carbon Accounting Toolbox
NCST	National Committee on Soil and Terrain
NGA	National Greenhouse Accounts
NGBR Project	North Galilee Basin Rail Project
NGBR Project realignment	North Galilee Basin Rail Project realignment
N2O	Nitrous oxide

Terms and abbreviations	Definition
NO2	Nitrogen dioxide
Noise Sensitive Place/Receptor	With consideration to the Environmental Protection (Noise) Policy 2008 and of relevance to the NGBR Project a noise sensitive place (that is a potential sensitive receptor) is defined as (amongst others): • A dwelling. • A library, childcare centre, kindergarten, school, college, university or other educational institution. • A hospital, surgery or other medical institution. • A protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest under the *Nature Conservation Act 1992*. • A marine park under the *Marine Parks Act 1982*. A park or garden that is open to the public (whether or not on payment of money) for use other than for sport or organised entertainment
NRCS	Natural Resources Conservation Service
NRM	Natural Resource Management
NSW EPA	New South Wales Environmental Protection Authority
NT	Listed as Near Threatened under the NC Act
NT Act	*Native Title Act 1993*
NWC	National Water Commission
O3	Ozone
OPEX	Operational expenditure
PFC	Perfluorocarbon
PIA	Pavement Impact Assessment
PL	Petroleum lease
PM2.5	Particulate matter of less than 2.5 micron
PM10	Particulate matter of less than 10 micron
PMST	Protected matters search tool
PPV	Peak particle velocity, a measure of the ground vibration magnitude and is the maximum instantaneous particle velocity at a point during a given time interval in mm/s
Pty Ltd	Proprietary Limited
QFRS	Queensland Fire and Rescue Service

Terms and abbreviations	Definition
Qld	Queensland
QM	Queensland Museum
QR	Queensland Rail
RA	Restricted Area
RBL	Rating background level, The rating background level (RBL) or minLA90,1hour is the overall single-figure background noise level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24 hour period used for the assessment background level). This is the level used for assessment purposes. It is defined as the median value of: All the day assessment background levels over the monitoring period for the day (7:00 am to 6:00 pm) All the evening assessment background levels over the monitoring period for the evening (6:00 pm to 10:00 pm) All the night assessment background levels over the monitoring period for night (10:00 pm to 7:00 am)
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
RHS	Right Hand Side
RIA	Road Impact Assessment
RLRPA	Regional Landscape and Rural Production Area
RPDM	Road Planning and Design Manual
RUMP	Road Use Management Plan
SCL	Strategic cropping land
SCL Act	*Strategic Cropping Land Act 2011*
SCR	State-controlled road
SDAP	State Development Assessment Provisions
SEIS	Supplementary Environmental Impact Statement
SEVT	semi-evergreen vine thicket
SEWPaC	Former Department of Sustainability, Environment, Water, Populations and Communities
SF6	Sulfur hexafluoride

Terms and abbreviations	Definition
SP Act 2009	*Sustainable Planning Act 2009*
SPP	State Planning Policy
SO2	Sulphur dioxide
t	Tonne
TAPM	prognostic meteorological model
t/CO2-e	Tonnes of CO2 equivalent
TEC	Threatened Ecological Community
TIA	Traffic Impact Assessment
TSP	Total suspended particulates
TSSC	Threatened Species Scientific Committee
Type AU	Intersections with auxiliary lanes
Type BA	Basic intersections
Type CH	Channelised intersections
UK	United Kingdom
V	Vulnerable
VDV	Vibration Dose Value (VDV) – As defined in BS6472 – 2008, VDV is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration
VM Act	*Vegetation Management Act 1999*
WPA	Wetland Protection Area
WO	Wildlife Online
WONS	Weeds of National Significance
WRC	Whitsunday Regional Council

1. Introduction

1.1 Project overview

Adani Mining Pty Ltd (Adani) proposes the construction and operation of the North Galilee Basin Rail Project (NGBR Project), a multiuser, standard gauge, greenfield rail line that will transport coal from mines in the northern Galilee Basin to the Port of Abbot Point.

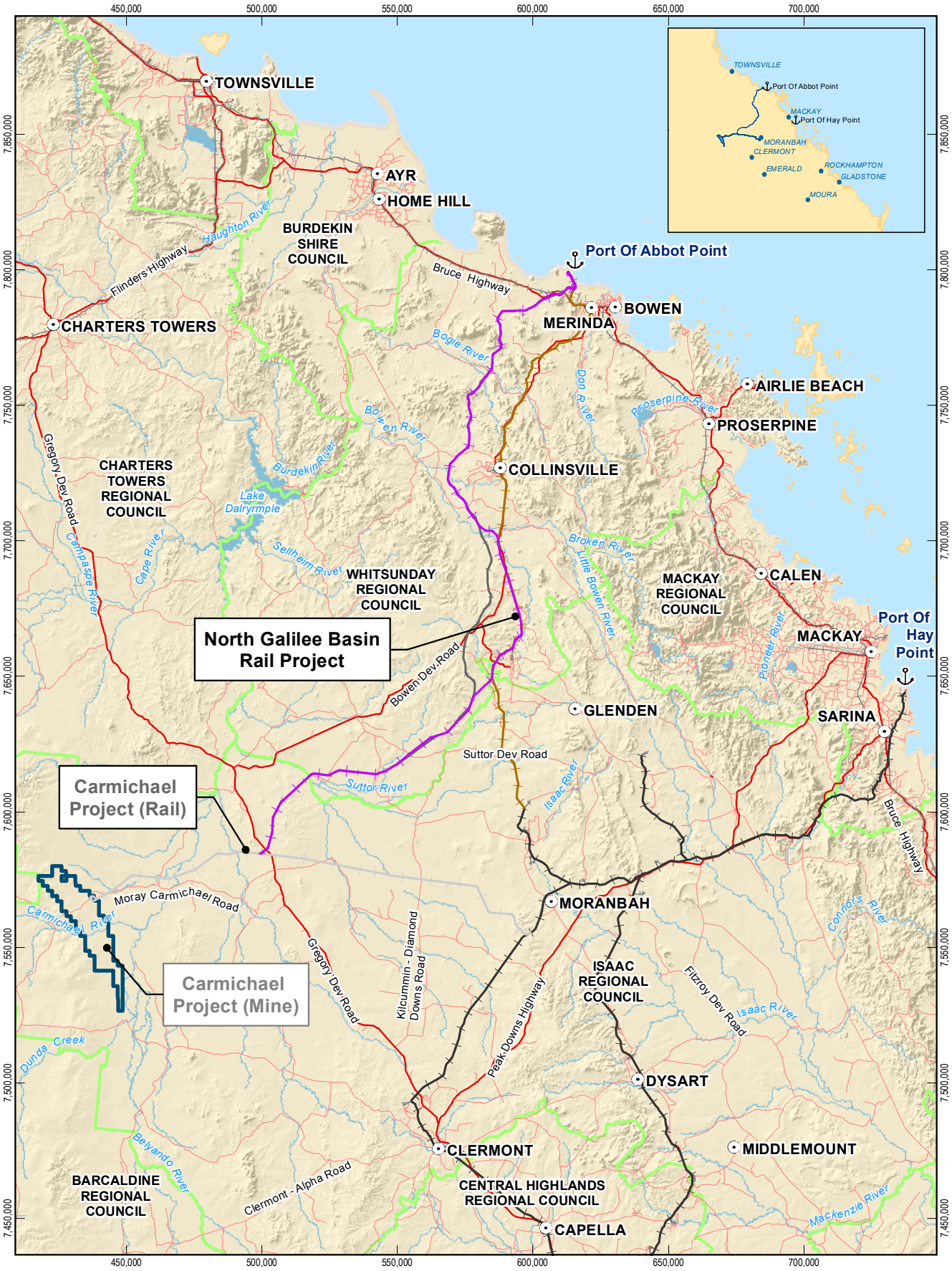
Following publication of the NGBR Environmental Impact Statement (EIS) in December 2013, further consultation occurred with the State government and resource companies with mining and resource tenement interests traversed by the NGBR Project. This stakeholder consultation process culminated in submissions received on the NGBR Project from the affected parties confirming the preference for a realignment of the NGBR Project final rail corridor (as defined in the EIS) to avoid potential resource sterilisation (refer to Additional Information to the EIS (AEIS), Volume 2, Appendix A Submissions Register). This has resulted in a realignment of a 70 km section of the final rail corridor (southward of Bowen River) to accommodate requests to minimise known/potential sterilisation of coal resources and/or encroachment on existing coal tenements.

The NGBR Project realignment is approximately 77 km in length, travels eastwards to the existing Newlands line, then runs southwards adjacent to the rail corridor for approximately 57 km (coinciding with the already State and Commonwealth approved GVK-Hancock proposed Alpha Coal Rail Project EIS corridor) before heading westwards across the Suttor River (refer Figure 1-1).

Key features of the realignment include:

- 77 km of standard gauge, bi-directional rail track
- A rail maintenance access road running parallel to the track and located wholly within the rail corridor
- At grade and grade separated crossings at key road, rail, stock route and occupational crossing locations
- Bridge and culvert structures at major waterways and drainage lines
- One temporary accommodation camp for construction workers
- One temporary construction yard
- Two passing loops
- Concrete batching plant, bridge and track laydown areas and heavy vehicle turning circles.

Further information regarding the description of the NGBR Project realignment is provided in Section 2 Project Description.



LEGEND

- Population centres
- Major Port
- Other Rail Network
- Goonyella System
- Newlands System
- Major road
- Local road
- Watercourse
- Local Government area
- Carmichael Project (Rail)
- Carmichael Project (Mine)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:2,000,000 (at A4)

0 10 20 30 40 50

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number 41-26457
Revision B
Date 28 Feb 2014

Project location

Figure 1-1

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0017_rev_b.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. While GHD Pty Ltd has taken care to ensure the accuracy of this product, GHD Pty Ltd, DME, GA, ADANI and DNRM make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD Pty Ltd, DME, GA, ADANI and DNRM cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data Source: © Commonwealth of Australia (Geoscience Australia): Population centres, Railways, Watercourses (2007); DNRM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); DME: EPC1690 (2010), EPC1080 (2011); Adani: Option 9 Rev1 Final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Carmichael Project (Rail) (2012). Created by: AJ

1.2 Purpose of this report

This report provides a high level environmental assessment of the NGBR Project realignment footprint. The report utilises existing publically available information from previously approved rail infrastructure projects within close proximity to the project and other public database and mapping searches to identify the baseline environmental values and to determine the likely nature and extent of potential impacts of the NGBR Project realignment.

The environmental elements addressed in the report include:

- Land use and tenure
- Scenic amenity and lighting
- Topography, geology, soils and land contamination
- Nature conservation
- Matters of national environmental significance
- Water resources
- Air quality
- Greenhouse gas
- Noise and vibration
- Transport
- Cultural heritage
- Cumulative impacts
- Other matters such as coastal environment, social and economic impacts, climate and natural hazards, hazard, risk, health and safety and offsets were also considered where relevant.

This report forms part of the additional Information required by the Coordinator General to the North Galilee Basin Rail Project Environmental Impact Statement (NGBR AEIS). It has been prepared after public display of the NGBR Project EIS and following further consultation with the Department of State Development, Infrastructure and Planning (DSDIP) and Department of the Environment (DotE).

1.3 Public consultation

Following publication of the NGBR Project EIS in December 2013, further consultation has occurred with the State government and resource companies with mining and resource tenement interests traversed by the NGBR Project, resulting in the realignment of a 70 km section of the final rail corridor, affecting an additional five lots (four properties) and no longer affecting two lots (two properties). No new landholders are affected by the NGBR Project realignment, as each landholder was affected by the original NGBR final rail corridor.

Consultation with landholders impacted by the realignment has been ongoing since October 2013 and included consultation with all five directly affected landholders. Adani will continue to seek further involvement with directly affected landholders to identify potential impacts and develop appropriate mitigation and management measures.

2. Project description

2.1 Purpose of this section

The purpose of this chapter is to describe the North Galilee Basin Rail Project realignment (NGBR Project realignment). This description of the NGBR Project realignment forms the basis for the identification of impacts throughout the NGBR realignment report.

Where project description elements previously identified in the NGBR Project EIS (Volume 1, Chapter 2 Project description) have not significantly changed as a result of the NGBR Project realignment, they have not been discussed within this report. This generally includes rail design and configuration criteria, bridge and culvert design, crossing treatment criteria, construction phases and operational aspects. A project update (Volume 1 Chapter 2 Project update) and complete version of the NGBR Project Description (Volume 2 Appendix B Revised project description, which incorporates the NGBR Project realignment and other updates) has been included within the NGBR Project AEIS.

2.2 Overview of the realignment

Following publication of the NGBR Project Environmental Impact Statement (EIS) in December 2013, further consultation occurred with the state government and resource companies with mining and resource tenement interests traversed by the NGBR Project. This stakeholder consultation process culminated in submissions received on the NGBR Project from the affected parties confirming the preference for a realignment of the NGBR Project final rail corridor (as defined in the EIS) to avoid potential resource sterilisation (refer to the Additional Information to the EIS (AEIS) Volume 2 Appendix A Submissions Register). This has resulted in a realignment of a 70 km section of the final rail corridor (southward of Bowen River) to accommodate stakeholder requests to minimise sterilisation of known/potential coal resources and/or encroachment on existing coal tenements.

The NGBR Project realignment is approximately 77 km in length, travels eastwards to the Newlands rail corridor, then turns southwards running adjacent to the existing Newlands rail corridor for approximately 57 km (coinciding with the already State and Commonwealth approved GVK-Hancock proposed Alpha Coal Rail Project EIS corridor) before heading westwards across the Suttor River and connecting back into the NGBR Project EIS final rail corridor (refer Figure 1-1).

The NGBR Project is proposed in accordance with the Galilee Basin Coal Infrastructure Framework (State of Queensland 2013a) and Galilee Basin Development Strategy (State of Queensland 2013b), being a north-south, multi-user, common access rail corridor from the northern Galilee Basin to the Port of Abbot Point. As such, the NGBR Project is within the south to north rail corridor precinct boundaries of the proposed Galilee Basin State Development Area (GBSDA). The final NGBR Project, including the NGBR Project realignment, will provide significant capital investment of approximately $2.2 billion and will generate approximately 6,150 jobs (1,700 direct and 4,450 indirect) in the region, while its conformance with the GBSDA promotes the minimisation of impacts to landholders.

2.3 Realignment corridor selection

A number of realignment alternatives were considered during consultation with the State government and resource companies following publication of the NGBR Project EIS. The alternatives considered attempted to simultaneously minimise impacts on apparent resource

areas (identified to Adani by affected resource tenement holders based on commercially sensitive data and confirmed by the Department of Natural Resources and Mines as constituting economically viable resource deposits) and minimise impacts on and/or sterilisation of agricultural land. These alternatives were refined into three realignment options that were evaluated prior to the selection of the NGBR Project realignment. Further details regarding the evaluation of alternative options have been included within the NGBR Project AEIS (Volume 1 Chapter 2 Project update).

2.4 Key components

In accordance with the NGBR Project EIS, the NGBR Project realignment has generally been considered to occur in two phases: construction and operation.

The key components of the NGBR Project realignment during the construction phase are provided in Table 2-1. The key components of the operation phase are provided in Table 2-2. The key features of the realignment are shown in Figure 2-1 and each of the key components during construction and operation are described further in Section 2.5.

Where project description elements previously identified in the NGBR Project EIS (Volume 1 Chapter 2 Project description) have not significantly changed or are expected to be unchanged as a result of the NGBR Project realignment, they have not been discussed within this report. These include:

- Rail design criteria and ruling gradients
- Construction material quantities and traffic associated with haulage numbers
- Proposed workforce levels (construction and operational)
- Means of transport to / from the site
- CAPEX/OPEX estimates
- Construction schedules
- Location of the key infrastructure including construction and rollingstock maintenance depots
- Location and type of corridor fencing
- Signalling and communication requirements
- Rolling stock specifications and utilisation
- Maintenance activities
- Decommissioning and rehabilitation.

Table 2-1 Key components (construction phase)

Component	Quantity	Unit
Construction camp	1	no.
Concrete batch plant	1	no.
Bridge laydown area	13	no.
Track laydown area	12	no.

Component	Quantity	Unit
Ballast stockpile area	1	no.
Construction maintenance yard	1	no.
Turning circle	18	no.
Bridge crossings	8	no.

Table 2-2 Key components (operational phase)

Component	Quantity	Unit
Route length	77	km
Passing loops	2	no.
Public road treatments	8	no.
• At-grade crossings	3	no.
• Grade-separated crossings	2	no.
• Possible closures	3	no.
Occupational crossings	17	no.
• At-grade crossings	6	no.
• Grade-separated crossings	11	no.
Grade-separated stock route crossings	2	no.

2.4.1 Property and tenure

The NGBR Project realignment crosses eight lots, three of which were previously traversed by the NGBR Project EIS corridor (refer Table 2-3). The area and tenure of these properties are further described in Section 3.

Table 2-3 Properties

Lot on plan	Previously crossed
618PH2106	Yes
62SP195387	Yes
1DK230	No
2CP866147	No
3SP171922	No

Lot on plan	Previously crossed
14SP225054	No
689SP251696	No
667PH1321	Yes

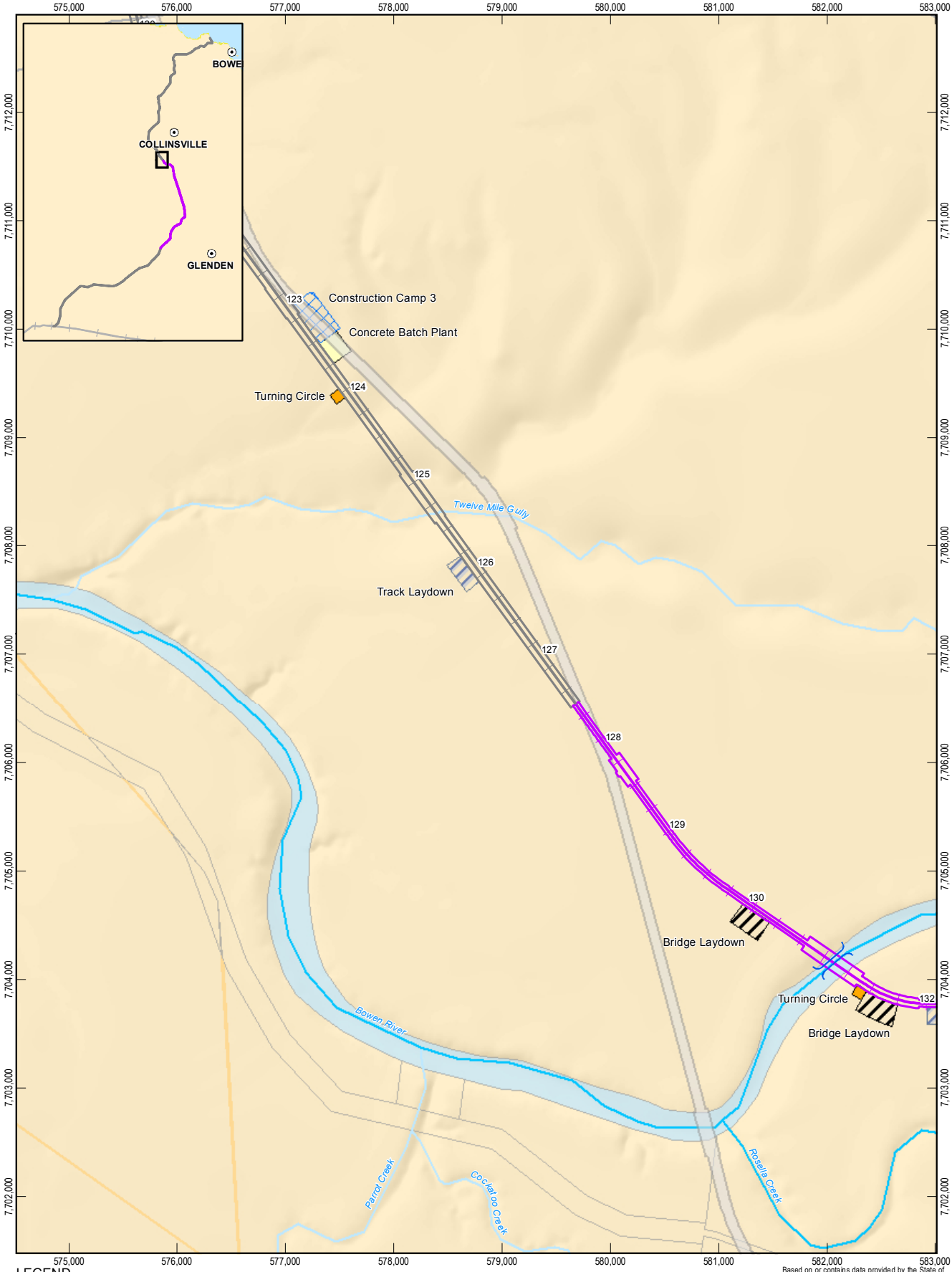
Land acquisition will be approached in accordance with the land acquisition protocol identified in the NGBR Project EIS Volume 2 Appendix R Adani land acquisition protocol.

2.4.2 Potential sensitive receptors

Sensitive receptors identified within approximately six kilometres of the NGBR Project realignment include seven homesteads. Distances between the identified homesteads and the final rail corridor are provided in Table 2-4.

Table 2-4 Potential sensitive receptors

Homestead	Lot on plan	Distance from final rail corridor (m)	Chainage (km)
Homestead 16	62SP195387	721	138.0
Homestead 17	4SP171921	10,932	158.0
Homestead 18	1510SP171920	6,485	190.0
Homestead R1	2CP866147	2,938	167.0
Homestead R2	3SP171922	1,062	171.7
Homestead R3	689PH2015	3,764	196.0
Homestead R4	1CP905226	7,825	201.5



LEGEND

- Highway
- Main road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- Easement
- Lot
- Water
- NGBR Project final rail corridor
- NGBR Project realignment
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major waterway crossing structures
- Alignment functional areas
- Bridge laydown area
- Concrete batch plant
- Construction camp
- Construction yard
- Rolling stock maintenance yard
- Track laydown
- Turning circle
- Temporary ballast stock pile

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:50,000 Paper Size A4

0 0.25 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Key features of the NGBR Project realignment

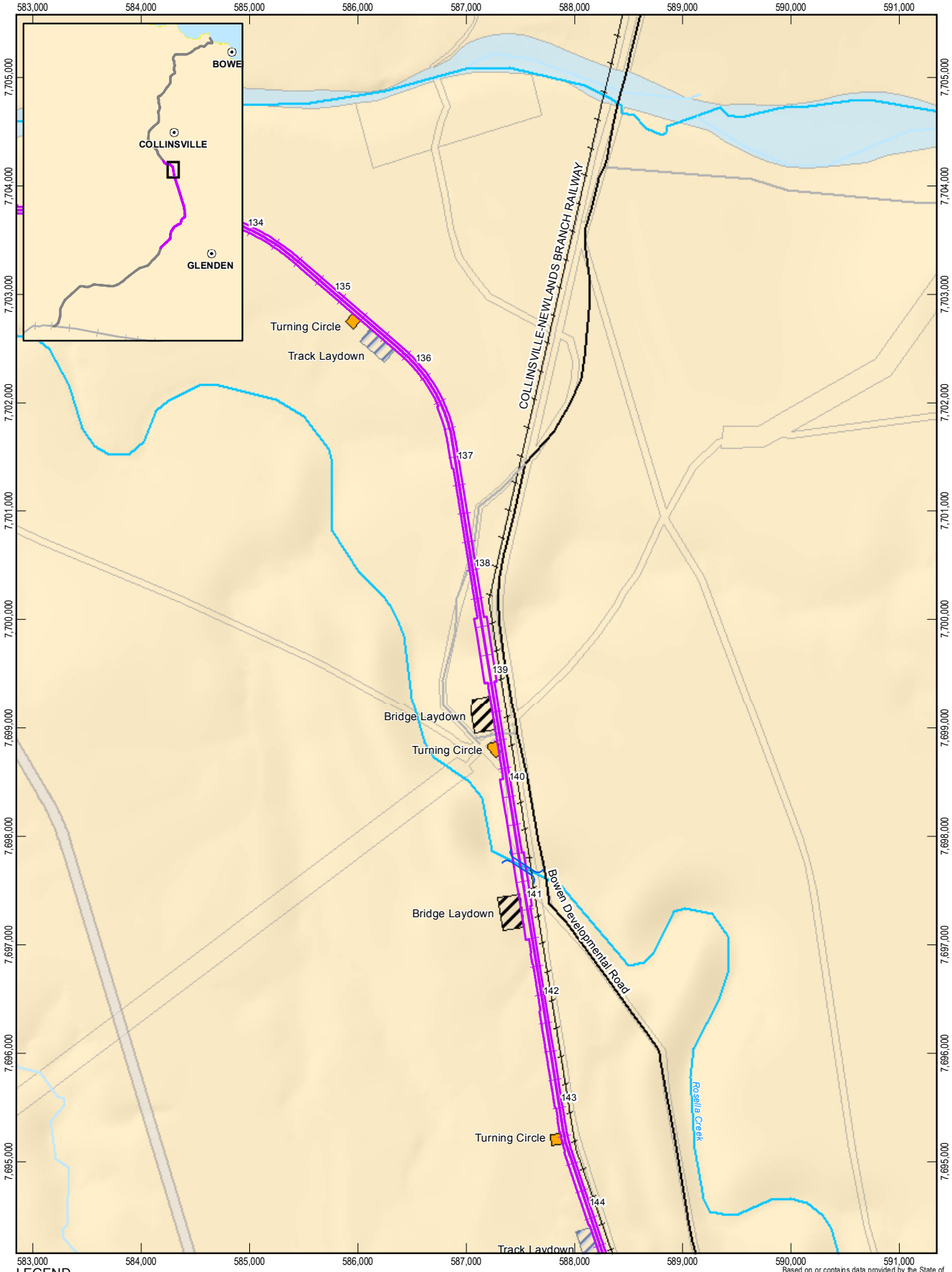
Figure 2-1
Sheet 1 of 8

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0024_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DNRM: DEM (2008), Cadastre (2013), Roads (2010), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Watercourse (2007);
Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Alignment Functional Areas (2014); GHD: Major waterway crossing structures (2013). Created by: MS



LEGEND

- Highway
- Main road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- Easement
- Lot
- Water
- NGBR Project final rail corridor
- NGBR Project realignment
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major waterway crossing structures
- Alignment functional areas
- Bridge laydown area
- Concrete batch plant
- Construction camp
- Construction yard
- Rolling stock maintenance yard
- Track laydown
- Turning circle
- Temporary ballast stock pile

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:50,000 Paper Size A4

0 0.25 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Key features of the NGBR Project realignment

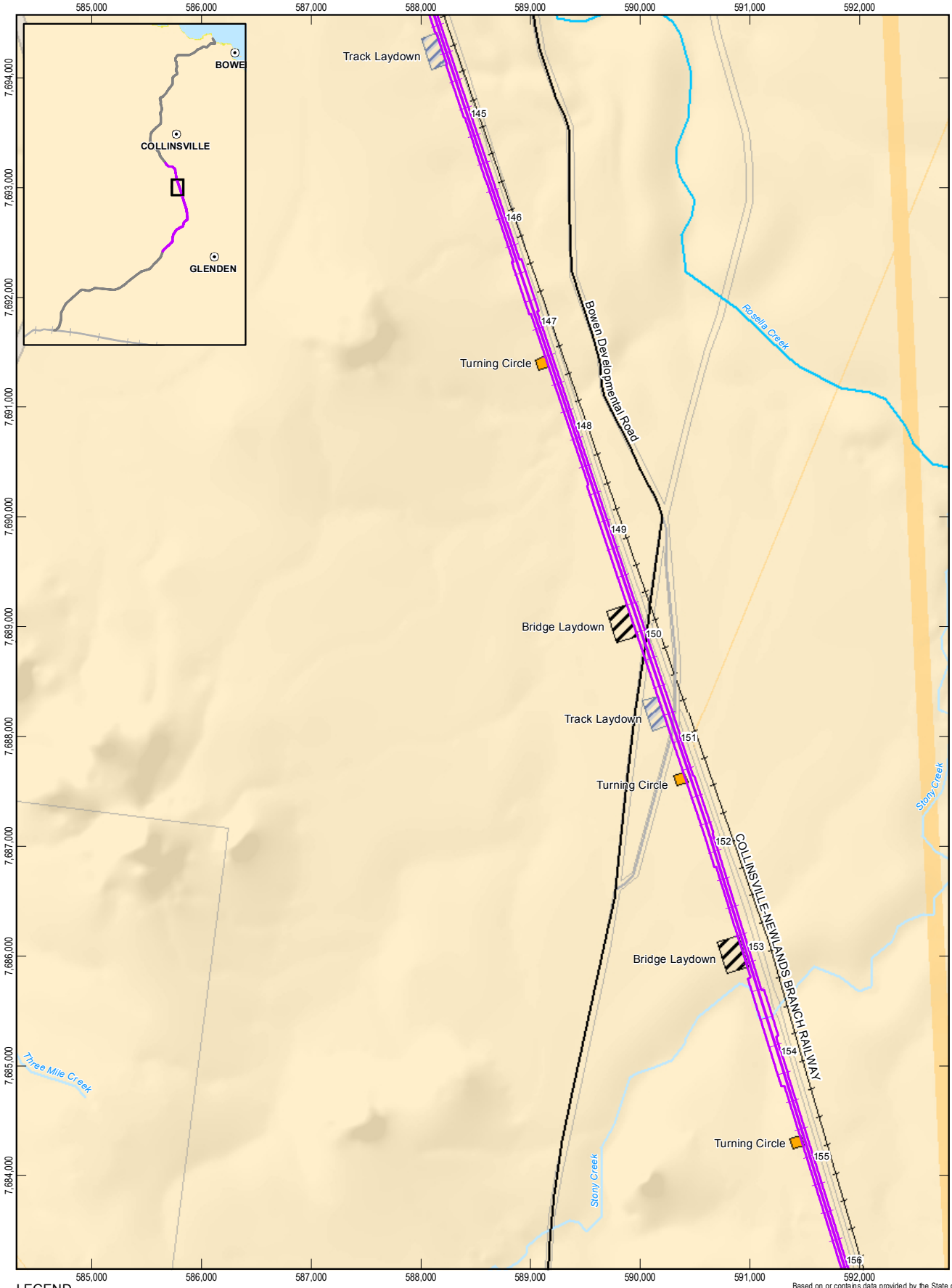
Figure 2-1
Sheet 2 of 8

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0024_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DNRM: DEM (2008), Cadastre (2013), Roads (2010), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Watercourse (2007);
Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Alignment Functional Areas (2014); GHD: Major waterway crossing structures (2013). Created by: MS



LEGEND

- Highway
- Main road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- Easement
- Lot
- Water
- NGBR Project final rail corridor
- NGBR Project realignment
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major waterway crossing structures
- Alignment functional areas
- Bridge laydown area
- Concrete batch plant
- Construction camp
- Construction yard
- Rolling stock maintenance yard
- Track laydown
- Turning circle
- Temporary ballast stock pile

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:50,000 Paper Size A4

0 0.25 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Key features of the NGBR Project realignment

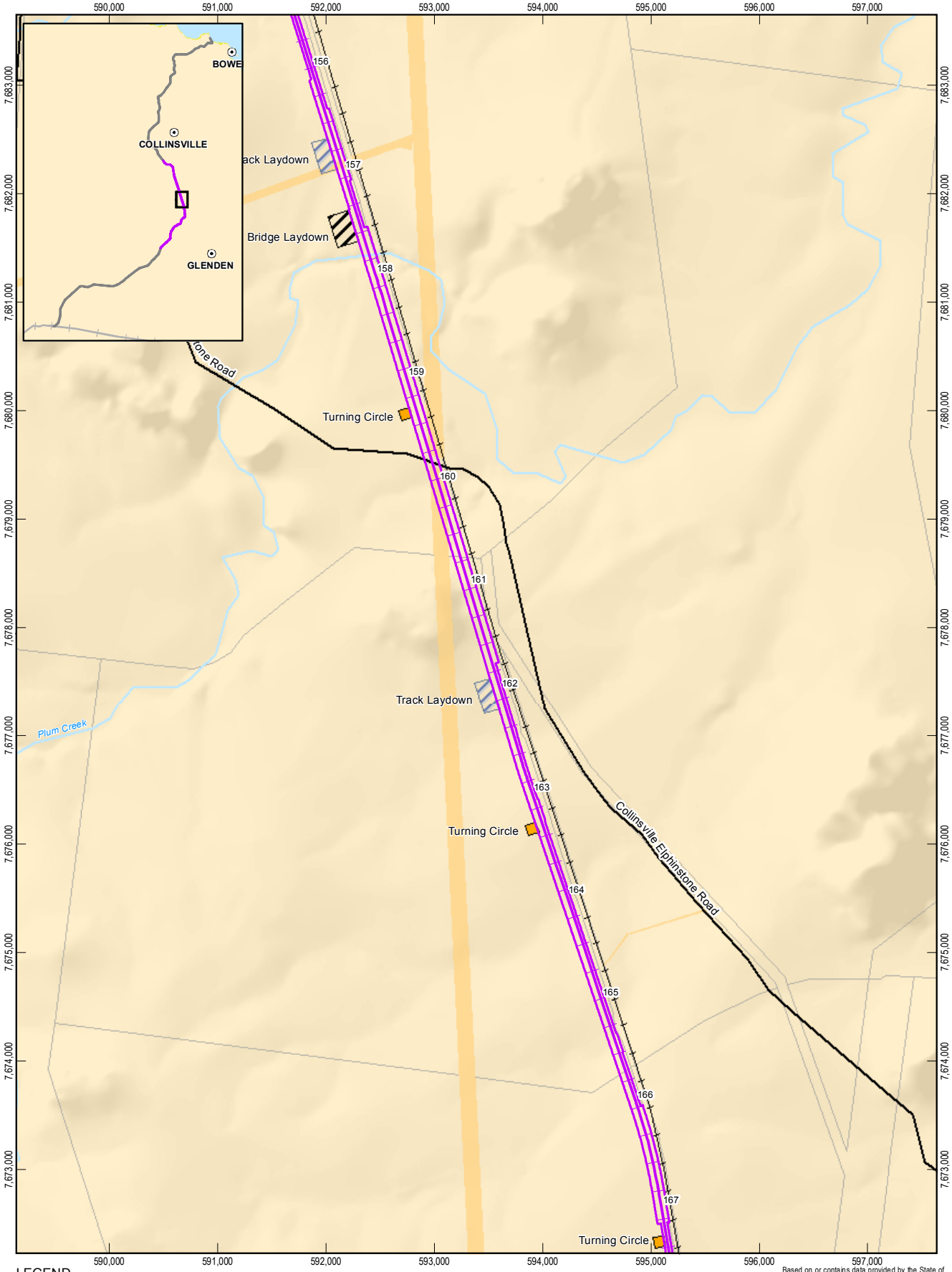
Figure 2-1
Sheet 3 of 8

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0024_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DNRM: DEM (2008), Cadastre (2013), Roads (2010), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Watercourse (2007);
Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Alignment Functional Areas (2014); GHD: Major waterway crossing structures (2013). Created by: MS



LEGEND

- Highway
- Main road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- Easement
- Lot
- Water
- NGBR Project final rail corridor
- NGBR Project realignment
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major waterway crossing structures
- Alignment functional areas
- Bridge laydown area
- Concrete batch plant
- Construction camp
- Construction yard
- Rolling stock maintenance yard
- Track laydown
- Turning circle
- Temporary ballast stock pile

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:50,000 Paper Size A4

0 0.25 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Key features of the NGBR Project realignment

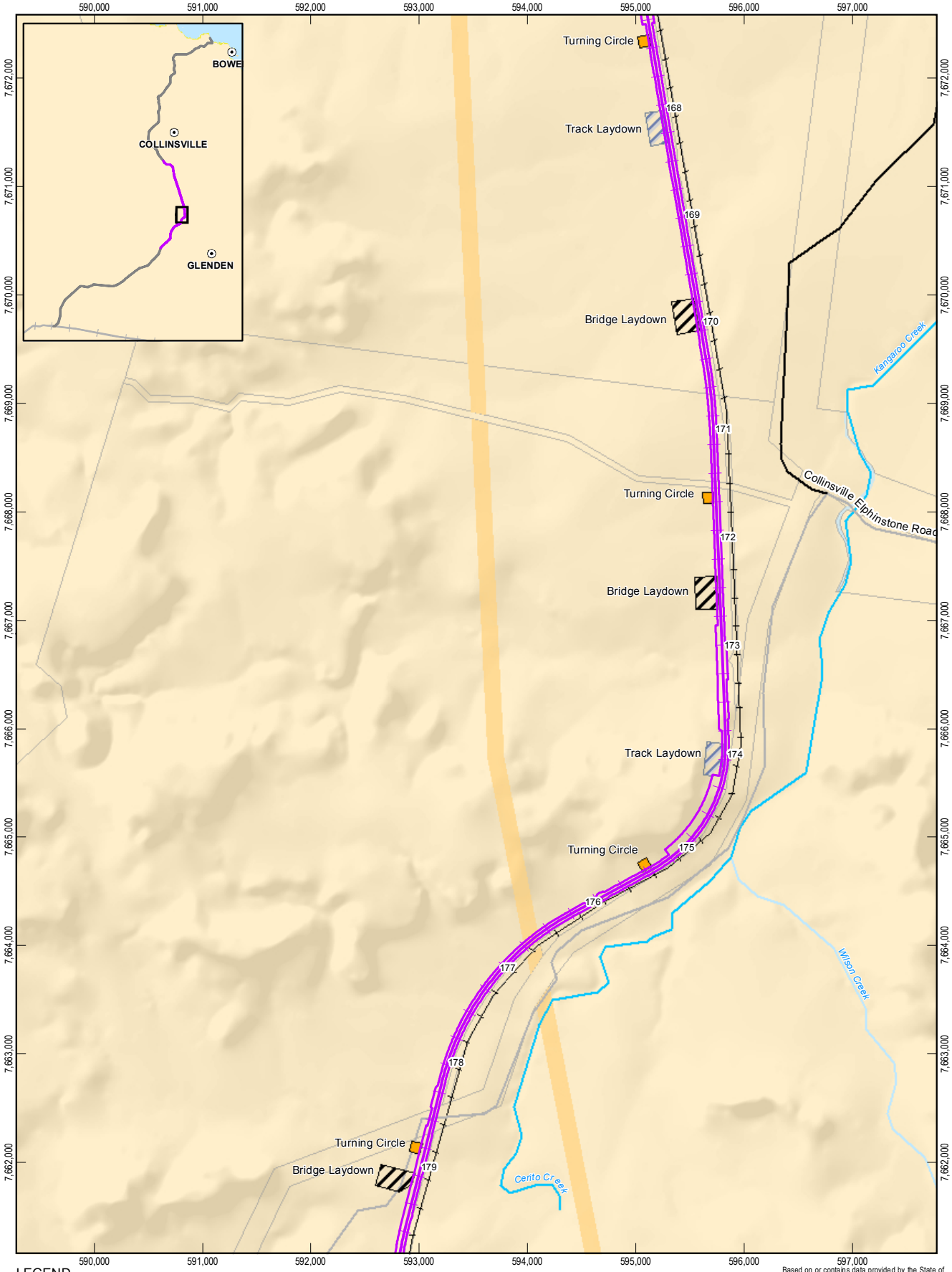
Figure 2-1
Sheet 4 of 8

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0024_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DNRM: DEM (2008), Cadastre (2013), Roads (2010), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Watercourse (2007);
Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Alignment Functional Areas (2014); GHD: Major waterway crossing structures (2013). Created by: MS



LEGEND

- Highway
- Main road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- Easement
- Lot
- Water
- NGBR Project final rail corridor
- NGBR Project realignment
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major waterway crossing structures
- Alignment functional areas
- Bridge laydown area
- Concrete batch plant
- Construction camp
- Construction yard
- Rolling stock maintenance yard
- Track laydown
- Turning circle
- Temporary ballast stock pile

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:50,000 Paper Size A4

0 0.25 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Key features of the NGBR Project realignment

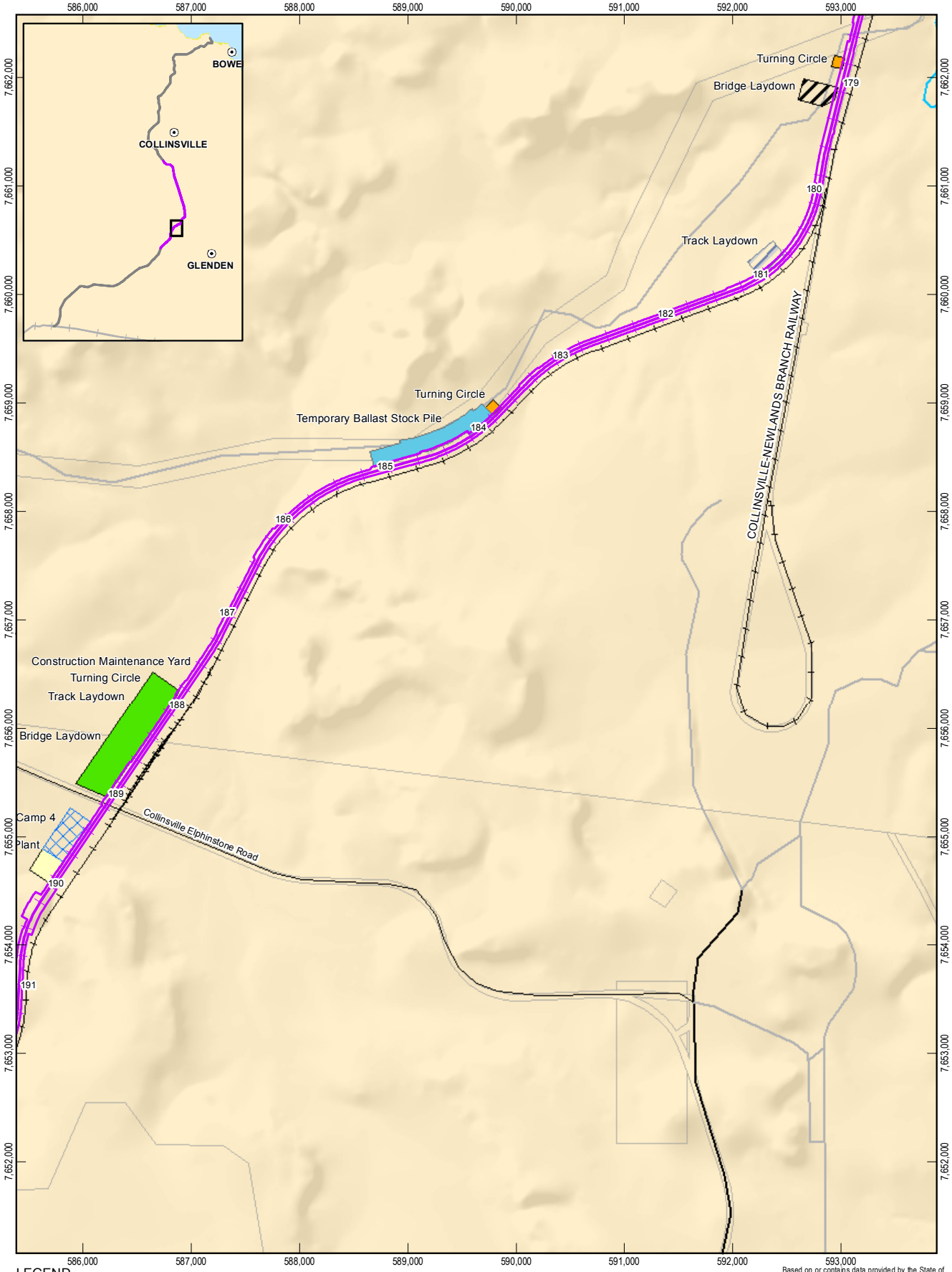
Figure 2-1
Sheet 5 of 8

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0024_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DNRM: DEM (2008), Cadastre (2013), Roads (2010), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Watercourse (2007);
Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Alignment Functional Areas (2014); GHD: Major waterway crossing structures (2013). Created by: MS



LEGEND

- Highway
- Main road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- Easement
- Lot
- Water
- NGBR Project final rail corridor
- NGBR Project realignment
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major waterway crossing structures
- Alignment functional areas
- Bridge laydown area
- Concrete batch plant
- Construction camp
- Construction yard
- Rolling stock maintenance yard
- Track laydown
- Turning circle
- Temporary ballast stock pile

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:50,000 Paper Size A4

0 0.25 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number 41-26457
Revision A
Date 28 Feb 2014

Key features of the NGBR Project realignment

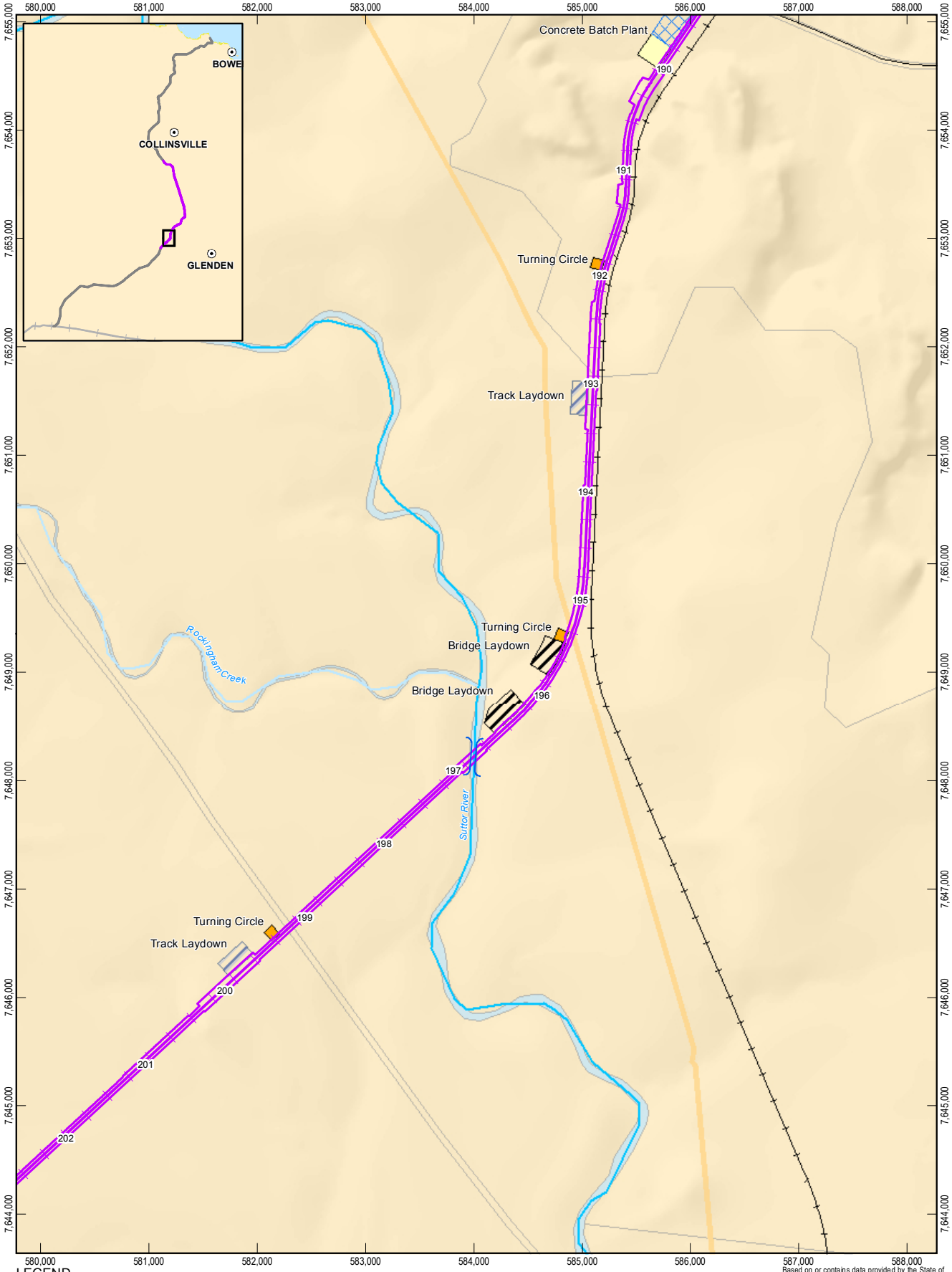
Figure 2-1
Sheet 6 of 8

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0024_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DNRM: DEM (2008), Cadastre (2013), Roads (2010), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Watercourse (2007);
Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Alignment Functional Areas (2014); GHD: Major waterway crossing structures (2013). Created by: MS



LEGEND

- Highway
- Main road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- Easement
- Lot
- Water
- NGBR Project final rail corridor
- NGBR Project realignment
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major waterway crossing structures
- Alignment functional areas
- Bridge laydown area
- Concrete batch plant
- Construction camp
- Construction yard
- Rolling stock maintenance yard
- Track laydown
- Turning circle
- Temporary ballast stock pile

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:50,000 Paper Size A4

0 0.25 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Key features of the NGBR Project realignment

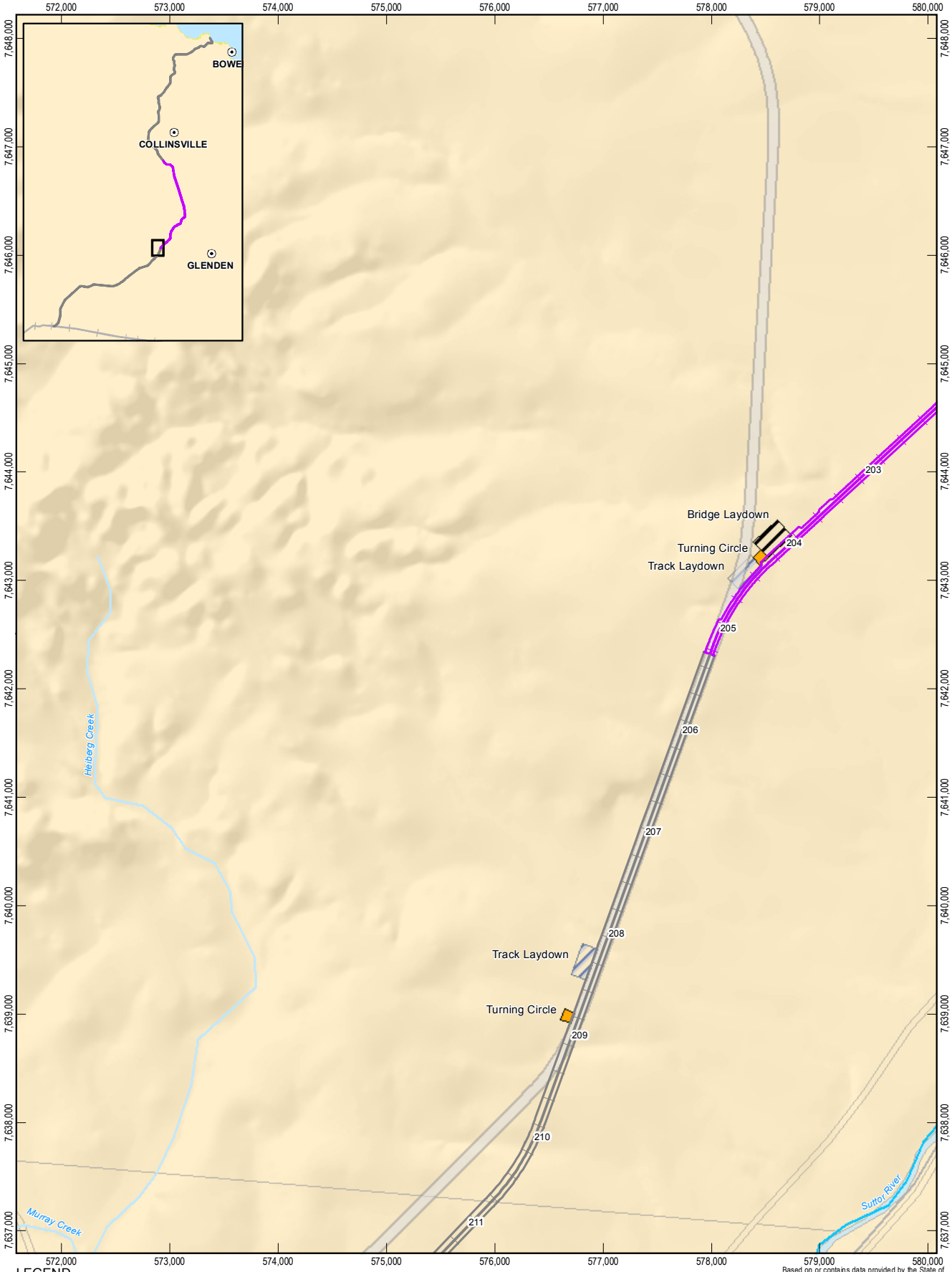
Figure 2-1
Sheet 7 of 8

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0024_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DNRM: DEM (2008), Cadastre (2013), Roads (2010), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Watercourse (2007);
Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Alignment Functional Areas (2014); GHD: Major waterway crossing structures (2013). Created by: MS



LEGEND

- Highway
- Main road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- Easement
- Lot
- Water
- NGBR Project final rail corridor
- NGBR Project realignment
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major waterway crossing structures
- Alignment functional areas
- Bridge laydown area
- Concrete batch plant
- Construction camp
- Construction yard
- Rolling stock maintenance yard
- Track laydown
- Turning circle
- Temporary ballast stock pile

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:50,000 Paper Size A4

0 0.25 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Key features of the NGBR Project realignment

Figure 2-1
Sheet 8 of 8

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0024_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DNRM: DEM (2008), Cadastre (2013), Roads (2010), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Watercourse (2007);
Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Alignment Functional Areas (2014); GHD: Major waterway crossing structures (2013). Created by: MS

2.5 Concept design

2.5.1 Overview

The NGBR Project realignment runs in a general north-south direction, to the east of the former 70 km section of the NGBR alignment. The realignment commences at chainage 128.2 km of the NGBR final EIS corridor then travels eastwards for approximately 2.2 km, where it overlays the approved Alpha Coal rail corridor approximately 300 metres north of the Bowen River. The corridor travels across the Bowen River in a south easterly direction for approximately 7.5 km, where it meets on the western side of the existing Newlands line at chainage 138.6 km.

The NGBR Project realignment footprint travels parallel to the existing Newlands line for approximately 56 km, passing over Rosella Creek (chainage 141.0 km), Bowen Developmental Road (chainage 150.0 km), Old Collinsville-Elphinstone Road (chainage 159.79 km) and Cerito Road (chainage 178.6 km) before diverting in a south westerly direction from the existing Newlands line.

The NGBR Project realignment footprint extends for approximately 10.6 km, passing over Collinsville Elphinstone Road (chainage 189.06) and Suttor River (chainage 196.8 km) before connecting back into the NGBR Project EIS final rail corridor at chainage 205.3 km.

A nominal 60 m wide corridor will be required for the track, drainage, access roads and other infrastructure to support the construction and operation of the Project. The corridor width will be wider at certain locations to enable deep cutting and/or deep filling activities to be accommodated in areas of challenging terrain.

2.5.2 Passing loops

The NGBR Project realignment is a single line, with passing loops to allow for bidirectional train passage. Passing loops are nominally 4.5 kilometres long (minimum clear length, excluding turnouts). A total of two passing loops are proposed within the 77 km NGBR project realignment footprint as outlined in Table 2-5.

Table 2-5 Passing loops

Component	Chainage (km)	Lot on plan
PL4	144.4	62SP195387
PL5	192.8	14SP225054 689SP251696

2.5.3 Ancillary construction facilities

The NGBR Project realignment will require a number of temporary ancillary facilities situated adjacent to the rail corridor, in the vicinity of the associated works to facilitate construction activities and will include the following:

- Bridge laydown areas
- Concrete batching plant
- Temporary ballast stockpile
- Construction camp

- Construction maintenance yard
- Track laydown areas
- Turning circles.

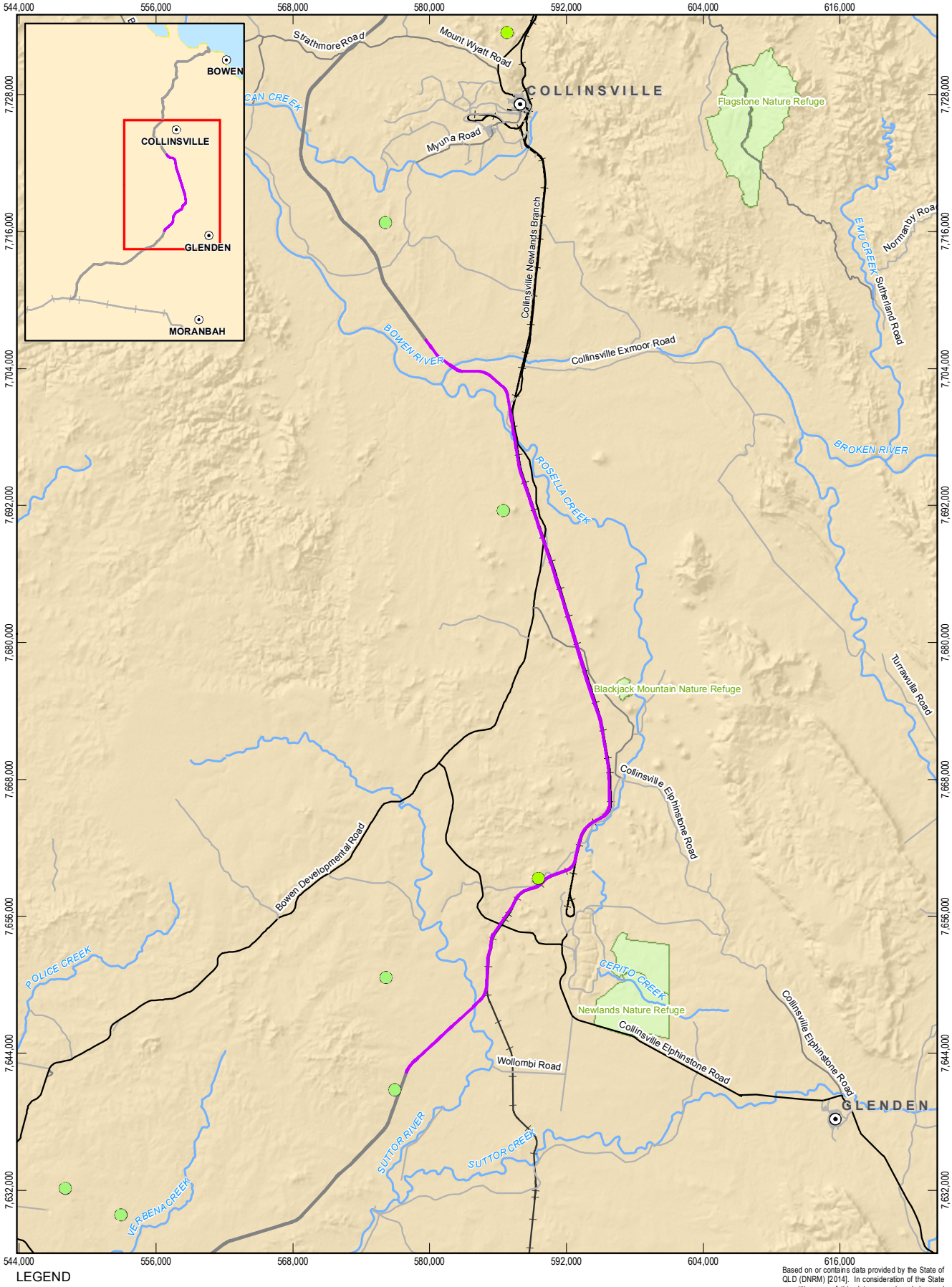
The area and location of temporary ancillary facilities (excluding track laydown areas and turning circles) are provided in Table 2-6 below. Track laydown areas will be approximately 4.5 ha in area and will occur at six to eight kilometre intervals. Turning circles will be approximately one hectare in area and will occur at three to four kilometre intervals.

Table 2-6 Temporary construction infrastructure

Chainage (km)	Component	Area (ha)
130.2	Bridge laydown area	6
131.6	Bridge laydown area	6.8
139.5	Bridge laydown area	6.18
141.2	Bridge laydown area	6
149.9	Bridge laydown area	6
153.0	Bridge laydown area	6
157.6	Bridge laydown area	6
169.9	Bridge laydown area	6
172.5	Bridge laydown area	6
179.1	Bridge laydown area	6.07
183.7 – 185.0	Temporary ballast stockpile area	18.24
187.8 – 189.0	Construction maintenance yard	26.07
188.8	Bridge laydown area	6
189.6	Construction camp	10.13
189.9	Concrete batching plant	5.18
195.6	Bridge laydown area	6.43
196.3	Bridge laydown area	7.53
204.0	Bridge laydown area	6

2.5.4 Quarries and borrow areas

Two additional existing quarriesto those identified in the NGBR Project EIS Volume 1 Chapter 2 Project description will be required for the construction of the NGBR Project realignment (Figure 2-2). The quantity of materials required during construction is detailed in the Volume 2 Appendix B Revised project description.



LEGEND

- Populated centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Nature refuges
- Potential Quarry Locations

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:475,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Potential quarry location

Figure 2-2

G:\41\26457\06 GIS\Maps\MXD\0001_Overview\41_26457_0029_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: LGA (2012), Physical Road Network (2010), Nature Refuge (2010). Created by:MS

2.5.5 Water supply infrastructure

The NGBR Project realignment will require water to support construction activities. A construction water supply strategy will be developed during detailed design to identify water supply requirements and to determine adequate water supply sources.

2.5.6 Haul roads and access roads

No new additional haul roads and access roads will be required for construction of the NGBR Project realignment in addition to the haul roads and access roads identified in the NGBR Project EIS Volume 1 Chapter 2 Project description.

2.5.7 Road Crossings

The NGBR Project realignment includes eight road crossings as identified in Table 2-7. Proposed treatments for each crossing were determined in accordance with the criteria shown in Table 2-11 of the NGBR Project EIS Volume 1 Chapter 2 Project description. The treatment criteria are subject to further consultation with the Department of Transport and Main Roads (DTMR) and local councils and will undergo further review during subsequent design stages.

Table 2-7 Road treatments

Chainage (km)	Name	Treatment
137.87	Road reserve	At grade crossing
139.97 to 140.97	Road reserve	Closure
150.03	Bowen Developmental Road	Grade separated crossing
150.84	Road reserve	Closure
159.79	Old Collinsville Elphinstone Road	At-grade crossing
171.47	Road reserve	Closure
178.47	Road reserve	At-grade crossing
189.06	Collinsville Elphinstone Road	Grade separated crossing

2.5.8 Occupational and stock crossings

The NGBR Project realignment includes 17 occupational crossings and two national stock route crossing as outlined in Table 2-8. Proposed treatments for each crossing were determined in accordance with criteria shown in Table 2-13 of the NGBR Project EIS Volume 1 Chapter 2 Project description. The criteria are subject to further consultation with the Department of Natural Resources and Mines (DNRM), local government and landholders, and will undergo further review during subsequent design stages. Further refinement of occupational crossing treatments and identification of minor crossings or closures will be undertaken to support detailed design.

Table 2-8 Occupational and stock route crossings

Chainage (km)	Name	Proposed Treatment
130.77	Occupational crossing	At-grade (passive)
132.22	Occupational crossing	Through large culvert
135.91	Occupational crossing	At-grade (passive)
139.51	Stock route (U409BOWN02)	Through large culvert
141.18	Occupational crossing	Through large culvert
144.97	Occupational crossing	Through large culvert
155.63	Occupational crossing	At-grade (passive)
163.53	Occupational crossing	At-grade (passive)
167.79	Occupational crossing	Through large culvert
172.75	Occupational crossing	Through large culvert
176.62	Occupational crossing	At-grade (passive)
189.50	Occupational crossing	Through large culvert
191.76	Occupational crossing	Through large culvert
194.03	Occupational crossing	Through large culvert
195.27	Occupational crossing	Through large culvert
196.87	Occupational crossing	Through large culvert
199.07	Stock route (U403BOWN02)	Through large culvert
200.66	Occupational crossing	Through large culvert
204.46	Occupational crossing	At-grade crossing

2.5.9 Service crossings

A ‘dial before you dig’ search was undertaken for the NGBR Project realignment, which identified two pipeline crossings and seven power line crossings (refer Table 2-9). All nine service crossings have been previously identified in the NGBR Project EIS; however the location of the crossing will change as a result of the NGBR Project realignment. Treatments for each crossing will be negotiated with the relevant service authorities.

Table 2-9 Service crossings

Chainage (km)	Service
137.3	Power line

Chainage (km)	Service
141.1	Power line
151.	132kV network cable (Ergon)
158.2	Power line (Ergon)
160.1	132kV network cable (Ergon)
170.78	Power line
176.5	132kV network cable (Ergon)
195.3	SunWater Water Pipeline
195.3	North Queensland Gas Pipeline

2.5.10 Rail network crossings

The NGBR Project realignment will not intersect any existing rail networks.

2.5.11 Waterway crossings

Identification of major waterways and crossing structures for the NGBR Project realignment was undertaken with reference to existing crossing structures on the Newlands line, and crossing structures identified in the Alpha Coal Project SEIS. Further refinement and identification of waterways will be undertaken to support detailed design.

Generally, the design criteria defined in the NGBR Project EIS will apply equally to the NGBR Project realignment. Bridge and culvert design criteria, afflux design criteria and flood immunity criteria are shown in Volume 2 Appendix B Revised project description.

Table 2-10 Major waterways and crossing structures

Chainage (km)	Waterway	Crossing structure
131	Bowen River	Bridge (16 span)[1]
138.8	Station Creek	Bridge (4 span)[2]
140.9	Rosella Creek	Bridge (6 span)[2]
153.6	Unnamed creek	Bridge (2 span)[2]
158	Unnamed creek	Bridge (4 span)[2]
179.5	Unnamed creek	Bridge (4 span)[2]
187.1	Unnamed creek	Bridge (3 span)[2]
196.8	Suttor River	Bridge (4 span)

1 Proposed in Alpha Coal Project Alpha Coal Project Supplementary Environmental Impact Statement 2011 Appendix Y BFS Drainage Engineering Report

[2] Matched with existing structures on the Newlands line

3. Land use and tenure

3.1 Purpose of section

The objective of this land use and tenure section is to describe the existing land use and tenure values relevant to the NGBR Project realignment, including the following values.

- State interests in land
- Property tenures
- Mining tenure
- Agricultural land uses
- Existing and proposed infrastructure
- Stock routes.

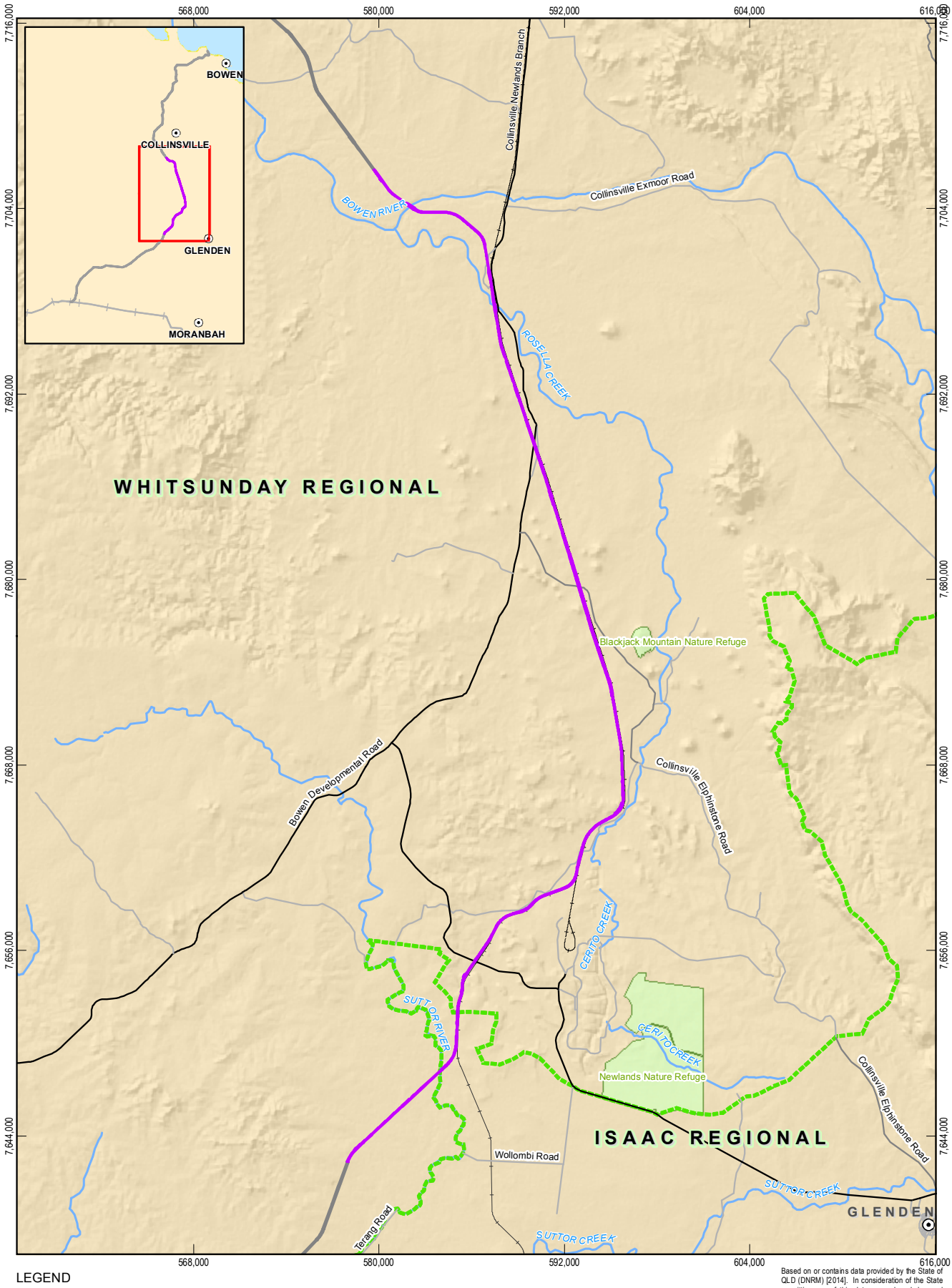
3.2 Methodology

3.2.1 Study area

The study area for this land use and tenure section is defined at the local scale only and is defined by the NGBR Project realignment footprint, the eight immediately adjacent leasehold properties, six easements, infrastructure, the nearest local communities and surrounding predominant land use patterns (refer Figure 3-1).

The key communities that will potentially be influenced by the NGBR Project realignment are considered to be Collinsville and Glenden. The local study area is located within both the Whitsunday regional Council (WRC) and the Isaac Regional Council (IRC) local government areas (LGA).

Due to the nature and scale of the NGBR Project realignment, the regional assessment of land use and tenure aspects provided within the NGBR Project EIS Volume 1, Chapter 3 Land use and tenure is still relevant and therefore has not been included within this section.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Nature refuges
- Local government area

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Land use study area

Figure 3-1

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0816_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: LGA (2012), Physical Road Network (2010), Nature Refuge (2010). Created by:MS

3.2.2 Data sources

Primary data and information were reviewed to assist in a clear understanding of the existing environment regarding land use and tenure. This included drawing on existing data sets, and undertaking geographic information system (GIS) analysis to accurately determine how the NGBR Project realignment transects with key features. The data reviewed included:

- NGBR Project EIS Volume 1 Chapter 2 Project description
- NGBR Project EIS Volume 2 Chapter 3 Land use and tenure
- NGBR Project EIS Volume 2 Appendix E Topography, geology, soils and land contamination
- Alpha Coal Project EIS and SEIS (Hancock Prospecting Pty Ltd 2010)
- Aerial photography (Google Earth Professional Imagery 2013)
- Topographic maps (DERM, 2010)
- Cadastral maps (DNRM 2014)
- Title and tenure details of freehold and leasehold properties (DNRM 2014)
- Mining tenures (DNRM 2014)
- Native title claim areas and determinations (ELH 2014)
- Location of roads (DNRM, Physical Road Network, 2010)
- Location of rail lines (Geosciences Australia, Railway network, 2007)
- Location of gas and water pipelines (Geosciences Australia, Pipelines, 2007)
- Stock route network maps (DNRM, Stock Routes, 2013)
- Maps identifying sensitive receptors (Geosciences Australia, 2007)
- Mackay, Isaac and Whitsunday Regional Plan (DLGP 2012)
- Bowen Shire Council Planning Scheme 2006 (Whitsunday Regional Council 2006)
- Planning Scheme for Belyando Shire (Isaac Regional Council 2008)
- Draft Development Scheme for the Galilee Basis State Development Area (Queensland Government 2014)
- Department of Natural Resources and Mines 2013 Guide to Tenure under the *Land Act 1994*.

3.2.3 Legislation

Legislation relevant to this land use and tenure section is as follows:

- *Sustainable Planning Act 2009* and *Sustainable Planning Regulation 2009*
- *Transport Infrastructure Act 1994*
- *Land Act 1994*
- *Mineral Resources Act 1989*
- *Nature Conservation Act 1992*
- *Vegetation Management Act 1999* and *Vegetation Management Regulation 2000*

- *Stock Route Network Management Bill 2011*
- *Land Protection (Pest and Stock Route Management) Act 2002*
- *Transport Planning and Coordination Act 1994*
- Local government planning schemes.

An explanation of the above legislation and how it applies to the NGBR Project realignment is provided in Volume 2 Appendix J Revised legislation and approvals and Section 14 of this report.

3.2.4 Desktop assessment

The desktop assessment documented in this report involved the following tasks:

- The review of primary data (refer to Section 3.2.2) to determine the environmental values of the study area
- The review of documentation and mapping of the environmental values of the study area
- A review of the Alpha Coal Project EIS 2010 was undertaken to determine where the NGBR Project realignment impacts overlay with those outlined in the Alpha Coal Project EIS.

3.3 Existing environment

3.3.1 Overview

As identified in Section 3.2.1, the local study area is within a rural area and is defined by the NGBR Project realignment footprint (i.e. a nominal 60 m wide corridor and ancillary infrastructure) and immediately adjacent parcels of land, infrastructure, communities and land use.

The NGBR Project realignment traverses:

- Eight leasehold lots and six easements (refer Figure 3-2 and Table 3-1)
- The WRC and IRC LGAs (refer Figure 3-1)
- The proposed Galilee Basin State Development Area (GBSDA) (Figure 3-10)
- Mining and petroleum tenures (refer Figure 3-3)
- Agricultural land (refer Figure 3-5 and Figure 3-6)
- Water and gas pipelines and power lines (refer Figure 3-9)
- Existing infrastructure (refer Section 3.3.4)
- The native title claims of the Jangga and Birriah People (referred to in NGBR Project EIS as Birri) (refer Figure 3-11).

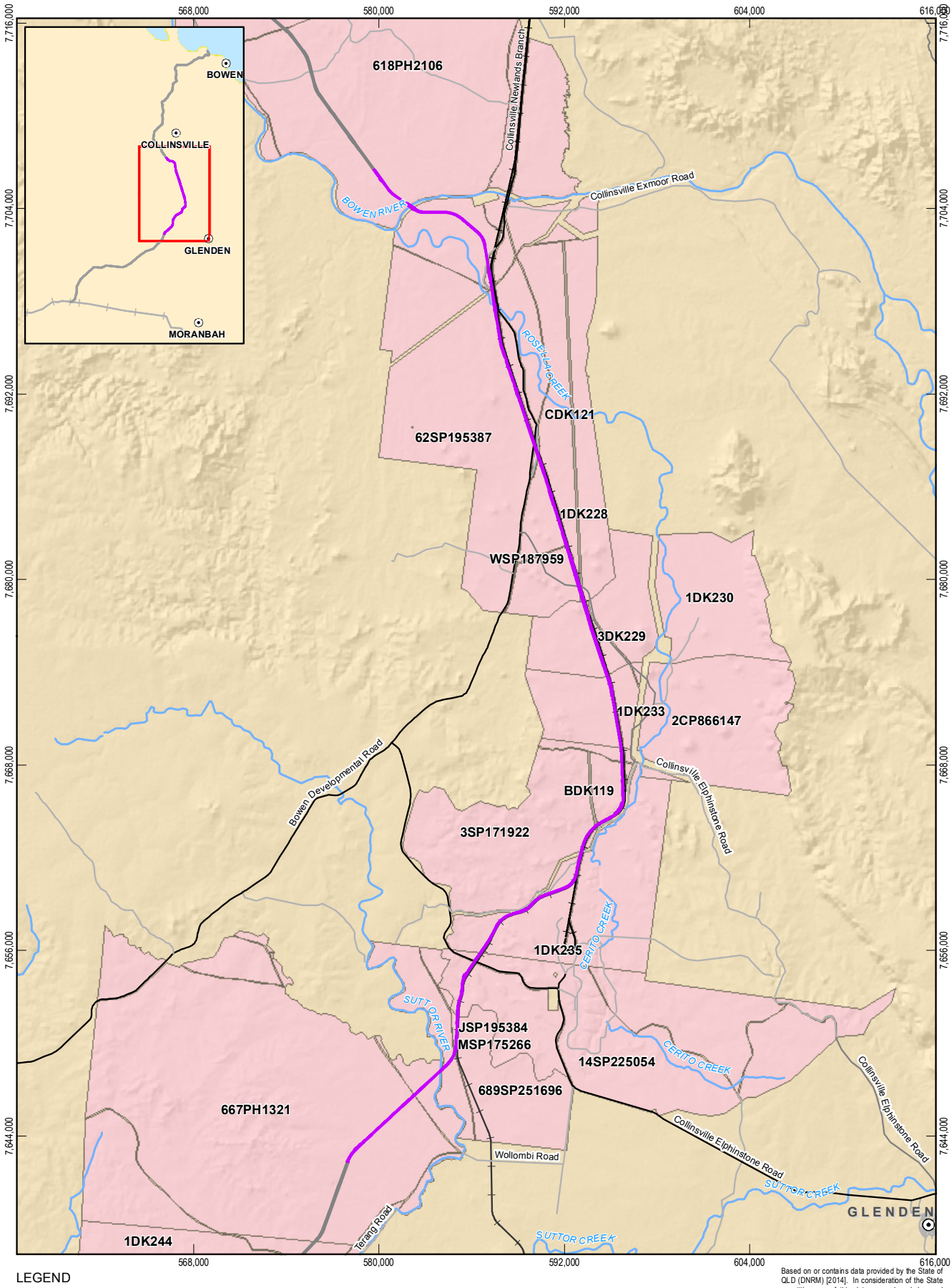
3.3.2 Tenure

Tenure administered under the *Land Act 1994*

The NGBR Project realignment traverses a total of eight leasehold properties and six easements; these properties and easements are listed in Table 3-1 and shown in Figure 3-2.

Table 3-1 NGBR Project realignment property tenure

Lot on plan	Area of lot (ha)	Tenure	Local government
1DK230	9,968.68	Leasehold	WRC
2CP866147	10,664.71	Leasehold	WRC
3SP171922	17,587.78	Pastoral lease	WRC
689SP251696	6,800.00	Pastoral lease	IRC
14SP225054	16,900.00	Pastoral Lease	WRC
618PH2106	4,674.90	Leasehold	WRC
62SP195387	30,100.00	Leasehold	WRC
667PH1321	35,000.00	Leasehold	WRC
DDK121	5.17	Easement	WRC
WSP187959	1.63	Easement	WRC
CDK121	1.27	Easement	WRC
BDK119	1.02	Easement	WRC
MSP175266	0.36	Easement	IRC
JSP195384	0.26	Easement	IRC



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Easement
- Lands lease

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Local context and tenure

Figure 3-2

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0817_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Cadastre, (2014), Physical Road Network (2010), Nature Refuge (2010). Created by:MS

Tenure administered under the *Mineral Resources Act 1989*

A review of the Department of Natural Resources and Mines (2014) data illustrates that the NGBR Project realignment traverses tenements comprising eight exploration permits for coal (EPC), one exploration permit for minerals (EPM)and six mining leases (ML) (refer Table 3-2). The location of mining and petroleum tenures in the study area is illustrated in Figure 3-3.

Table 3-2 Mining tenures

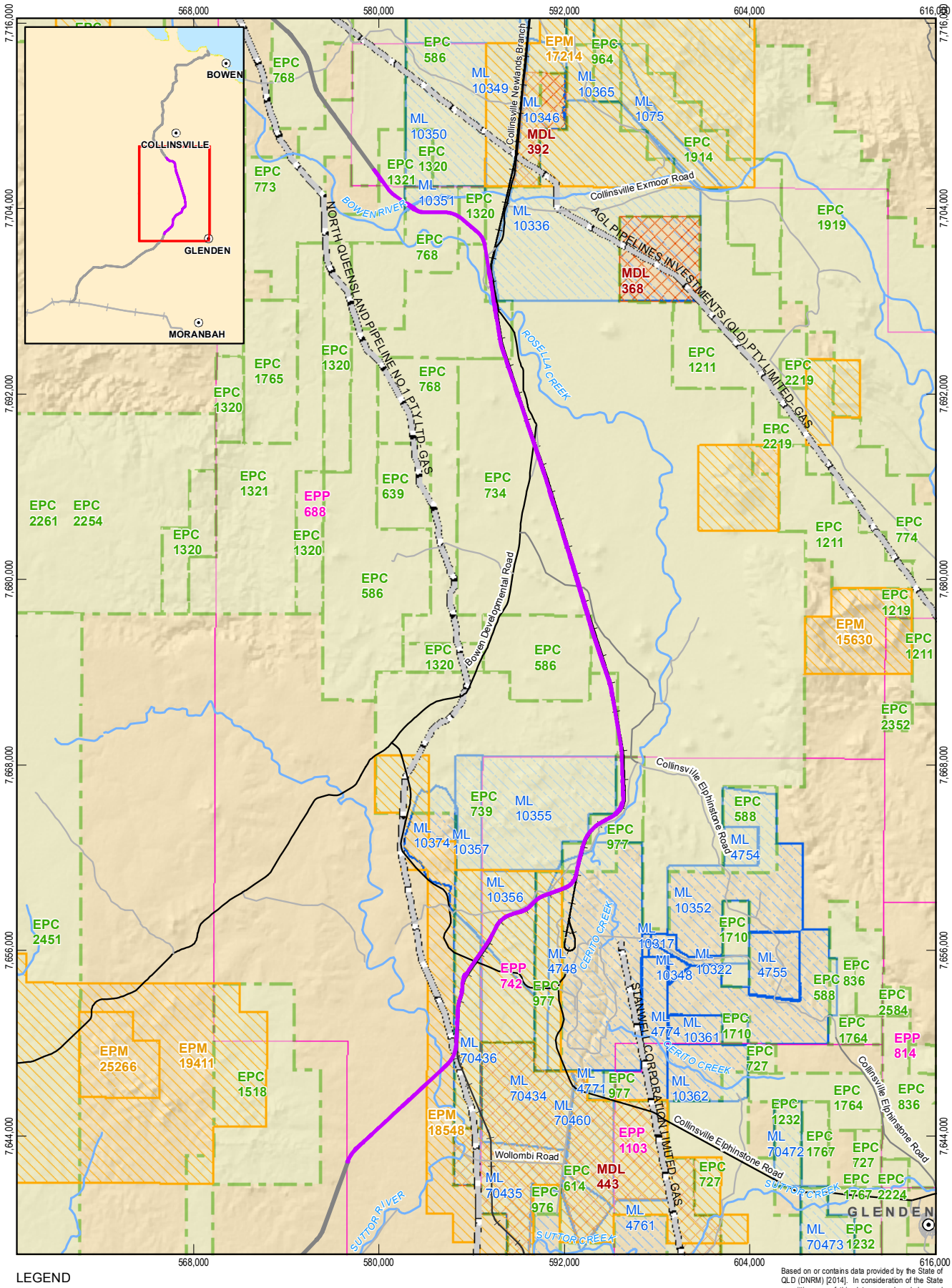
Tenure	Holder	Status	Impacted area ha
Exploration permits for coal			
EPC 586	Bowen River Coal Pty Ltd	Granted	45.72
EPC 734	Glencore Coal Queensland Pty Ltd	Granted	270.22
EPC 739	Byerwen Coal Pty Ltd	Granted	198.85
EPC 768	Rosella Creek Coal Pty Ltd	Granted	41.75
EPC 773	Glencore Coal Queensland Pty Ltd	Granted	2.54
EPC 977	Glencore Coal Queensland Pty Ltd	Granted	89.31
EPC 1320	North Coal Pty Ltd	Granted	20.70
EPC 1321	Brothers Mining Pty Ltd	Application	22.84
Exploration permits for minerals			
EPM 18548	Byerwen Coal Pty Ltd	Granted	207.47
Mining Leases			
ML 4748	Glencore Coal Queensland Pty Ltd	Granted	37.57
ML 10351	Drake Coal Pty Ltd	Granted	6.46
ML 10355	Byerwen Coal Pty Ltd	Application	1.88
ML 10356	Byerwen Coal Pty Ltd	Application	49.37
ML 70434	Byerwen Coal Pty Ltd	Application	12.88
ML 70436	Byerwen Coal Pty Ltd	Application	101.85

Tenure administered under the *Petroleum and Gas (Production and Safety) Act 2004*

A review of the Department of Natural Resources and Mines (2014) data illustrates that the NGBR Project realignment traverses tenements comprising two exploration permits for petroleum (EPP), and a petroleum lease (PL) (refer Table 3-2). The location of mining and petroleum tenures in the regional study area is illustrated in Figure 3-3.

Table 3-3 Petroleum tenures

Tenure	Holder	Status	Impacted area ha
Exploration permits for petroleum			
EPP 688	BNG (Surat) Pty Ltd	Granted	625.29
EPP 742	CH4 Pty Ltd	Granted	170.92
Petroleum pipeline license			
PPL 89 (Gas)	North Queensland Pipeline No 1 Pty Ltd	Granted	Unknown



LEGEND

- Population centres
- Railway
- Main road
- Carmichael Project (Rail)
- Secondary road
- Watercourse (Major)
- Local road
- NGBR Project final rail corridor
- NGBR Project realignment
- Exploration permits mineral (EPM)
- Exploration permits coal (EPC)
- Exploration permits petroleum (EPP)
- Mineral development licence (MDL)
- Mining leases (ML)
- Petroleum pipeline licence (PPL)

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Mining and petroleum tenure Figure 3-3

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0818_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Mine Tenements (2014), Physical Road Network (2010). Created by:MS

3.3.3 Land use

Overview

The NGBR Project realignment is located within the rural zones of the IRC and WRC LGAs in the Bowen Basin. The land uses within these local government areas and the wider Bowen Basin are discussed further in the NGBR Project EIS (Volume 1, Chapter 3 Land use and tenure).

The NGBR Project realignment is located within the proposed Galilee Basin State Development Area (GBSDA) boundary. The NGBR Project realignment will fall within the South to North Rail Corridor Precinct of the GBSDA. This precinct is to accommodate future rail infrastructure and associated activities in the Galilee Basin. The GBSDA is discussed further in Section 14.

The NGBR Project realignment is located within the Regional Landscape and Rural Production Area (RLRPA) land use category under the Mackay, Isaac and Whitsunday Regional Plan 2011 – 2031 (MIWRP) (refer Figure 3-4). The RLRPA includes land with significant biodiversity values, Good Quality Agricultural Land (GQAL), cultural and landscape heritage values, extractive resources of economic significance (e.g. mining), water catchments, native forests, coastal wetlands, land unsuitable for urban/rural residential purposes and rural towns and associated activities such as transport and telecommunication networks (DLGP 2012).

The land which the NGBR Project realignment traverses is classified as ‘production from relatively natural environments (DLGP 2012)’. Land use in the study area is predominantly for the purposes of cattle breeding and fattening (refer Figure 3-4). Limited areas are defined as being for the purposes of cattle grazing and breeding.

The landscape of the NGBR Project realignment is characterised by a combination of flat floodplains dominated by a number of creeks which have reasonably well defined channels but with wide floodplains that are inundated during flood events, and steeper undulating terrain associated with the edges of the Leichhardt and Clarke ranges. A number of wetland protection areas are located in the southern portion of the NGBR Project realignment footprint. These wetlands are identified and discussed further in Section 8.

The main watercourses crossed by the NGBR Project realignment comprise major waterways (including the Bowen River, Rosella Creek and the Suttor River) and several smaller creeks and ephemeral water bodies (including Stony Creek, Plum Creek, Kangaroo Creek and Cerito Creek). These water resources within the vicinity of the NGBR Project realignment are further discussed in Section 8.

The NGBR Project realignment also traverses a number of State-controlled roads, minor roads and stock routes (refer Section 3.3.4).

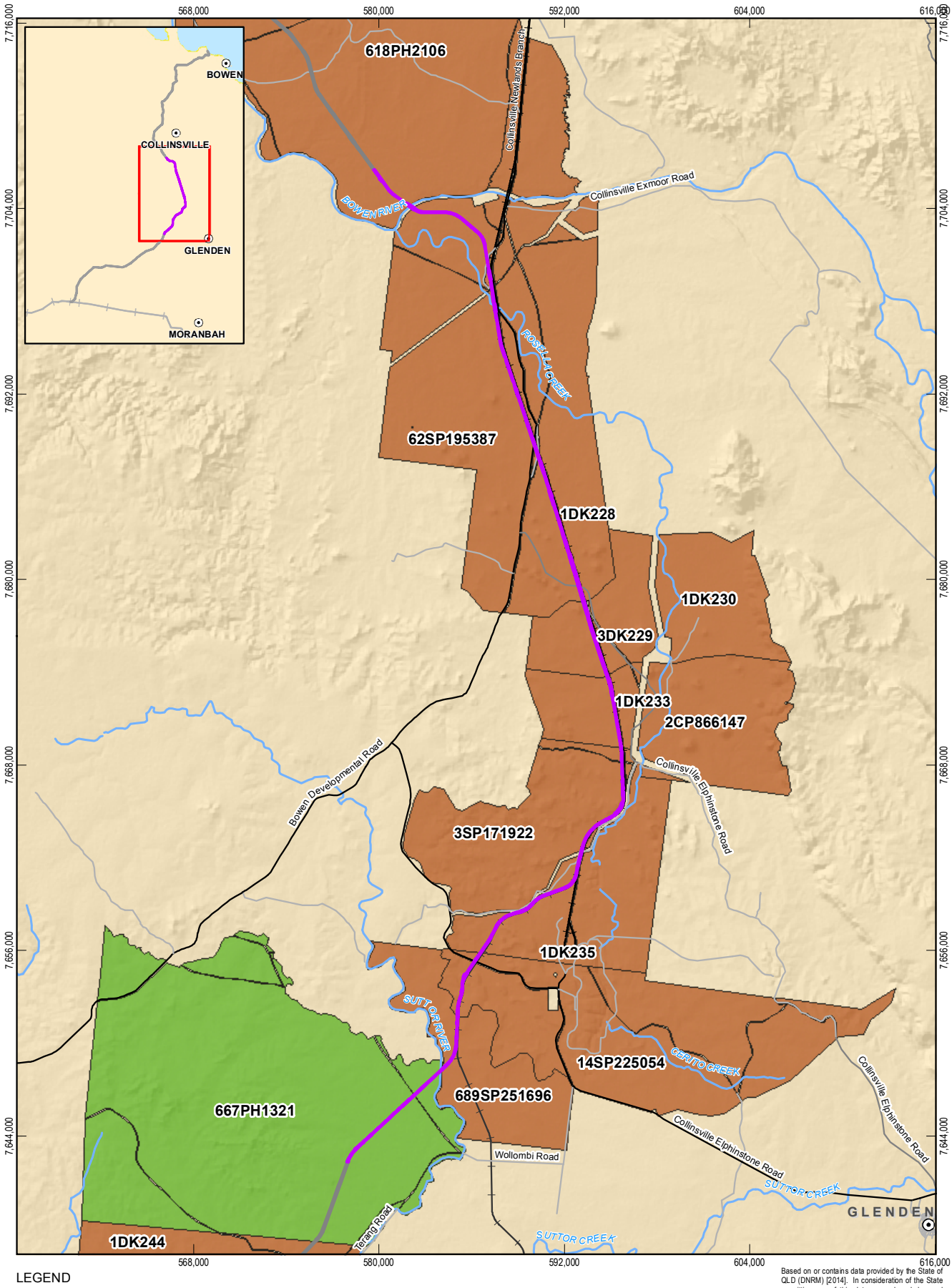
Rural uses

Land in the local study area is primarily used for the purposes of cattle breeding and fattening (refer Figure 3-4) with limited areas used for the purposes of cropping and horticultural activities. The suitability of the local study areas for agricultural uses is discussed further in Section 5.

The presence of ‘good quality agricultural land’ (GQAL) in the local study area is illustrated in Figure 3-5 and discussed in Section 5. GQAL refers to any set of agricultural land classes that are determined by a local government to have agricultural characteristics important to the local economy. A total area of 267.2 ha of GQAL will be intersected by the NGBR Project realignment.

The Queensland Government considers that strategic cropping land (SCL) i.e. high quality cropping land is a finite resource that must be conserved and managed for the long term (Queensland Government 2010). As a general aim, planning and approval powers should be used to protect such land from those developments that would lead to its permanent alienation or diminished productivity. The NGBR Project realignment falls entirely within the Western Cropping zone. A of total 252.22 ha of potential SCL is located within the NGBR Project realignment. The mapped areas are illustrated in Figure 3-5 and is discussed further Section 5.

Regional rural land uses are discussed further in the NGBR Project EIS Volume 1, Chapter 3 Land use and tenure.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment

Landuse

- Cattle breeding & fattening
- Cattle grazing & breeding

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Study area land use

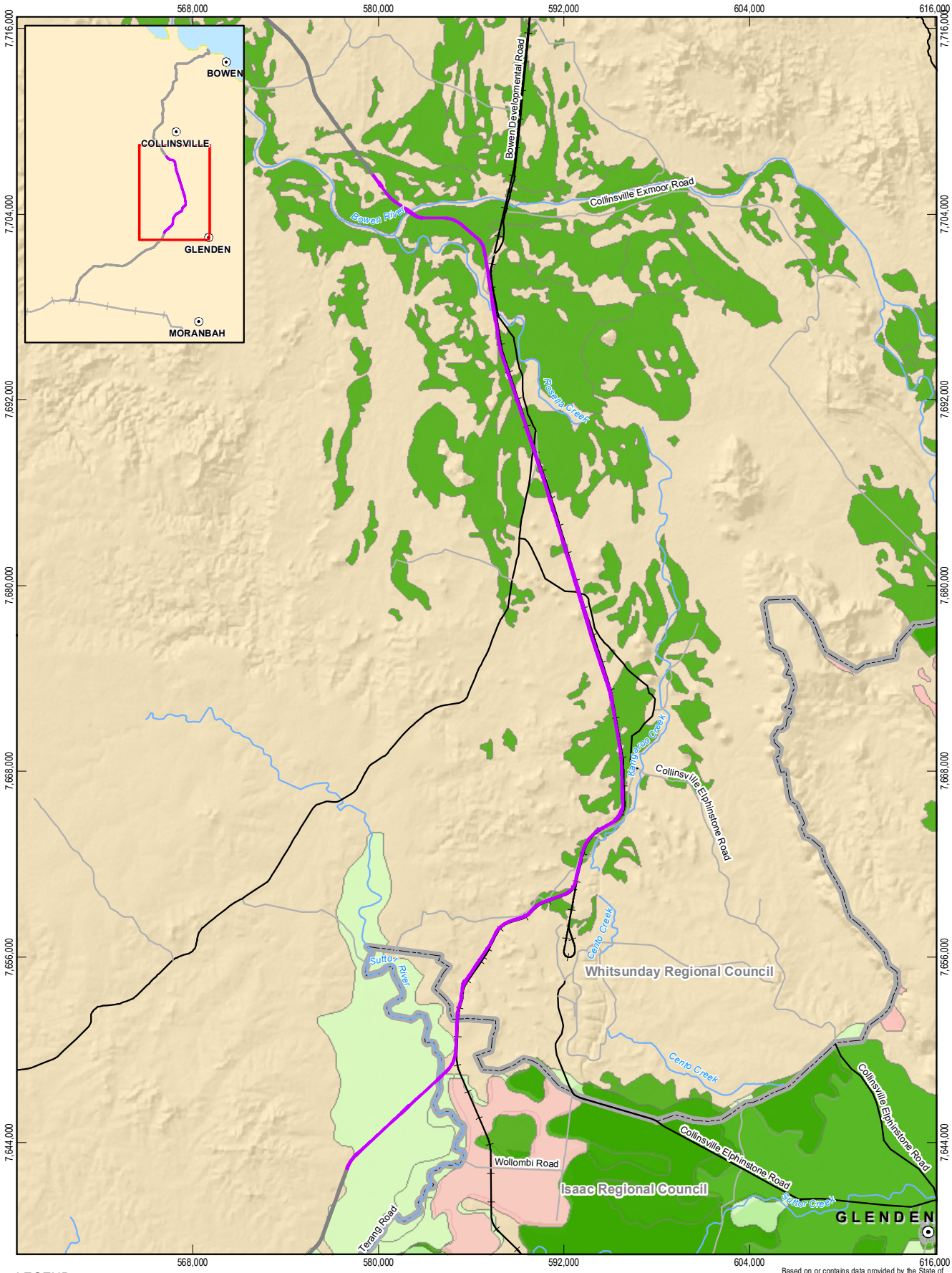
Figure 3-4

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0819_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Cadastre-Landuse (2014), Physical Road Network (2010). Created by:MS



LEGEND

- Population centres
- Main Road
- Local Road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- GQAL
  - A
  - B
  - C1 (Isaac Regional Council only)
- Local government area

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number 41-26457
Revision A
Date 28 Feb 2014

Good quality agricultural land

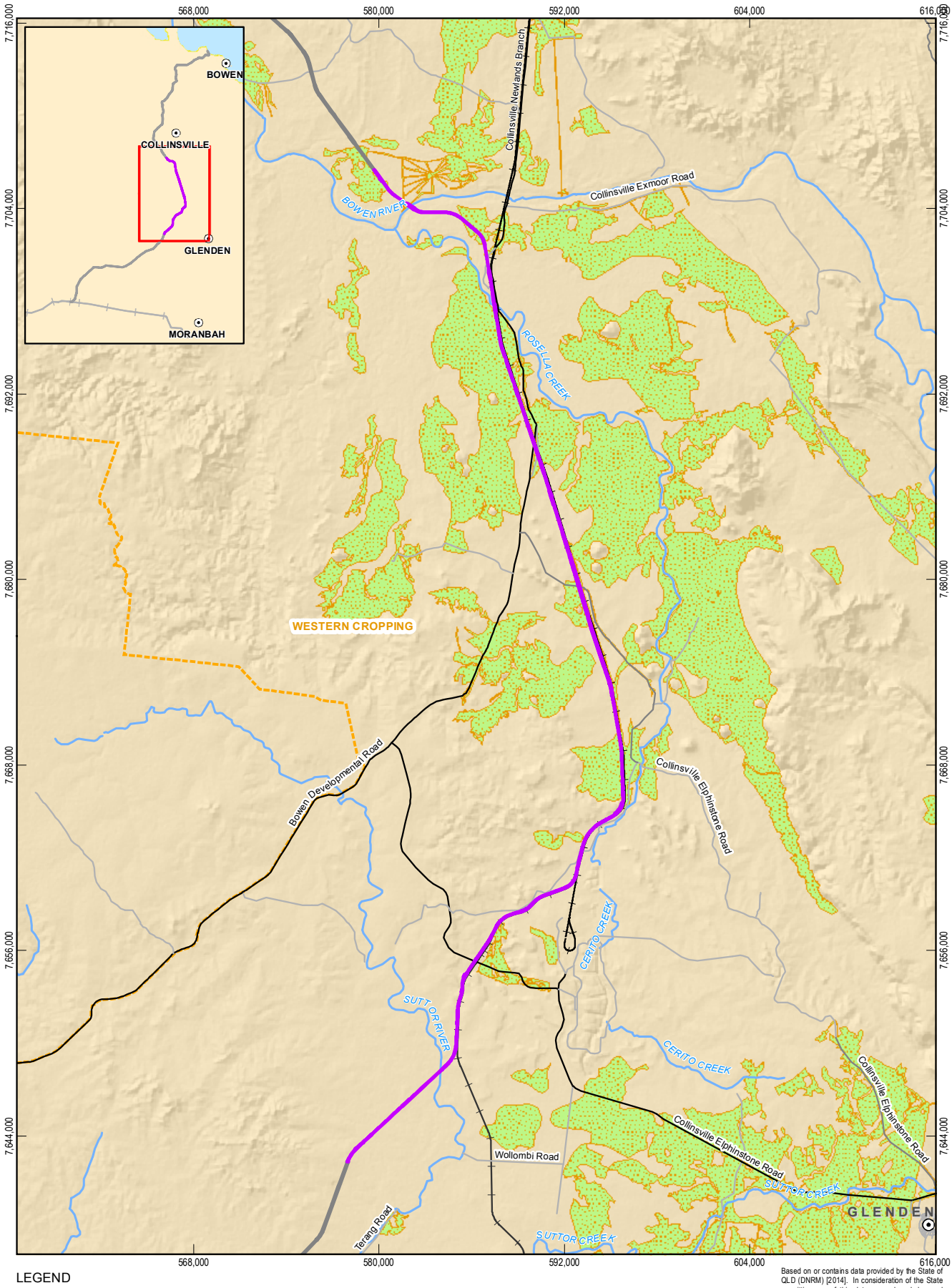
Figure 3-5

G:\41\26457\06 GIS\Maps\MXD\0400_Geology_Soils\41_26457_0440_rev_a.mxd

Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Population centres, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014); DNRM: Roads (2010), GQAL (2010), LGA (2012). Created by:MS



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Strategic Cropping Land (Zones)
- Strategic Cropping Land (Trigger)

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Strategic cropping land

Figure 3-6

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0821_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: SCL Zones, Trigger v2 (2012), Physical Road Network (2010). Created by:MS

Non rural uses

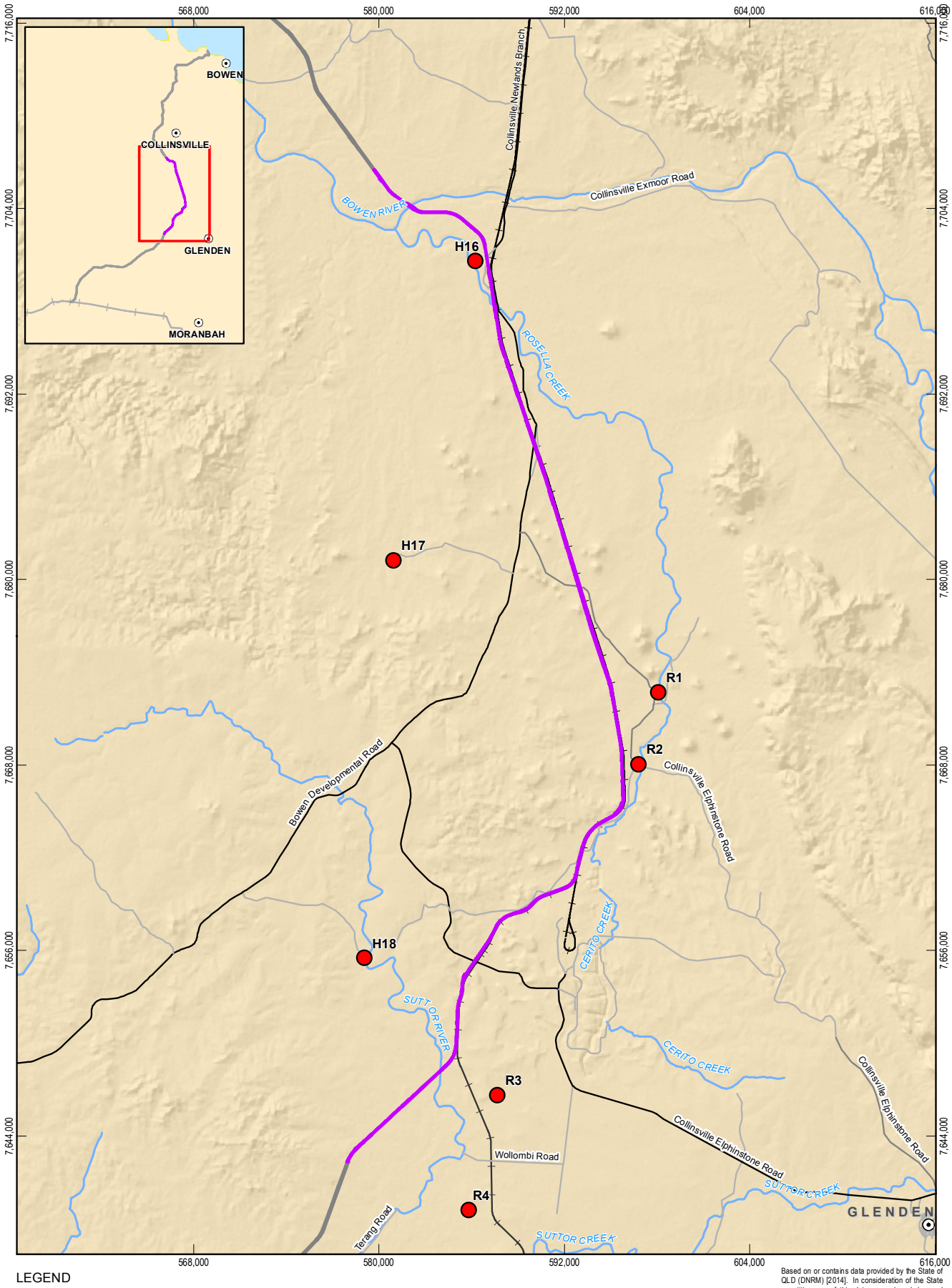
Non-rural land comprises land that is not for a rural purpose, including but not limited to land zoned as rural-residential, residential, urban, industrial and commercial.

The main residential areas surrounding the NGBR Project realignment are located in excess of 20 km from the NGBR Project realignment footprint at Collinsville and Glenden.

The closest potentially sensitive receptors to the NGBR Project realignment are Homestead 16 and Homestead R2. Identified homesteads are shown in Figure 3-7 and summarised in Table 3-4.

Table 3-4 Summary of potential sensitive receptors

Sensitive receptor	Easting, mE (GDA94)	Northing, mN (GDA94)	Approximate distance from NGBR Project realignment footprint (m)	Lot on Plan
Homestead H16	586276	7700610	721	62SP195387
Homestead H17	580954	7681237	10,932	4SP171921
Homestead H18	579067	7655503	6,485	1510SP171920
Homestead R1	598184	7672543	2,938	2CP866147
Homestead R2	596833	7668054	1,062	3SP171922
Homestead R3	587731	7646724	3,764	689SP251696
Homestead R4	585850	7639199	7,825	1CP905226



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Sensitive Receptors

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Sensitive receptors

Figure 3-7

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0822_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Physical Road Network (2010), GA/NGBR EIS: Sensitive Receptors (2014) Created by:MS

Recreation areas

The NGBR Project realignment does not traverse any public recreation reserves. There are a number of sites surrounding the NGBR Project realignment footprint that are used for recreational purposes by the community and tourists as listed in Table 3-5.

Table 3-5 Significant recreational areas near the deviation corridor

Recreational area	Approximate Distance from final rail corridor
Newlands Nature Refuge	10 km east
Blackjack Mountain Nature Refuge[1]	2.2 km west
Flagstone Nature Refuge	28 km north east
Hells Gate Nature Refuge	26 km north west
Sonoma State Forest	27 km north west

1. Private nature refuge

3.3.4 Existing and proposed infrastructure

Road and stock route networks

The NGBR Project realignment will intersect State-controlled roads, local roads, gazetted stock routes, gazetted public road reserves (unconstructed) and occupational (private farm) tracks within private property boundaries and/or connecting adjoining properties of different ownership.

A total of eight roads are likely to be intersected by the NGBR Project realignment, of which two are considered major roads (State-controlled roads), three are minor roads (Council owned roads), and three are road reserves (refer Table 3-6). A total of 17 occupational tracks and two national stock routes will be intersected by the NGBR Project realignment.

Table 3-6 Road and stock route crossings

Crossing	Chainage (km)	Classification
Road reserve	137.87	Minor road
Stock route ((U409BOWN02)	139.51	Stock route
Road reserve (not constructed)	139.97 to 140.97	Road reserve
Bowen Developmental Road	150.03	Major road
Road reserve	150.84	Road reserve
Old Collinsville Elphinstone Road (not constructed)	159.79	Minor road
Road reserve (not constructed)	171.47	Road reserve

Crossing	Chainage (km)	Classification
Cerito Road	178.47	Minor road
Collinsville Elphinstone Road	189.06	Major road
Stock route (U403BOWN02)	199.07	Stock route

Current and proposed road infrastructure upgrades occurring within the study area at a local, state or federal level are discussed further in Section 11 and within the NGBR Project EIS Volume 1, Chapter 14 Transport.

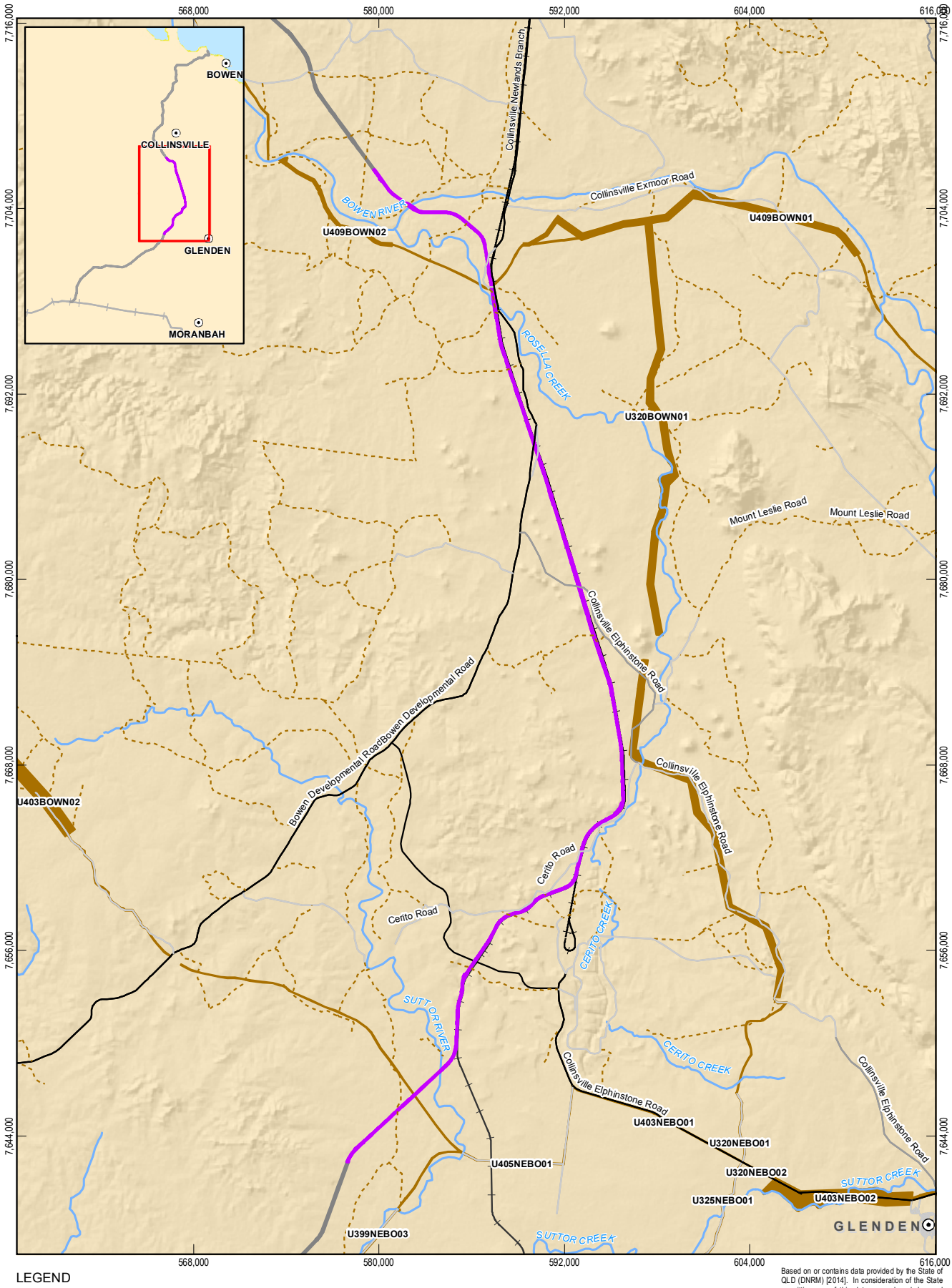
Further details on road and stock route networks within the local study area are provided in Section 11.

Rail

The closest existing rail freight network within the vicinity of the NGBR Project realignment is the Newlands line (operated by Aurizon) which links the Port of Abbot Point coal terminal to Collinsville and between Collinsville and Newlands Junction. The NGBR Project realignment will run alongside the Newlands line for approximately 57 km. The Newlands line is linked, via the Northern Missing Link (North Goonyella Junction to Newlands Junction) with the Goonyella rail network which services the Port of Hay Point and Dalrymple Bay Coal Terminal south of Mackay (refer Figure 3-8).

Approximately 64 km of the NGBR Project realignment will be developed in a corridor consistent with the proposed Alpha Coal Project EIS rail corridor (approved but not yet constructed). The northern portion near the Bowen River and the southern end near the Suttor River (approximately 10 km) will be within a greenfield rail corridor. The NGBR Project realignment will not intersect any existing rail networks.

The NGBR Project realignment is within the South to North Rail Corridor Precinct of the proposed GBSDA. This precinct is to accommodate future rail infrastructure and associated activities servicing the Galilee Basin.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Vehicular track
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Stock Route

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Transport infrastructure

Figure 3-8

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0823_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Population centres, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Stock Routes (2014), Physical Road Network (2010) Created by:MS

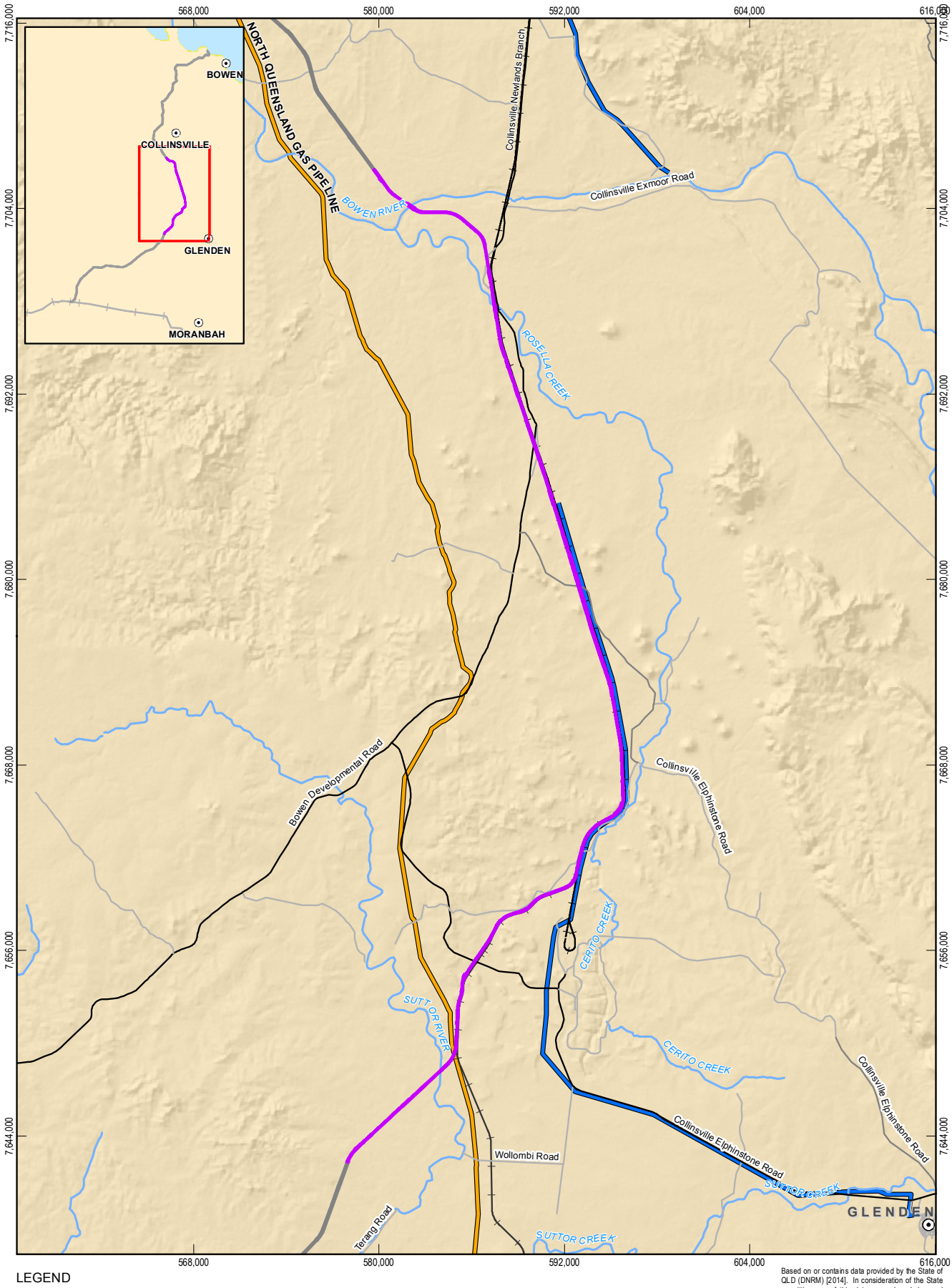
3.3.5 Utilities

Gas, water and power infrastructure intersected by the NGBR Project realignment is summarised in Table 3-7 and illustrated in Figure 3-9. There are a total of seven power lines, one water pipeline and one gas pipeline that cross the NGBR Project realignment. All nine service crossings have been previously identified in the NGBR Project EIS; however the location of the crossing will change as a result of the NGBR Project realignment. Treatments for each crossing will be negotiated with the relevant service authorities. Existing electricity and power supply is discussed further in the NGBR Project EIS.

Gas and water infrastructure is discussed further in the NGBR Project EIS (Volume 1, Chapter 3 Land Use and tenure).

Table 3-7 Service crossings

Utility	Chainage
Power line	137.3
Power line	141.1
132kV network cable (Ergon)	151.0
Power line (Ergon)	158.2
132kV network cable (Ergon)	160.1
Power line	170.78
132kV network cable (Ergon)	176.5
SunWater Water Pipeline	195.3
North Queensland Gas Pipeline	195.3



LEGEND

- Population centres
- NGBR Project final rail corridor
- NGBR Project realignment
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- Gas Pipelines
- Water Pipelines

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Utilities

Figure 3-9

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0824_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Pipelines, Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Physical Road Network (2010) Created by:MS

3.3.6 Designated areas

Local government zoning

The NGBR Project realignment is located within the rural zones of the WRC and IRC local government areas (refer Figure 3-10), and is located within the jurisdictions of the following planning schemes:

- Properties within the WRC LGA are regulated by the Bowen Shire Planning Scheme 2006
- Properties within IRC LGA are regulated by the Nebo Shire Planning Scheme 2008.

The NGBR Project realignment also traverses the extractive resource separation area (chainage 182 km to 186 km) regulated by the Bowen Shire Planning Scheme.The land uses within these local government areas and the wider Bowen Basin are discussed further in the NGBR Project EIS (Volume 1, Chapter 3 Land use and tenure).

Galilee Basin State Development Area

THE NGBR Project realignment is located within the proposed Galilee Basin State Development Area (GBSDA) boundary. The NGBR Project realignment will fall within the South to North Rail Corridor Precinct of the GBSDA. This precinct is to accommodate future rail infrastructure and associated activities in the Galilee Basin.

The NGBR Project realignment is defined as 'rail infrastructure' under the draft GBSDA Development Scheme 2014 (Queensland Government 2014a) and is considered to be a use that 'is consistent with the preferred land use intent of the land use designation', and is therefore a consistent use in the above precinct.

Protected areas

The NC Act makes provisions for the management of protected areas, each with a rigid management regime. The NGBR Project realignment footprint does not intersect any mapped protected area estates. A GIS assessment identified two protected areas that occur within 10 km of the NBGR realignment; these include the Newlands Nature Refuge (6.9 km to the west) and the Blackjack Mountain Nature Refuge (2.2 km to the west) (refer Figure 3-10).

Restricted areas

Restricted areas can be described as areas of land that have varying conditions and restrictions placed over them. The restrictions vary, however they relate primarily to the nature and type of activity that may be undertaken in the restricted area.

The NGBR Project realignment does not traverse any restricted areas. The Suttor River dam site (RA8) is located approximately 1.5 km directly south of chainage 205 km of the NGBR Project realignment (refer to the NGBR Project EIS Volume 1, Chapter 03 Land use and tenure for assessment of the NGBR Projects impacts on RA8). The NGBR Project realignment is also located approximately 400 m north east of the Blue Valley Dam site and Burdekin and Bowen River Valley restricted area (RA48).

Declared water storage catchments

The NGBR Project realignment does not traverse any declared water storage catchments. Information on declared water storage catchments in the regional study area are discussed further in the NGBR Project EIS (Volume 1, Chapter 9 Water resources).

Key resource areas

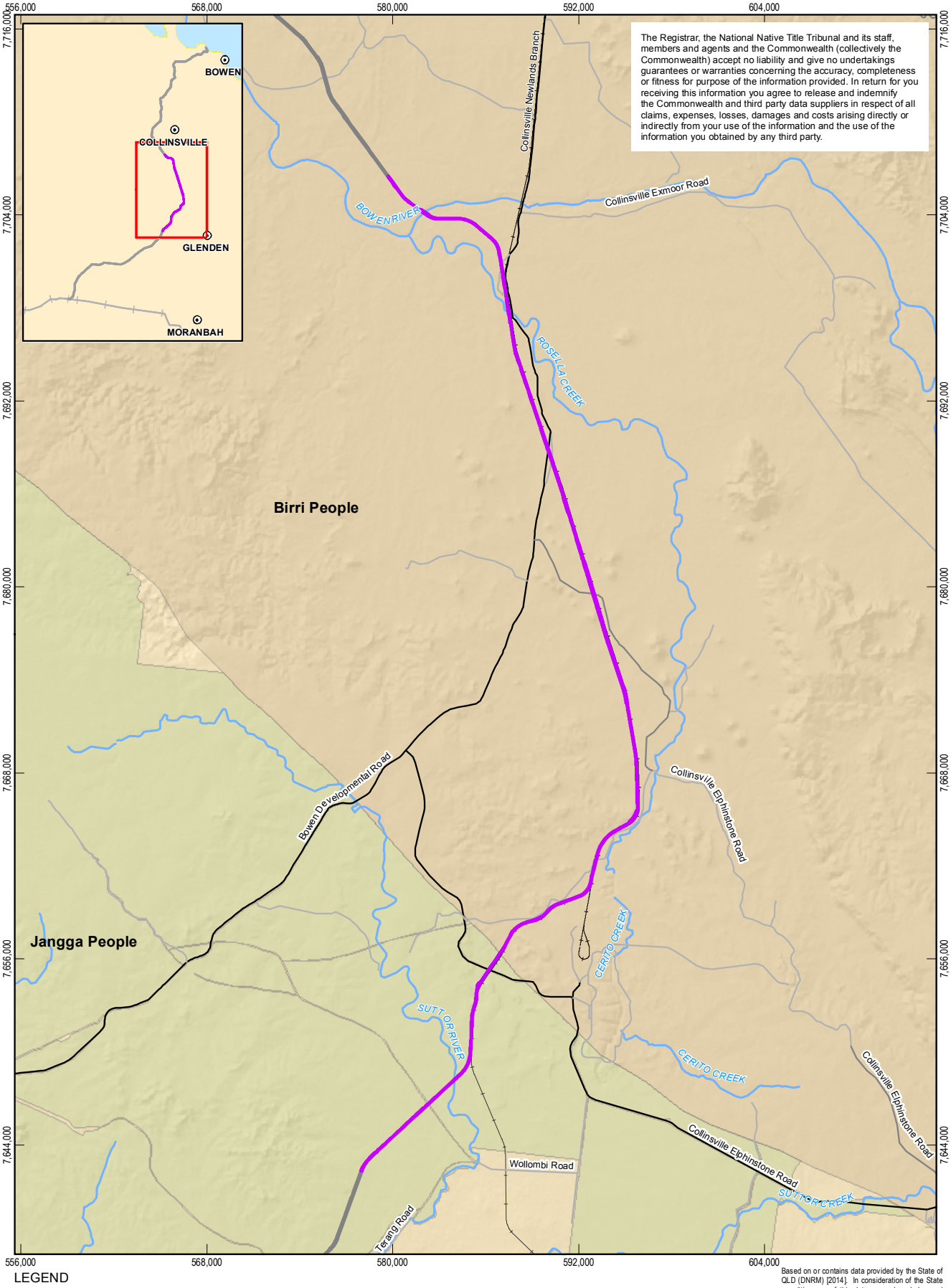
Key Resource Areas (KRAs) are extractive resources of State or regional significance as defined in Queensland State Planning Policy December 2013. There are no KRAs within the NGBR Project realignment footprint.

3.3.7 Native title

The *Native Title Act 1993* (NT Act) recognises the rights and interests of Indigenous people under their traditional laws and customs. A Native Title search on potentially impacted properties indicates that parts of the NGBR Project realignment footprint are located within the external boundaries of the following registered native title claims:

- Jangga People (QUD6230/98, QC98/10)
- Birriah People (referred to in NGBR Project EIS as Birri) (QUD6244/1998, QC98/12).

Native Title is discussed further in Section 13.



The Registrar, the National Native Title Tribunal and its staff, members and agents and the Commonwealth (collectively the Commonwealth) accept no liability and give no undertakings guarantees or warranties concerning the accuracy, completeness or fitness for purpose of the information provided. In return for you receiving this information you agree to release and indemnify the Commonwealth and third party data suppliers in respect of all claims, expenses, losses, damages and costs arising directly or indirectly from your use of the information and the use of the information you obtained by any third party.

LEGEND

- Population centres
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Birri People
- Jangga People

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12 Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Native title claims

Figure 3-11

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0826_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Pipelines, Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Nature Refuge (2010), Physical Road Network (2010); GA/NTT: Native title claims (EIS) (2013). Created by:MS

3.4 Potential impacts and mitigation measures

3.4.1 Overview

The construction and operation of the NGBR Project realignment has the potential to directly impact upon land use and tenure within the local study area. The impacts will occur during both construction and operation stages, with the majority of the change occurring immediately on commencement of construction of the NGBR Project realignment.

The potential impacts to land use and tenure associated with the NGBR Project realignment in both the construction and operation phases relate to:

- Land use and accessibility
- Mining tenure and resource areas
- Agricultural land and SCL
- Existing and proposed infrastructure
- Restricted areas
- Native Title.

Where not identified in this section, the potential construction and operation management and mitigation measures of the NGBR Project realignment on land use are detailed in the NGBR Project EIS.

3.4.2 Land use and accessibility

Affected Properties

Development of the NGBR Project realignment will directly impact approximately 581.34 ha of land across eight properties (refer Figure 3-2) resulting in a permanent land use change for impacted areas. The land use change would be from predominantly cattle breeding and fattening activities to rail infrastructure.

During construction, sites including temporary laydown areas, a construction maintenance yard, concrete batching plant and construction camp will directly impact an additional 224.49 ha (refer Table 3-8). However, as these areas are temporary, following decommissioning of infrastructure these sites will be rehabilitated to a state consistent with their original land use.

Landholders of impacted areas will permanently (at least for the planned 90 year life of the NGBR Project) lose the use of the final rail corridor area thus reducing the total area of productive agricultural land available on their properties. These land use impacts are considered to be minor as the majority of NGBR Project realignment will be developed in a corridor consistent with the approved rail corridor for the proposed Alpha Coal Project (64 km) and adjacent the existing Newlands line (57km), therefore minimising further reduction and fragmentation of usable agricultural land for landholders.

The closest residential land use to the NGBR Project realignment, Havilah Homestead, is less than one kilometre (721 m) west of the NGBR Project realignment. This section of the realignment is consistent with the approved Alpha Coal Project and is located approximately 300 m closer to the homestead than the adjacent Newlands line (the Newlands line is approximately 1.22 km east of Havilah Homestead) to accommodate the required trajectory for crossing the Bowen River.

Compensation packages relating to loss of land and reduced accessibility are the subject of ongoing discussion and negotiations with affected landholders. Land acquisition for the NGBR Project will be approached in accordance with a land acquisition protocol. This protocol is discussed further in Volume 2 Appendix B Revised project description.

Table 3-8 Ancillary features impact

Utility	Count	Area ha
Batching plant	1	5.18
Bridge laydown	14	87.09
Construction camp 4	1	10.13
Construction maintenance yard	1	26.07
Temporary ballast stock Pile	1	18.24
Track laydown	13	58.67
Turning circle	19	19.11
	Total	**224.49**

Land use and zoning

The properties immediately affected by the NGBR Project realignment are zoned as rural within the WRC and IRC planning schemes> the NGBR Project realignment is also located within the extractive resource separation area of regulated by the Bowen Shire Planning Scheme. The NGBR Project will also be developed entirely in land designated for rail infrastructure within the proposed GBSDA. As the NGBR Project realignment is for the purpose of the proposed GBSDA South North Rail Precinct.

A summary of the development intent for each zone and an assessment of the NGBR Project's consistency with the objectives of the respective planning instruments are further discussed in Section 14 and Volume 2 Appendix J Revised legislation and approvals.

Land fragmentation

Approximately 20 km of the NGBR Project realignment is to be built within a greenfield rail corridor (10 km at the north of the alignment and 10 km at the south of the alignment). It is also noted that approximately 64 km of the proposed realignment is located within the approved Alpha Coal Project corridor and approximately 57 km is to be constructed alongside the existing Newlands line. Therefore the potential for land fragmentation will be confined to the greenfield corridor. Land fragmentation impacts and management and mitigation measures are discussed further in NGBR Project EIS (Volume 1, Chapter 3 Land use and tenure).

Where appropriate the locations of occupational crossings for the NGBR Project realignment will be located in the same locations as the existing occupational crossings on the Newlands line and those previously approved for the proposed Alpha Coal Project. These measures will limit the number of new occupational crossings required for the NGBR Project realignment, therefore preventing further fragmentation of the local study area. Any modifications to existing access tracks or occupational crossings will be undertaken in consultation with relevant affected landholders.

Further mitigation measures that will be implemented to minimise potential impacts to land use and tenure are provided in the NGBR Project EIS (Volume 1, Chapter 3 Land use and tenure).

Mining tenure and resource areas

The NGBR Project realignment traverses two MLs, four mining lease applications (MLAs), seven EPCs, one EPC application; one EPM, two EPPs and a PPL (refer Section 3.3.2).

The sections of the NGBR Project realignment that cross the above mentioned MLs and MLAs are largely consistent with where the Newlands Line and approved Alpha Coal Project rail line cross these tenements. Therefore, the NGBR Project realignment will not further impact these areas than what is already approved under the proposed Alpha Coal Project EIS. The sections of the NGBR Project realignment to be located within the greenfield corridor (20 km) will only affect approximately 200 m of the south western boundary of ML 10351 and approximately 300 m of western boundary of ML 70436.

Potentially affected MLs, EPC, PPL and EPM holders were informed of the NGBR Project and offered the opportunity to discuss the NGBR Project, as detailed in the NGBR Project EIS. Consultation with affected tenement holders regarding the NGBR Project realignment is ongoing.

Impacts upon the North Queensland Gas Pipline (PPL 89(Gas)) are discussed in Section 3.4.3.

Restricted areas

The NGBR Project realignment does not impact any RAs as it does not traverse any restricted areas.

Agricultural land and strategic cropping land

Development of the NGBR Project realignment has the potential to isolate and sterilise areas of GQAL and potential SCL within the final rail corridor. Approximately 267.2 ha of GQAL and 252.22 ha of potential SCL will become sterilised due to the NGBR Project realignment.

The impacts on GQAL and SCL are considered to be minor as the majority of NGBR Project realignment will be developed consistent with the approved rail corridor for the proposed Alpha Coal Project (64 km) and adjacent the existing Newlands line (57km), therefore preventing further reduction and fragmentation of usable agricultural land.

The potential impacts of the NGBR Project realignment on agricultural land and SCL as well as proposed mitigation and management measures are discussed further in Section 5.

3.4.3 Existing and proposed infrastructure

Road network

A total of eight roads are likely to be intersected by the NGBR Project realignment, of which two are considered major roads (State-controlled roads) three are minor roads (Council owned roads) and three are road reserves. Road crossing treatments will be consistent with those outlined in the NGBR Project EIS.

The potential for construction and operation of the NGBR Project realignment to impact the road network, including access to properties, network performance and road pavement damage, are considered in Section 11.

Stock route network

There are 17 occupational crossings and two national stock route crossings that will be traversed by the NGBR Project realignment. The majority of these crossings will be located either alongside the existing Newlands line (57 km) or consistent with the approved Alpha Coal Project rail corridor (64 km). The realignment will incorporate similar associated crossing treatments as those approved as part of the Alpha Coal Project EIS.

Only a small number of crossings will be located within the greenfield corridor (20 km). Occupational crossings within the greenfield corridor have the potential to constrain the movement of stock on existing crossings, increase the wait times for stock on foot or truck, cause stress to animals and incur delays for landholders trying to transport stock for sale. Potential delay times for vehicular stock movements in the greenfield corridor are expected to be minimal and similarly of a minor nature for movements of stock on foot. Where located within the greenfield corridor the crossings will be provided in accordance with the NGBR Project EIS.

Consultation with Department of Natural Resources and Mines (DNRM) and landholders will continue regarding existing stock routes to be traversed by the NGBR Project realignment. Where deemed necessary, holding yards may be established at either side of stock crossings or underpasses provided where practicable (i.e. subject to formation height considerations, etc).

Rail network

The NGBR Project realignment is situated to the west of the existing Newlands line. The NGBR Project realignment does not intersect any existing or proposed rail lines in the local study area. Therefore no impacts will be caused to the existing or proposed rail network as part of the NGBR Project realignment.

Utilities

The NGBR Project realignment intersects with seven power lines. The potential construction and operation impacts of the NGBR Project realignment on power lines include:

- Impacts upon infrastructure corridor access for maintenance requirements
- Temporary disruption of services to end users of services to end users during construction
- Temporary raising or realignment during construction
- Any disturbance or potential damage to existing underground infrastructure will be temporary, appropriately managed and confined to the proposed construction period.

Additionally, ongoing consultation is being undertaken with the relevant electricity infrastructure owners (Ergon Energy, Powerlink) regarding potential disruptions to their infrastructure, including appropriate and acceptable protection measures and infrastructure agreements.

Water and gas pipelines

The NGBR Project realignment crosses one gas pipeline and one water pipeline namely the North Queensland Gas Pipeline and SunWater Burdekin Moranbah Pipeline.

The North Queensland Gas Pipline (PPL 89(Gas)) is intersected by the NGBR Project realignment at chainage 195-196 km. At this location the Alpha Coal Project rail corridor and the existing Newland line alignments do not intersect the pipeline but continue to run alongside the eastern side of the pipeline to the south. The NGBR Project realignment has reduced the area

impacted by the NGBR Project as the previous NGBR Project alignment crossed the pipeline for approximately 9 km as opposed to the realignment's single crossing.

Potential impacts of the NGBR Project realignment on water and gas infrastructure include construction activities such as bulk earthworks causing damage to underground pipes. Any disturbance or potential damage to existing underground infrastructure will be temporary, appropriately managed and confined to the proposed construction period. For example, a portable frame structure may be constructed at each existing underground pipeline to protect the asset from damage.

Further discussions with the service providers (SunWater and North Queensland Gas Pipeline Pty Ltd) are planned during detailed design to establish the most effective protection, relocation or modification for each service crossing in accordance with AS 4799—Installation of Underground Utility Services and Pipelines within Railway boundaries and in accordance with any relevant legislative requirements (such as the *Petroleum and Gas (Production and Safety) Act 2004*).

3.4.4 Native title

Parts of the NGBR Project realignment are located within the external boundaries of the following registered native title claims detailed in Section 3.3.7:

- Jangga People (QUD6230/98, QC98/10)
- Birriah People (referred to in NGBR Project EIS as Birri) (QUD6244/1998, QC98/12).

Adani have entered into Indigenous Land Use Agreements with the Jangga People and Birriah People regarding the NGBR Project. Adani will continue to engage with the Jangga, and Birriah Peoples.

Further discussions regarding the potential impacts and mitigations measures associated with indigenous cultural heritage are presented in Section 12.

3.5 Conclusion

Construction and operation of the NGBR Project realignment has the potential to directly impact land use and tenure within the local study area, including:

- Land use and accessibility
- Mining tenure and resource areas
- Agricultural land and SCL
- Existing and proposed infrastructure
- Restricted areas
- Native Title.

Operation of the NGBR Project realignment will directly impact approximately 581.34 ha of land across eight properties resulting in a permanent land use change for impacted areas. The land use change would be from predominantly cattle breeding and fattening activities to rail infrastructure. These land use impacts are considered to be minor as the majority of NGBR Project realignment will be developed in a corridor consistent with the approved rail corridor for the proposed Alpha Coal Project (64 km) and adjacent the existing Newlands line (57 km), therefore limiting land use change impacts to the proposed 20 km of greenfield corridor to the north and south of the NGBR Project realignment.

During construction, sites including temporary laydown areas, a construction maintenance yard, concrete batching plant and construction camp will directly impact an additional 224.49 ha. However, as these areas are temporary, following decommissioning of infrastructure these sites will be rehabilitated to a state consistent with their original land use. Ongoing consultation will be undertaken with affected landowners regarding potential loss of land during construction and operation.

The majority of the properties immediately affected by the NGBR Project realignment are zoned rural under the Bowen Shire Planning Scheme 2006 and Belyando Shire Planning Scheme 2008. The NGBR Project realignment will also be developed entirely in land designated for rail infrastructure within the proposed GBSDA. As the NGBR Project realignment is for the purpose of rail infrastructure to support extractive industries, it is considered consistent with the purpose of these areas.

The closest residential land use to the NGBR Project realignment, Havilah Homestead, is less than one kilometre (730 m) west of the NGBR Project realignment. This section of the realignment is consistent with the approved Alpha Coal Project.

A total of eight roads, 17 occupational crossings and two national stock routes are likely to be intersected by the NGBR Project realignment. Where deemed necessary, holding yards either side of stock crossings or corridor underpasses will be incorporated into detailed design. Where appropriate the locations of occupational crossings for the NGBR Project realignment will be located in the same locations as the existing occupational crossings on the Newlands line and those previously approved for the proposed Alpha Coal Project. These measures will limit the number of new occupational crossings required for the NGBR Project realignment, therefore preventing further fragmentation of the local study area.

The NGBR Project realignment traverses a number of existing utilities including one gas pipeline and one water pipeline, and seven power lines. The NGBR Project realignment has reduced the area impacted by the NGBR Project as the previous NGBR Project alignment crossed the pipeline for approximately 9 km as opposed to the single crossing proposed for the NGBR Project realignment. Ongoing consultation will also be undertaken with relevant asset owners and operators regarding potential disruptions to their infrastructure and appropriate protection measures during construction.

Approximately 267.2 ha of GQAL and will 252.22 ha of potential SCL become sterilised due to the NGBR Project realignment. The impacts on GQAL and SCL are considered to be minor as the majority of NGBR Project realignment will be developed within the approved rail corridor for the proposed Alpha Coal Project (64 km) and adjacent the existing Newlands line (57 km), therefore preventing further reduction and fragmentation of usable agricultural land.

Where not identified in this section, the potential construction and operation management and mitigation measures of the NGBR Project realignment on land use are detailed in the NGBR Project EIS.

After the implementation of the proposed management and mitigation measures, residual land use impacts resulting from the NGBR Project realignment are anticipated to be minimal.

The potential cumulative impacts of the NGBR Project realignment on land use and tenure are assessed within Section 13.7.

4. Scenic amenity and lighting

4.1 Purpose of section

This section assesses the potential impacts of the North Galilee Basin Rail Project realignment (NGBR Project realignment) on scenic amenity and lighting. For the purposes of this section, scenic amenity and lighting is assessed using the industry accepted methodology for landscape and visual impact assessment. This includes an overview of the existing visual environment, identification of sensitive receptors and consideration of potential construction and operation impacts. Mitigation and management measures are also proposed for identified impacts.

A detailed existing environment report for scenic amenity and lighting was prepared for the NGBR Project EIS. The key findings of the existing environment report relevant to the NGBR Project realignment are summarised within this section.

The potential impacts of the NGBR Project realignment on fauna due to lighting associated with construction and operation are briefly considered in this section and discussed in detail within Section 6.

4.2 Methodology

4.2.1 Study area

For the purpose of this scenic amenity and lighting assessment, the study area is defined by a visual catchment that extends six kilometres from the nominally 60 m wide NGBR Project realignment footprint.

4.2.2 Legislation and guidelines

Legislation relevant to this scenic amenity and lighting assessment includes:

- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*
- *Native Title Act 1993*
- *Vegetation Management Act 1999*
- *Aboriginal Cultural Heritage Act 2003*
- *Sustainable Planning Act 2009.*

As stated in the NGBR Project EIS there are currently no Australian specific guidelines for the assessment of landscape and visual impacts. This assessment has followed standard industry practice which is to refer to the Guidelines for Landscape and Visual Impact Assessment 2nd edition (the Landscape Institute and the Institute of Environmental Management 2002) published by The Institute of Landscape Architects and the Institute for Environmental Management and Assessment (UK).

Generally, terminology and assessment methods have been derived from Visual Landscape Planning in Western Australia, produced by the Western Australian Planning Commission (Western Australian Planning Commission 2007) and A Manual for Forest Landscape Management (Forest Practice Board of Tasmania 2006) produced by the Forest Practice Board of Tasmania.

4.2.3 Data sources

This assessment of potential scenic amenity and lighting impacts relied on the following data sources:

- Aerial photography (Google Earth Professional Imagery 2013)
- Topographic maps with 10 m contours (DERM, 2010)
- Burdekin Catchment 25 m Digital Elevation Model (DEM) (DNRM 2013)
- Hillshade (Shuttle Radar Topography Mission Shaded Relief)
- Road network maps (DERM 2010)
- Rail network maps (DERM 2007)
- Homestead locations (GA 2007)
- Cadastral maps (DERM 2012)
- Watercourse maps (GA 2007)
- Digital Cadastral Database (DCDB) to delineate protected areas (DERM 2011)
- Local Government Area (LGA) boundaries
- Interim Biogeographic Regionalisation for Australia (IBRA; DEH 2005)
- Alpha Coal Project EIS (Hancock Prospecting Pty Ltd 2010).

4.2.4 Desktop assessment

A desktop review of the data sources outlined in Section 4.2.3 was undertaken to identify potential sensitive receptors within the study area that will have fixed or transient views of the NGBR Project realignment. For this assessment, sensitive visual receptors are considered residents or workers at homesteads, users of transport routes (road and rail) and users of public recreation spaces. For each sensitive receptor, an assessment of the realignment's visual elements was undertaken. A total of seven viewing locations (homesteads) were identified.

Landscape character units (common landscape types) and key landscape features were also identified in the desktop assessment. The study area for the NGBR Project EIS was divided into six landscape character units (LCUs) based on shared common landscape features and visual characteristics. The NGBR Project realignment crosses three LCUs. Categorisation by LCU enables general statements to be made about landscapes and their sensitivity. The elements that contribute to the identification of LCUs include landform, vegetation, surface water, land use, significant features and views of the study area.

4.2.5 Assessment of impacts

Overview

The potential impacts on landscape character are measured by the visual and emotional responses that are felt by sensitive visual receptors towards the combined effects of a development. Impacts are defined as the relative capacity of the landscape to accommodate changes to the physical landscape of the type and scale that would occur as a direct result of the development.

Impact upon landscape was defined in terms of:

- Visual impact, or the extent to which new developments can be seen within a visual catchment
- Impact to landscape character, or the response felt by sensitive visual receptors to the combined effects of the new development.
- The level of the impact is evaluated considering:
- Visual modification
- Visual sensitivity.

Assessment of landscape and visual impacts is necessarily qualitative as both the values of a particular landscape and the extent to which change to landscape character are acceptable are subjective.

Visual modification

Visual modification refers to the extent of change to the landscape including features such as vegetation, built elements and topography. Features of the landscape are considered an integral part of the visual context and therefore important contributors to scenic amenity. The assessment of changes to the landscape included identification of the following:

- The degree of contrast or integration with existing features
- The scale or magnitude of change, including duration
- The nature of the change (adverse or beneficial).

For the purposes of this assessment visual modification was described using the definitions outlined in Table 4-1.

Table 4-1 Visual modification definitions

Level of modification	Definition
Large reduction or improvement	A substantial / obvious change to the landscape due to total loss of, or change to, elements, features or characteristics of the landscape. Would cause a landscape to be permanently changed.
Moderate reduction or improvement	Discernible changes in the landscape due to partial loss of, or change to the elements, features or characteristics of the landscape. May be partly mitigated. The change would be out of scale with the landscape, and at odds with the local pattern and landform.
Small reduction or improvement	Minor loss or alteration to one or more key landscape elements, features, or characteristics, or the introduction of elements that may be visible but may not be uncharacteristic within the existing landscape.
No perceivable reduction or improvement	Almost imperceptible or no change in the view as there is little or no loss of / or change to the elements, features or characteristics of the landscape.

Source: Landscape Institute and Institute for Environmental Management and Assessment (2002)

Visual sensitivity

Visual sensitivity refers to visual receptors and their sensitivity to their visual environment. Generally, sensitivity is derived from a combination of factors including:

- Receptors' interest in the visual environment i.e. high, medium or low interest in their everyday visual environment
- Receptors' duration and viewing opportunity i.e. prolonged, regular viewing opportunities
- Number of viewers and their distance / angle of view from the source of the effect, extent of screening / filtering of the view, where relevant.

For the purpose of this assessment, the terminology in Table 4-2 has been used to describe visual sensitivity.

Table 4-2 Visual sensitivity definitions

Sensitivity	Definition
High	Occupiers of residential properties with long viewing periods, within close proximity to the NGBR Project realignment. Communities that place value upon the landscape and enjoyment of views of their landscape setting.
Medium	Outdoor workers who have a key focus on their work that may also have intermittent views of the NGBR Project realignment. Viewers at outdoor recreation areas located within close proximity but where viewing periods are limited. Occupiers of residential properties with long viewing periods, at a distance from or screened / filtered views of the NGBR Project realignment.
Low	Road users in motor vehicles, trains or on transport routes that are passing through or adjacent to the study area and have short-term/transient views. Viewers indoors at their place of work, or similar.
Negligible	Viewers from locations where there is screening by vegetation or structures where only occasional views are available and viewing times are short.

Source: Landscape Institute and Institute for Environmental Management and Assessment (2002)

For this assessment, the duration of the impact was considered in accordance with the terms outlined in Table 4-3.

Table 4-3 Duration of impact

Duration	Description
Temporary	Impacts lasting one year or less
Short-term	Impacts lasting one to seven years
Medium-term	Impacts lasting seven to fifteen years
Long-term	Impacts lasting fifteen to sixty years
Permanent	Impacts lasting over sixty years

Source: Landscape Institute and Institute for Environmental Management and Assessment (2002)

Significance of impact

The significance of impacts was assessed in accordance with the impact significance criteria provided in Table 4-4.

Table 4-4 Significance of impact

Sensitivity	Landscape Impact			
	Large	Moderate	Small	Negligible
High	Major significance	High significance	Moderate significance	Minor significance
Medium	High significance	Moderate significance	Minor significance	Not significant
Low	Moderate significance	Minor significance	Not significant	Not significant
Negligible	Minor significance	Not significant	Not significant	Not significant

Source: Landscape Institute and Institute for Environmental Management and Assessment (2002)

4.3 Existing environment

4.3.1 Landscape character

The NGBR Project realignment predominantly traverses a rural landscape used for cattle grazing and the mining (Newlands Coal Mine). Distinctive topographical features of the realignment include Bowen River valley, the Leichhardt Range to the north-west, the Cardborough Range to the north-east and the Suttor River floodplain to the south.

The landscape of the NGBR Project realignment is characterised by a combination of flat floodplains dominated by a number of creeks which have reasonably well defined channels and steeper undulating terrain associated with the Leichhardt Range.

The main watercourses crossed by the NGBR Project realignment comprise major waterways (including the Bowen River, Rosella Creek and Suttor River) and several smaller creeks (including Stony Creek, Plum Creek, Kangaroo Creek and Cerito Creek) and ephemeral water bodies.

The alignment traverses the Brigalow Belt bioregion. As such the vegetation is predominantly consistent of brigalow and ironbark. The existing vegetation is likely to serve as a visual buffer minimising potential visual impacts from the nearest sensitive receptors (Hancock Prospecting Pty Ltd 2010).

The presence of vegetation within the study area strongly influences the rural (agricultural) landscape character. There are two distinct vegetation patterns that dominate. The first type displays modification to the natural landscape through open, broad acre paddocks of rough grasses and scattered acacias / eucalypt clumps and woodlands. Native stands of trees are

also evident between paddocks. The second type exhibits dense and open acacia woodlands, with understories of grasses.

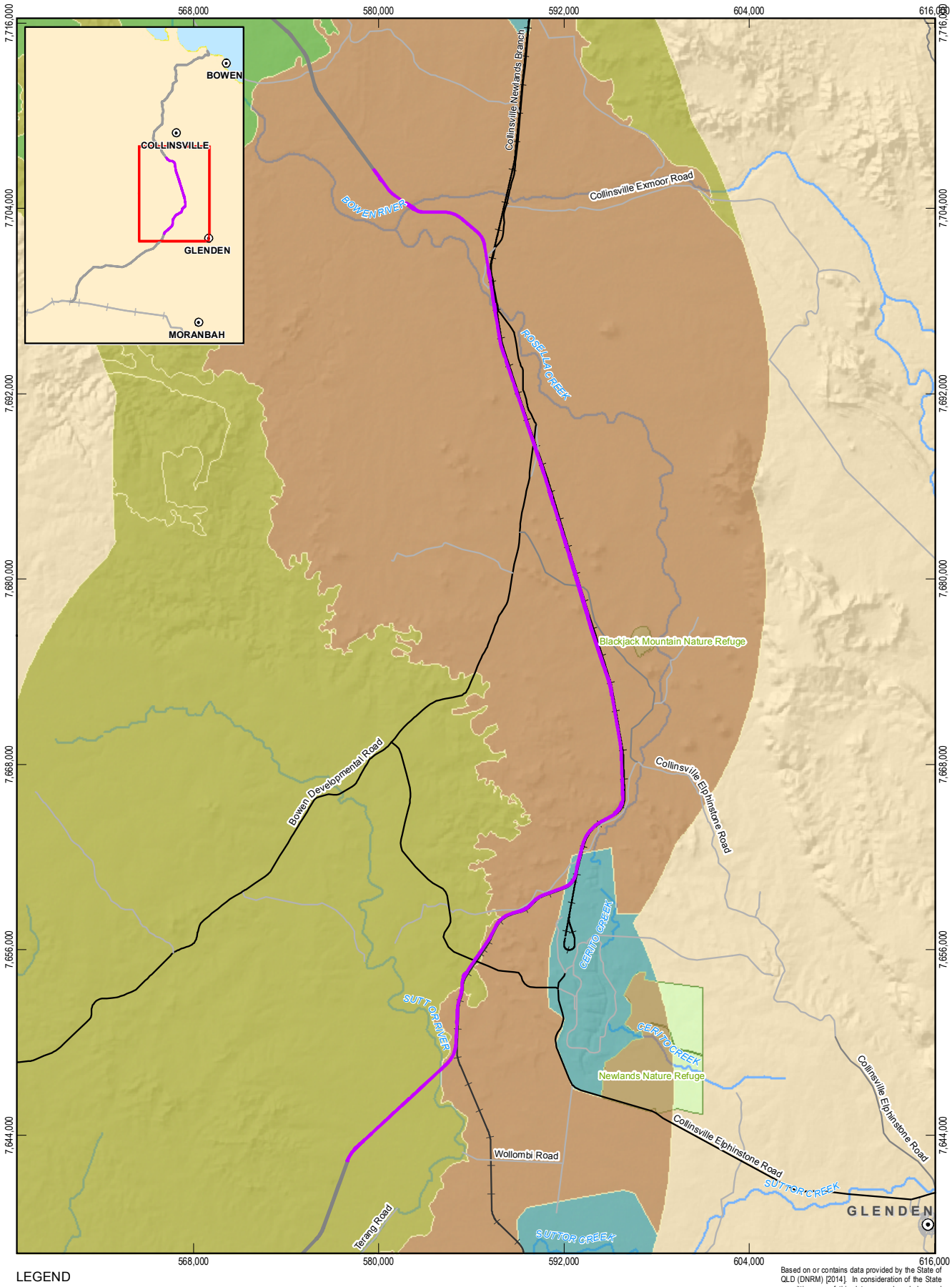
A 56 km section of the realignment is travels parallel to the eastern side of the Newlands rail line. The Newlands rail line is a single track line that services a number of mines in the region.

The three broad LCUs identified for the study area are summarised in Table 4-5 and mapped in Figure 4-1.

Table 4-5 Landscape character units

Landscape character units	Summary
LCU3 – Mining	LCU 3 consists of areas of commercial mining operations. There is one mine located within the five kilometre study area at Collinsville with a number of others in the wider area. The NGBR Project realignment does traverse this LCU and therefore forms part of the NGBR Project realignment visual catchment. The heavily modified areas in this LCU consist of deep extraction areas and large overburden berms of excess soil and materials.
LCU5 – Inland valleys	The area defined as the inland valleys is located between Collinsville in the north to east of the north of Suttor Creek. The NGBR Project realignment is located within this LCU approximately between chainage 128 km and 185 km The topography consists of gentle undulating plains with views to the Wyarra Hills to the west; Leichhardt ranges to the north and Redcliffe tableland to the east.
LCU6 – Upland and mountains	This LCU consists of the Clarke Range and its associated peaks of Wyarra Hills and the Leichhardt Range. The NGBR Project realignment is located within this LCU between chainage 185 km and 206 km The upland and mountains LCU has raised areas with prominent ridges and steep hills with flat areas between them. These areas form part of the Great Dividing Range.

Further detail regarding the LCUs is provided in the NGBR Project EIS Volume 1, Chapter 4 Scenic amenity and lighting.



LEGEND

- Populated centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Nature refuges
- Landscape character units
  - Coastal lowland valleys
  - Inland valleys
  - Mining
  - Upland & mountains

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Landscape character units

Figure 4-1

G:\41\26457\06 GIS\Maps\MXD\1600_ScenicAmenityLighting\41_26457_1617_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Physical Road Network (2010), Nature Refuge (2010); GHD:LCA units (2013). Created by:MS

4.3.2 Viewing locations and sensitive visual receptors

Within the LCUs, seven viewing locations were selected based on a representative sample of potential views of the NGBR Project realignment. These viewing locations included seven homesteads.

The representative sample of viewing locations are shown in Figure 4-2 and summarised in Table 4-6.

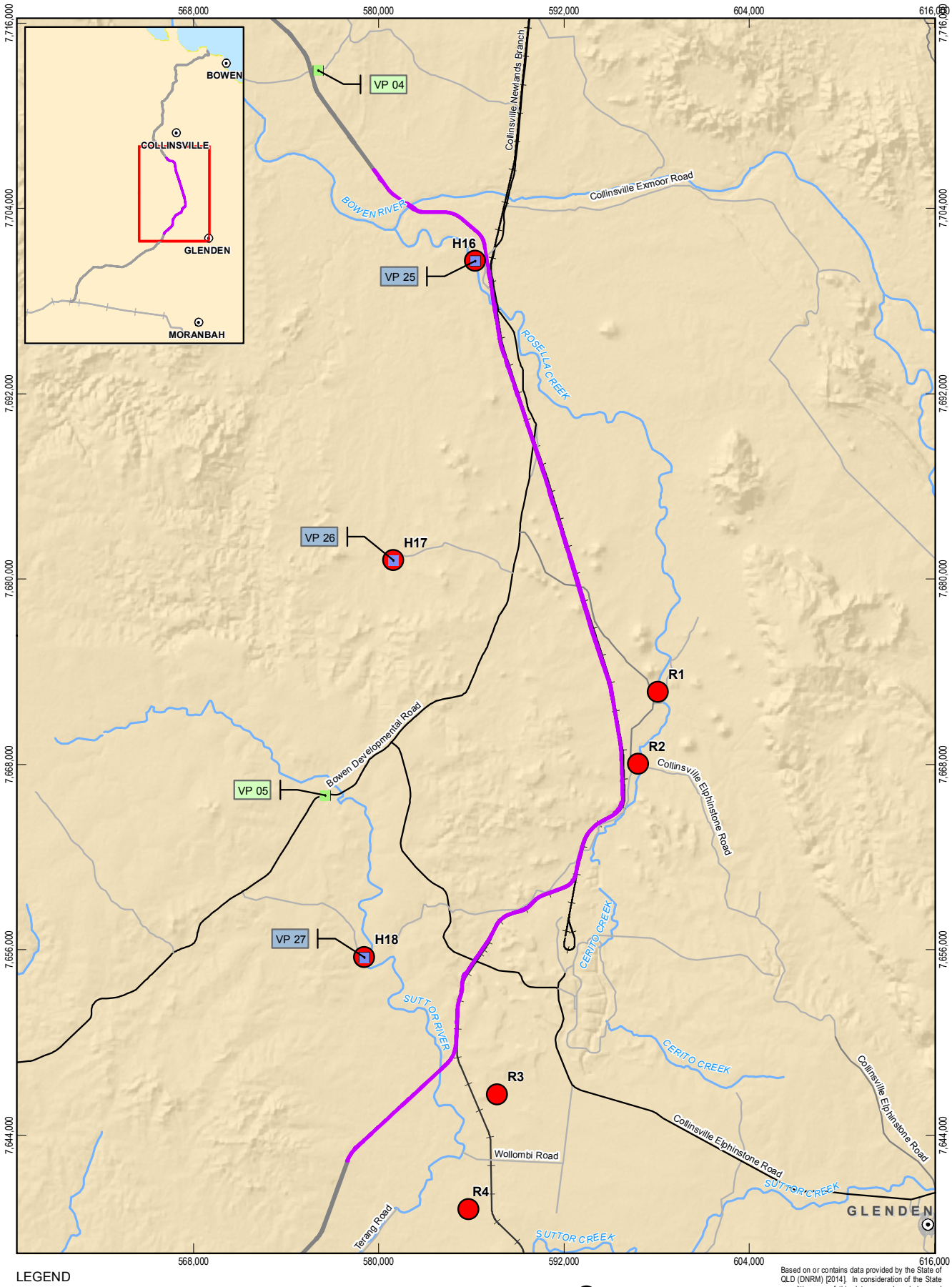
Table 4-6 Viewing locations

Viewing location	Location	Visual context
Viewing location 25 from the NGBR project EIS - Homestead 16	Located on a private road approximately 1.5 km to the south-west of the Bowen Developmental Road entrance on Lot 62 SP195387. Located approximately 721 m from the NGBR project realignment west of chainage 138 km. The homestead is located approximately 300 m east of Rosella Creek.	Views of the NGBR Project realignment will be experienced by the occupants of Homestead 16. The Newlands line is a freight rail line that runs in a north-south direction from North Goonyella to Abbot Point and is located at the entrance to the property. The homestead is located approximately 1.22 km west of the existing Newlands line. As outlined in the Alpha Coal Project EIS, the Bowen Developmental Road runs in close proximity to the dwelling. The existing visual context consists of a predominantly rural landscape with sparse bushland and Rosella Creek located to the north west of the dwelling. Relatively low land, with the dwelling being located on a higher ground level than the NGBR Project realignment. General topography of the surrounding area is flat, particularly towards Rosella Creek. Views from this viewpoint are experienced by: residents occupying the dwelling and will include the nominal 60 m rail corridor and ancillary infrastructure located along a 5 km section including a turning circle and truck laydown at chainage 135 km and 136 km and the bridge laydown at chainage 139 km and 140 km during construction of the NGBR Project realignment.

Viewing location	Location	Visual context
Viewing location 26 from the NGBR Project EIS - Homestead 17	Located on a private road approximately 8.5 km to the west of Bowen Developmental Road on Lot 4 SP171921. Located approximately 10,932 m to the west of the NGBR Project realignment at chainage 157 km.	Views are screened/filtered by topography and woodland to the east and open cleared pasture land to the north. Due to the long distance from the homestead to the NGBR Project realignment it is not expected that the occupants of Homestead 17 will see the proposed NGBR Project realignment and associated infrastructure.
Viewing location 27 from the NGBR project EIS - Homestead 18	Located on a private road approximately 10 km to the east of Bowen Developmental Road and approximately 47 km north-west of Mount Coolon on Lot 1510 SP171920. Located approximately 6,485 m to the west of the existing Newlands line and the proposed NGBR Project realignment at chainage 190 km. Located approximately 170 m west of the Suttor River.	Views are screened/filtered by densely wooded grasslands and riparian vegetation. Due to the long distance from the homestead to the proposed NGBR Project realignment, it is not expected that the occupants of Homestead 18 will see the proposed realignment and associated infrastructure.
Homestead R1	Located approximately 2,938 m east of the NGBR Project realignment at chainage 167 on Lot 2 CP886147. The homestead is situated to the east of Kangaroo Creek.	Existing views are through predominantly grassy open woodland onto the existing Newlands line approximately 3 km west of the homestead. Due to the distance from the homestead to the NGBR Project realignment it is not expected that the occupants of Homestead R1 will see the proposed realignment and associated infrastructure.

Viewing location	Location	Visual context
Homestead R2	Located approximately 1,062 m east of NGBR Project realignment at chainage 172 on Lot 14 SP225054. The homestead is situated to the east of Kangaroo Creek with access onto Collinsville Elphinstone Road. Located approximately 1 km to the east of the existing Newlands line.	Short distance views across predominantly grassy open woodland onto the Collinsville Elphinstone Road and existing Newlands line approximately 1.1 km west of the homestead. The Newlands System is a freight rail line that runs in a north-south direction from North Goonyella to Abbot Point. Collinsville Elphinstone Road borders the homestead to the north east and north west. The homestead is located approximately 1 km to the east of the existing Newlands line. Views will include the nominal 60 m rail corridor and ancillary facilities including turning circles (chainage 171 km and 172 km), track laydown (chainage 174) and bridge laydowns (chainage 172 km and 173 km) during construction of the NGBR Project realignment. Views from this viewpoint will be experienced by residents occupying the dwelling.
Homestead R3	Located approximately 3,764 m south east of NGBR Project realignment at chainage 196 km. The homestead is situated on Lot 689 SP251696 Located approximately 1.5 km to the east of the existing Newlands line. The Suttor Creek Coal Mine is 8.5 km to the south of the homestead and the Newlands Coal Mine is 5.5 km to the north east of the homestead.	Existing views are experienced through predominantly grassy open woodland. The homestead is located approximately 1.5 km to the east of the existing Newlands line. Due to the distance from the homestead to the NGBR Project realignment it is not expected that the occupants of Homestead R3 will see the proposed realignment and associated infrastructure.

Viewing location	Location	Visual context
Homestead R4	Located approximately 7,825 m south east of NGBR Project realignment at chainage 204 km. The homestead is situated on Lot 1 CP905226. Located approximately 1.4 km to the west of the existing Newlands line and 3 km east of the Suttor River. Located approximately 4.5 km north west of the Suttor Creek Coal Mine.	Views are experienced through predominantly grassy open woodland and flood plain. The homestead is located approximately 1.4 km to the west of the existing Newlands line and 4.5 km north west of the Suttor Creek Coal Mine. Due to the distance from the homestead to the NGBR Project realignment it is not expected that the occupants of Homestead R4 will see the proposed realignment and associated infrastructure.



LEGEND

- Populated centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Sensitive Visual Receptor Locations (EIS)
- Road Intersections
- Homesteads
- Sensitive Receptors

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Viewing locations

Figure 4-2

G:\41\26457\06 GIS\Maps\MXD\1600_ScenicAmenityLighting\41_26457_1618_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Physical Road Network (2010); GHD: Viewing locations (2013). Created by:MS

The NGBR Project realignment is likely to be viewed by road users. The location of roads within the local study area and the location of road crossings are discussed further in Section 2 and Section 3. The main road crossings for the NGBR Project realignment include:

- Collinsville Elphinstone Road (approximate crossing at chainage 189 km)
- Bowen Developmental Road (approximate crossing at chainage 150 km).

Tourists or recreational users may also view the NGBR Project realignment while visiting the surrounding National Parks and mountain ranges such as:

- Newlands Nature Refuge (10 km east)
- Blackjack Mountain Nature Refuge (2.2 km west)
- Flagstone Nature Refuge (28 km north east)
- Hells Gate Nature Refuge (26 km north west)
- Sonoma State Forest (27 km north west)
- Leichardt Range to the north west of the Project
- Clark Range to the north east of the Project.

While the construction and operation of the NGBR Project realignment may be visible from these locations, it is unlikely to cause a significant negative impact due to the presence of vegetation and topographical features.

4.3.3 Lighting

The study area has little existing anthropogenic lighting influences, with the exception of areas in the vicinity of existing roads, mines, and rail line.

4.4 Potential impacts and mitigation measures

4.4.1 Construction

Overview

Construction of the NGBR Project realignment will result in changes to the landscape due to vegetation clearing and earthworks. In particular, areas associated with large cut and fill activities will experience the greatest change. Construction will also require the establishment of the rail embankment on which the rail ballast, sleepers and tracks would be placed.

Sensitive receptors

During construction, it is anticipated that the NGBR Project realignment and ancillary infrastructure has the potential to be viewed from a number of sensitive receptors as well as motorists travelling along the two main road crossings of Collinsville Elphinstone Road and Bowen Developmental Road. Views from roads are considered to be minor and short term. The receptor sensitivity at these locations is considered low due to the short-term/transient nature of views experienced by road users. During construction, the magnitude of the change within this view is considered to be moderate due to the nature of the construction activities. Visible elements of construction from roads will include:

- Vegetation clearing
- Earthworks

- Large machinery, trucks and other vehicles
- Fence surrounding construction areas
- Construction camp
- Temporary ballast stockpile area
- Construction maintenance yard
- Bridge and truck laydown areas
- Batching plant.

A total of seven viewing locations were selected based on a representative sample of potential views of the NGBR Project realignment. Using the methodology outlined in Section 4.2, five of the selected viewing locations were assessed to have no perceivable reduction in visual amenity as no elements of the NGBR Project realignment will be visible from those locations during construction. The viewing locations anticipated to experience no visual impacts during construction are summarised in Table 4-7.

Table 4-7 Viewing locations with no anticipated impact during construction

Viewing location	Visible project elements
Viewing location 26 from the NGBR Project EIS Homestead 17	Located approximately 11 km west of the NGBR Project realignment footprint. There will be no views towards the NGBR Project realignment footprint and associated infrastructure during construction due to undulating local topography and the presence of medium height vegetation.
Viewing location 27 from the NGBR Project EIS Homestead 18	Located approximately 6.5 km west of the existing Newlands line and the NGBR Project realignment. Views would be medium in distance and screened/filtered by densely wooded grasslands and riparian vegetation along Suttor River. This viewing point already experiences views of the Newlands line within the landscape screened through Suttor River and is a medium distance to the NGBR Project realignment. Due to the long distance from the homestead to the NGBR Project realignment it is not expected that the occupants of Homestead 18 will see the proposed realignment and associated infrastructure during construction.
Homestead R1	Located approximately 3 km east of existing Newlands line and the NGBR Project realignment at chainage 167. This viewing location will experience short to medium distance views through predominantly grassy open woodland. Due to the distance from the homestead to the NGBR Project realignment, it is not expected that the occupants of Homestead R1 will see the proposed realignment and associated infrastructure during construction.
Homestead R3	Located approximately 3.8 km south east of existing Newlands line and the proposed NGBR Project realignment at chainage 196 km. This Homestead also experiences views of the Newlands line approximately 1.5 km to the south west. Due to the distance from the homestead to the NGBR Project realignment

Viewing location	Visible project elements
	and the screening provided by the Newlands line, it is not expected that the occupants of Homestead R3 will see the proposed realignment and associated infrastructure during construction.
Homestead R4	Located approximately 7.8 km south east of NGBR Project realignment at chainage 204 km, with Suttor River located approximately 3 km north west of the NGBR Project realignment. This viewing point already experiences view of the Newlands line (approximately 1.4 km east of the homestead) and Suttor Creek Coal Mine (approximately 4.5 km south east of the homestead). Due to the distance from the homestead to the NGBR Project realignment, it is not expected that the occupants of Homestead R4 will see the proposed realignment and associated infrastructure during construction of the NGBR Project realignment.

Viewing locations anticipated to experience a minor or moderate degree of visual impact during construction are summarised in Table 4-8. No sensitive receptors are anticipated to experience a high level of visual impact during construction.

The minor and moderate visual impacts on these sensitive receptors are due to their distance (721 and 1,062 m) from the realignment. However, partial screening effects of existing vegetation and the existing visual impacts already experienced from the Newlands rail line moderate the potential for more substantial impacts.

Table 4-8 Viewing locations impacted during construction

Viewing location	Visible project elements	Landscape and visual impact	Significance of impact
Viewing location 25 from the NGBR Project EIS Homestead 16	Homestead 16 is located approximately 730 m west of the NGBR Project realignment footprint. The following elements of the NGBR Project realignment may be visible from this location during the construction stage: • Clearing of vegetation prior to construction • Earthworks, cut and fill operations • Transport of materials by large trucks to the corridor • Turning circle and truck laydown at chainage 135 and 136	Homestead 16 will experience similar visual impacts as discussed in the Alpha Coal Project EIS 2010, including: • Moderately high landscape visual impacts as the corridor within this location is located in a dip. Clearing of vegetation for the corridor will change the existing landscape which is currently dominated by bush and medium height trees. • Moderate visual impact from the	Moderate

Viewing location	Visible project elements	Landscape and visual impact	Significance of impact
	• Bridge laydowns at chainage 139 and 140	dwelling due to the fact that the house is located on a hill. Trains will be mostly visible from the north-west view of the dwelling. This viewing point already experiences views of the Newlands line within the landscape. Regrowth of vegetation surrounding the corridor may mitigate impacts.	
Homestead R2	Located approximately 1.1 km east of existing Newlands line and the NGBR Project realignment at chainage 172. This viewing location will experience short distance views across predominantly grassy open woodland and views from this viewpoint will be experienced by: residents occupying the dwelling. Views will include the 60 m nominal rail corridor and ancillary infrastructure including turning circles (chainage 171 km and 172 km), the track laydown (chainage 174) and bridge laydowns (chainage 172 km and 173 km) during construction of the NGBR Project realignment.	This viewing point already experiences views of the Newlands line within the landscape and is a short distance to the NGBR Project realignment. The NGBR Project realignment will be on the other side of the Newlands line from the homestead. The Newlands line will therefore offers some screening of the proposed NGBR Project realignment. Regrowth of vegetation surrounding the corridor may mitigate impacts.	Moderate

Lighting

Night works during construction of the NGBR Project realignment have the potential to impact sensitive receptors due to light spill from construction lighting. Construction activities will aim to minimise the visual impact on sensitive receptors (including light sensitive fauna) through the mitigation and management measures outlined in the NGBR Project EIS Volume 1, Chapter 4

Scenic amenity and lighting. These measures include using directional lighting during night works to minimise light spill and minimising vegetation clearing to preserve natural screening of construction works.

Earthworks

Construction of the NGBR Project realignment will require earthworks to achieve a suitable corridor width and gradient. Earthworks will disturb vegetation and exposes large areas of soil, contributing to potential visual impacts during construction. The section of the NGBR Project realignment in proximity to Homestead 16 will be approximately 35 per cent cut and 65 per cent fill. The maximum depth of cut will be approximately three metres while the maximum depth of fill will be approximately six metres.

The section of the NGBR Project realignment in proximity to Homestead R2 will also be approximately 35 per cent cut and 65 per cent fill. The maximum depth of cut will be approximately six metres while the maximum depth of fill will be approximately six metres.

4.4.2 Operation

During operation, permanent changes would be experienced at major cut and fill locations along the NGBR Project realignment footprint as well as areas where the rail embankment exceeds approximately five metres in height above existing ground surface. Such a change to visual amenity will continue for the duration of operations and is considered to be a permanent impact over this period.

Sensitive receptors

During operation, bridge structures over major waterways, cut and fill locations, the rail embankment, and freight trains carrying coal all have the potential to impact scenic amenity and lighting for sensitive receptors.

The viewing locations considered to have no perceivable reduction in visual quality during operation of the NGBR Project realignment are summarised in Table 4-9. Operation of the NGBR Project realignment would result in permanent changes in the visual amenity for these sensitive receptors however the sensitivity of their view is considered low due to the short-term/transient nature of views by road users or limited to no views from homesteads.

Table 4-9 Viewing locations with no anticipated impact during operation

Viewing location	Visible project elements
Viewing location 26 Homestead 17	Located approximately 11 km west of the NGBR Project realignment footprint. There will be no views towards the NGBR Project realignment footprint during operation due to undulating local topography and the presence of medium height vegetation.
Viewing location 27 Homestead 18	Located approximately 6.5 km west of the existing Newlands line and the proposed NGBR Project realignment. Views would be medium in distance and screened/filtered by densely wooded grasslands and riparian vegetation along Suttor River. This viewing point already experiences views of the Newlands line within the landscape screened through Suttor River and is a medium distance to the NGBR Project realignment. It is therefore assessed that the NGBR Project realignment will have no significant impact from

Viewing location	Visible project elements
	this location.
Homestead R1	Located approximately 3 km east of the existing Newlands line and the NGBR Project realignment at chainage 167. This viewing location will experience medium distance views through predominantly grassy open woodland. Due to the distance from the homestead to the NGBR Project realignment, it is not expected that the occupants of Homestead R1 will see the proposed realignment and associated infrastructure during construction.
Homestead R3	Located approximately 3.8 km south east of existing Newlands line and the proposed NGBR Project realignment. This viewing location experiences medium distance views of the proposed NGBR Project realignment through predominantly grassy open woodland. This viewing point already experiences views of the Newlands line within the landscape (approximately 1.5 km west of the homestead). The Newlands line will therefore offer some screening of the proposed NGBR Project realignment. It is therefore assessed that the NGBR Project realignment will have no significant impact from this location.
Homestead R4	Located approximately 7.9 km south east of the NGBR Project realignment footprint. There will be limited views towards the NGBR Project realignment during operation due to distance, local undulating topography and the presence of dense medium height vegetation in close proximity to the homestead. It is therefore assessed that the NGBR Project realignment will have a no significant impact during operation from this location.

Viewing locations anticipated to experience a minor or moderate level of visual impact during operation of the NGBR Project realignment are summarised in Table 4-10. No sensitive receptors are anticipated to have a high level of visual impact during operation.

Table 4-10 Viewing locations impacted during operation

Viewing location	Visible project elements	Landscape and visual impact	Significance of impact
Viewing location 25 Homestead 16	There will be short distance views of the NGBR Project realignment from this homestead during operation. The following elements of the NGBR Project realignment may be visible from this location during the operations:	As identified in the Alpha Coal project EIS 2010 the impact on the landscape in this location is likely to be moderately high as the corridor within this location is located in a dip. Clearing of vegetation for the corridor will change the existing landscape which is	Moderate

Viewing location	Visible project elements	Landscape and visual impact	Significance of impact
	• Constructed railway line • Fence surrounding the corridor • Coal trains passing the location • Bridge structures over major waterways • Cut and fill locations • Rail embankment	currently dominated by bush and medium height trees. The visual impact from the dwelling is likely to be moderate. This is primarily due to the fact that the house is located on a hill. Trains will be mostly visible from the north east and south east view of the dwelling. This viewing point already experiences views of the Newlands line within the landscape it is therefore assessed that the NGBR Project realignment will have a moderate visual impact from this location. Regrowth of vegetation surrounding the corridor may mitigate this impact.	
Homestead R2	There will be short distance views of the NGBR Project realignment from this homestead during operations. The following elements of the NGBR Project realignment may be visible from this location during the operation stage: • Constructed railway line • Fence surrounding the corridor • Coal trains passing the location • Rail embankment.	This viewing location will experience short distance views across predominantly grassy open woodland and views from this viewpoint will be experienced by residents occupying the dwelling. This viewing point already experiences views of the Newlands line within the landscape and is a short distance to the NGBR Project realignment. The NGBR Project realignment will be on the other side of the Newlands line from the homestead. The Newlands line will therefore offer some screening of the proposed NGBR Project realignment. It is therefore assessed that the NGBR Project realignment will have a moderate visual impact during operation from this location.	Moderate

Viewing location	Visible project elements	Landscape and visual impact	Significance of impact
		Regrowth of vegetation surrounding the corridor may mitigate this impact.	

4.5 Conclusion

During construction, changes to the landscape within the NGBR Project realignment footprint will occur due to vegetation clearing and earthworks. In particular, areas associated with large cut and fill activities will experience the greatest change. Construction would also require the establishment of the rail embankment on which the rail ballast, sleepers and tracks would be placed. During operation, changes to landscape character due to cut and fill activities and the rail embankment would be permanent. While the changes would be permanent, they are not considered significant in the context of the broader local area due the low lying topography and overall lack of significant landscape elements.

A total of seven homestead viewing locations were selected to assess the potential visual impacts of the NGBR Project realignment based on a representative sample of potential views. During construction, the NGBR Project realignment footprint and ancillary infrastructure will be viewed from a number sensitive receptors such as homesteads and motorists travelling along adjacent roads. The majority of views from homesteads are only available from a long distance and typically incorporate some degree of vegetative or topographic screening.

During operation, bridge structures over major waterways, cut and fill locations, the rail embankment, and freight trains carrying coal all have the potential to impact scenic amenity for sensitive receptors. However, no sensitive receptors are anticipated to have a high level of visual impact during operation due to the distance of the NGBR Project realignment to sensitive receptors.

The majority of sensitive receptors within the study area would experience a negligible level of visual impact as a result of the NGBR Project realignment, during construction and operation. In summary, two sensitive receptors would experience a moderate visual impact, being Homestead 16 and Homestead R2.

The scenic amenity and lighting mitigation measures outlined in the NGBR Project EIS Volume 1 Chapter 4 Scenic amenity and lighting will be implemented during construction and operation to minimise the potential visual impacts on these sensitive receptors.

5. Topography, geology, soils and land contamination

5.1 Purpose of section

The purpose of this section is to identify and assess the potential impacts of the NGBR Project realignment on topography, geology, soils and land contamination.

The section is based upon the detailed existing environment report provided in NGBR Project EIS Volume 1 Chapter 5 Topography, geology, soils and land contamination, and provides the key findings in relation to the areas of the NGBR Project realignment. Calculations are provided that quantify areas of good quality agricultural land and strategic cropping land intersected by the NGBR Project realignment.

5.2 Methodology

5.2.1 Study area

The study area for the identification and description of geology and soils, and the quantification of agricultural land, was the NGBR Project realignment footprint which includes the nominal 60 m final rail corridor and all ancillary infrastructure.

5.2.2 Data sources

In addition to the data sources referred to in the NGBR Project EIS, the following information was relied upon to inform this section.

- NGBR Project EIS Volume 1 Chapter 5 Topography, geology, soils and land contamination
- Adani NGBR O9R1 Draft Realignment Preliminary Geotechnical Desktop Report (4DGeotechnics 2014)
- Alpha Coal Project Environmental Impact Statement Volume 3 Railway Corridor (Hancock Prospecting 2010).

5.2.3 Legislation and guidelines

Legislation, policy and guidelines relevant to this section are stated in Volume 2 Appendix J Revised legislation and approvals, noting the following recent amendments:

- The *Strategic Cropping Land Act 2011* (SCL Act) will be repealed on commencement of the *Regional Planning Interests Bill 2013*.
- Since the NGBR Project EIS was submitted, the Queensland Government has developed a single State Planning Policy (SPP) that replaces the multiple policies that were previously in place. The SPP now contains policies regarding state interests in land use planning and development under five broad themes. The following State interests are of relevance to topography, geology, soils and land contamination:
    - Agriculture (replaced State Planning Policy 1/92 Development and the Conservation of Agricultural Land, and State Planning Policy 1/12: Protection of Queensland's Strategic Cropping Land)

- Water quality - aspects relating to acid sulfate soils (replaced State Planning Policy 2/02: Planning and Managing Development involving Acid Sulfate Soils).

An assessment of legislation relevant to the NGBR Project realignment that has come into effect since publication of the NGBR Project EIS is included in Section 14.

5.2.4 Desktop assessment

Information consistent with that utilised for NGBR Project EIS, including topographic maps, aerial photography and contour data and geology maps and associated reports were used in the desktop assessment to characterise the main topographic features and understand the relationship between soils and geology of the NGBR Project realignment.

The assessment of geological properties related to erosion risk and potential impacts upon stormwater quality from the NGBR Project realignment has used the high/low risk rating employed in the NGBR Project EIS Volume 1, Chapter 5 Topography, geology, soils and land contamination.

5.3 Existing environment

5.3.1 Topography

The NGBR Project realignment extends through six very low relief, broad to very broad alluvial plains comprised of active floodplains, low relief alluvial terrace and upper terrace floodplains, separated by low to moderate relief hills and colluvial slopes (4DGeotechnics 2014). Elevations within the NGBR Project realignment range from 120 m at the Bowen River, to 310 m along the Leichhardt Range south of chainage 190 km.

Topographical features within the NGBR Project realignment include the Leichhardt Range and the Suttor River Floodplain in the south along with the Bowen River Valley in the north. It crosses major watercourses including the Bowen River in the north and the Suttor River in the south as well as a number of other watercourses including Rosella Creek, Plum Creek and Stony Creek.

Topographic and landform features are shown on Figure 5-1.

5.3.2 Geology

Overview

The northern section of the NGBR Project realignment is mapped in the 1:250,000 Bowen Sheet SF/55-3 regional geological map, while the southern section is mapped on the Bywerwen Sheet 8455 of the Mount Coolon Sheet SF/557 (1:100,000).

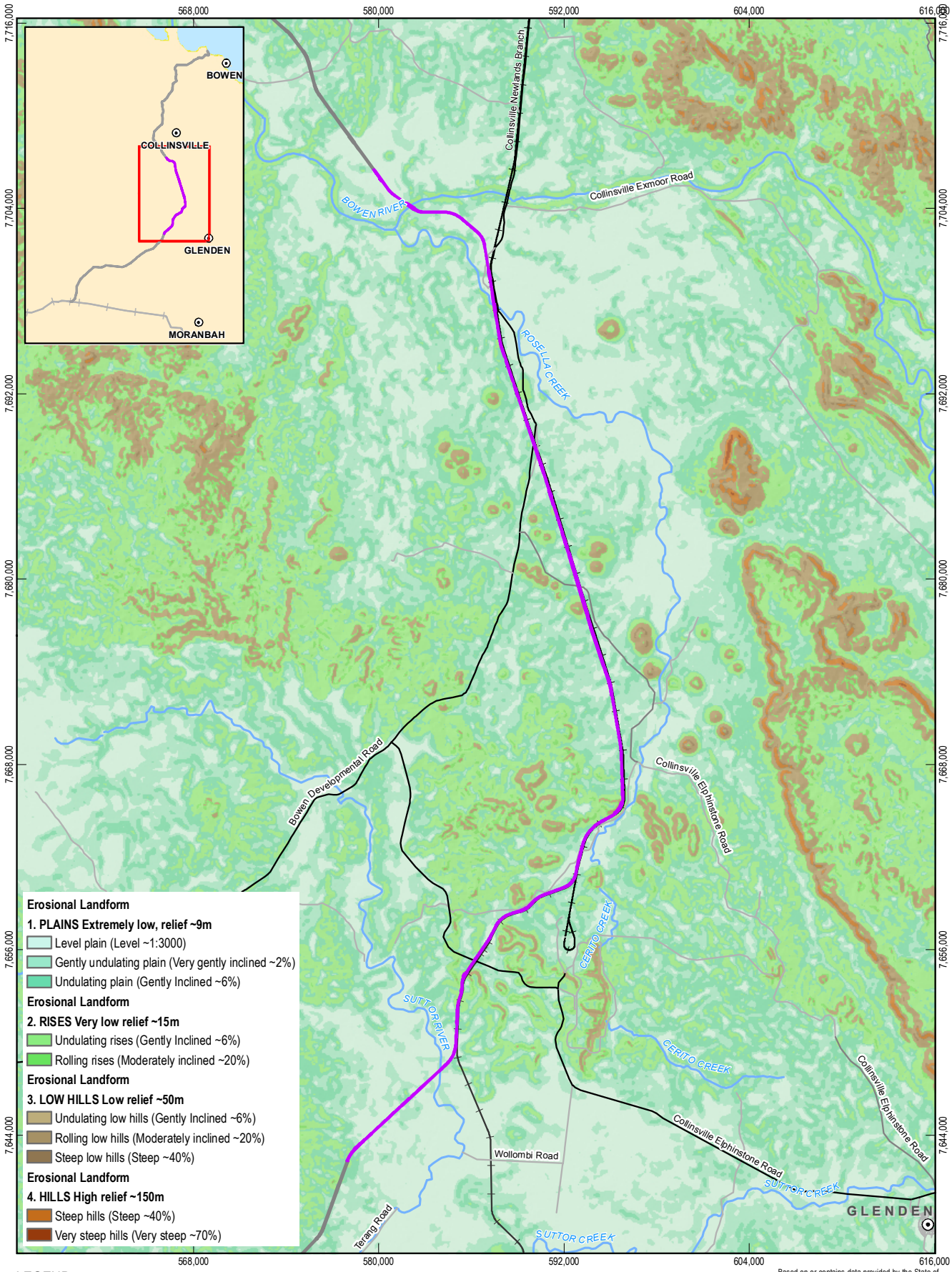
The geology of the NGBR Project realignment is generally consistent with that previously described for chainage 128.1 km to chainage 198.5 km in the NGBR Project EIS as the geological region ‘Bowen River to Verbena Creek’. A key difference is that that the NGBR Project realignment extends over an area of the Fort Cooper Coal Measures (map code Pwt) and does not traverse the BIuegrass Creek Granite (map code CPgb). Geological units within the NGBR Project realignment are identified in Table 5-1.

The underlying geology south of the Bowen River in the north of the NGBR Project realignment is Late Permian, predominantly containing sedimentary rock formations including the Black Creek marine sedimentary rocks, and the Blackwater Group which includes various coal measures. South of Rosella Creek, the geology is interspersed with Tertiary basalts, including

along the Leichhardt Range, and locally as plugs throughout the alignment, particularly near Plum Creek. Basaltic rocks have weathered into expansive clays, and sedimentary rocks to sand or sandy clay dominated soils.

Fossil presence

The NGBR Project realignment traverses Late Permian sedimentary geological units in the north (predominantly between chainage 128 km and 175 km), which include sandstone, shale and limestone. Mapped units include the Blackwater Group (map symbol Puw), which is associated with plant fossils, with smaller areas of the Black Creek Group, Blenheim Sub-group, (map symbol Pue), which is associated with marine fossils.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Topography and landform

Figure 5-1

G:\41\26457\06 GIS\Maps\MXD\0400_Geology_Soils\41_26457_0436_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

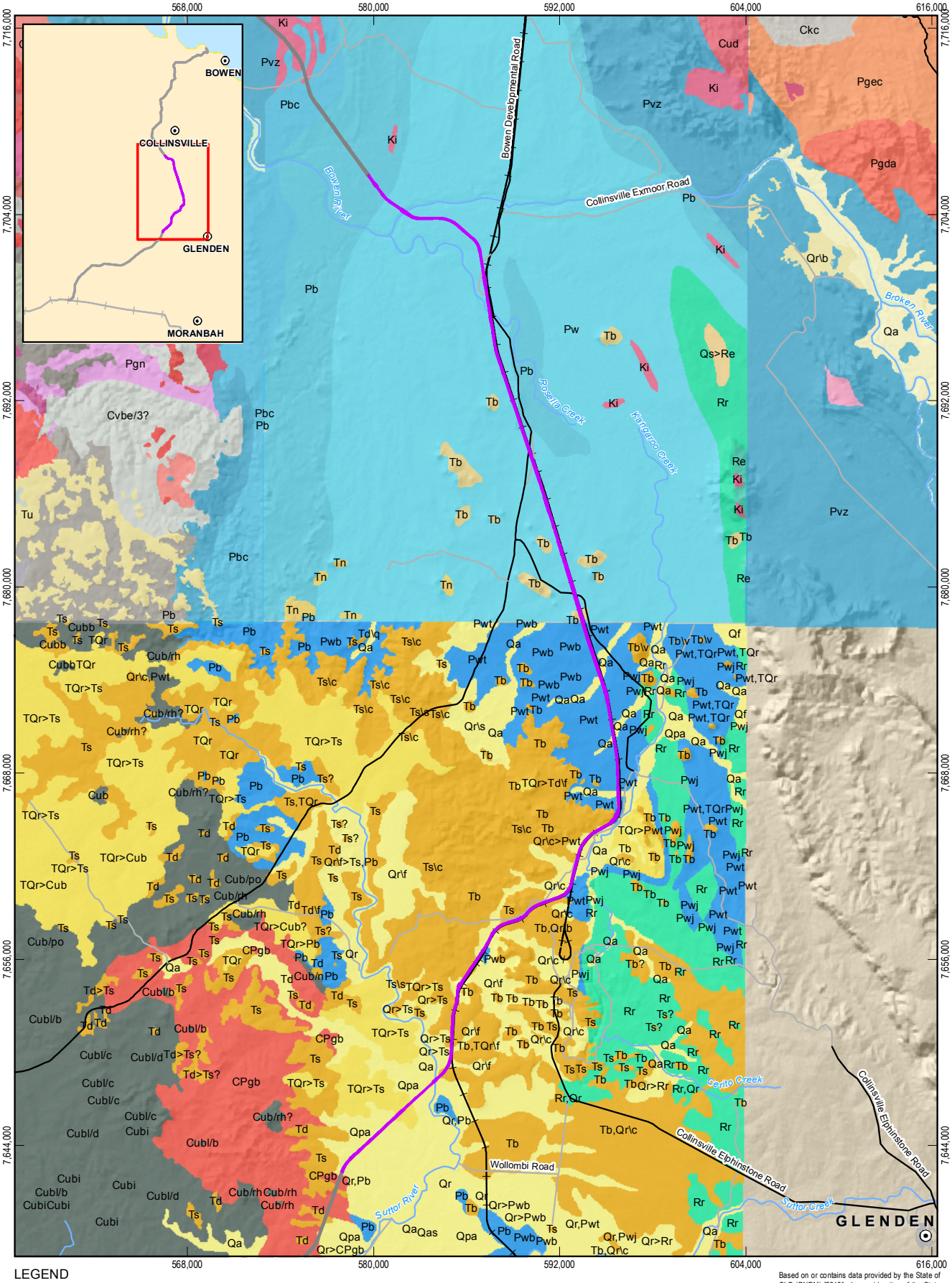
© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Spot heights, Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Physical Road Network (2010), Swift NRM/GHD: Erosional landform (2012). Created by:MS

Table 5-1 Mapped geology within the NGBR Project realignment

Age	Map symbol	Formation name	Dominant rock type	Lithology summary	Potential stability risk
Quaternary	Qa		Alluvium	Clay, silt, sand, gravel, floodplain alluvium	High
	Qr\c>Pwt	Overlying Fort Cooper Coal Measures	Colluvium	Clay and silt, minor sand; colluvial and residual deposits	High
	Qr\f		Colluvium	Sandy red soil, minor gravel; residual soil, colluvium	High
	Qr,Pb	Back Creek Group	Colluvium	Clay, silt, sand, gravel and soil; colluvial and residual deposits	High
Quaternary (Pleistocene)	Qpa		Alluvium	Clay, silt, sand, gravel; flood-plain alluvium on high terraces	High
Late Tertiary – Quaternary	TQr>Tu	Overlying Suttor Formation	Colluvium	Clay, silt, sand, gravel and soil; colluvial and residual deposits (generally on older land surfaces)	High
Tertiary	Qr\b		Basalt	Mostly olivine basalt flows and some plugs; some areas of nephelinite, basanite etc	Low
	Tb	Suttor Formation	Basalt	Mostly olivine basalt flows and some plugs; some areas of nephelinite, basanite etc	Low
	Tb,TQr\f		Basalt	Mostly olivine basalt flows and some plugs; some areas of nephelinite, basanite etc	High
	Tb,Qr\b		Basalt	Mostly olivine basalt flows and some plugs; some areas of nephelinite, basanite etc	High
	Tu\s	Suttor Formation	Arenite	Fluvial and lacustrine sediments (sandy)	High
Late Permian	Pue	Black Creek Group, Blenheim Sub-Group	Sedimentary	Siltstone, pebbly sublabile sandstone, fossiliferous calcareous siltstone and sandstone, coquinite, limestone. Marine fossils.	High
	Puw	Blackwater Group	Sedimentary	Cross-bedded well sorted lithic sandstone, siltstone, quartzose sandstone; carbonaceous shale with some coal seams, pebble and cobble conglomerate, dolomitic and calcareous sandstone, tuff. Plant fossils.	Low

Age	Map symbol	Formation name	Dominant rock type	Lithology summary	Potential stability risk
Late Permian	Pwb	Moranbah Coal Measures	Arenite-Mudrock	Labile sandstone, siltstone, mudstone, coal, conglomerate in the east	Low
	Pwt	Fort Cooper Coal Measures	Sedimentary	Lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff, tuffaceous (cherty) mudstone	High



LEGEND

- Population centres
- Main Road
- Local Road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Refer to Sheet 2 for Geology legend

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Mapped geology

Figure 5-2
Sheet 1

G:\41\26457\06 GIS\Maps\MXD\0400_Geology_Soils\41_26457_0438_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, DEEDI, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Population centres, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010); DEEDI: 100k Geology, 250k Geology (2011). Created by:MS

WATER BODIES
Water body (unspecified)
HOLOCENE
Qha-QLD
Qhh-QLD
QUATERNARY
Qa-QLD
Qcr-QLD
Qct-QLD
Qr-QLD
Qrlb-QLD
Qrls-QLD
LATE TERTIARY - QUATERNARY
TQa-QLD
TQr-QLD
TERTIARY
Suttor Formation
Suttor Formation?
Tb-QLD
To-8557
To?-8557
Ts-QLD
CRETACEOUS
Griman Creek Formation
CRETACEOUS (Intrusive)
Hecate Granite/1
Hecate Granite/2
Hecate Granite/3
Hecate Granite/4
Hecate Granite/5
Hecate Granite/6
Hecate Granite/7
EARLY CRETACEOUS? (Intrusive)
Summer Hill Gabbro
Summer Hill Gabbro?
EARLY CRETACEOUS (Intrusive)
Ben Lomond Granite
Blackwall Quartz Diorite
Devlins Pocket Quartz Diorite
Elliot River Granodiorite
Flagstaff Hill Granite
Kg/1-8557
Kg/1?-8557
Kg/2-8557
Kg/3-8557
Kg/4-8557
Kg/5-8557
Kg/6-8557
Kg/7-8557
Kg/b1-NCON
Kg/b2-NCON
Kg/b3-NCON
Kg/d?-NCON
Kg/f-8557
Kg/x-8557
Kgd/x-8557
Kgd/y-8557
Kgd/z-8557
Monte Christo Granite
Mount Abbot Igneous Complex/1
Mount Abbot Igneous Complex/2
Mount Pring Granite
Mount Roundback Granodiorite
Pretty Bend Quartz Monzodiorite
Pretty Bend Quartz Monzodiorite?
Selina Creek Granodiorite
Selina Creek Granodiorite?
Seventy Creek Granite
Seventy Creek Granite/f
Ward Creek Granodiorite
MIDDLE TRIASSIC (Intrusive)
Gloucester Granite
EARLY TRIASSIC? - MIDDLE TRIASSIC? (Intrusive)
Passage Islet Granite
PERMIAN
Mount Wickham Rhyolite
Mount Wickham Rhyolite?
PERMIAN (Intrusive)
CPn-8555
Mamelon Quartz Monzodiorite
Thunderbolt Granite
EARLY PERMIAN
Carmila beds
Carmila beds?
Collinsville Coal Measures
Karungle Volcanics
Lizzie Creek Volcanic Group
Lizzie Creek Volcanic Group/f
Lizzie Creek Volcanic Group/f?
Lizzie Creek Volcanic Group/s
Lizzie Creek Volcanic Group?
Lizzie Creek Volcanics/a
Lizzie Creek Volcanics/r
Lizzie Creek Volcanics/r?
Mount Aberdeen Volcanics
EARLY PERMIAN (Intrusive)
Adaluma Tonalite
Alick Creek Tonalite
Beckford Granodiorite
Dartmoor Granodiorite
East Creek Tonalite
Easter Granodiorite
Ernest Creek Granodiorite
Expedition Pass Granite
Fence Creek Granodiorite
First Pocket Igneous Complex/1
First Pocket Igneous Complex/2
Goldbeetle Creek Granodiorite
Grant Creek Granite
Highlanders Bonnet Granodiorite
Humbug Creek Granite
Lady Norman Granodiorite
Marlborough Pocket Granodiorite
Massey Granite
Mount Cauley Granite
Nostone Creek Granodiorite
Nostone Creek Granodiorite?
Pbr-8557
Perch Creek Granodiorite
Pg-8556
Pg/d-NCON
Pg/l?-NCON
Pgd-8556
Pickhandle Tonalite
Pla Creek Granodiorite
Salitros Granite
Scrubby Top Granite
Starvation Creek Complex
Turn Back Granite
Viola Creek Granodiorite
LATE CARBONIFEROUS? - EARLY PERMIAN? (Intrusive)
Glenmore Creek Granodiorite
LATE CARBONIFEROUS - EARLY PERMIAN
Arundel Rhyolite/1
Arundel Rhyolite/2
Collins Creek Rhyolite
Collins Creek Rhyolite?
McGregors Bonnet Volcanics
McGregors Bonnet Volcanics?
The Tableland Volcanics
The Tableland Volcanics?
LATE CARBONIFEROUS - EARLY PERMIAN (Intrusive)
Billy-can Creek Granite
Binbee Quartz Monzodiorite
Black Pinnacle Igneous Complex/1
Black Pinnacle Igneous Complex/2
Black Pinnacle Igneous Complex/3?
Black Pinnacle Igneous Complex/v1
Black Pinnacle Igneous Complex/v2
Bluestone Creek Granodiorite
Brawl Creek Granite
Brown Creek Rhyolite
CPd/b1-NCON
CPg-QLD
CPg/1-8356
CPg/10-8356
CPg/2-8356
CPg/2?-8356
CPg/8-8356
CPg/9-8356
CPg/b-NCON
CPg/b1-NCON
CPg/b2-NCON
CPg/b2?-NCON
CPg/b3-NCON
CPg/b4-NCON
CPg/b5-NCON
CPg/b6-NCON
CPg/b7-NCON
CPg/b8-NCON
CPg/b9-NCON
CPg/h-NCON
CPg/i-Leichhardt Range
CPg/l?-NCON
CPg/mg-NCON
CPg/mg?-NCON
CPg/w1-NCON
CPg/w2-NCON
CPg/w3-NCON
CPg/w4-NCON
CPg/w5-NCON
CPg/w5?-NCON
CPg/w6-NCON
CPg/w7-NCON
CPg/y2-NCON
CPgaa-NCON
CPgl-NCON
CPm-8356
CPr/1-8356
CPr/1?-8356
CPr/2-8356
CPr/2?-8356
CPr/3-8356
CPr/3?-8356
CPr/4-DRUM
CPr/4?-DRUM
CPx-8356
Charlie Creek Microgranite
Dozer Creek Granite
Dozer Creek Granite?
Eight Mile Station Granite
Euri Creek Granodiorite
Glen Alpine Granite
Glen Easter Leucogranite
Glen Easter Leucogranite/1
Glendon Granodiorite
Glenella Creek Granite
Glenore Road Quartz Diorite
Glenroy Creek Granodiorite
Greentop Granite
Isabella Creek Rhyolite?
Joe-De-Little Granite
Joe-De-Little Granite/m
Joe-De-Little Granite/m?
Joe-De-Little Granite?
Lagoon Creek Granite
Leichhardt Range Granite
Leichhardt Range Granite?
Lionel Diggings Granite
Molongle Creek Granite
Morer Granite
Mount Mackenzie Granite
Mount Mackenzie Granite?
Mount Magnus Granite
Oaky Creek Monzogranite
Panhandle Granite
Peak John Well Granite/a
Peak John Well Granite/b
Peak John Well Granite/c
Peak John Well Granite/d
Peak John Well Granite/e
Percy Douglas Tonalite
Pine Creek Granite
Pine Creek Granite?
Red Hill Creek Granodiorite
Roscow Granite/1
Roscow Granite/2
Roscow Granite/3
Shannon Vale Gabbro
Smoko Creek Granite
Smoko Creek Granite?
Springlands Gabbro
Stony Creek Granite
Stuart Pocket Granite
Sunbeam Granodiorite
Sundown Creek Diorite
Swans Lagoon Granite
Teatree Creek Gabbro
Terry Creek Quartz Monzodiorite
The Three Brothers Gabbro
Upper Rosetta Creek Granite
Upper Rosetta Creek Granite/a
Upper Rosetta Creek Granite?
Wynne Creek Diorite
CARBONIFEROUS - PERMIAN (Intrusive)
CPd-NCON
CPd?-NCON
CPm?-NCON
CPp-NCON
CPp?-NCON
Lulu Pocket Igneous Complex/2
Lulu Pocket Igneous Complex/3
CARBONIFEROUS - EARLY PERMIAN (Intrusive)
CPg-DRUM/BULG
CPg?-QLD
LATE CARBONIFEROUS
Bobby Dazzler Rhyolite
Bobby Dazzler Rhyolite?
Bulgonunna Volcanic Group/10
Bulgonunna Volcanic Group/10?
Bulgonunna Volcanic Group/12
Bulgonunna Volcanic Group/13
Bulgonunna Volcanic Group/14
Bulgonunna Volcanic Group/14?
Bulgonunna Volcanic Group/15
Bulgonunna Volcanic Group/15?
Bulgonunna Volcanic Group/17
Bulgonunna Volcanic Group/18
Bulgonunna Volcanic Group/19
Bulgonunna Volcanic Group/20
Bulgonunna Volcanic Group/21
Bulgonunna Volcanic Group/21?
Bulgonunna Volcanic Group/22
Bulgonunna Volcanic Group/23
Bulgonunna Volcanic Group/27
Bulgonunna Volcanic Group/27?
Bulgonunna Volcanic Group/28
Bulgonunna Volcanic Group/7
Bulgonunna Volcanic Group/7?
Bulgonunna Volcanic Group/8
Bulgonunna Volcanic Group/8?
Bulgonunna Volcanic Group/rh?
Bulgonunna Volcanic Group/s
Bulgonunna Volcanic Group/s?
Conway Volcanics
Conway Volcanics?
Earlscliffe Dacite/1
Earlscliffe Dacite/2?
Earlscliffe Dacite/3
Earlscliffe Dacite/3?
Pyramid Rhyolite
Pyramid Rhyolite?
Smedley Dacite
Smedley Dacite?
Whitestone Creek Dacite
LATE CARBONIFEROUS (Intrusive)
Amelia Creek Tonalite
Birds Nest Granodiorite
Cg-NCON
Cg/l1-NCON
House and Kitchen Granite
McGains Gossan Granodiorite
McGains Gossan Granodiorite?
Milwarra Quartz Diorite
Milwarra Quartz Diorite?
Mount Crompton Granodiorite
Mount Hector Granite
Mount Nutt Granite
Tommy Roundback Granodiorite
Tommy Roundback Granodiorite?
CARBONIFEROUS
Locharwood Rhyolite
Locharwood Rhyolite?
Saint Anns Formation/b
Scartwater Formation
Scartwater Formation?
CARBONIFEROUS (Intrusive)
Bootooloo Gabbro
Bootooloo Gabbro?
Cgd-8557
EARLY CARBONIFEROUS
Cs-8556
Edgecumbe beds
Edgecumbe beds?
Key Creek Gneiss
Mount Cavana beds
Star of Hope Formation
Star of Hope Formation?
LATE DEVONIAN - EARLY CARBONIFEROUS
Bimurra Volcanics
Bimurra Volcanics/d?
Bimurra Volcanics/r
Bimurra Volcanics?
Mount Wyatt Formation
Rosetta Creek Formation
Rosetta Creek Formation/m
Rosetta Creek Formation/mv
Rosetta Creek Formation?
Saint Anns Formation
Stones Creek Volcanics
Stones Creek Volcanics/1
Stones Creek Volcanics/2
Stones Creek Volcanics/3
Stones Creek Volcanics/4
Stones Creek Volcanics?
DEVONIAN
Ukalunda Formation?
EARLY DEVONIAN - MIDDLE DEVONIAN
Ukalunda Formation
LATE SILURIAN - EARLY DEVONIAN (Intrusive)
Kedumba Granodiorite
Mount Cuthbert Granodiorite
Rangeview Station Tonalite
Rangeview Station Tonalite?
SDg/1-8357
SDg/2-8357
SILURIAN - EARLY DEVONIAN (Intrusive)
Dalmore Granodiorite
ORDOVICIAN (Intrusive)
Carse Creek Complex
Elbow Creek Granodiorite
Og/a-8357
Og/a-Ravenswood Batholith
Og/a?-8357
Og/a?-Ravenswood Batholith
Two Creek Granodiorite
CAMBRIAN - ORDOVICIAN
Les Jumelles beds
Les Jumelles beds/q
Mount Windsor Volcanics
CAMBRIAN
Mount Windsor Volcanics?
ORDOVICIAN - PERMIAN (Intrusive)
Landers Igneous Complex/2
ORDOVICIAN - DEVONIAN (Intrusive)
ODg/d-8357
ODg/d-Ravenswood Batholith
ODg?-Ravenswood Batholith
NEOPROTEROZOIC? - CAMBRIAN
PLEm-8357
NEOPROTEROZOIC - CAMBRIAN
Charters Towers Metamorphics?
NEOPROTEROZOIC? - EARLY CAMBRIAN?
Anakie Metamorphic Group/s

LEGEND

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:1,000,000 Paper Size A4
0 4.5 9 18
Kilometres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number 41-26457
Revision A
Date 28 Feb 2014

Mapped geology - legend

Figure 5-2
Sheet 2

G:\41\26457\06 GIS\Maps\MXD\0400_Geology_Soils\41_26457_0441_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD and DEEDI make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: 250k Geology/2011. Created by:MS

5.3.3 Soils

Soil mapping in the region intersected by the NGBR Project realignment is at an exploratory scale of 1:1,000,000 in the north and at a 1:250,000 scale in the south. Australian Soil Classification (ASC) soil types, descriptions and the mapped soil types that are mapped within the NGBR Project realignment are included in Table 5-2.

In the north at the Bowen River and Rosella Creek, the dominant soil types are mapped as duplex soils with a deep sandy to sandy loam A horizon with a clear horizon change to reddish brown clay or sandy clay. Further south within the broad undulating valleys, the alignment passes through a small area of sandy to loamy mottled duplex soils of shallow to moderate depth. Areas containing brown clays with moderate depth and loamy duplex soils occur along with sandy duplex soils around areas of gently undulating plains (Hancock Prospecting 2010).

Near Cerito Creek (approximate chainage 185 km) the dominant soil types are grey slopes on the middle and lower slopes of the undulating plains. Deep clay soils are likely to occur within the lower alluvial plain areas. As the terrain gets higher in elevation the soil becomes shallower and is more of a brown to red clay. In the south of the NGBR Project realignment, the soil includes deep sands on low hilly or strongly undulating lands (Hancock Prospecting 2010).

Most soil types possess inherent characteristics that will require specific management during construction activities. Mapped soil boundaries will be confirmed following a soil survey, allowing targeted soil management plans to be developed. Broad scale soil mapping has revealed occurrence of sodicity and gilgai microrelief in the vicinity of the NGBR Project realignment; both of these soil properties will require application of specific management strategies.

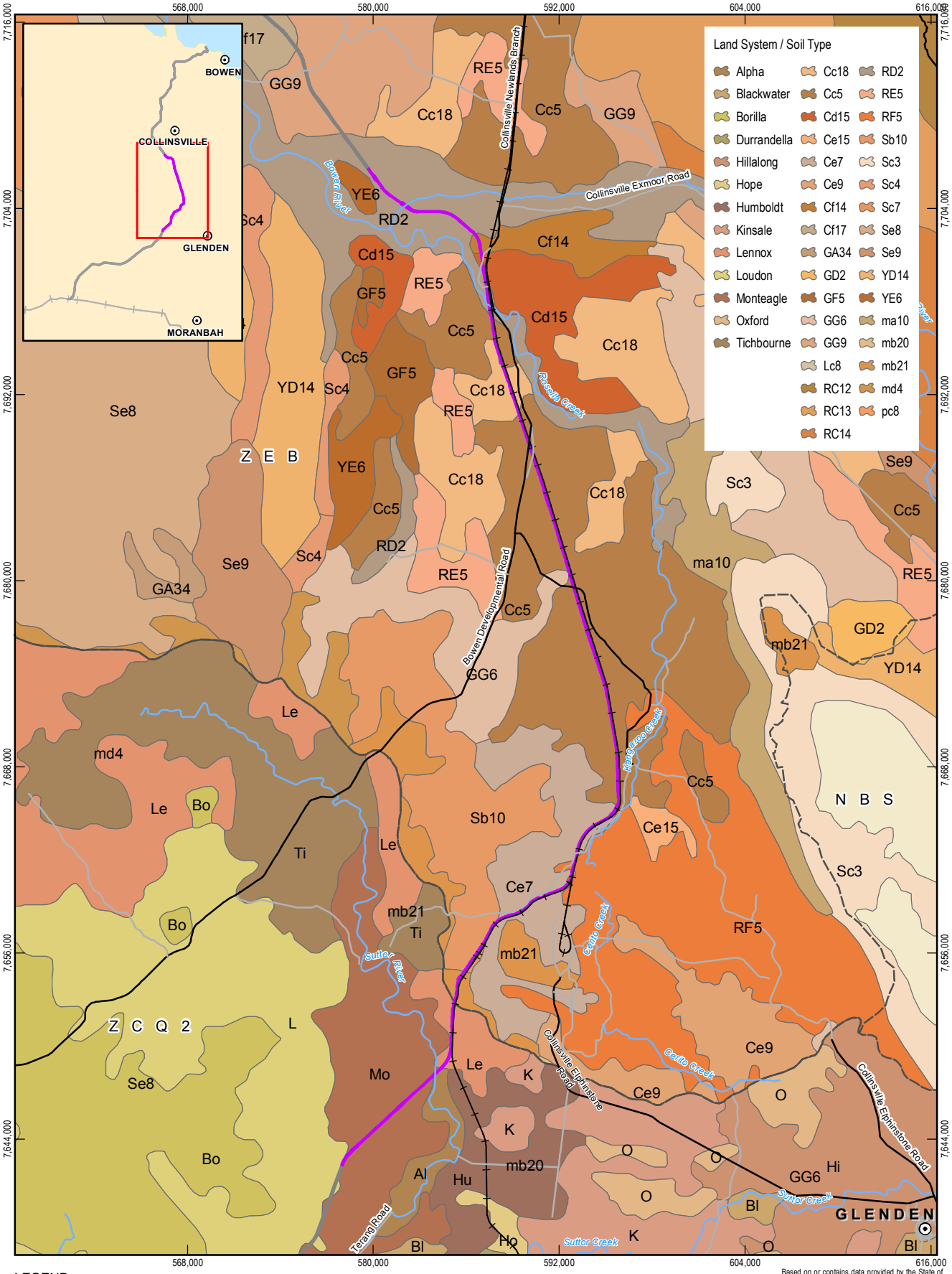
Sodic soils (predominantly Sodosols) may lead to surface crusting, low infiltration, low hydraulic conductivity, compaction of subsoils and increased susceptibility to erosion (Hazelton & Murphy 2007). Sodosols have been identified throughout the NGBR Project realignment.

Vertosols are typified by expansive properties, whereby the soils swell and shrink according to water content (NCST, 2009). Expansive properties of some of these soils have been expressed as gilgai microrelief, which may require management prior to stripping of topsoil due to variation of chemical properties between soil depressions and soil mounds (NRCS, 1993). Furthermore, trafficability of and construction activities associated with Vertosols are impacted during periods of wet weather and will require management during such periods.

Table 5-2 Soils within the NGBR Project realignment

ASC soil type	ASC description	Mapped soil type
Dermosol	Structured soils which do not have a strong texture change between topsoil and subsoil. These soils are commonly described as uniform or gradational soils.	Alkaline red bleached duplex soils
Kandosol	Soils with greater than 15 per cent clay, with a massive or weakly structured subsoil.	Red massive earths
		Red massive earths
		Alkaline mottled bleached duplex soils

ASC soil type	ASC description	Mapped soil type
Rudosol	Soils with limited structural development, commonly associated with hill tops.	Deep sands
Sodosol	Soils with a clear or abrupt texture change between the upper sandy material and underlying clay material. The underlying clay material is sodic (dispersive) and not strongly acidic (pH>5.5).	Neutral red duplex soils
		Alkaline mottled bleached duplex soils
Vertosol	Colloquially known as cracking clays, these soils swell when wet and shrink when dry. They are typically impassable when wet.	Dark cracking clays
		Grey and brown cracking clays
		Grey and brown cracking clays
		Grey and brown cracking clays
		Dark cracking clays



LEGEND

- Population centres
- Main Road
- Local Road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Land systems and soils

Figure 5-3

G:\41\26457\06 GIS\Maps\MXD\0400_Geology_Soils\41_26457_0439_rev_a.mxd

Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Spot heights, Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Roads (2010); Combined Soils (2010). Created by:MS

5.3.4 Good quality agricultural land

The term 'good quality agricultural land' (GQAL), applies to any set of agricultural land classes that are determined by a local government to have agricultural characteristics important to the local economy. Agricultural land classes are defined in Table 5-3. With respect to these classes, Whitsunday Regional Council considers class A and B as GQAL, while Isaac Regional Council considers class A, B and C1 (refer Table 5-4). The majority of the NGBR Project realignment is located within the Whitsunday Regional Council local government area. A small section (between chainage 193 km and chainage 197 km) passes through the Isaac Regional Council local government area. The GQAL mapping is consistent with that utilised for the NGBR Project EIS.

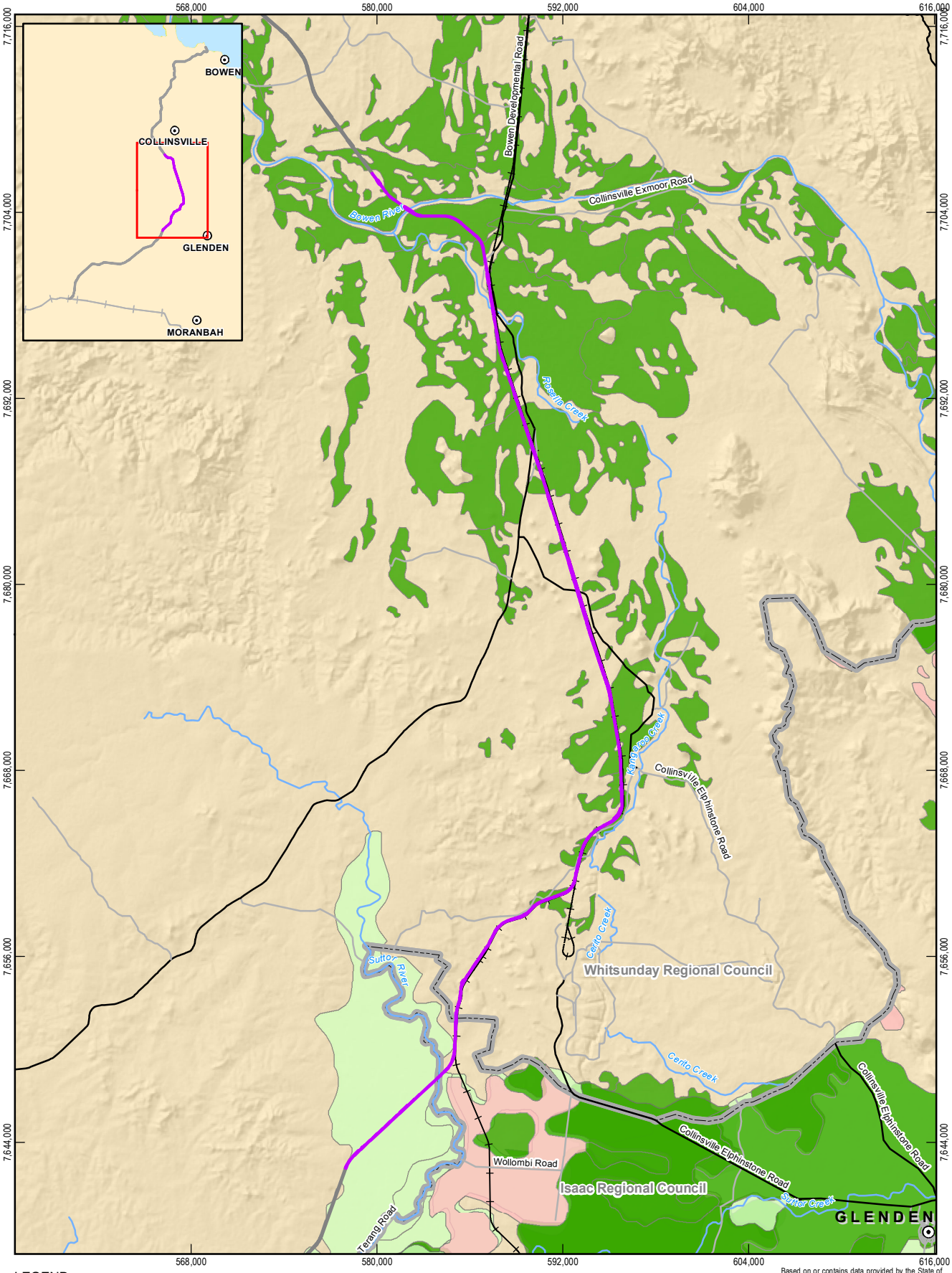
A total area of 367.5 ha of GQAL would be intersected by the NGBR Project realignment, including ancillary infrastructure (refer Table 5-4). This extent would be confirmed via field survey.

Table 5-3 Agricultural land classes

Class	Definition
A	Crop land - land that is suitable for current and potential crops with limitations to production that ranges from none to moderate.
B	Limited crop land - land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
C1	Pasture land – suitable for grazing high quality pastures, either sown pastures where ground disturbance is possible for pasture establishment or native pastures on higher fertility soils. Land that is suitable only for pastures due to limitations which preclude continuous cultivation for crop production.
C2	Pasture land – suitable for grazing native pastures with or without the addition of pasture species introduced without ground disturbance. Land that is suitable only for pastures due to limitations which preclude continuous cultivation for crop production.
C3	Pasture land – suitable for light grazing of native pastures in accessible areas, otherwise very steep land more suited to forestry, conservation or catchment protection. Land that is suitable only for pastures due to limitations which preclude continuous cultivation for crop production.
D	Non-agricultural land - land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

Table 5-4 Good quality agricultural land intersected by the NGBR Project realignment

Footprint	GQAL Class	Area (ha)
Final rail corridor	A	207.5
	B	59.7
Ancillary infrastructure	A	69.2
	B	18.2



LEGEND

- Population centres
- Main Road
- Local Road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- GQAL
  - A
  - B
  - C1 (Isaac Regional Council only)
- Local government area

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number 41-26457
Revision A
Date 28 Feb 2014

Good quality agricultural land

Figure 5-4

G:\41\26457\06 GIS\Maps\MXD\0400_Geology_Soils\41_26457_0440_rev_a.mxd

Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Population centres, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014); DNRM: Roads (2010), GQAL (2010), LGA (2012). Created by:MS

5.3.5 Strategic cropping land

The SCL Act was introduced with the aim to protect Queensland's best cropping land from development that would adversely impact upon its productive capacity. A trigger map, based upon soil, land and climate information identifies areas of potential SCL. Further refinements, including an on-ground assessment against the eight field criteria for SCL would further confirm or refine the extent of SCL and inform a validation application to the Department of Natural Resources and Mines.

The NGBR Project realignment falls entirely within the Western Cropping zone. Approximately 143 ha of potential SCL is mapped within the NGBR Project realignment footprint.

5.3.6 Contaminated land

The legislative requirements covering contaminated land in Queensland are primarily contained in the *Environmental Protection Act 1994* (EP Act) and subordinate regulations and policies. Schedule 3 of the EP Act lists a number of notifiable activities related to land contamination.

A search of the Queensland Department of Environment and Heritage Protection (DEHP) Environmental Management Register (EMR) and Contaminated Land Register (CLR) was conducted for the NGBR Project EIS. Lot 618 on PH2106 was found to be listed on the EMR. This property is listed for 'Petroleum product or oil storage' and 'Livestock dip or spray race'. Approximately 30 ha of this lot is crossed by the NGBR Project realignment.

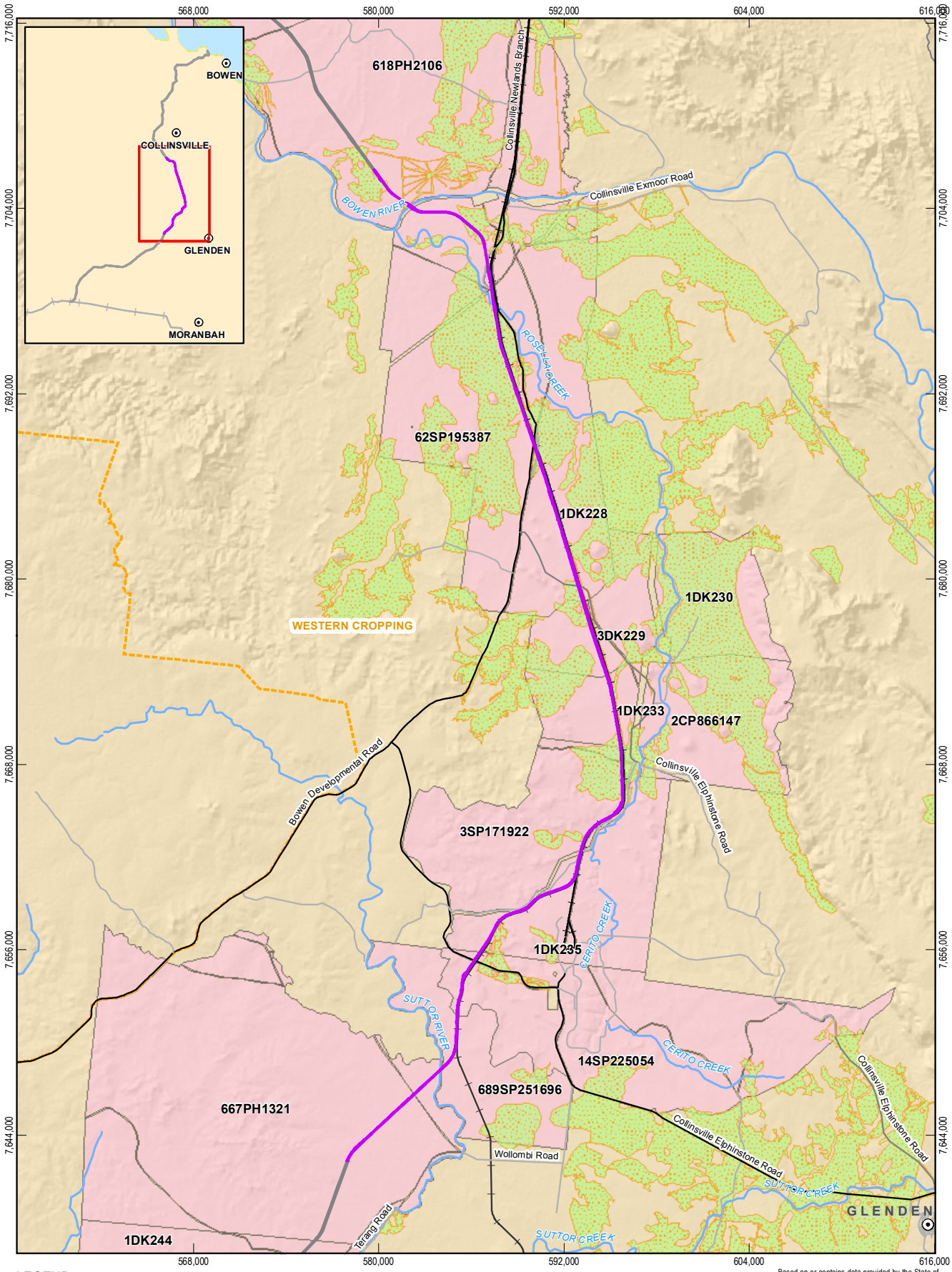
There were five allotments within the NGBR Project realignment for which a search was not previously conducted. These five allotments were part of the Alpha Coal rail alignment, and were considered in the Alpha Coal Project Environmental Impact Statement (Hancock Prospecting, 2010). Four properties, including Lot 618 on PH2106, in the NGBR Project realignment were listed on the EMR, details of which are presented in Table 5-5.

Table 5-5 Property details and EMR listing

Lot on plan	Location of property (chainage)	Petroleum product or oil storage	Livestock dip or spray race	Mineral Processing	Explosives production or storage	waste storage, treatment or disposal
Lot 4 DK264 (subdivided from Lot 14 SP225054)	188.4 km to 192.7 km	✓	✓	✓	✓	✓
Lot 2 CP866147	165.6 km to 170.7 km	✓	✓			
Lot 618 PH2106	129 km to 130.8 km	✓	✓			
Lot 3 DK236 (subdivided from Lot 3 SP171922)	178.7 km to 188.4 km	✓		✓		✓

5.3.7 Acid sulfate soils

Acid sulfate soils (ASS) are generally confined to areas of Holocene to Quaternary aged marine and estuarine sediments that occur in low-lying coastal areas. The NGBR Project realignment does not correspond with areas that are likely to contain ASS and the formation of inland ASS within the NGBR Project realignment is considered to be of low probability.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Strategic cropping land (zones)
- Strategic cropping land (trigger)
- Property boundary

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Strategic cropping land within the NGBR Project realignment

Figure 5-5

G:\41\26457\06 GIS\Maps\MXD\0400_Geology_Soils\41_26457_0437_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Population centres, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Strategic Cropping Land Zones/Trigger v2 (2012), Cadastre (2014). Created by:MS

5.4 Potential impacts and mitigation measures

The potential construction and operation impacts of the NGBR Project on topography, geology, soils and land contamination are detailed in the NGBR Project EIS. There were no additional impacts that would require mitigation identified as a result of the NGBR Project realignment in relation to topography, geology, soils and land contamination.

5.5 Conclusion

There are minor differences in underlying geology and soil types as a result of the NGBR Project realignment, however these were not likely to result in additional potential impacts or change the order of magnitude of the potential impacts.

Management of soil and geological polygons will be developed following a soil survey. Most soil types will require some form of targeted management. Two such soil types are Sodosols, which are typified by sodic B2 horizons, and Vertosols, which possess expansive properties that are expressed as gilgai microrelief in some areas of the NGBR Project realignment. Underlying geology considered to present potential stability risk has been identified and is predominant in formations generated by alluvial and colluvial depositions.

Further on-ground investigations including geotechnical investigations and a soil survey will provide more detailed information in relation to constructability of the NGBR Project and management of soils, as well as to confirm or refine the mapped extent of GQAL and SCL.

6. Nature conservation

6.1 Purpose of section

The purpose of this section is to assess the potential impacts of the NGBR Project realignment on terrestrial and aquatic ecology. It includes an overview of the existing environment, consideration of potential construction and operation impacts, and the identification of proposed mitigation and management measures. This section summarises the key findings of the existing environment report and identifies the potential impacts and the proposed mitigation and management practices to be employed during development of the NGBR Project realignment.

The terrestrial and aquatic ecological values that are considered in this section include:

- Broad vegetation communities (BVCs) and habitats for terrestrial fauna
- Regional Ecosystems (REs) and regulated regrowth protected under the *Vegetation Management Act 1999* (VM Act)
- Terrestrial flora species 'confirmed present' or considered 'likely to occur', including those listed as threatened, near threatened or vulnerable under the *Nature Conservation Act 1992* (NC Act), *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and species listed as least concern under the NC Act
- Terrestrial fauna species 'confirmed present' or considered 'likely to occur', including those listed as threatened, near threatened or vulnerable under the NC Act, EPBC Act and species listed as least concern under the NC Act
- Wetlands, watercourses and other aquatic habitats
- Aquatic fauna and flora species confirmed present or considered 'likely to occur', including those listed as threatened, near threatened or vulnerable under the NC Act, EPBC Act and species listed as least concern under the NC Act.

Terrestrial and aquatic ecological values that are matters of national environmental significance (MNES), protected under the EPBC Act, are identified in this section in order to provide a comprehensive assessment of all ecological issues relevant to the NGBR Project realignment; however, they are discussed in detail within Volume 2 Appendix D Revised MNES.

6.2 Methodology

6.2.1 Study area

This section considers vegetation communities, terrestrial and aquatic fauna habitats and flora and fauna species that are present or are likely to be present in the NGBR Project realignment. This is a nominal corridor of 60 m width. In order to understand large-scale vegetation communities, landscape-induced patterns, sub-catchment scale processes and the broader distribution of species and habitat (and the role areas adjacent to the final rail corridor play in these), the study area extended beyond the NGBR Project realignment footprint where appropriate. Therefore, the study area encompasses the NGBR Project realignment (approximately 77 km in length), as well as the broader landscape in which this corridor is located (Figure 6-1). This includes surface watercourses and their watersheds, floodplains and wetlands.

The NGBR Project realignment footprint (consisting of a nominal 60 m wide final rail corridor and ancillary infrastructure) was used for calculating vegetation clearing impacts.

6.2.2 Desktop assessment

Given the majority of the NGBR Project realignment coincides with the previously approved GVK Hancock Alpha Coal corridor, the ecological values of the receiving environment are currently described by that project. For this report ecological values were identified from a desktop assessment, gathering relevant information from the following sources:

- Ecological field assessments undertaken for the Alpha Coal Project EIS (GHD 2010a, GHD 2010b)
- Ecological field assessments undertaken for the Drake Coal Project EIS (GHD 2012a)
- Relevant regional information from the NGBR Project EIS ecological surveys
- Database searches to identify historical records and predicted ecological values within the final rail corridor.

The desktop assessment also involved searching a variety of literature and database sources for information on the terrestrial and aquatic ecological values of the study area. These sources included:

- The Department of the Environment (DotE) Protected Matters Search Tool and Directory of Important Wetlands
- The Department of Environment and Heritage Protection (DEHP) (former Queensland Department of Environment and Resource Management) Essential Habitat mapping (Version 3), Burdekin Natural Resource Management Region Back on Track Actions for Biodiversity report, Biodiversity Planning Assessment expert panel report and mapping, RE and regrowth mapping (Version 6.1), HERBRECS Specimen Database
- Queensland Museum database search
- Birds Australia Bird Atlas data
- Abbot Point cumulative impact assessment report (Eco Logical Australia (ELA) and Open Lines 2013)
- DEHP Wetland mapping
- DEHP Wildlife Online Database
- Aquatic Conservation Assessments, using AquaBAMM, for the Riverine and Non-Riverine Wetlands of the Great Barrier Reef Catchment, Inglis and Howell 2009ab
- Freshwater Fishes of North-Eastern Australia, Pusey *et al*. 2004
- Freshwater Fish of Burdekin Dry Tropics Natural Resource Management Region, Carter and Tait 2008.

Many of these desktop sources collate historical records from across all seasons, ranging from 1870 through to 2012. However, in many instances the record date was not specified.

Likelihood of occurrence assessment

The information collected from desktop assessments was used to identify the existing ecological values of the NGBR Project realignment. These ecological values were in turn used to develop a likelihood of occurrence assessment for conservation significant flora and fauna species. The

likelihood of occurrence assessments incorporated the following considerations for each given species:

- Known distribution
- Habitat preferences
- The presence and availability of suitable habitat in the NGBR Project realignment footprint
- Relative abundance
- Previous records from desktop sources (based on seasonal historical records)
- Observations of the species in the NGBR Project realignment footprint.

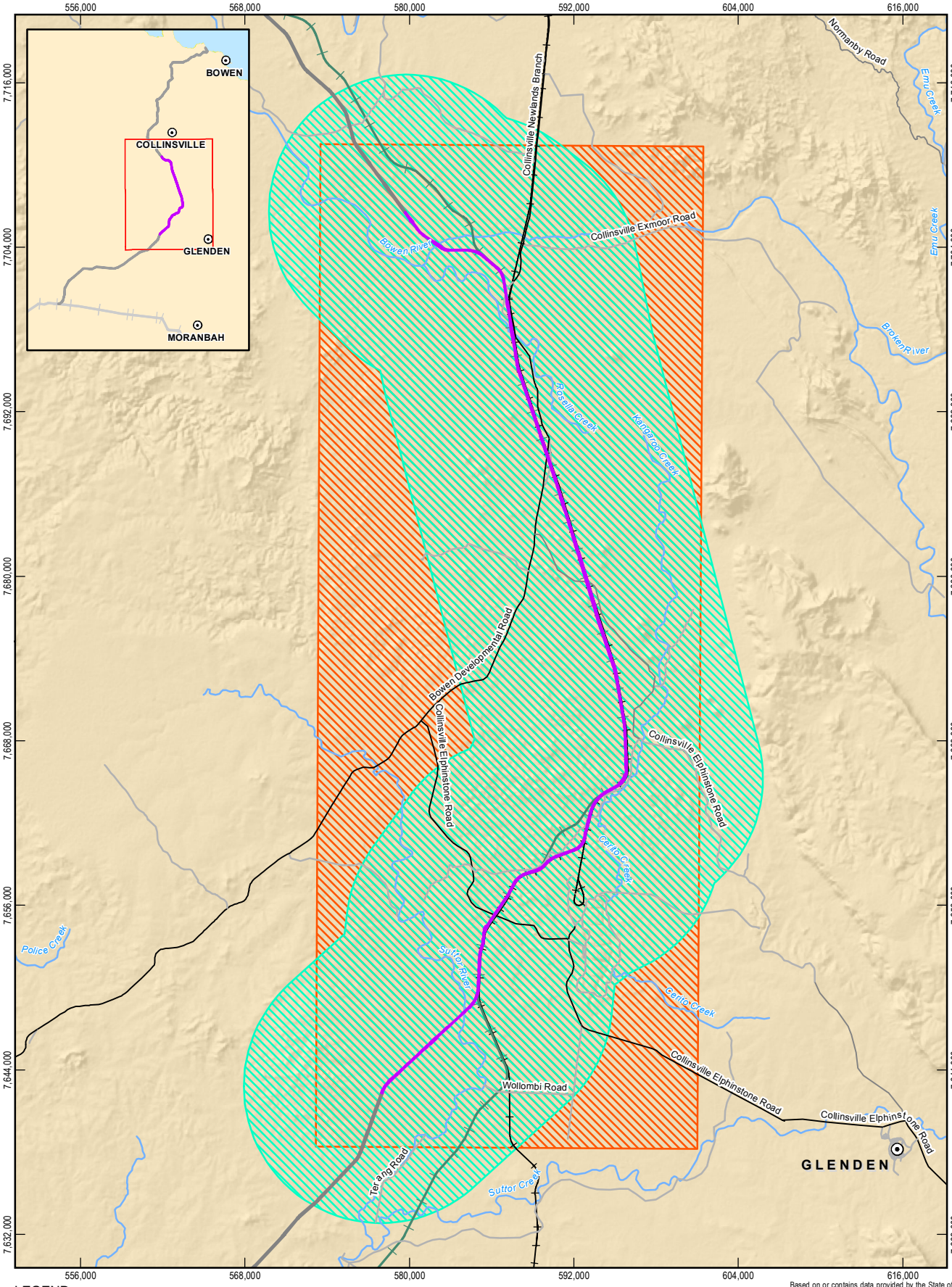
For each given species, the likelihood of occurrence was assessed using the following categories:

- **Unlikely to occur**: species has not been recorded in the region (no records from desktop searches) AND/OR current known distribution does not encompass the NGBR Project realignment footprint AND/OR suitable habitat is generally lacking from the NGBR Project realignment footprint
- **May occur**: species either has or has not been recorded in the region (desktop searches) although species' distribution incorporates the NGBR Project realignment footprint AND potentially suitable habitat occurs in the NGBR Project realignment footprint (but may not be particularly abundant or optimal habitat)
- **Likely to occur**: species has been recorded in the region (desktop searches) AND suitable habitat is present in the NGBR Project realignment footprint; however were not recorded during field surveys for the Alpha Coal Project EIS
- **Confirmed present**: species recorded during previous field surveys for the Alpha Coal Project EIS and/or Drake Coal Project EIS that were recorded at locations that are within one kilometre of the NGBR Project realignment footprint.

Species assigned to categories unlikely to occur or may occur are not specifically assessed in the impact assessment component of this section, since significant impacts to these species are unlikely and the objective of the assessment is to focus on key issues that need to be taken into account in decision making (EIANZ, 2010).

Predictive habitat mapping

Predictive habitat mapping was undertaken for NC Act and EPBC Act listed flora and fauna species confirmed present or assessed as likely to occur in the NGBR Project realignment footprint. For each species, habitat requirements were identified and assessed against existing environmental information using an analysis of various habitat characteristics. This allowed for the mapping of likely suitable habitat and therefore the identification of potential habitat distribution of listed species. Where possible, potential habitat mapping was validated using historic field observations and publicly available sightings data from previous surveys undertaken in the region.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Alpha Coal Rail Search
- Protected matters and herbrecs
- Wildlife Online Database, bird australia and queensland museum

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:400,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Desktop assessment extents

Figure 6-1

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1215_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Rail Project (2012); DNRM: Physical Road Network (2010); GHD: Desktop Search Areas (2014), Alpha Hancock Coal EIS, Alpha Rail Section Digitised (2010). Created by: AJ

6.3 Existing environment

6.3.1 Regional context

Brigalow Belt bioregion

The NGBR Project realignment is located in the far north of the Brigalow Belt bioregion; traversing two subregions of the Brigalow Belt North bioregion (Bogie River Hills and Northern Bowen Basin) (refer Figure 6-3). The Brigalow Belt bioregion is a large, complex area covering approximately 365,326 km^2 of central Queensland, extending south from Townsville to Narrabri in New South Wales (Sattler and Williams 1999). The Brigalow Belt bioregion is characterised by the presence of brigalow (*Acacia harpophylla*) dominated forests and woodlands on clay soils (Sattler and Williams 1999). In addition to brigalow, other communities that characterise the bioregion are eucalypt forests and woodlands, grasslands, dry rainforests, cypress pine woodland and riparian communities (Sattler and Williams 1999).

Burdekin River Basin

The Burdekin River Basin is the second largest river basin on the Queensland coast (NWC 2013) and covers approximately 130,109 km^2 (DEHP 2013b). The NGBR Project realignment runs through the north-east section of the Suttor River catchment and crosses into the central parts of the Bowen River catchment, following the Newlands line (Figure 6-2). Cattle grazing is the most dominant land use for the area, and covers approximately 96 per cent of the Basin area (Dight 2009). Additional land uses include irrigated cropping, horticulture, aquaculture and mining (Dight 2009). The Burdekin River Basin also contains Queensland's largest dam, the Burdekin Falls Dam, which has a total capacity of 1,860,000 ML (NWC 2013).

The Burdekin River Basin is subject to strong seasonality with mean annual rainfall varying between 600 to 2500 mm, falling predominantly during the wet season (December to April) (Dight 2009; NWC 2013). Water flows within the Burdekin River Basin also exhibit distinct seasonality, where changes in rainfall result in the basin being predominantly dry during the winter and wet in the summer. Rainfall is highly variable throughout the basin and varies between years. Generally, rainfall is highest and least variable in the coastal uplands, and lowest and most unpredictable in the western and southern parts of the basin (Dight 2009). However, prolonged dry conditions and drought are also characteristic of the basin. Mean annual discharge from the basin (taken from the Clare Weir in the lower Burdekin River Basin) is approximately 9.4 million ML. This accounts for approximately a third of all coastal mean annual discharge into Great Barrier Reef along the north Queensland coast (NWC 2013). Further information on the Burdekin River Basin in provided in the NGBR Project EIS Volume 2 Appendix F Nature conservation.

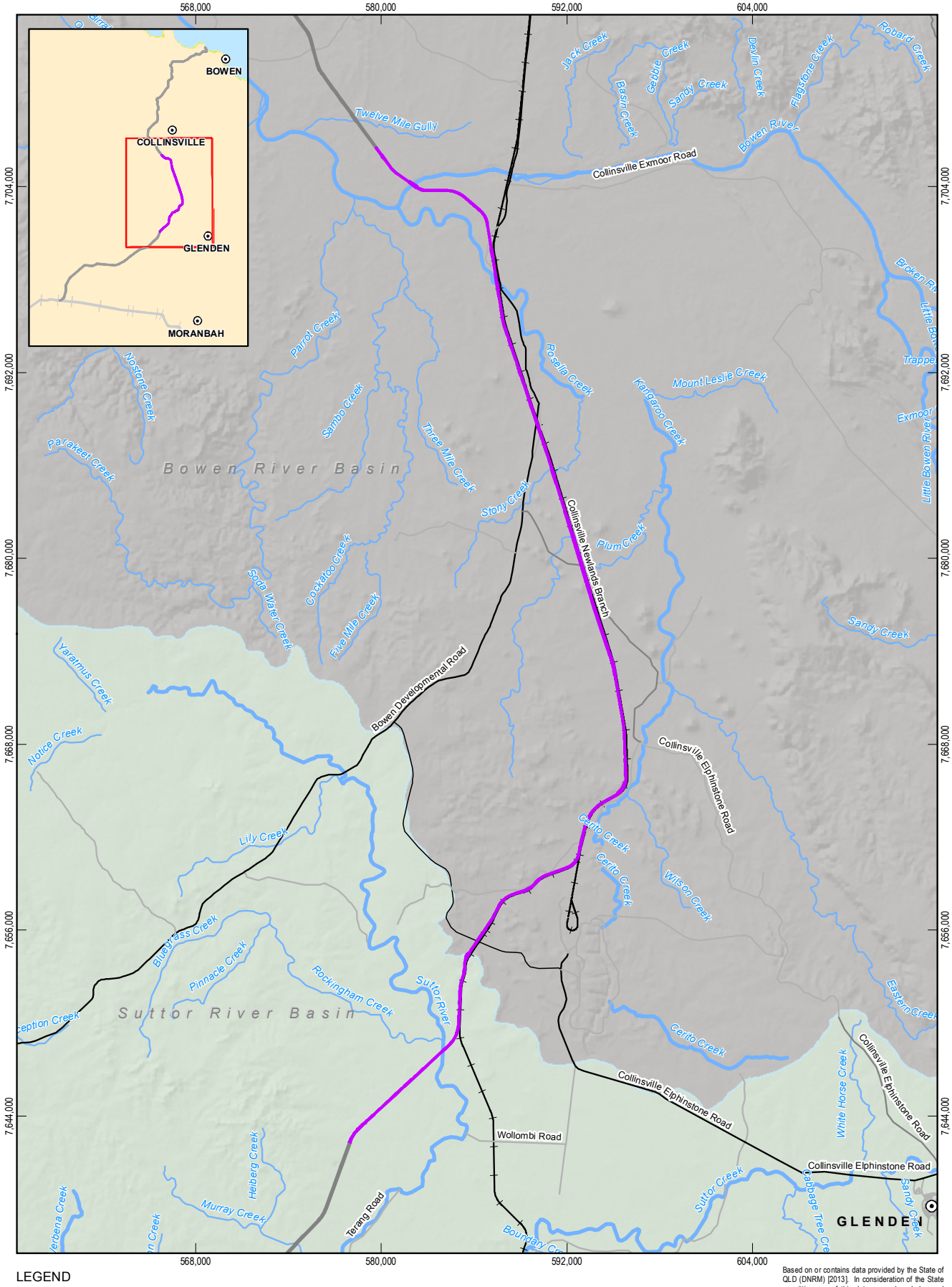
Suttor River catchment

The NGBR Project realignment footprint within the Suttor River catchment sits perpendicular to the Suttor River and crosses the river just before the Rockingham Creek confluence (Figure 6-2). The Suttor River catchment is approximately 18,000 km^2 and comprises almost 14 per cent of the area of the Burdekin River Basin. The Suttor River and its tributaries are ephemeral streams with large waterholes fed from groundwater. The terrain in this basin differs markedly from others within the Burdekin River Basin, lacking the high mountain backdrops and representing a drier, typically semi-arid western landscape. Cattle grazing is the dominant land use of the area and a small percentage of the land is used for dry land cropping of cereals.

The last 30 years of clearing riparian and floodplain vegetation has resulted in altered hydrological regimes and deterioration of the riparian habitat of many of the waterways crossed by the NGBR Project realignment. This area shows some dry land salinity, which is a potential threat to the ecological and agricultural values of the Suttor River catchment. Macroinvertebrates have experienced moderate change along the whole river; fish and water quality are moderately affected below the junction of Suttor River with Belyando River (Greiner and Hall 2006).

Bowen River catchment

The Bowen River catchment is approximately 8,200 km^2 and forms a major tributary of the Burdekin River. The NGBR Project realignment intersects Rosella Creek and the Bowen River just before the confluence of these two waterways (Figure 6-2). The Bowen River, being a major tributary of the Burdekin River, has many perennial waterholes and flowing water for most of the year, and provides significant aquatic habitat. Land use in this catchment is almost exclusively grazing on natural pastures. Additional land uses within the Bowen River subcatchments include irrigation, drinking water, recreation (swimming and boating) and industrial usage. Condition is generally typical of the Burdekin rangelands, but ground cover has been poor in recent dry years, bank erosion is significant in the middle reaches and weeds are an ongoing riparian management issue. The recent decline in condition (to poor) is due to floodplain clearing and gully erosion.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- River basins
  - Bowen river
  - Suttor river

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Watercourses of relevance to the NGBR Project realignment

Figure 6-2

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1168_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Rail Project (2012); DNRM: Physical Road Network (2010), River Basin (2010). Created by: AJ

Landscape corridors and connectivity

Information on the connectivity of habitats and biodiversity corridors within the region surrounding the NGBR Project realignment is discussed and mapped through the Brigalow Belt North Landscape Expert Panel Report (EPA 2008) and DEHP Biodiversity Planning Assessment mapping. The NGBR Project realignment occurs in a landscape that has been extensively cleared for cattle grazing. Despite this, significant landscape features remain and hold important ecological value for native flora and fauna.

Two key areas of ecological value identified in Brigalow Belt North Landscape Expert Panel Report (EPA 2008) occur within the region directly intersected by the NGBR Project realignment:

- Spinifex ridges between Collinsville and Mount Coolon are considered to be of significance. These predominantly occur to the west of the NGBR Project realignment.
- The Leichhardt Range is located to the north-west of the NGBR Project realignment and contains large tracts of contiguous remnant vegetation. As does the Drummond Range which is located to the south of the NGBR Project realignment. Both these areas are classified as being of very high value as wildlife refugia.

Biodiversity Planning Assessment (BPA) Mapping J rating (Corridors) shows the NGBR Project realignment intersects three broad biodiversity wildlife corridors, as shown in Figure 6-4:

- A small regionally significant corridor running westward from the Clarke Range to link with the Leichhardt Range in the Einasleigh Uplands bioregion. This corridor also links to the more continuous riparian corridor along the Bowen River.
- The Leichhardt Range corridor runs along the watershed between the Suttor and Bowen Rivers from the Denham Range north-west to Redcliffe Tableland, and then along the Leichhardt Range, which tracks north to the Einasleigh Uplands bioregion. This represents a state significant bioregional wildlife corridor.
- A regionally significant bioregional wildlife corridor extends north-west along the Suttor River, west of Glenden.

Biodiversity Planning Assessment (BPA) Mapping G rating (Context and connection) shows the NGBR Project realignment generally intersects an area in which habitats are somewhat less connected than expanses of interconnected habitat that occur to the west, east and north. This can be seen in Figure 6-5. Nevertheless, areas mapped as ‘high’ and ‘very high’ for their connectivity occur in localised areas. These are located:

- Along the Bowen River in the north of the NGBR Project realignment
- Immediately south-west of the junction with the Bowen Developmental Road, south of Rosella Creek
- In southern sections of the NGBR Project realignment, immediately north-west, west and south of the existing Newlands Mine.

The following major rivers of relevance to the NGBR Project realignment were identified as significant riparian corridors in the Burdekin catchment from BPA mapping and the *Brigalow Belt* North Landscape Expert Panel Report (EPA 2008):

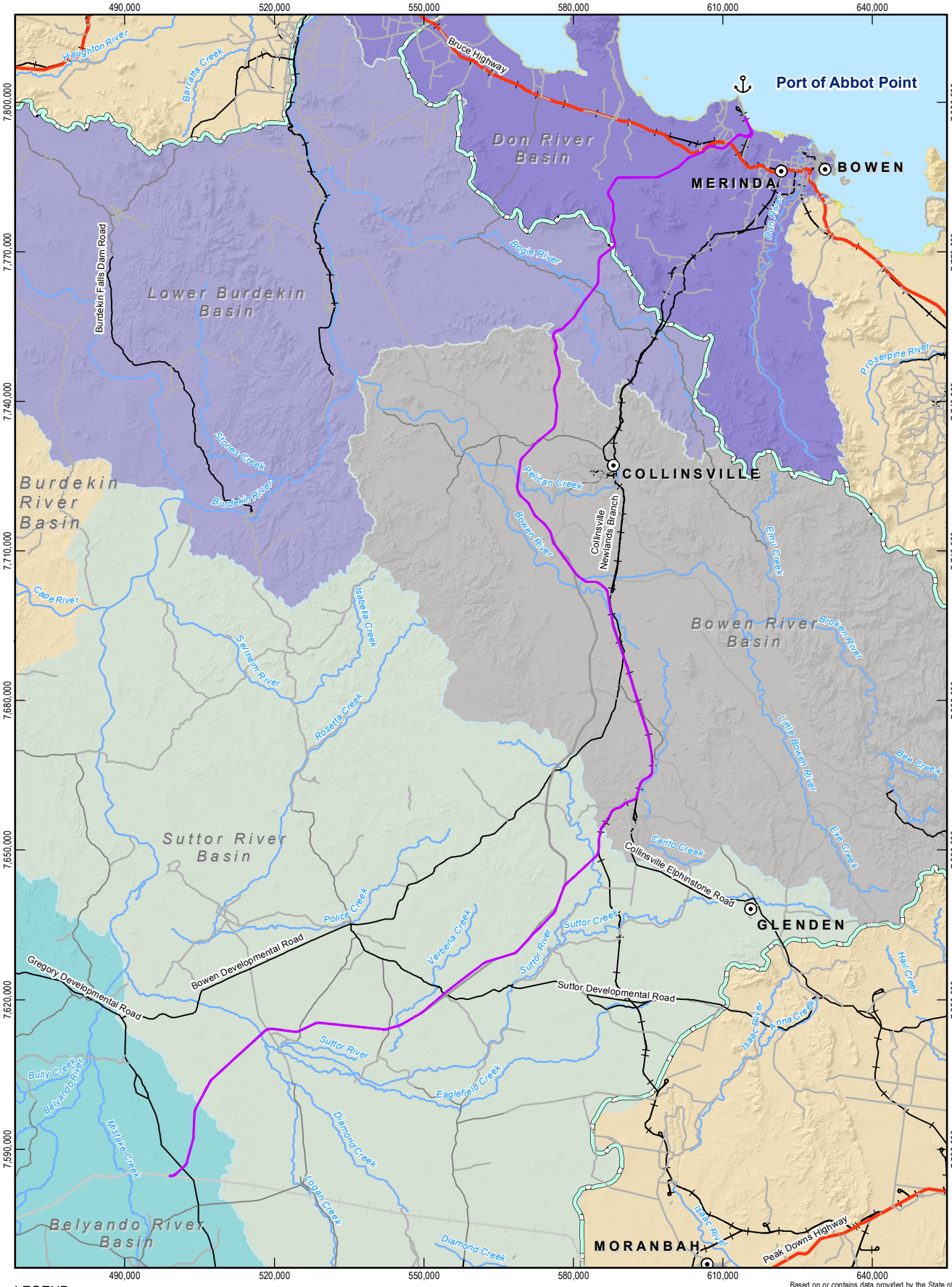
- Bowen River
- Suttor River upstream of Lake Dalrymple.

Protected area estate

The NGBR Project realignment does not intersect any mapped protected area estates; however, two occur within 10 km. Those two protected areas and their approximate locations in relation to the NGBR Project realignment are:

- Newlands Nature Refuge (7 km east and south-east)
- Blackjack Mountain Nature Refuge (2 km east).

The location of the protected areas in relation to the NGBR Project realignment is presented in Figure 6-6. Other protected areas of relevance to the broader NGBR Project are discussed in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation.



LEGEND

- Population centres
- Major Port
- Highway
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor
- NGBR Project final rail corridor (EIS)
- Burdekin river basin
- River Basins
- Belyando river
- Suttor river
- Bowen river
- Don river
- Lower burdekin river

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:1,100,000 Paper Size A4

0 7.5 15 30

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Regional context

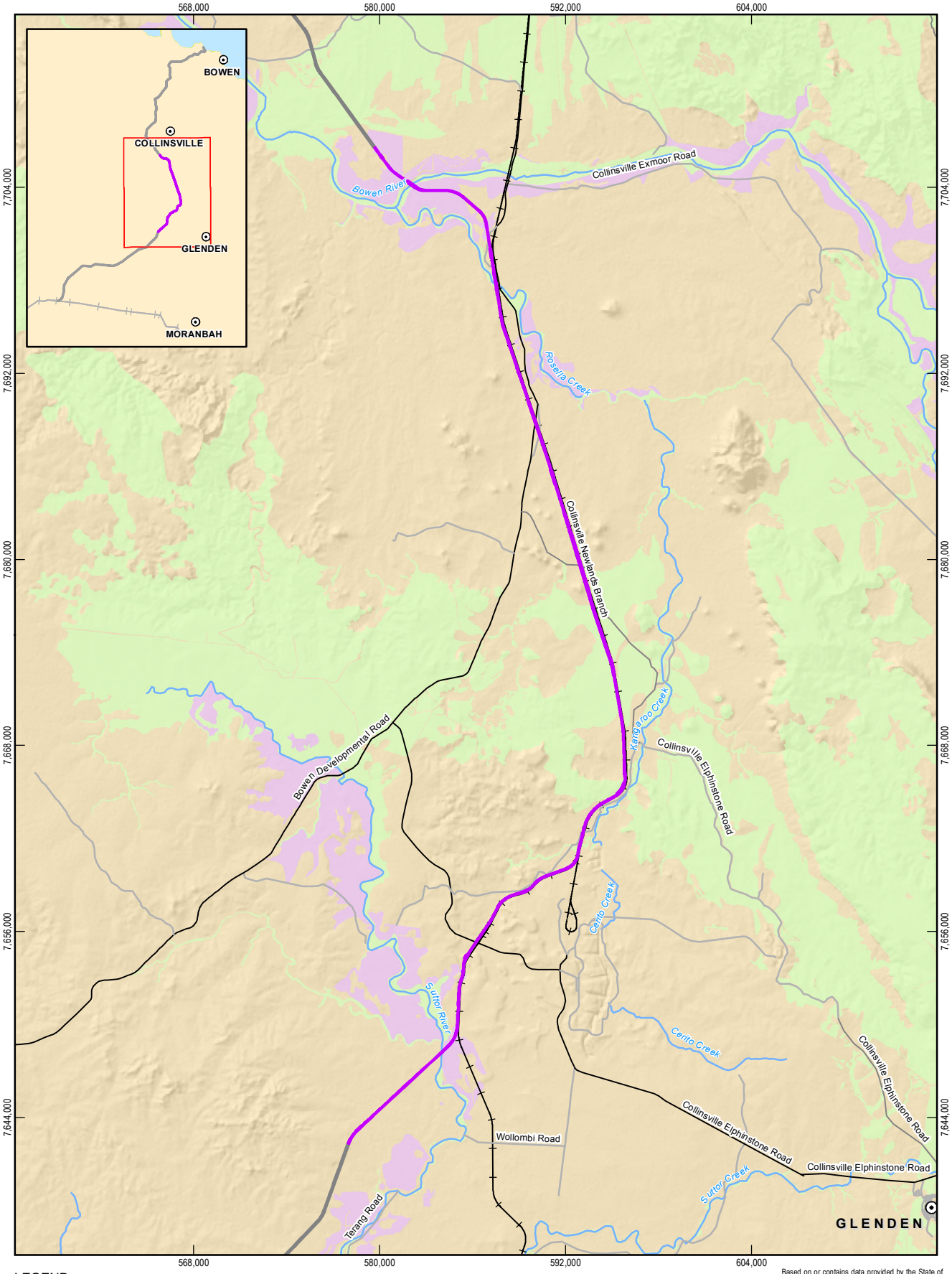
Figure 6-3

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1164_rev_a.mxd

Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM and Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2 (2013), Carmichael Rail Project/2012, Option 9 Rev1 Realignment Corridor (2014); DNRM: River Basin (2010), Roads (2010). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Central Queensland coast J Rating
- Very high
- High

Brigalow Belt and Einasleigh Uplands J Rating
- Regional
- State

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12 Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Biodiversity Planning Assessment mapping - J rating

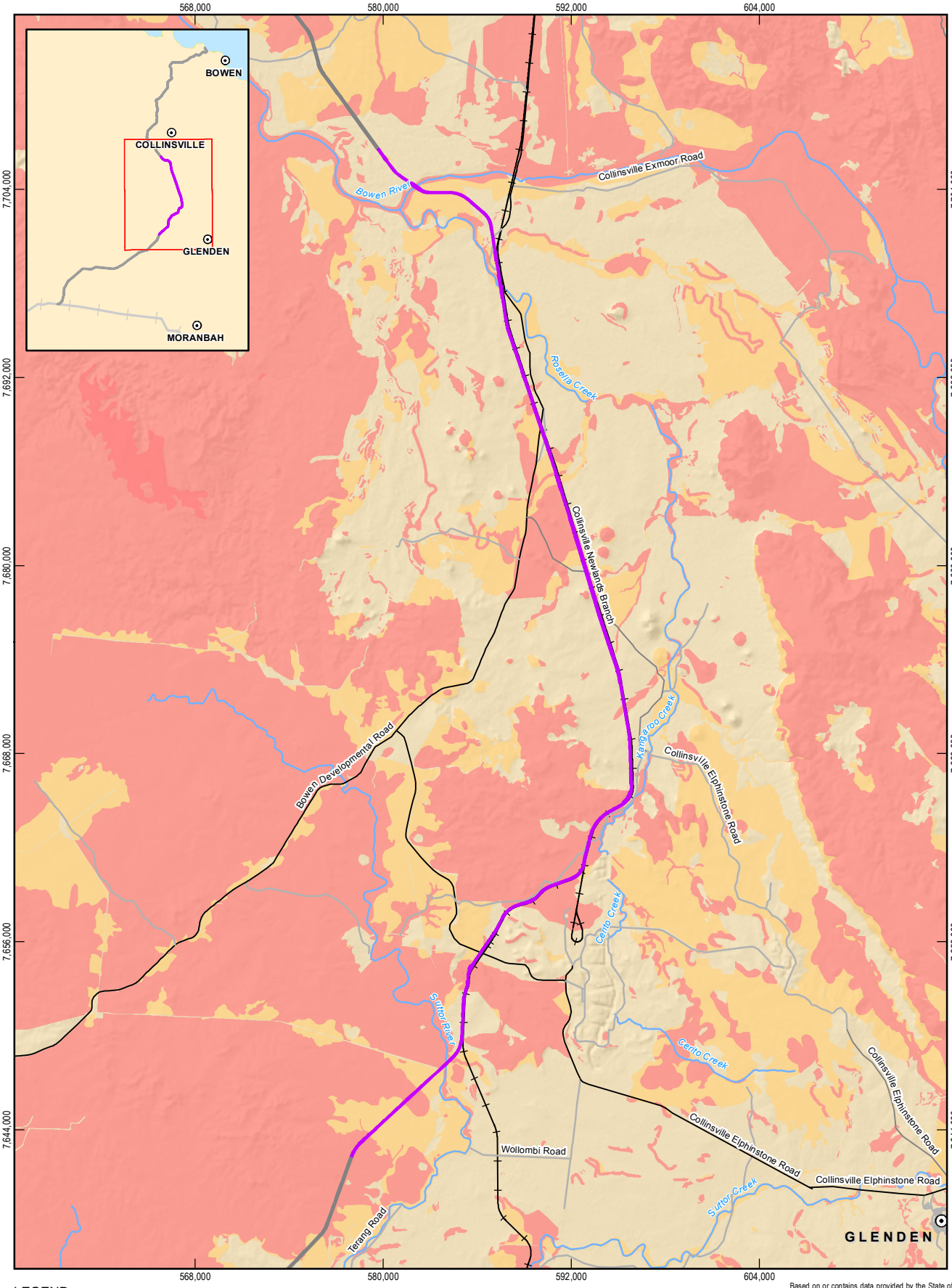
Figure 6-4

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1165_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Rail Project (2012); DNRM: Physical Road Network (2010), BPA Mapping (2010). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Brigalow Belt, Central Queensland coast and Einasleigh Uplands

G Rating

- Very high
- High

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Biodiversity Planning Assessment mapping - G rating

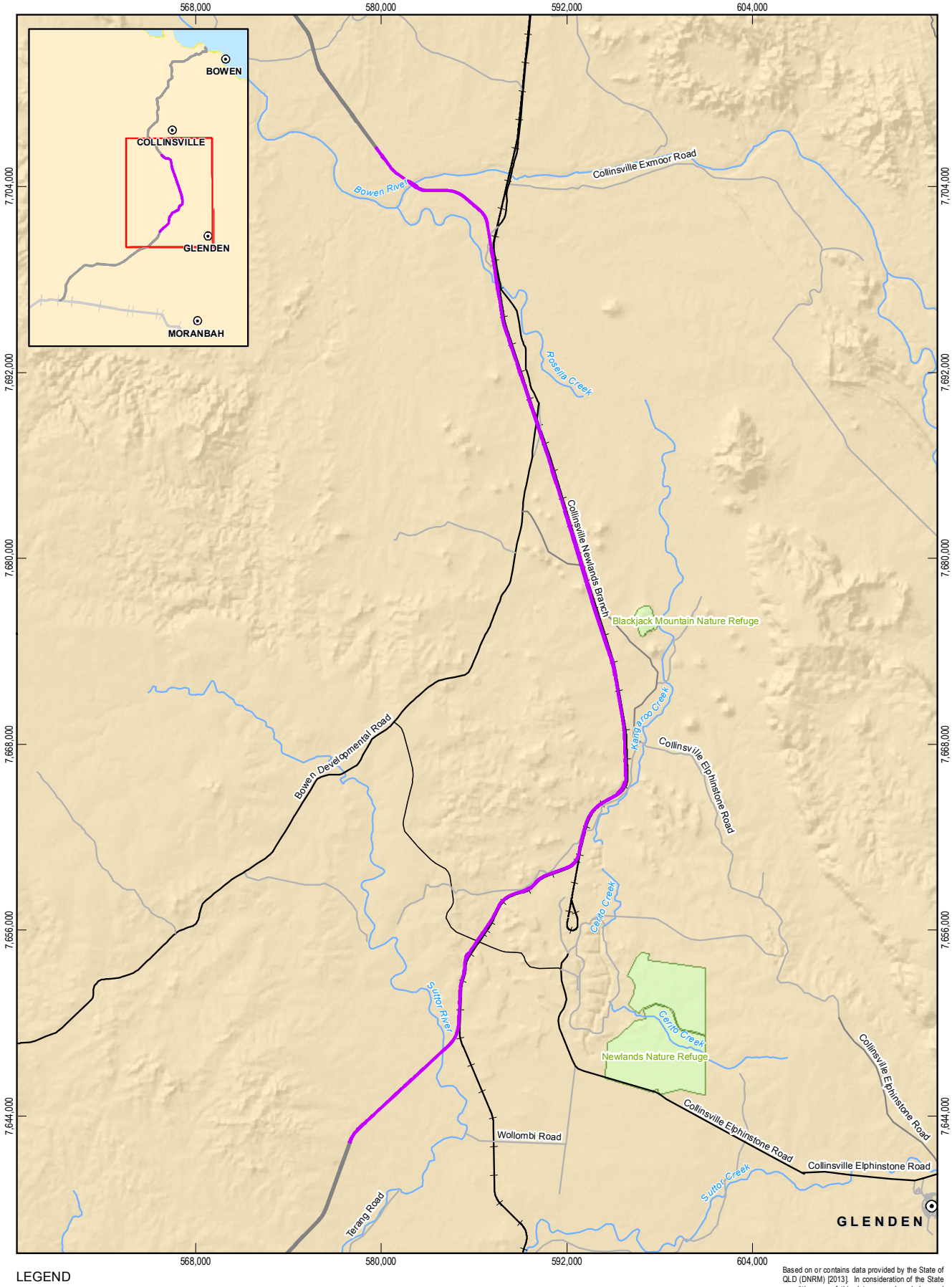
Figure 6-5

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1170_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Rail Project (2012); DNRM: Physical Road Network (2010), BPA (2010). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Nature refuges

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Protected area estates

Figure 6-6

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1171_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Nature Refuges (2012). Created by: AJ

6.3.2 Regional ecosystems

The certified RE mapping (Version 6.1) identifies 27 REs within the NGBR Project realignment footprint, including five classified as endangered, five of concern and 17 least concern under the VM Act.

In terms of area, 84 percent of the mapped remnant vegetation within the NGBR Project realignment occurs within a least concern RE, eight percent occurs within an of concern RE, and eight percent occurs within an endangered RE (to arrive at this figure mixed mapping polygons have been broken down into their constituent parts using the given percentages).

Within the NGBR Project realignment footprint, 46 percent of the total area of mapped remnant vegetation and 54 percent of the total number of REs intercepted are located in land zones one to five (the land zones comprising plains and rises). In addition, all three of the threatened ecological communities (TECs) protected under the EPBC Act that are mapped as occurring (via inference from constituent REs) in the NGBR Project realignment footprint are represented on these land zones. Table 6-1 briefly describes the REs that occur within the study area. Detailed descriptions of each RE can be found in Sattler & Williams (1999).

Numerous polygons of high value regrowth (HVR) vegetation are mapped throughout the NGBR Project realignment footprint. These HVR polygons are often small and situated directly adjacent to mapped remnant vegetation or connect two or many remnant vegetation polygons. The distribution of mapped REs along the Project is shown in Figure 6-7.

Table 6-1 Regional ecosystems within the NGBR Project realignment footprint

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
Land zone 9					
11.9.1	Endangered/ endangered	Open-forest to woodland of *Eucalyptus cambageana* or *E. thozetiana* and *Acacia harpophylla*. *Eucalyptus cambageana* is commonly codominant with *Acacia harpophylla* in the open-forest, or the open-forest may be dominated by *A. harpophylla* and have scattered emergent *Eucalyptus cambageana* or *E. thozetiana* trees. The *A. harpophylla* trees range from about 12 m to 14 m in height and the eucalypts 15-18 m high. In central western areas the *Acacia harpophylla* may form tall shrubland c. 4 m high with emergent *Eucalyptus cambageana* trees 10-12 m high. The community has a moderately dense to dense lower tree/tall shrub layer dominated by species such as *Eremophila mitchellii, Carissa ovata* and *Geijera parviflora*, with *Terminalia oblongata* often present in the north. The ground layer is frequently sparse.	Associated with slopes and crests of undulating plains and below low ridges and escarpments formed from Cainozoic to Proterozoic consolidated, fine-grained sediments. Texture contrast soils predominate, often with surface stone or gravel in sub-surface horizons, but other soils such as clays, sandy clay loams and cracking clays may also be present.	Low	Mapped in small areas within the NGBR Project realignment, particularly near chainage 155. A minor RE within the NGBR Project realignment.
11.9.2	Least concern/of concern	*Eucalyptus melanophloia* and/or *E. orgadophila* grassy woodland to open-woodland. Other tree species occasionally present as subdominants include *Corymbia erythrophloia*, *Eucalyptus populnea* or *Corymbia dallachiana*.	Occurs on rises on undulating plains with cracking clay or texture contrast soils.	Medium	Mapped in a number of small polygons, mostly near the central sections of the NGBR Project realignment.

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
11.9.3	Least concern/of concern	Grassland dominated by *Dichanthium sericeum* and/or *Astrebla* spp. (*A. lappacea*, *A. elymoides* and *A. squarrosa*) but contains large numbers of short-lived perennial grasses, annual grasses and annual forbs, which may dominant depending on seasonal conditions and management regime. Isolated low shrubs and trees and open-woodland occur in some areas, including *Eucalyptus melanophloia*, *E. orgadophila*, *Corymbia erythrophloia*, *Lysiphyllum carronii*, *Atalaya hemiglauca*, *Acacia pendula*, *A. omalophylla* and *Geijera parviflora*.	Occurs on gently undulating to undulating plains and rises with cracking clay soils derived from fine-grained sediments.	Low	Mapped over numerous areas near the central sections of the NGBR Project realignment, particularly between chainage 162 km and 170 km.
11.9.5	Endangered/ endangered	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.	Occurs on undulating plains and rises formed mainly on shales. The soils are predominantly cracking clay soils.	Low	Mapped in small polygons along the NGBR Project realignment, in areas adjacent to Rosella Creek and Kangaroo Creek.
11.9.9	Least concern/of concern	*Eucalyptus crebra* grassy woodland. *Eucalyptus moluccana* sometimes conspicuous on lower slopes.	Occurs on Cainozoic to Proterozoic consolidated, fine-grained sediments.	Low	Mapped in mixed polygons in the northern sections of the NGBR Project realignment, near Rosella Creek.
11.9.10	Of concern/ endangered	*Eucalyptus populnea* predominates forming a distinct but discontinuous canopy (15-18 m tall). *Acacia harpophylla* and sometimes *Casuarina cristata* usually forms a lower tree layer (8-14 m tall) which occasionally becomes the dominant layer. An open to moderately dense layer of tall	Occurs on Cainozoic to Proterozoic consolidated, fine-grained sediments, lower parts of undulating plains often with deep texture-contrast soils, or on	Low	Mapped, generally as a sub-component of mixed polygons, near the central sections of the NGBR Project realignment.

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
		shrubs is usually present and dominated by *Eremophila mitchellii* and *Geijera parviflora* with *Acacia excelsa*, *Atalaya hemiglauca*, *Psydrax oleifolia*, *Alectryon oleifolius* frequent. Scattered low shrubs such as *Carissa ovata* and *Eremophila deserti* are frequently present. The ground cover is usually sparse, and dominated by the grasses *Aristida ramosa*, *Enteropogon acicularis*, *Bothriochloa decipiens* and *Paspalidium* spp.	sodic and saline soils which may act as a discharge area if adjacent to alluvium.		
Land zone 8					
11.8.3	Of concern/of concern	Semi-evergreen vine thicket which may have emergent *Acacia harpophylla, Casuarina cristata* and *Eucalyptus* spp.	Occurs on Cainozoic igneous rocks. Generally restricted to steeper, rocky hillsides.	Low	Mapped in southern sections of the NGBR Project realignment.
11.8.5	Least concern/no concern at present	*Eucalyptus orgadophila* grassy open-woodland. *Eucalyptus orgadophila* predominates and forms and distinct but discontinuous canopy sometimes with sub-dominant species such as *Corymbia erythrophloia, E. melanophloia* and occasionally *E. crebra.* Shrubs are usually scarce and scattered although a well-defined shrubby layer does develop in some areas. The ground layer is moderately dense to dense and dominate by species that include the *Aristida lazaridis, A. ramosa*, *Bothriochloa ewartiana*, *Themeda triandra* and *Tragus* australianus and	Occurs on undulating plains, rises, low hills or sometimes flat tablelands on top of mountains, formed from basalt. Generally soils are shallow to moderately shallow, often rocky or stoney clays.	Low	Mapped in two large polygons north-west of Newlands Mine, between chainage 175 km and 185 km.

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
		the herbs *Brunoniella australis*, *Evolvulus alsinoides* and *Indigofera linnaei.*			
11.8.11	Of concern/of concern	Grassland dominated by *Dichanthium sericeum*, *Aristida* spp., *Astrebla* spp. And *Panicum decompositum* with or without trees such as *Eucalyptus orgadophila*, *E. melanophloia*, *Corymbia erythrophloia* and *Acacia salicina*. Frequently occurring and sometimes locally dominant species include the grasses *Aristida lazaridis*, *A. ramosa*, *Bothriochloa ewartiana*, *Dichanthium sericeum*, *Chrysopogon fallax*, *Heteropogon contortus*, *Enneapogon gracilis*, *Themeda triandra* and *Tragus australianus*, and a number of herb species. Isolated emergent tree species including *E. orgadophila, E. melanophloia* and *C. erythrophloia* or small areas of open-woodland may also be present.	Occurs on Cainozoic igneous rocks, particularly fresh basalt, and is generally associated with undulating to gently undulating rises. Associated soils are moderately shallow to deep cracking clay soils, often self-mulching and with gravel stones or linear gilgai sometimes present.	Low	Small polygons are mapped along the central sections of the NGBR Project realignment near Kangaroo Creek.
11.8.13	Endangered/ endangered	Grassland dominated by *Dichanthium sericeum*, *Aristida* spp., *Astrebla* spp. and *Panicum* decompositum with or without trees such as *Eucalyptus orgadophila*, *E. melanophloia*, *Corymbia erythrophloia* and *Acacia salicina*. Frequently occurring and sometimes locally dominant species include *Aristida lazaridia*, *A. ramosa, Bothriochloa ewartiana, D. sericeum*, *Chrysopogon fallax, Heteropoong contortus*, *Enneapogon avenaceus, Themeda triandra* and *Tragus australianus* and the herbs *Brunoniella*	Occurs on Cainozoic igneous rocks, particularly fresh basalt, and is generally associated with undulating to gently undulating rises. It usually occurs on the crests and middle and upper slopes. Associated soils are moderately shallow to deep cracking clay soils, often	Low	Small polygons are mapped towards the southern end of the NGBR Project realignment, between chainage 185 km and 187 km.

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
		australis, *Evolvulus alsinoides* and *Indigofera linnaei.* Isolated emergent tree species including E. orgadophila, E. melanophloia and C. erythrophloia or small areas of open-woodland may also be present.	self-mulching, and with gravel, stone or linear gilgai sometimes present.		
Land zone 7					
11.7.2	Least concern/no concern at present	Monospecific stands of *Acacia* spp. forest/woodland on Cainozoic lateritic duricrusts. *Acacia shirleyi* and or *Acacia catenulata* usually predominate the woodland to low woodland to low open-forest tree canopy (7-12 m high). Emergent eucalypt species such as *Eucalyptus thozetiana*, *E. crebra*, *E. decorticans* and *E. exserta* may be present.	Occurs on scarps and adjacent tops and slopes of dissected tablelands, mesas and buttes formed from chemically altered sediments and duricrusts. The soils are shallow to very shallow lithosols with surface stone and boulders.	Low	This RE is scattered over the southern half of the NGBR Project realignment in small patches.
11.7.3	Least concern/no concern at present	*Eucalyptus persistens* low open-woodland often with a *Triodia mitchellii* ground layer. Other scattered eucalypts such as *Corymbia leichhardtii* or *Eucalyptus melanophloia* may also occur.	Occurs on the stripped margins of ranges and plateaus. Soils are usually shallow loamy red earths overlying a hard pan.	Low	This RE is scattered over the southern half of the NGBR Project realignment in small patches.
11.7.4	Least concern/no concern at present	Mixed *Eucalyptus* spp. woodland. Species can include *Eucalyptus crebra, E. decorticans*, *Corymbia trachyphloia, E. tenuipes, C. watsoniana* and Callitris *glaucophylla*. There is usually a distinct tree to tall shrub layer	Occurs on low hills and ranges with shallow soils formed on Cainozoic lateritic duricrusts.	Low	Small polygons are mapped at the southern end of the NGBR Project realignment between chainage 195 km and 197 km.

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
		comprising species including *Lysicarpus angustifolius* or *Acacia* spp.			
Land zone 5					
11.5.3	Least concern/no concern at present	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* +/- *C. dallachiana* and occasionally *E. cambageana* or *E. brownii* dominate the tree layer (14 m median height and 11-15 m range) woodland. Localised areas may be dominated by *E. melanophloia*, occasionally *E. crebra* and other canopy species.	Occurs on flat to gently undulating plains formed from Cainozoic sediments. Associated soils are generally deep texture contrast with thick sandy surface horizons with some deep red earths.	Low	A relatively common RE located in the southern and central sections of the NGBR Project realignment.
11.5.9	Least concern/no concern at present	*Eucalyptus crebra* and/or *Eucalyptus melanophloia* woodland. Other tree species that may be present and locally dominant include *Corymbia citriodora* or *C. clarksoniana* sometimes in association with *C. intermedia, C. dallachiana, C. lamprophylla, E. tenuipes, E. exserta, E. cloeziana, E. acmenoides*. The mid layer ranges from absent to a sparse to dense shrubland typically dominated by *Acacia* spp. (such as *A. excelsa, A. leiocalyx*), *Petalostigma pubescens, Lysicarpus angustifolius, Alphitonia excelsa* and occasionally *Melaleuca nervosa* (on texture contrast soils).	Occurs on plateaus and broad crests of hills and ranges which are formed by Cainozoic sandplains. Soils are generally deep red earths.	Low	Mapped in polygons near the southern end of the NGBR Project realignment between chainage 199 km and 200 km.
11.5.15	Least concern/ endangered	Semi-evergreen vine thicket. The following species are commonly present in the tree layer:	Occurs on remnant Tertiary surfaces. Deep red and	Low	Mapped in polygons near the southern end of the NGBR

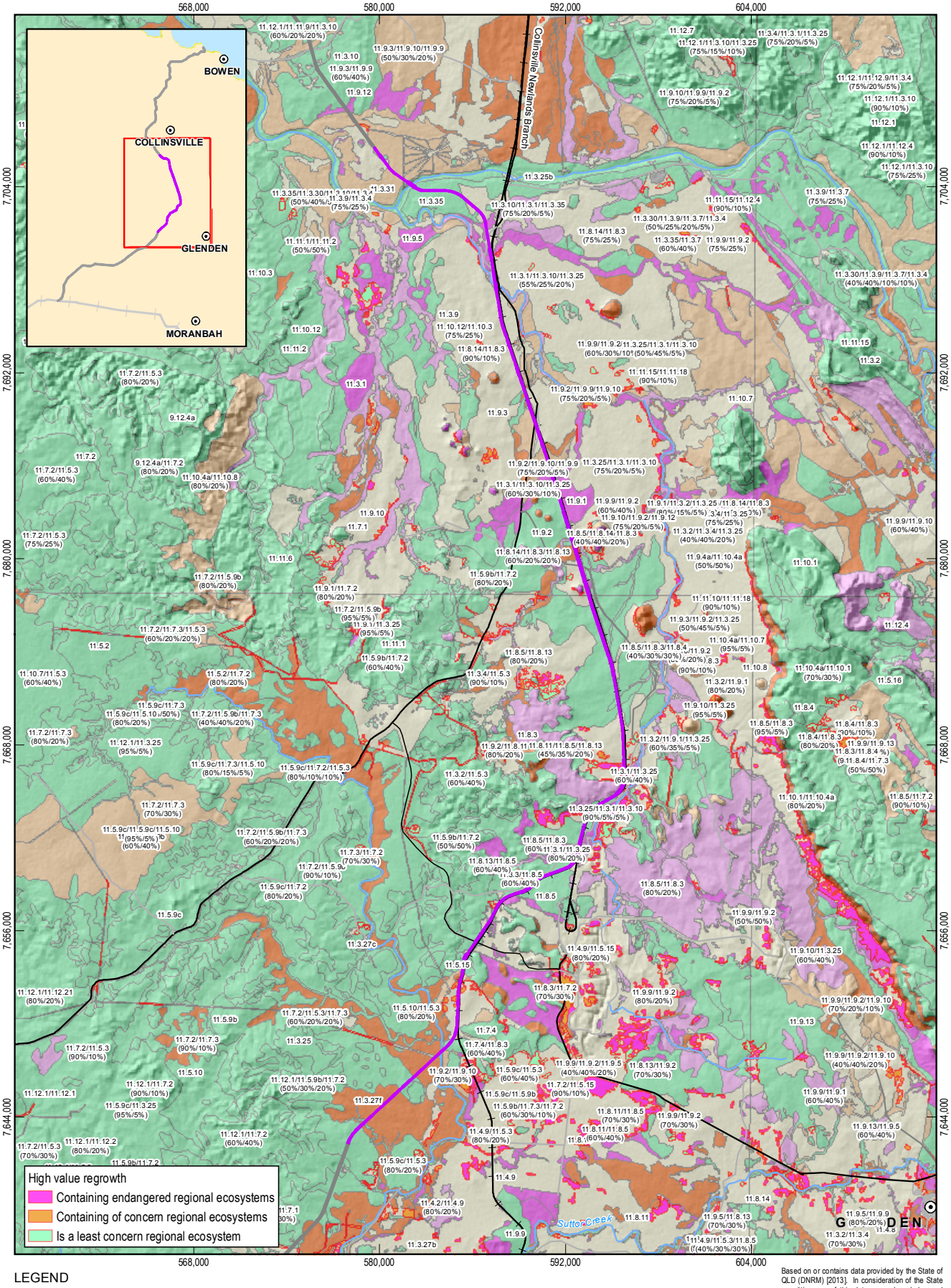
RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
		Flindersia australis, *Flindersia collina*, *Alstonia constricta*, *Excoecaria dallachyana*, *Geijera parviflora*, Notelaea spp., *Planchonella pubescens*, *Diospyros humilis* and *Denhamia oleaster*, with emergent *Brachychiton rupestris* or Flindersia australis. A dense shrub layer of *Psydrax odorata* and *Acalypha eremorum* is often present. May contain emergent *Eucalyptus decorticans* or *Eucalyptus melanoleuca* in some southern locations.	yellow earths.		Project realignment between chainage 190 km and 191 km.
Land zone 4					
11.4.9	Endangered/ endangered	Open-forest, occasionally woodland, dominated by *Acacia harpophylla* usually with a low tree mid-storey of *Terminalia oblongata* and *Eremophila mitchellii*. *Casuarina cristata* sometimes replaces *Acacia harpophylla* in the overstorey and *Lysiphyllum cunninghamii* sometimes co-dominates.	Occurs on level to gently undulating Cainozoic plains, including weathered basalt. Associated soils are predominantly moderately deep to deep cracking clays that may be brown, red-brown or grey-brown, and with much surface gravel in some areas.	Low	Mapped in mixed polygons in the central sections of the NGBR Project realignment between chainage 185 km and 188 km.
Land zone 3					
11.3.1	Endangered/ endangered	Open-forest dominated by *Acacia harpophylla* and/or *Casuarina cristata* (particularly in southern parts), with or without scattered emergent *Eucalyptus* spp. such as *E. coolabah*,	Landforms range from level to very gently sloping plains, alluvial flats, drainage floors, back-	Low	Predominantly mapped in the northern and central sections of the NGBR Project realignment in areas near Rosella Creek and

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
		E. largiflorens, *E. populnea*, *E. orgadophila*, and *E. woollsiana*.	swamps and abandoned channels. Associated soils are predominantly deep to very deep cracking clays, sometimes with gilgai or texture contrast soils with sandy surface (particularly where *Eucalyptus populnea* is present).		Kangaroo Creek.
11.3.2	Of concern/of concern	*Eucalyptus populnea* woodland to open-woodland. *E. melanophloia* may be present and locally dominant. There is sometimes a distinct low tree layer dominated by species such as *Geijera parviflora*, *Eremophila mitchellii*, *Acacia salicina*, *Acacia pendula*, *Lysiphyllum* spp., *Cassia brewsteri*, *Callitris glaucophylla* and *Acacia excelsa*.	Occurs on Cainozoic alluvial plains with variable soil types including texture contrast, deep uniform clays, massive earths and sometimes cracking clays.	Low	Present in large polygons at the southern end of the NGBR Project realignment.
11.3.4	Of concern/of concern	*Eucalyptus tereticornis* woodland to open-forest. Other tree species that may be present and locally dominant include *E. camaldulensis*, *Corymbia tessellaris*, *E. coolabah*, *C. clarksoniana*, *E. populnea* or *E. brownii*, *E. melanophloia*, *E. platyphylla* or *Angophora floribunda*.	Occurs on variety of soils, including deep cracking clays, medium to fine textured soils, and deep texture-contrast soils.	Low	Mapped in small polygons along the NGBR Project realignment, between chainage 158 km and 159 km.
11.3.7	Least concern/of concern	*Corymbia clarksoniana*, *C. tessellaris* and *C. dallachiana* tall woodland to open-woodland (12-17 m high). There is usually a low open-	Occurs on levees and plains formed from Quaternary alluvial	Low	A minor RE mainly mapped within the NGBR Project realignment with the Pelican

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
		woodland tree layer (7-11 m high) dominated by species such as *Acacia salicina*, *Lysiphyllum hookeri* or *Grevillea striata*.	deposits. Soils are usually deep uniform sands with minor areas of sandy red earths.		Creek and Bowen River flood plain.
11.3.9	Least concern/no concern at present	*Eucalyptus platyphylla* +/- *Corymbia clarksoniana* +/- *C. intermedia* +/- *E. tereticornis* +/- *Lophostemon suaveolens* woodland.	Occurs on Cainozoic alluvial plains, on sandy surface with clay subsoil. Usually with 'wet' influence, either closely adjacent to major river, or undergoes inundation relatively frequently. May occur in wet depressions.	Low	A minor RE mainly mapped within the NGBR Project realignment with the Pelican Creek and Bowen River flood plain.
11.3.10	Least concern/no concern at present	*Eucalyptus brownii* grassy woodland.	Occurs on Cainozoic alluvial plains.	Low	A relatively common RE mapped within the NGBR Project realignment, restricted to the Bowen River alluvial plain and those plains north of the Bowen River.
11.3.25	Least concern/of concern	*Eucalyptus camaldulensis* or *E. tereticornis* open-forest to woodland. Other tree species such as *Casuarina cunninghamiana*, *E. coolabah*, *Melaleuca bracteata*, *Melaleuca viminalis*, *Livistona* spp. (in north), *Melaleuca* spp. and *Angophora floribunda* are commonly present and may be locally dominant.	Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains throughout the region. Soils are very deep, alluvial, grey and brown cracking clays with or without some texture	Low	This RE fringes watercourses in the northern end of the NGBR Project realignment mapping along the Bowen River.

RE code	VM Act status/ biodiversity status	Description	Land form	Protected area representation[1]	Comments
			contrast.		
11.3.30	Least concern/no concern at present	*Eucalyptus crebra* or *E. paedoglauca* and *Corymbia dallachiana* woodland. Forms an open-woodland to open forest in places.	Occurs on older floodplain complexes on Cainozoic alluvial plains.	Low	A common RE in the NGBR Project realignment mapping north of the Bowen River, particularly prevalent on the coastal plain.
11.3.31	Least concern/of concern	*Ophiuros exaltatus* and *Dichanthium* spp. grassland. The ground layer has a variable composition, with drier areas dominated by *Ophiuros exaltatus*, *Iseilema membranaceum* or *Dichanthium* spp. or *Brachyachne tenella*.	Occurs on older floodplain complexes on Cainozoic alluvial plains. Black or dark grey earths or brown clays, in some areas with strong gilgai or debil debil microrelief. Often with self-mulching surface, and alkaline subsoil.	Low	A minor RE within the NGBR Project realignment, mapped near the Bowen River.
11.3.35	Least concern/no concern at present	*Eucalyptus platyphylla*, *Corymbia clarksoniana* woodland. This association usually occurs as woodland of *Eucalyptus platyphylla* and *Corymbia clarksoniana* with *Corymbia tessellaris* occurring in some areas.	Occurs on Cainozoic alluvial plains. Older floodplain complexes, major stream levees and lighter deltaic deposits.	Low	Mapped immediately south of the Bowen River in the northern section of the NGBR Project realignment.

[1] From REDD (Queensland Herbarium 2014)



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Regional ecosystems v6.1

- Endangered - dominant
- Endangered - sub-dominant
- Of Concern - dominant
- Of Concern - sub-dominant
- Least concern
- Non-remnant

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Certified regional ecosystems and regrowth mapping

Figure 6-7

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1163_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Rail Project (2012); DNRM: Physical Road Network (2010), Regional Ecosystems (2011), Regrowth (2011), Essential Habitat (2011). Created by: AJ

6.3.3 Vegetation communities and habitat

For the purposes of understanding the general vegetation patterns across the NGBR Project realignment, the 27 mapped REs can be reduced to a set of seven broad vegetation communities (BVCs), including one BVC that comprises non-remnant areas. The BVCs are based on similarities in the species composition and community structure of the vegetation. Six broad habitats which correspond with the BVCs were identified as occurring within the NGBR Project realignment footprint (refer Table 6-2). Each of the BVCs are summarised in Table 6-3.

Table 6-2 Broad vegetation communities and corresponding fauna habitats

Broad vegetation community	Fauna habitats
Natural grassland	Grassland
Brigalow/gidgee	Acacia dominated woodland/shrubland
Sclerophyll woodland/open forest (excluding watercourse associated vegetation)	Eucalypt woodlands
Woodland/open forest fringing watercourses	Fringing riparian vegetation
Vine thicket	Semi-evergreen vine thicket
Mixed species shrubland/low woodland	Eucalypt woodlands Acacia dominated woodland/shrubland
Non-remnant areas (including regrowth)	Non-remnant cleared land

Table 6-3 Broad vegetation communities identified within the NGBR Project realignment

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes*	Representative photo
Natural grassland 11.3.31, **11.8.11, 11.9.3** Includes the EPBC Act TEC 'natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin'.	Entirely located on plains and lowlands, mostly on clay.	Queensland blue grass (*Dichanthium sericeum*), white speargrass (*Aristida leptopoda*), curly Mitchell grass (*Astrebla squarrosa*), hoop Mitchell grass (*Astrebla elymoides*), coolabah (*Eucalyptus coolabah*), mountain coolabah (*Eucalyptus orgadophila*), *Paspalidium globoideum*, red bloodwood (*Corymbia erythrophloia*), red flinders grass (*Iseilema vaginiflorum*).	Primarily mapped in the central region of the NGBR Project realignment; however, the natural grasslands in the broader region have been almost entirely replaced by exotic pasture grasses.	
Brigalow/gidgee 11.3.1, **11.4.9, 11.9.1, 11.9.5** Includes the EPBC Act TEC 'Brigalow (*Acacia harpophylla* dominated and co-dominated)'.	Generally plains and lowlands, mostly on clays and loams; sometimes occurs on scarps and low ridges.	Brigalow (*Acacia harpophylla*), currant bush (*Carissa ovata*), Dawson's gum (*Eucalyptus cambageana*), *Enteropogon* spp., gidgee (*Acacia cambagei*), false sandalwood (*Eremophila mitchellii*), yellow wood (*Terminalia oblongata*), wilga (*Geijera parviflora*).	Condition for both brigalow and gidgee communities ranges from slightly to heavily modified. Usually at least the ground layer and sometimes the shrub layer is significantly altered, in some cases, the canopy has been thinned or removed by stock/clearing, which can also affect canopy species recruitment.	

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes*	Representative photo
Sclerophyll woodland/open forest (excluding watercourse associated vegetation) **11.3.2, 11.3.4**, 11.3.7, 11.3.9, 11.3.10, 11.3.30, 11.3.35, 11.5.3, 11.5.9, 11.7.3, **11.9.1**, 11,9,9, **11.9.10**	Occurs on all landform types across the corridor, most commonly on undulating to rolling country.	Brown's box (*Eucalyptus brownii*), Dallachy's ghost gum (*Corymbia dallachiana*), Dawson's gum, *Eucalyptus persistens*, mountain coolabah, narrow-leaved ironbark (*Eucalyptus crebra/drepanophylla*), peppermint gum (*Eucalyptus exserta*), poplar box (*Eucalyptus populnea*), poplar gum (*Eucalyptus platyphylla*), red bloodwood, silver-leaved ironbark (*Eucalyptus melanophloia*).	The diverse BVC is found along the entire NGBR Project realignment footprint. Grassy woodland/open woodland is the most common type of sclerophyll community, with shrubby woodland occurring less often. Most communities are slightly to heavily modified; at least one layer, almost always the ground layer, has been modified to some extent through the replacement of species by exotics. In some cases, the shrub layer has been thinned or removed by stock/clearing, which can also affect canopy species recruitment.	

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes*	Representative photo
Woodland/open forest fringing watercourse 11.3.25	Fringes watercourses.	Belalie (*Acacia stenophylla*), black ironbox (*Eucalyptus raveretiana*), black tea-tree (*Melaleuca bracteata*), carbeen (*Corymbia tessellaris*), coolabah, creek mahogany (*Lophostemon grandiflorus*), mat rush (*Lomandra* spp.), paperbarks (*Melaleuca dealbata, M. leucadendra, M. stenostachya, M. fluviatilis*), Queensland blue gum (*Eucalyptus tereticornis*).	This BVC is generally intact; however, in some areas the ground and shrub layers are often moderately to heavily infested with environmental weeds, particularly Hyptis (*Hyptis suaveolens*), snake weed (*Stachytarpheta jamaicensis*) and Urena lobata, and the class three declared weed lantana (*Lantana camara*). This BVC contains the listed vulnerable species (under both the EBPC Act and NC Act), black ironbox.	
Vine thicket **11.8.13** Includes the EPBC Act TEC 'Semi-evergreen vine thicket of the Brigalow Belt North and Nandewar Bioregions'	Occurs on coastal dunes (11.2.3), undulating rises and gentle slopes (11.11.18) and low hills and ranges (11.12.4).	Burdekin plum (*Pleiogynium timorense*), bush tuckeroo (*Cupaniopsis anacardioides*), broad-leaved bottletree (*Brachychiton australis*), caustic vine (*Sarcostemma viminale*), *Drypetes deplanchei*, *Jasminum didymum,* pythonwood (*Gossia bidwillii*), native peach (*Ehretia membranifolia*), small-leaved water vine (*Clematocissus opaca*), wild prune (*Sersalisia sericea*).	Vine thickets observed in the general area are considered to be in good condition; however many have thinned due to grazing and adjacent clearing, and area often infested with the class two weed Harrisia cactus (*Eriocereus* sp.).	

BVC name and associated REs[1]	Landforms	Characteristic species	Conditions and notes*	Representative photo
Mixed species shrubland/low woodland 11.7.2	Various landforms – most are on plains and lowlands, some are from ranges and low mesas.	*Acacia argyrodendron, A. catenulata,* beefwood (*Grevillea striata*), lancewood (*A. shirleylii*), *A. tephrina,* bulloke (*Allocasuarina luehmannii*), false sandalwood (*Eremophila mitchellii*), *Oxychloris scariosa.*	Often located in small, discrete patches, little modified from the natural state. These communities are generally located in marginal areas (highly erodible soils of low fertility) and consequently have not often been cleared or developed. Weed incursion is usually low.	
Non-remnant areas (including regrowth N/A	Various landforms, but mostly occurs on plains and lowlands (where soils and pasture are more suitable for farming).	Mostly exotic pasture species such as bluegrass (*Dichanthium aristatum*), buffel grass (*Cenchrus ciliaris*), creeping bluegrass (*Bothriochloa pertusa*), signal grass (*Urochloa mosambicensis*).	Non-remnant vegetation in the NGBR project realignment footprint, (other than in built areas or crops), is generally grazed and heavily modified from its natural state.	

[1]REs in bold are of conservation significance (of concern or endangered under the VM Act)

*BVCs observed during the NGBR Project EIS field surveys

6.3.4 Threatened ecological communities

The desktop database search identified three TECs as having the potential to occur within the NGBR Project realignment. Two of these have been confirmed present within one kilometre of the NGBR Project realignment footprint, during investigations for the Drake Coal Project EIS. The two endangered TECs confirmed present include the 'Brigalow (*Acacia harpophylla* dominant and co-dominant)' and 'Natural grasslands of the Queensland and central highlands and the northern Fitzroy Basin'. The third TEC has not been confirmed as present but is represented within the NGBR Project realignment footprint by a single RE, 11.8.13.

The occurrence of TECs was predicted based on the presence of TEC constituent REs occurring within the NGBR Project realignment. This assessment was undertaken using DNRM version 6.1 certified RE mapping. Based on previous project experience within the region, it is likely that the mapped extent of these REs is an over-estimation of their actual presence on the ground. The values of these communities and their presence or likely presence within the NGBR Project realignment footprint are discussed below.

Brigalow (Acacia harpophylla dominant and co-dominant)

The brigalow TEC (*Acacia harpophylla* dominant and co-dominant) is listed as endangered under the EPBC Act. This ecological community is characterised by the presence of brigalow (*Acacia harpophylla*) as one of the three most abundant tree species (Butler 2007). Brigalow is usually dominant in the tree layer or co-dominant with other species such as *Casuarina cristata* (belah), other species of Acacia, or species of Eucalyptus. Occasionally, belah or species of Acacia or Eucalyptus may be more common than brigalow within the broad matrix of brigalow vegetation. The structure of the vegetation ranges from open forest to open woodland. The height of the tree layer varies from about 9 m in low rainfall areas (averaging around 500 mm per annum) to around 25 m in higher rainfall areas (averaging around 750 mm per annum) (Butler 2007). A prominent shrub layer is usually present. Within Queensland, 16 REs are described as forming part of this TEC.

The TEC was confirmed present for Drake Coal Project EIS site and was represented by the RE 11.9.5. This RE, along with three of other constituent REs of the brigalow TEC (11.3.1, 11.4.9 and 11.9.1) is mapped within the NGBR Project realignment footprint (Figure 6-7). For more details regarding TECs refer to Section 7.

Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

The natural grasslands TEC is a tussock grassland community comprised of a number of native grass species throughout its range, depending upon factors such as rainfall, soil and geology. The TEC is endemic to Queensland, extending from Collinsville in the north to the Carnarvon National Park in the south, and broadly occurs within the Fitzroy River Basin and the Brigalow Belt North bioregion (TSSC 2008adq). The TEC is acknowledged (TSSC 2008adq) to only occur in certain subregions of the Brigalow Belt bioregion. In relation to the NGBR Project realignment, this correlates to the Northern Bowen Basin subregion which comprises an area between the Suttor Development Road and a point just south of Pelican Creek (Figure 6-8).

Native tussock grasslands, such as the natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin, once occurred over a large area of Australia (TSSC 2008adq). However, in general, natural grasslands TEC has been heavily affected by disturbance and degradation throughout the State and there are very few patches of undisturbed natural grasslands remaining (TSSC 2008adq).

The grassland TEC was confirmed present within a location within one kilometre of the NGBR Project realignment. The constituent REs for this TEC observed for the Drake Coal Project EIS included, 11.9.2 and 11.9.3. One of these constituent REs for this TEC is mapped within the NGBR Project realignment, along with an additional RE, 11.8.11 (Figure 6-7). For more details regarding TECs refer Section 7.

Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

The listed TEC comprises semi-evergreen vine thicket (SEVT) in eastern Queensland and northern New South Wales (TSSC 2001o). This TEC is listed as endangered under the EPBC Act.

Semi-evergreen vine thicket is considered an extreme form of dry seasonal subtropical rainforest (McDonald 1996). It is generally characterised by the prominence of trees with microphyll sized leaves (i.e. leaves usually 2.5–7.6 cm long), the presence of bottle trees (*Brachychiton* spp.) as emergents from the vegetation, and the thickets occurring in areas with a subtropical, seasonally dry climate on soils of high to medium fertility (Webb and Tracey 1994).

The SEVT ecological community extends from the Townsville area in Queensland to northern New South Wales. It is mostly located within the Brigalow Belt Bioregion. In Queensland, the remnant vine thicket patches are mostly scattered from coastal dunes and river deltas in the vicinity of Townsville and Ayr through the northern and central parts of the Brigalow Belt Bioregion to its south-eastern parts between Jandowae and Killarney on the Queensland/New South Wales border (Queensland Herbarium 2002).

In 2005, only about 140,000 ha of the TEC in the Brigalow Belt Bioregion remained as scattered patches (from Appendix 3 of McDonald 2007), or approximately 16 per cent of its pre-clearing area. It was estimated that approximately 1,000 ha of SEVT remained in the region, with the majority located along the eastern coastline to the south of Cape Upstart (CDM Smith 2012).

A total of one of the six constituent REs (11.8.13) for this TEC is mapped within the NGBR Project realignment and is considered likely to occur (refer to Section 7 for more detail on TECs).

6.3.5 Terrestrial flora

Flora species diversity

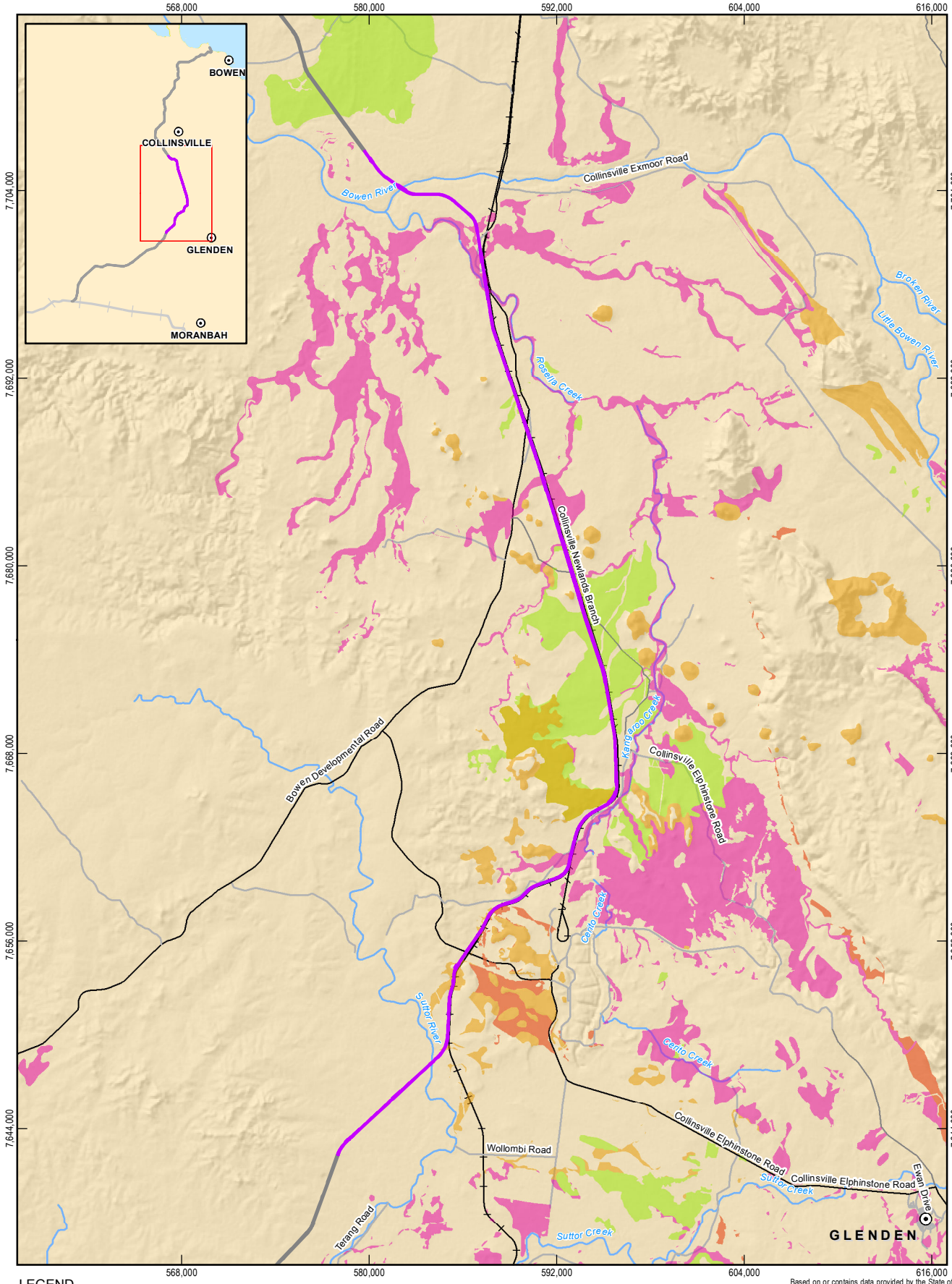
Desktop review identified a total of 521 flora species that have been historically recorded within the desktop search extent incorporating the NGBR Project realignment footprint. Of the 521 flora species previously recorded, 62 are introduced flora species.

Field surveys within the Drake Coal Project EIS survey area identified a total of 213 flora species (85 families) within one kilometre of the NGBR Project realignment. Of the 213 flora species recorded, 29 (18 percent) were introduced. A full species list from the desktop and database searches are provided inAppendix A.

Threatened terrestrial flora species – likelihood of occurrence

Five species listed under the EPBC Act and/or NC Act were predicted to occur within the NGBR Project realignment footprint. One threatened species, bluegrass (*Dichanthium setosum*), was confirmed present during field surveys for the Drake Coal Project EIS, located within one kilometre of the NGBR Project realignment. An additional single flora species was assessed as being likely to occur and four species as may occur within the NGBR Project realignment.

The species that were either confirmed present or likely to occur are discussed in detail below. The likelihood of occurrence assessment results can be found in Appendix B.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Semi-evergreen vine thickets of the brigalow Belt Bioregions (north and south)
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Threatened ecological communities

Figure 6-8

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1219_rev_a.mxd

Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Threatened Ecological Communities/2013. Created by:MS

Bluegrass (*Dichanthium setosum*)

Dichanthium setosum is listed as vulnerable under the EPBC Act. In Queensland, this species has been recorded from the Leichardt, Morton, North Kennedy and Port Curtis regions. Bluegrass is associated with heavy basaltic black soils and stony red-brown hardsetting loam with clay subsoil and is found in moderately disturbed areas such as cleared woodland, grassy roadside remnant, grazed land and highly disturbed pasture (TSSC, 2008agn).

Individuals of this species were recorded for the Drake Coal Project EIS within native grassland communities at three discrete locations. The soil types within the NGBR Project realignment are suitable for this species; however its occurrence is restricted due to the dominance of buffel grass and other introduced grasses that have encroached and out-competed native species throughout most of the NGBR Project realignment.

Black ironbox *(Eucalyptus raveretiana)*

Eucalyptus raveretiana is listed as vulnerable under the EPBC Act and the NC Act. It is a medium sized tree that grows to approximately 25 m and is endemic to Queensland. The species has a wide distribution in coastal and sub-coastal areas of Queensland, from south of Townsville to Nebo, around Rockhampton and areas 100 km west of the city (TSSC 2012au). Records from the HERBRECS database obtained from the Queensland Herbarium indicate the species is found in two main population areas to the north and northwest of Rockhampton, and centred around Collinsville (primarily to the north and south-east).

The species typically occurs along watercourses or on adjacent floodplains/alluvial flats on soils ranging from sandy to heavy clay (TSSC 2012au). To date, it has been recorded from about 23 sites throughout its range and is known to occur in the region. Population data for black ironbox is limited, although it is locally common on some permanent streams, including the Bowen River, but absent from many others (pers. comm., Bean 2010 cited in DotE 2014). The Bowen River intersects the NGBR Project realignment footprint at the footprint's northern extent.

King bluegrass (*Dichanthium queenslandicum*)

Dichanthium queenslandicum is listed as endangered under the EPBC Act and vulnerable under the NC Act.). It has been recorded in three key areas within Queensland; around Dalby on the Darling Downs, the Hughenden district; and from Nebo and Monto west to Clermont (TSSC, 2013n).

The species was not recorded during field surveys within the preliminary investigation corridor in May 2013, and was not recorded during field surveys for the Alpha Coal Project EIS or Drake Coal Project EIS. However, potentially suitable habitat (natural grassland) is likely to exist within the NGBR Project realignment footprint based on the species' known habitat requirements and a desktop assessment of vegetation mapping. Nevertheless, the occurrence of king bluegrass is likely to be limited by the dominance of buffel grass and other introduced grasses that are present throughout much of the final NGBR Project footprint.

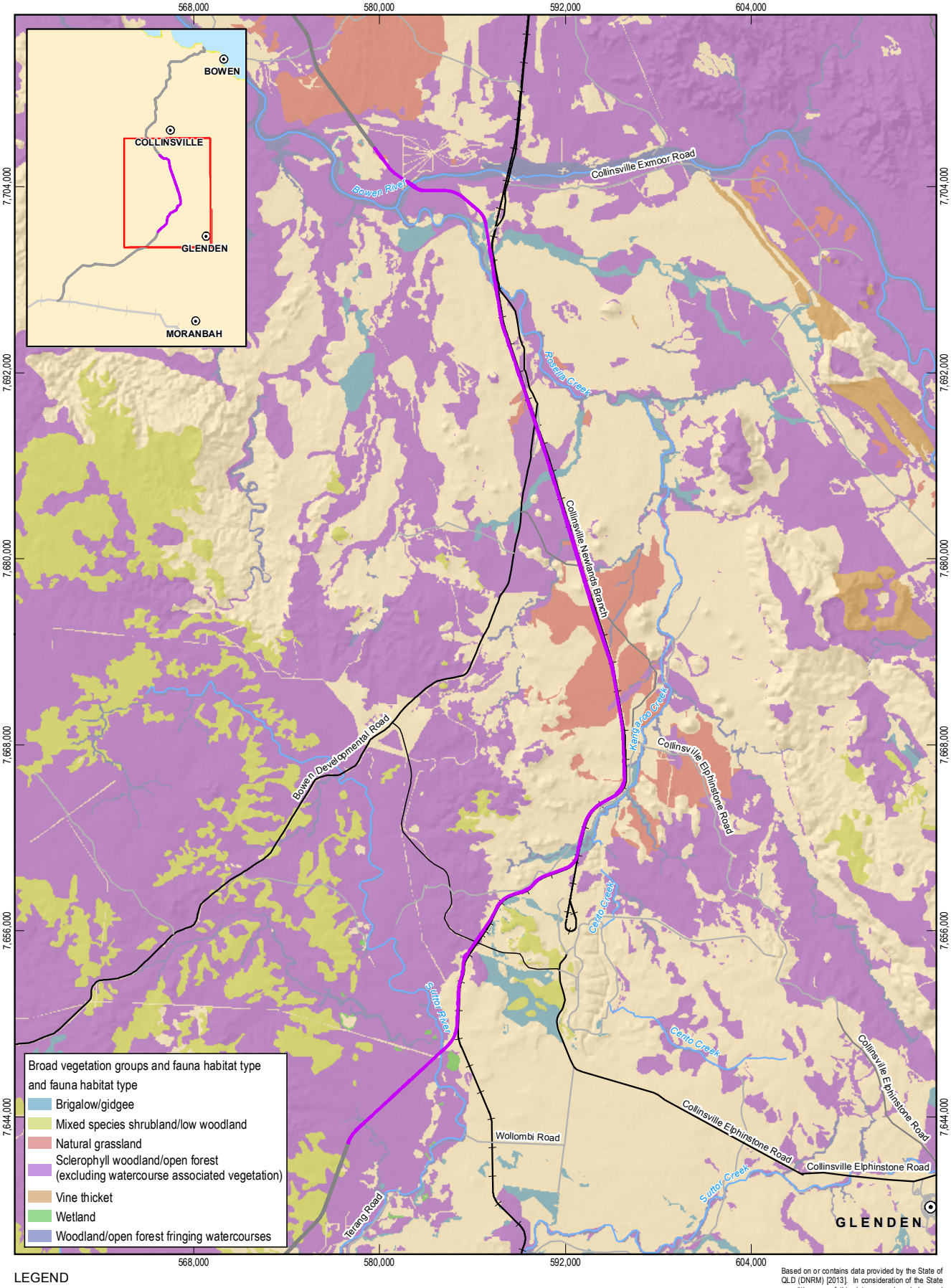
Introduced flora

The desktop review for weed species identified 10 species of declared plants under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) that have been recorded within the final rail corridor.

A total of 29 introduced plant species were recorded within one kilometre of the NGBR Project realignment footprint, during field surveys for the Drake Coal Project EIS. This included six declared weeds under the LP Act (Class 2), (refer Table 6-4).

Table 6-4 Declared weeds recorded along the NGBR Project realignment

Scientific name	Common name	Location in corridor
Class 2		
Cryptostegia grandiflora	Rubber vine	Individual recorded within one kilometre of the NGBR Project realignment.
Harrisia martini	Harrisia cactus	Recorded within one kilometre of the NGBR Project realignment as individual occurrences with less than one percent cover.
Opuntia stricta	Prickly pear	Recorded within one kilometre of the NGBR Project realignment as individual occurrences. Less than one percent cover.
Parthenium hysterophorus	Parthenium	Recorded within one kilometre of the NGBR Project realignment, approximately two percent cover, but some larger patches, particularly in the native grassland and around farm dams and access tracks were observed.
Acacia nilotica (now *Vachellia nilotica*)	Prickly acacia	Recorded within one kilometre of the NGBR Project realignment, generally less than two percent cover, but some larger patches were observed.
Ziziphus mauritiana	Chinee apple	Recorded largely along watercourses within one kilometre of the NGBR Project realignment. Overall less than one percent cover.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number 41-26457
Revision A
Date 28 Feb 2014

Broad vegetation groups and fauna habitat types

Figure 6-9

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1166_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

DData source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Broad Vegetation Communities (2013). Created by: AJ

6.3.6 Terrestrial fauna

Table 6-5 provides a summary of terrestrial fauna species predicted to occur, or previously recorded, as identified during the desktop assessments.

Table 6-5 Terrestrial fauna species diversity – desktop assessment

	Protected Matters Search Tool (predicted to occur)	DEHP Wildlife Online database (historically recorded)	Queensland Museum specimen database (historically recorded)	Birds Australia Atlas (historically recorded)
Species diversity	N/A	13 amphibians 54 reptiles 20 mammals 144 birds	12 amphibians 43 reptiles 0 mammals 171 birds	152 birds
Threatened EPBC Act listed species[1 2]	4 reptiles 2 mammals 6 birds	1 reptile 1 bird	1 reptile	2 birds
Threatened NC Act listed species[1]	4 reptiles 6 birds	2 reptiles 4 birds	1 reptile	5 birds
Introduced species	1 amphibians 8 mammals 3 birds	1 amphibian 4 mammals	1 amphibian	0 birds

[1] species listed under the NC Act and EPBC Act are not mutually exclusive and may be listed under both Acts

[2] whales, marine turtles and other marine species and marine and migratory bird species are not included in this table as the project is wholly terrestrial

* Note that these desktop results are based on historical records (of either a known or unknown date) or predictive modelling. Dated specimen collections range in age from 1974 through to 2005, and encompass a range of seasons.

Surveys undertaken within one kilometre of the NGBR Project realignment footprint for the Alpha Coal Project EIS and Drake Coal Mine EIS identified a total of nine amphibians, 25 reptiles, 23 mammals and 78 bird species within their project footprints (refer Table 6-6).

A full list of the terrestrial fauna species recorded within one kilometre of the NGBR Project realignment during surveys for the Alpha Coal Project EIS and Drake Coal Project EIS is provided in Appendix A.

Table 6-6 Terrestrial fauna species observed during surveys of Alpha Coal Project EIS and Drake Coal Project EIS within 1 km of NGBR Project realignment

	Amphibians	Reptiles	Mammals	Birds	Total
Total species	9	25	23	78	135
Introduced species	1	0	3	0	4
Threatened species (EPBC Act)	0	1	0	1	2
Threatened species (NC Act)	0	1	0	1	2
EPBC Act migratory	0	0	0	2	2
EPBC Act marine[1]	0	0	0	5	5

[1] Only bird species listed as marine under the EPBC Act are included, as these species may inhabit marine or terrestrial environments. Other marine species are not included as the project is wholly terrestrial.

Amphibians

Nine amphibian species were recorded during field surveys undertaken within one kilometre of the NGBR Project realignment during surveys for the Alpha Coal Project EIS and Drake Coal Project EIS. No threatened frog species listed under the EPBC Act or NC Act have been previously recorded or are predicted to occur within the region surrounding the NGBR Project realignment. Common amphibian species recorded in the region according to the Wildlife Online database include the bumpy rocket frog (*Litoria inermis*), broad-palmed frog (*Litoria latopalmata*), green tree frog (*Litoria caerulea*), ornate burrowing frog (*Platyplectrum ornatum*) and green-stripe frog (*Cyclorana alboguttata*). The exotic cane toad (*Bufo marinus*) is ubiquitous throughout the region.

Reptiles

A total of 25 reptile species were recorded in field surveys undertaken within one kilometre of the NGBR Project realignment during surveys for the Alpha Coal Project EIS and Drake Coal Project EIS. One threatened species, the ornamental snake (*Denisonia maculata*), listed as vulnerable under the EPBC Act and NC Act was recorded on the Drake Coal Project area, approximately one kilometre north of the Bowen River. Four other listed reptile species listed under the EPBC Act and NC Act have been recorded or are predicted to occur within the desktop search area. The likelihood of occurrence of these species is discussed in Section 6.3.7 and Appendix B.

Reptile species that are most frequently recorded within the region according to Wildlife Online database include dragons such as the bearded dragon (*Pogona barbata*), Tommy roundhead (*Diporiphora australis*), geckos including the dubious dtella (*Gehyra dubia*), Steindachner's gecko (*Diplodactylus steindachneri*), Bynoe's gecko (*Heteronotia binoei*), snakes including the Myall snake (*Suta suta*), ornamental snake, black-headed python (*Aspidites melanocephalus*) and Carpentaria whip snake (*Cryptophis boschmai*), Burton's legless lizard (*Lialis burtonis*) and skinks including *Carlia pectoralis* and copper-tailed skink *(Ctenotus taeniolatus).*

Mammals

A total of 23 mammal species were recorded in field surveys undertaken within one kilometre of the NGBR Project realignment during surveys for the Alpha Coal Project EIS and Drake Coal Project EIS. No threatened mammal species have been recorded. However, two mammal species listed under the EPBC Act are predicted to occur in desktop assessments of the region, the koala (*Phascolarctos cinereus*) and northern quoll (*Dasyurus hallucatus*). The likelihood of occurrence of these species is discussed in Section 6.3.7 and Appendix B. Three introduced mammals have been recorded from habitats within one kilometre of the NGBR Project realignment:

- Pig (*Sus scrofa*)
- Dingo (*Canis familiaris dingo*)
- European rabbit (*Oryctolagus cuniculus*).

Ground-dwelling mammals

Common ground-dwelling mammal species recorded within the region according to Wildlife Online database include the stripe-faced dunnart (*Sminthopsis macroura*), eastern grey kangaroo (*Macropus giganteus*), short-beaked echidna (*Tachyglossus aculeatus*), long-tailed planigale (*Planigale ingrami*) and rufous betong (*Aepyprymnus rufescens*).

Bats

Sixteen species of microchiropteran bats have been recorded in field surveys undertaken within one kilometre of the NGBR Project realignment during surveys for the Alpha Coal Project EIS and Drake Coal Project EIS. None of the species recorded are listed under the EPBC Act or NC Act. One species listed under the NC Act, the little pied bat (*Chalinolobus picatus*) is widely distributed throughout the broader region and has the potential to occur. Species that were recorded in surveys for the Alpha Coal Project EIS and Drake Coal Project EIS included the yellow-bellied sheathtail bat (*Saccolaimus flaviventris*), Troughton's sheathtail bat (*Taphozous australis*), inland broad-nosed bat (*Scotorepens balstoni*), Gould's wattled bat (*Chalinolobus gouldii*), chocolate wattled bat (*C. morio*), white-striped freetail bat (*Austronomus australis*), eastern bentwing bat (*Miniopterus orianae orianae*) and little bentwing bat (*M. australis*).

Birds

A total of 78 bird species have been recorded in field surveys undertaken within one kilometre of the NGBR Project realignment during surveys for the Alpha Coal Project EIS and Drake Coal Project EIS. These included one species listed under the EPBC Act and NC Act, the squatter pigeon (southern) (*Geophaps scripta scripta*). Nine bird species listed under the EPBC Act and/or NC Act have been previously recorded or are predicted to occur within the region according to desktop searches. The likelihood of occurrence of these species is discussed inSection 6.3.7 and Appendix B.

Common birds recorded within the region according to the Wildlife Online database include species that are typically found in open and cleared landscapes such as:

- Torresian crow (*Corvus orru*)
- Yellow-throated miner (*Manorina flavigula*)
- Striated pardalote (*Pardalotus striatus*)
- Pied butcherbird (*Cracticus nigrogularis*)

- Blue-faced honeyeater (*Entomyzon cyanotis*)
- Australian magpie (*Cracticus tibicen*)
- Galah (*Eolophus roseicapillus*)

Species that are typically associated with dams, waterbodies and water courses, such as:

- Australasian darter (*Anhinga novaehollandiae*)
- Hardhead (*Aythya australis*)
- Little black cormorant (*Phalacrocorax sulcirostris*)
- Eastern great egret (*Ardea modesta*)

Species that are found in open woodland areas, such as:

- Pale-headed rosella (*Platycercus adscitus*)
- Red-backed fairy-wren (*Malurus melanocephalus*)
- Singing honeyeater (*Gavicalis virescens*)
- Red-winged parrot (*Aprosmictus erythropterus*)
- Apostle bird (*Struthidea cinerea*)
- Grey-crowned babbler (*Pomatostomus temporalis*).

6.3.7 Threatened terrestrial fauna species likelihood of occurrence

A combined total of 23 threatened fauna species (listed under the NC Act or EPBC Act) were previously recorded or are predicted to occur within the NGBR Project realignment. This includes four mammals, seven reptiles and 12 birds. Two birds protected under the JAMBA, CAMBA and/or Bonn conventions, listed as migratory under the EPBC Act and special least concern under the NC Act have been confirmed from field surveys undertaken within one kilometre of the NGBR Project realignment. These two species were confirmed at locations within one kilometre of the NGBR Project realignment footprint during surveys for the Alpha Coal Project EIS and Drake Coal Project EIS. Five birds listed as marine under the EPBC Act (not NC Act listed) were also observed. Platypus (*Ornithorhynchus anatinus*) (special least concern wildlife under section 34(3) of the *Queensland Nature Conservation (Wildlife) Regulation 2006)* may also occur in the NGBR Project realignment footprint. A likelihood of occurrence assessment for threatened terrestrial fauna species was undertaken in accordance with the methodology outlined in Section 6.2.2 and is provided in Appendix B.

Seven listed threatened fauna species were considered likely to occur in habitats within and near the NGBR Project realignment, based on distribution, previous records and habitat suitability from the likelihood of occurrence assessment (refer Appendix B). Predictive habitat mapping for these species, based on the methodology outlined in Section 6.2.2 is presented in Appendix C. Eucalypt woodland, acacia dominated woodland and shrubland, and fringing riparian vegetation may provide habitat for the black-chinned honeyeater (*Melithreptus gularis*), black-throated finch (southern) (*Poephila cincta cincta*), common death adder (*Acanthophis antarcticus*) and little pied bat (*Chalinolobus picatus*). Eucalypt woodlands and fringing riparian vegetation were considered likely to provide habitat for the koala, based on sightings in similar habitat recorded during the NGBR Project EIS. Potential habitat for the black-throated finch (southern) includes fringing riparian vegetation and eucalypt woodlands featuring an understorey of suitable native grasses, where water is locally available. The black-necked stork

(*Ephippiorhynchus asiaticus*) and cotton pygmy-goose (*Nettapus coromandelianus*) are likely to occur within dams and waterbodies with floating vegetation.

Threatened marine and migratory species (listed under the EPBC Act) are addressed in Section 7.

Two threatened terrestrial fauna species were confirmed present in locations that occur within one kilometre of the NGBR Project realignment during field surveys for the Alpha Coal Project EIS and/or Drake Coal Project EIS (referAppendix B):

- Squatter pigeon (southern) (*Geophaps scripta scripta*) - vulnerable (NC Act), vulnerable (EPBC Act)
- Ornamental snake (*Denisonia maculata*) – vulnerable (NC Act), vulnerable (EPBC Act).

Squatter pigeon (southern)

Two squatter pigeons were recorded at locations within one kilometre of the NGBR Project realignment during field surveys for the Alpha Coal Project EIS (refer Figure 6-10). Squatter pigeons are commonly encountered within the region and are typically encountered from eucalypt woodland with a grassy understorey, and non-remnant cleared land habitat types. Potential habitat for this species occurs throughout the NGBR Project footprint. Squatter pigeons are associated with eucalypt woodland, fringing riparian vegetation and non-remnant cleared lands/regrowth areas (occurring on land zones 3, 4, 5, 7 and 10) within three kilometres of water (TSSC 2008agp). Predictive habitat mapping for this species is provided in Appendix C.

Ornamental snake

One ornamental snake was recorded within one kilometre of the NGBR Project realignment during field surveys for the Drake Coal Project EIS (refer Figure 6-10). This individual was found in a dry water trough with cracking clay sediments. The ornamental snake is a cryptic species with relatively specific habitat associations with brigalow woodlands, riparian areas and, in particular, gilgais (Shine 1983; Cogger *et al.* 1993). Therefore the distribution of potential habitat for ornamental snake is likely to be patchy along the final rail corridor. The species can persist in areas where brigalow has been cleared, provided suitable cracking clay soils and food sources (i.e. gilgais supporting frogs) remain.

Regionally significant fauna species

Of the fauna species potentially occurring within the NGBR Project realignment footprint, five priority reptiles, three priority birds and one priority mammal were identified in the Burdekin NRM Back on Track Actions for Biodiversity report (DERM 2010). Table 5-1 of NGBR Project EIS Volume 2 Appendix F Nature Conservation identifies 'Back on Track' priority species relevant to the NGBR Project and the NGBR Project realignment, including their regional-specific threats.

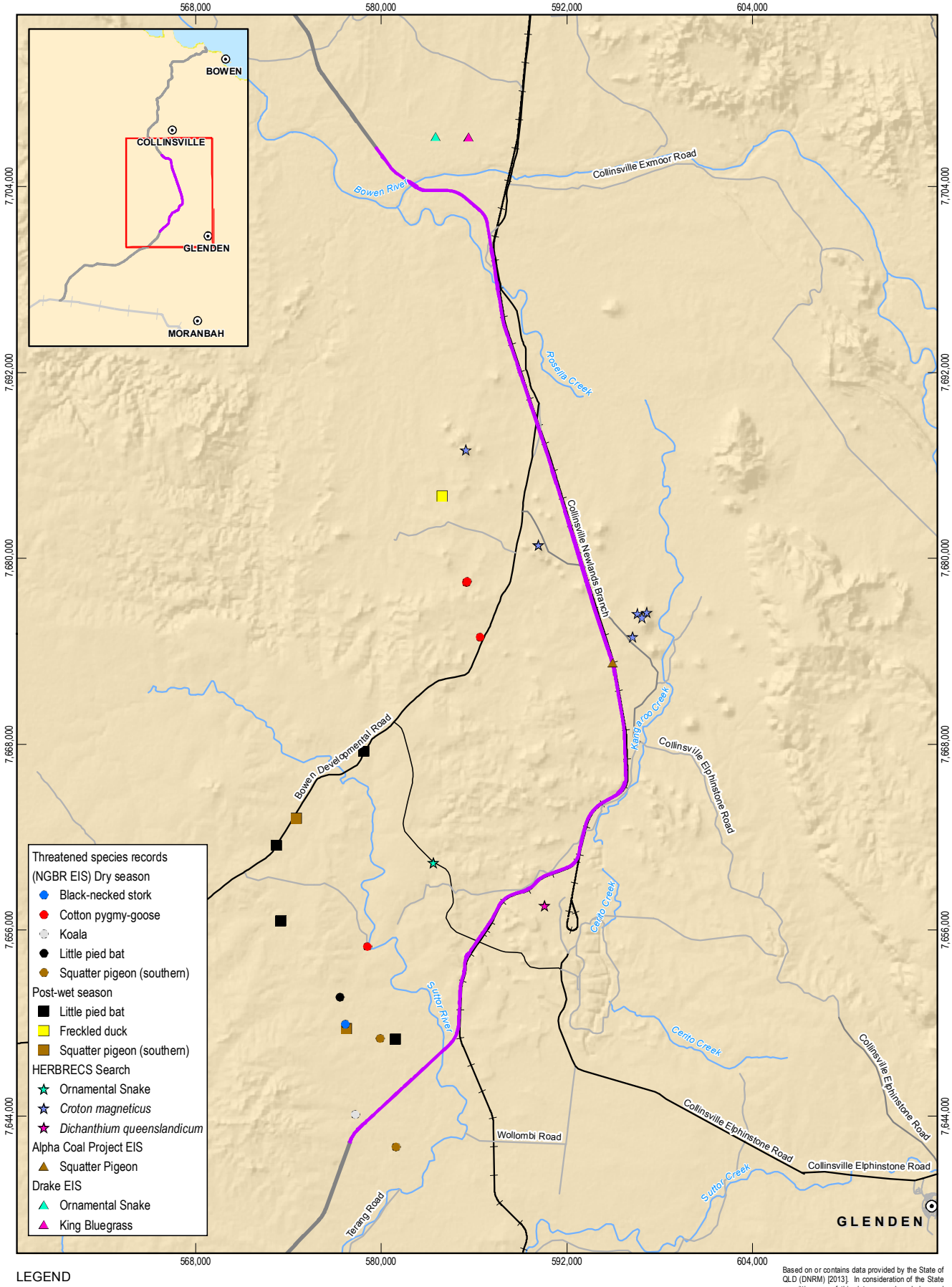
Introduced fauna

An assessment of the Queensland Department of Agriculture, Fisheries and Forestry (DAFF) maps illustrating the density and distribution of various pest species within the NGBR Project realignment indicated the following:

- Wild dogs, feral cats and cane toads are considered to be widespread and common
- European rabbits are considered to be widespread and occasional

- Feral pigs are considered to be widespread and common
- Feral horses are considered to be absent to occasional and localised
- The chital deer (*Axis axis*) is considered to be absent within the NGBR Project realignment, but occasional and localised in a small area north of the NGBR Project realignment near Collinsville
- European fox (*Vulpes vulpes*) is considered to be widespread and occasional to common
- The feral water buffalo (*Bubalis bubalis*) is mapped as being absent within the NGBR Project realignment, but occasional and localised in one small area north of the NGBR Project alignment near Collinsville.

Other introduced mammals that occur in the landscape include the house mouse (*Mus musculus*), black rat (*Rattus rattus*) and brown hare (*Lepus europeaus*). Tilapia (*Oreochromis mossambicus*), three spot gourami (*Trichogaster trichopterus*) and mosquitofish (*Gambusia holbrooki*) currently occur within the Burdekin River Basin (Pusey *et al.* 2004; Carter and Tait 2008). Tilapia (*Oreochromis mossambica*) has been observed in previous surveys of the Suttor River, Bowen River and Pelican Creek. For a list of introduced species recorded during field surveys for the NGBR Project, refer to the NGBR Project EIS Volume 2 Appendix F Nature conservation.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Threatened species records

Figure 6-10

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1186_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Herbarium, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010); GHD: Threatened Species Records (2013), Drake EIS: DigitisedThreatened Species (2011), Hancock EIS: Digitised Threatened Species (2010); Herbarium: HERBRES Searches (2014). Created by: AJ

6.3.8 Aquatic habitatsCattle egret

The NGBR Project realignment footprint crosses a variety of aquatic habitats. In total, 3 major waterways and 26 minor waterways are intersected by the NGBR Project realignment footprint. The major waterways crossed by the NGBR Project realignment are:

- Suttor River
- Rosella Creek
- Bowen River.

The aquatic habitats within and adjacent to the NGBR Project realignment footprint can be categorised as being either:

Riverine: all wetlands and surface water habitats within a channel (Plate 6-1). Channels may be naturally or artificially created, periodically or continuously contain moving water, or connect two bodies of standing water (EPA 2005). A number of small riverine channels exist within the NGBR Project realignment footprint. These small channels include narrow 1st order streams (hereafter referred to as drainage lines) which provide a pathway for flows during rainfall, but typically do not accommodate surface water for long periods. As drainage lines are ephemeral and hydrologically isolated for much of the year, they generally do not support aquatic communities for sustained periods of time. However, drainage lines can facilitate dispersal of aquatic organisms when surface waters are present and hydrologically connected.

Lacustrine: large, open, water-dominated systems (e.g. lakes) (Plate 6-2). Lacustrine habitats also include modified systems (e.g. dams), which have similar characteristics to natural lacustrine systems (e.g. deep, standing or slow-moving waters (EPA 2005)).

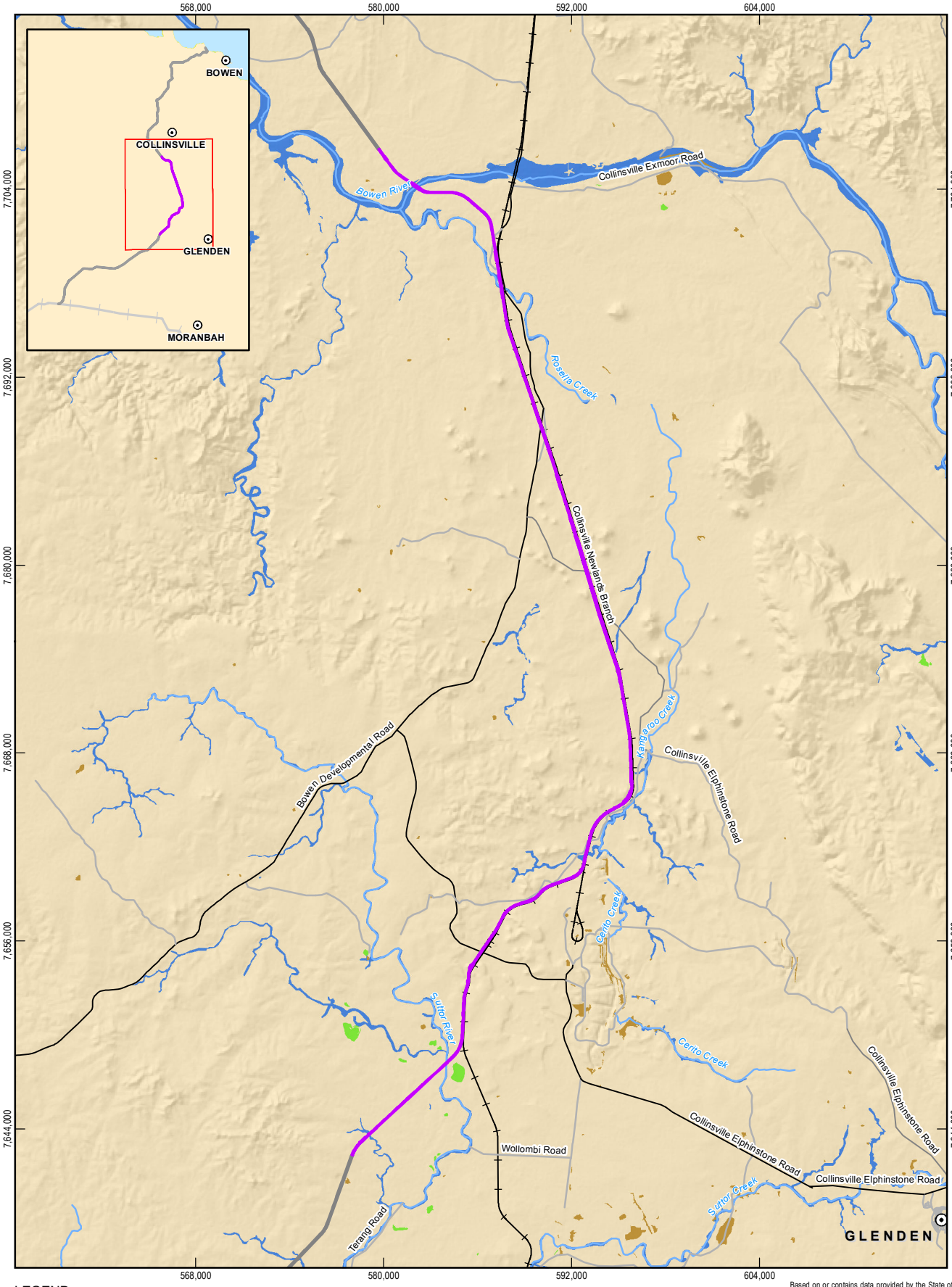
Palustrine: primarily vegetated off-channel environments (Plate 6-3). Palustrine habitats include billabongs, swamps, bogs, springs and soaks (EPA 2005). It should also be noted that gilgais are included within this category. Gilgais are microrelief depressions in cracking clay soils that form when the cycles of substrate shrinking and swelling create mounds and subsidence in the terrain (EPA 2005). These depressions then fill with rain water, and surface water may persist for some time. As a water source, gilgais can support a range of taxa; however, there are several species that are dependant or closely associated with gilgais, including a range of invertebrates and reptiles.

The riverine, lacustrine and palustrine habitats in the NGBR Project realignment footprint and wider study area are shown in Figure 6-11. No fish habitat areas declared under the *Fisheries Act 1994* occurs within 10 km of the NGBR Project realignment.

Plate 6-1 Example of a riverine habitat within the Burdekin River Basin

Plate 6-2 Example of a lacustrine habitat within the Burdekin River Basin

Plate 6-3 Example of a palustrine habitat within the Burdekin River Basin



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Habitats

- Lacustrine habitat
- Palustrine habitat
- Riverine habitat

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Aquatic habitat relevant to the NGBR Project realignment Figure 6-11

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1172_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Wetland Classification (2012). Created by: AJ

Aquatic habitats along the NGBR Project realignment are expected to provide habitat for fish, turtles, amphibians, waterbirds and invertebrates. Lacustrine, palustrine and riverine habitats also provide important habitat for many terrestrial species (such as waterbirds and amphibians) that depend on access to surface water. Waterbodies (and adjacent vegetation) provide drinking resources for numerous terrestrial fauna species and breeding habitat for amphibians and some bird species. Aquatic habitats also provided habitat for aquatic dependant mammals. Predatory species (including some birds of prey and snakes) also forage within aquatic habitats.

In general, the diversity of the aquatic community is highly influenced by the ephemerality of surface water, the quality of surface water and the habitat diversity (Therriault and Kolasa 2000). Perennial habitats typically support the most diverse and abundant aquatic communities and provide refugial habitat in dry periods. Alternatively, ephemeral habitats are dominated by species that are capable of undergoing periods of dormancy (aestivation) when surface waters disappear (Larned *et al.* 2007). Aerial dispersers (e.g. mayflies, dragonflies and waterbirds) are also likely to colonise ephemeral surface waters (Bogan and Boersma 2012).

Findings from the Great Barrier Reef catchments Aquatic Conservation Assessments for riverine (Inglis and Howell 2009a) and non-riverine wetlands (Inglis and Howell 2009b) identified a number of aquatic dependant flora species within the Burdekin River Basin. A total of 179 aquatic dependent flora species (of which 24 are introduced) were identified as occurring in riverine and/or non-riverine wetlands within the Burdekin River Basin. These species potentially occur within the NGBR Project realignment footprint. The ACA documents also identified seven aquatic flora species that are listed as 'threatened' under the NC Act and/or EPBC Act in the Burdekin River Basin. Wildlife Online and HERBRECS searches respectively identified 12 and 10 aquatic flora species occurring within the NGBR Project realignment footprint (full list provided in Appendix A. All of these species are listed as NC Act 'least concern'.

A total of 21 aquatic flora genera were identified in the field surveys for the NGBR Project EIS (including black ironbox (*Eucalyptus raveretiana*) (as discussed in Section 6.3.5)) (further details are provided in the NGBR Project EIS Volume 2 Appendix F Nature conservation). All 21 aquatic flora species are likely to occur within the NGBR Project realignment footprint.

The aquatic habitat values of the Bowen and Suttor Rivers are presented in the following sections. These prescriptive assessments of the aquatic habitat values are based on previous field surveys conducted within these catchments.

Bowen River catchment

The Bowen River is a broad river channel (approximately 300 m wide) characterised by sand bars, bed rock and clay margins. The field survey of the Bowen River (undertaken May 2013 for the NGBR Project EIS) is relevant to this assessment of ecological values as the aquatic habitat assessment site is approximately 6.4 kilometres upstream (as the fish swims) from the NGBR Project realignment footprint. Therefore, the aquatic habitat and ecological values at the NGBR Project realignment footprint crossing are likely to be similar. The May 2013 survey showed that deep pools were present, as well as rocky riffles and shallow backwaters (Plate 6-4). At the time of the survey, surface water was fast flowing and slightly turbid. The margins of the river had trailing vegetation, with stands of *Melaleuca* sp. in the bed (partially submerged) and on the banks of the reach. The site had varied aquatic habitat, and is likely to support a diverse and abundant fish, turtle and aquatic invertebrate community.

Field surveys undertaken for the Drake Coal Project EIS in the Drake Coal Project area, located north of the Bowen River adjacent to the NGBR Project realignment, identified that most natural drainage features and watercourses within the Drake Coal Project area are ephemeral in

nature, and only flow after rainfall. There are numerous (approximately 10) dams scattered across the Drake Coal Project area that hold permanent water (GHD 2012). All of the waterways within the Drake Coal Project area have been altered and impacted, generally as a result of cattle grazing (GHD 2012). Substrates surveyed within waterways consisted mostly of clays, and hard substrates (boulders, bedrock etc.) were absent. Riparian vegetation on the banks of the Bowen River consisted of mixed eucalypt and melaleuca woodland as observed during field surveys of the riparian vegetation within the Drake Coal Project area (GHD 2012).

Plate 6-4 Rocky riffle in the Bowen River, May 2013

Suttor River catchment

The Suttor River is the main waterway in the Suttor River catchment. The NGBR Project realignment crosses the upper Suttor River at the southern end of the NGBR Project realignment footprint (Figure 6-2). Riverine wetlands (RE 11.3.25) and freshwater wetlands with naturalised species (RE 11.3.27f) occur in the catchment. These are listed as 'least concern' under the VM Act (DEHP 2014a; DEHP 2014b).

The riverine environments of the catchment have been described as seasonal waterbodies with mainly bed rock to clay substrates (E3 Consulting 2010). The upper reaches of the Suttor River is a small channel with shallow runs, riffles, pools and woody debris. Erosion is prevalent in the Suttor River, with banks being extensively undercut and mature trees falling as the soil around their roots is eroded. The May/June 2013 field survey findings (refer NGBR Project EIS Volume 2 Appendix F Nature conservation) and the October 2013 field survey findings (refer Volume 1 Section 7.2.1) at the upper Suttor River were consistent with previous surveys in 2010, with the substrate being sand dominated in the upper Suttor River (Plate 6-5) (E3 Consulting 2010; GHD 2010a). No submerged aquatic macrophytes were observed during previous surveys conducted in 2010 at the upper Suttor River, most likely due to the high turbidity of the waters (E3 Consulting 2010). During the May/June/October 2013 field surveys, turtles, mussel shells, dead yabbies and freshwater crab burrows were observed in the Suttor River proper or its tributaries, and the Suttor River proper was found to provide habitat for aquatic communities.

Plate 6-5 Upper Suttor River (E3 Consulting 2010)

A field survey was undertaken in Rockingham Creek (a tributary of the Suttor River) in May 2013, approximately four kilometres upstream (as the fish swims) of the NGBR Project realignment. At this site dense sedges and lomandra were observed fringing the banks. This vegetation provides habitat for fish, turtles and invertebrates (Plate 6-6). Further details of the aquatic habitats in the broader Suttor River catchment are provided in the NGBR Project EIS Volume 2 Appendix F Nature conservation.

Plate 6-6 Shallow, flowing surface water at Rockingham Creek, May 2013.

6.3.9 Aquatic fauna

The fish community within the NGBR Project realignment footprint is likely to consist of a diverse range of species, given the broad range (i.e. lacustrine, palustrine and riverine) of habitats within or near to this area. A total of 35 fish species (3 introduced species and 32 native species not listed as threatened) are expected to occur within the NGBR Project realignment footprint, based on known presence and distributions described in Pusey *et al.* (2004), Carter and Tait (2008), Wildlife Online and the Queensland Museum records (refer Appendix A). The full fish species list of the Burdekin River Basin (which also includes a summary of the biology

and habitat requirements of each species) is presented in the NGBR Project EIS Volume 2 Appendix F Nature conservation (Appendix E). Each of the 35 fish species potentially occurring within the NGBR Project realignment footprint has specific movement requirements for breeding or non-breeding purposes.

The movement biology of fish can determine the extent of their distribution within a catchment. A marine vagrant is unlikely to occur in fresh headwater streams; alternatively, a diadromous species (i.e. a species that regularly migrates between fresh and marine waters) is unlikely to occur upstream of barriers to their dispersal. For the Burdekin River Basin, most diadromous species are thought to be restricted to the lower Burdekin River catchment as a result of both natural and artificial barriers to fish passage (Pusey *et al.* 1998; Cater and Tait 2008). Therefore, fish species occurring within the NGBR Project realignment are likely to have movement biology categorised as being either:

- **Sedentary:** species that do not actively or directionally migrate – can fulfil their entire life cycle within a single wetland, pool or river reach
- **Potamodromous:** species which undertake breeding or dispersal migrations wholly within freshwater (Carter and Tait 2008).

Of the 35 sedentary/potamodromous species likely to occur within the NGBR Project realignment, the following seven species are of AquaBAMM conservation 'priority':

- Freshwater longtom (*Strongylura krefftii*)
- Hyrtl's tandan (*Neosilurus hyrtlii*)
- Purple-spotted gudgeon (*Mogurnda adspersa*)
- Sailfin glassfish (*Ambassis agrammus*)
- Small-headed grunter (*Scortum parviceps*)
- Snakehead gudgeon (*Giurus margaritacea*)
- Soft-spined catfish (*Neosilurus mollespiculum*) (Inglis and Howell 2009a; Inglis and Howell 2009b).

A total of 17 fish species have been previously identified from Queensland Museum, Wildlife Online and relevant EIS fish surveys of the NGBR Project realignment (Appendix D). Of these species, three (marbled eel (*Anguilla reinhardtii*), barramundi (*Lates calcarifer*) and bullrout (*Notesthes robusta*)) are catadromous (migrate from freshwater to marine waters to spawn). Only the marbled eel (*Anguilla reinhardtii*) is of AquaBAMM conservation 'priority'. Further information on fish species and their biology can be found in Appendix D.

The Burdekin River Basin contains known habitat for up to five freshwater turtle species (Cann's long-necked turtle (*Chelodina canni*); eastern snake-necked turtle (*Chelodina longicollis*); Irwin's turtle (*Elseya irwini*); Krefft's river turtle (*Emydura macquarii krefftii*); saw-shelled turtle (*Wollumbinia latisternum*)) (Inglis and Howell 2009a; Inglis and Howell 2009b). Within the Suttor and Bowen River catchments, Krefft's river turtle (*Emydura macquarii krefftii*) was the only species observed during field surveys undertaken for the NGBR Project EIS (on one occasion in the Suttor River during the May 2013 field survey). Cann's long-necked turtle (*Chelodina canni*) was recorded from a June 2002 Queensland Museum record in the Bowen River. While turtle records within the Suttor and Bowen Rivers are scarce it is likely that the NGBR Project realignment intersects potential habitat for all the above turtle species, based on the habitat values of these rivers (Section 6.3.8). Further information on the habitat preferences of

freshwater turtles in the Suttor and Bowen River catchments is provided in the NGBR Project EIS Volume 2 Appendix F Nature conservation.

The estuarine crocodile (*Crocodylus porosus*) is listed as 'migratory' and 'marine' under the EPBC Act, and 'vulnerable' under the NC Act. This species inhabits coastal and estuarine waters, but can also be found in a range of riverine, palustrine and lacustrine freshwater habitats. It is typically confined to larger perennial rivers, coastal waterways and estuaries. Therefore, it is considered likely that this species will occur within the NGBR Project realignment footprint, particularly in the Bowen River. The estuarine crocodile has been previously recorded from the Burdekin River Basin (DotE 2014c).

Five species of aquatic macroinvertebrates have been previously observed within the Suttor and/or Bowen River catchments. These species are the:

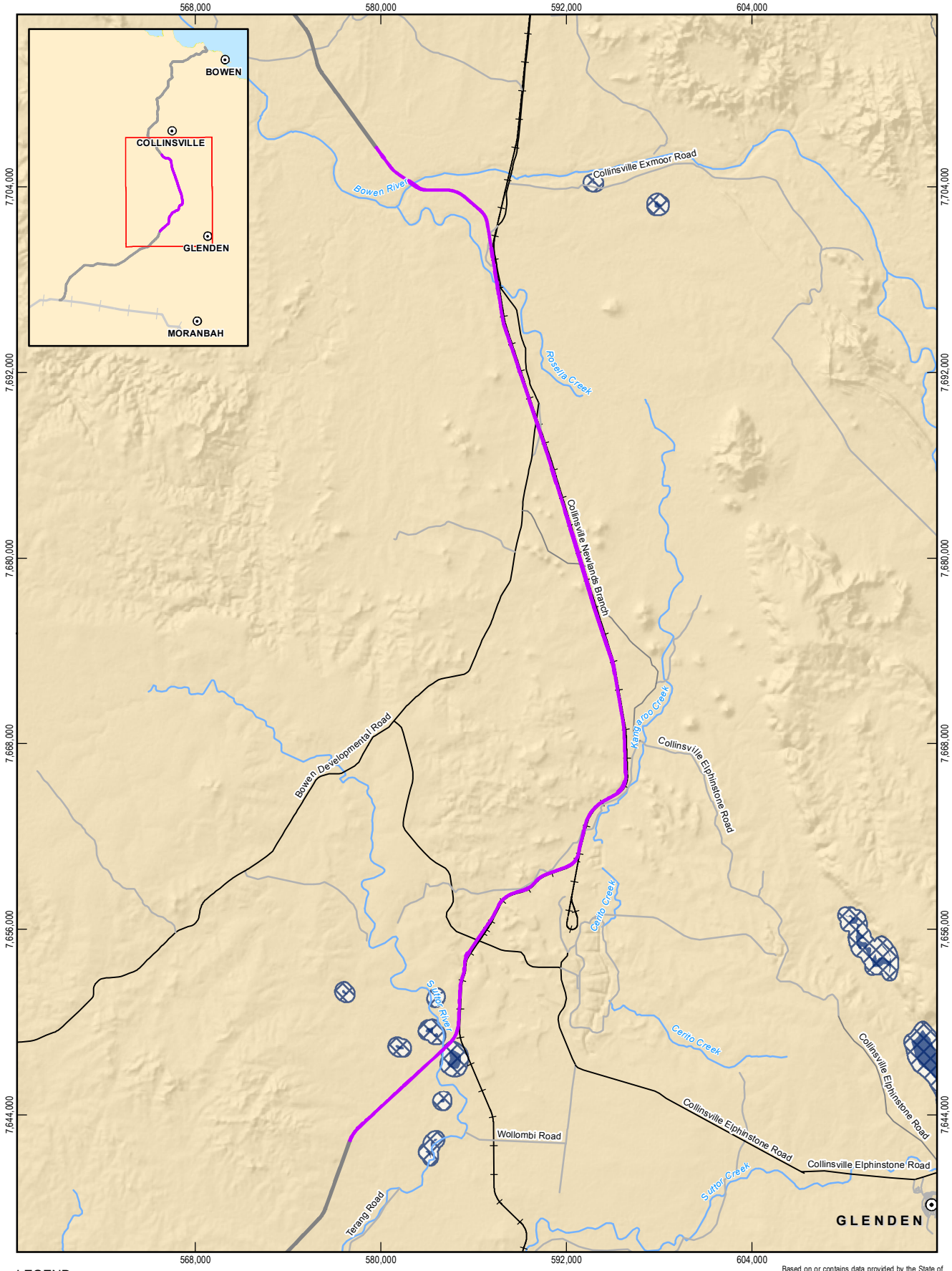
- Freshwater crab *(Austrothelphusa transversa)*
- Orange-fingered yabby *(Cherax depressus)*
- Freshwater mussel *(Alathyria sp.)*
- Freshwater shrimp *(Caridina sp.)*
- Australian river prawn *(Macrobrachium australiense).*

All of these species, in addition to a variety of other freshwater macroinvertebrates, are likely to occur within the NGBR Project realignment footprint.

6.3.10 Wetland protection areas and nationally important wetlands

Wetlands considered being of high ecological significance in GBR catchments are identified as wetland protection areas (WPAs). These WPAs are surrounded by a 500 m trigger area (taken from the outside margin of the WPA) for assessable developments. The NGBR Project realignment footprint does not intersect any WPAs (Figure 6-12). However, it does fall within the trigger area for a single WPA. This WPA (be_nr_fl_02) lies to the east of chainage 197 km, approximately 90 m from the NGBR Project realignment footprint (Figure 6-12).

No nationally listed wetlands occur within the NGBR Project realignment footprint. One such wetland does, however, occur downstream. The Bowen River: Biralee – Pelican Creek Wetland (recorded in the Directory of Important Wetlands in Australia (DIWA is located within the Bowen River catchment approximately 13.5 km downstream of the NGBR Project realignment footprint (Figure 6-13).



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Wetland protection area
- Wetland protection area trigger

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Wetland Protection Areas relevant to the NGBR Project realignment

Job Number	41-26457
Revision	A
Date	27 Feb 2014

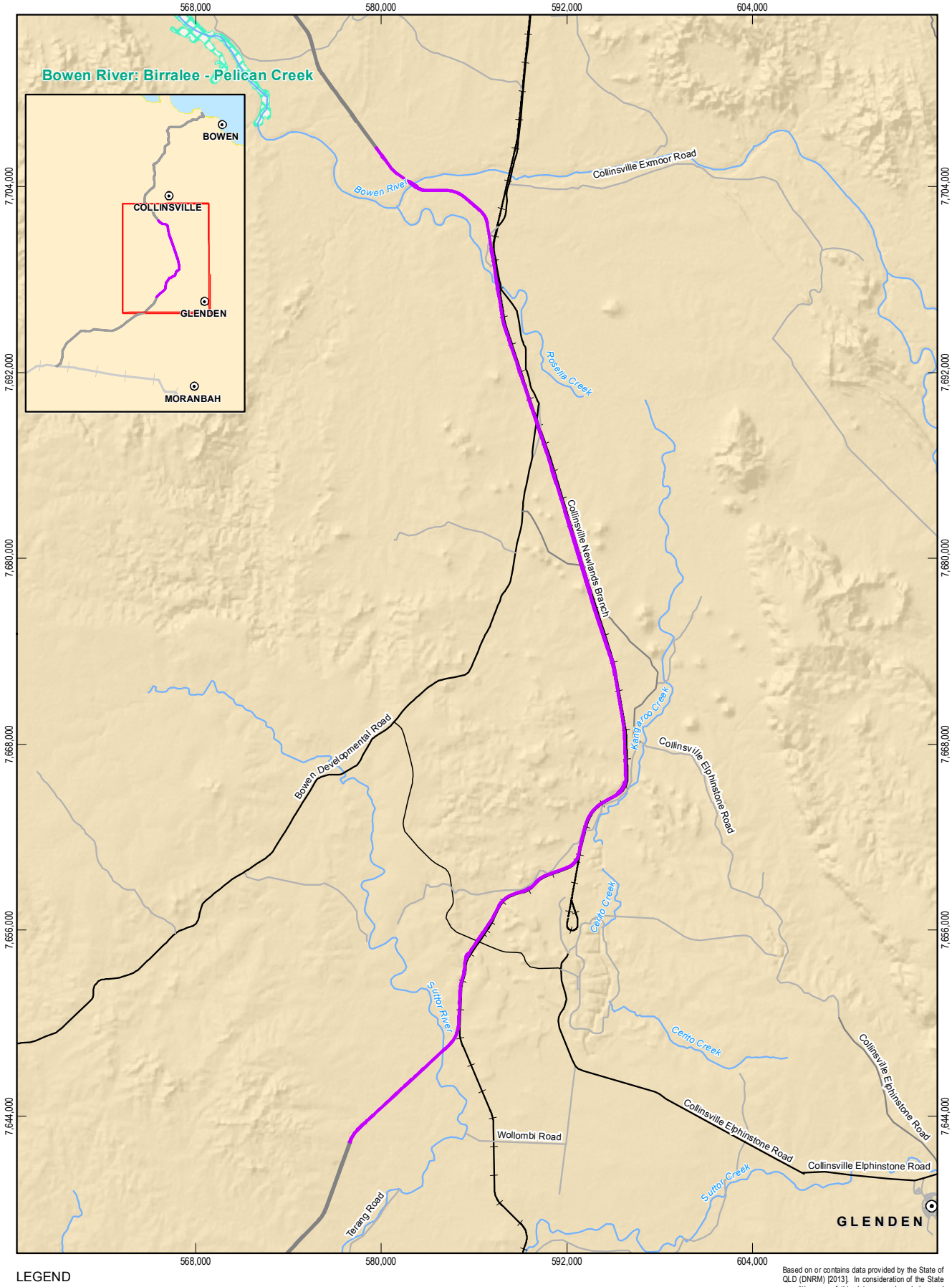
Figure 6-12

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1169_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network, Wetland Protect Area, WPA Trigger (2010). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Directory of important wetlands

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Nationally important wetlands in or of relevance to the NGBR Project realignment

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Figure 6-13

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1167_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network, DOIW (2010). Created by: AJ

6.3.11 Existing threatening processes

Much of the NGBR Project realignment is immediately adjacent to the existing Newlands line and is therefore subject to existing levels of vegetation clearing and intermittent noise, vibration, dust and light impacts due to existing rail operations.

These localised impacts occur within a landscape which has historically been, and continues to be, exposed to a diverse array of threatening processes. Sattler and Williams (1999) identified continued vegetation clearing, high total grazing pressure and exotic species as the major threats to biodiversity in the Brigalow Belt bioregion. The Burdekin NRM Back on Track Actions for Biodiversity report (DERM 2010) details a variety of threatening processes impacting upon priority terrestrial and aquatic taxa in the region. These include:

- Clearing of vegetation
- Feral animals (terrestrial and aquatic)
- Baiting
- Disease
- Vehicle collisions with wildlife
- Inappropriate fire regimes
- Inappropriate grazing regimes
- Linear infrastructure development and maintenance
- Mining
- Urban development
- Weeds (terrestrial and aquatic)
- Flow regime disruption (including disruptions to flow regimes and groundwater extraction)
- Water quality alteration.

These threatening processes are mostly related to the land use in the Brigalow Belt bioregion. Historical vegetation clearing has occurred in parts of the landscape to facilitate agricultural and mining industries, and associated infrastructure (such as roads and railways). Vegetation clearing has resulted in direct mortality of flora and fauna, habitat loss, habitat fragmentation and the erosion and sedimentation of watercourses. The introduction of non-indigenous grazing animals (mainly cattle) has resulted in terrestrial and aquatic habitat degradation in many parts of the NGBR Project realignment. Evidence of trampling, overgrazing, soil compaction and dung deposition were frequently observed, particularly adjacent to natural and artificial water sources (GHD 2010a and GHD 2010b).

Feral animals and exotic plants are relatively abundant and widespread throughout the region. Previous surveys, including those for the Alpha Coal Project EIS, Drake Coal Project EIS and NGBR Project EIS recorded the riparian areas throughout the landscape as appearing to be particularly susceptible to weed invasion, with a number of weed infestations noted. Introduced fauna or evidence of introduced fauna was common, particularly in riparian areas surrounding watercourses.

6.4 Potential impacts

Impacts to terrestrial and aquatic flora and fauna resulting from the NBGR Project realignment will be largely consistent with those described in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation. However, the magnitude and extent of these impacts is expected to be somewhat reduced, as the NGBR Project realignment is located directly adjacent to the existing Newlands line for much of its length. Given the disturbed nature of the Newlands line corridor, vegetation clearing for construction of the NGBR Project realignment is expected to have less of an impact on native vegetation, habitats, resources and wildlife compared to vegetation clearing occurring in a previously undisturbed area. Some operational impacts associated with noise and dust emanating from trains and the barrier effects attributed to the rail corridor may be exacerbated, given the NGBR Project realignment will run directly adjacent to the Newlands line for much of its length.

The key potential impacts during construction include:

- Vegetation clearance and the resulting loss of habitat and resources, fragmentation of habitats, injury and mortality to wildlife,
- Increased light, noise and vibration and the associated disturbance to wildlife
- Run-off, sedimentation, erosion and the resulting degradation of terrestrial and aquatic habitats
- Disturbance of watercourses and changes to surface water flows and the resulting degradation of aquatic habitats
- Increased anthropogenic activity leading to the introduction of weeds and pest fauna.

The key potential impacts during operation include:

- Loss of habitat connectivity and restricted fauna movement, due to the ongoing presence of the rail corridor
- Impacts of coal dust, noise and vibration on flora and fauna attributed to daily train movements
- Injury or mortality of fauna from collision with trains, maintenance vehicles and wire fencing and other infrastructure
- Spread of weeds and pests attributed to access by maintenance vehicles and other anthropogenic influences

Impacts on nature conservation values attributed to the NGBR Project realignment are discussed below. A comprehensive review of impacts attributed to the broader NGBR Project is described in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation. In addition, management measures to mitigate these impacts are summarised in Section 6.5 and explained in greater detail in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation.

6.4.1 Construction

Terrestrial vegetation communities

During construction, the NGBR Project realignment will require clearing of approximately 805 ha of vegetation, of which approximately 543 ha is mapped remnant vegetation (VM Act). The

mapped remnant vegetation encompasses 27 RE types within the Brigalow Belt bioregion. The total area of expected impact on endangered, of concern and least concern REs is summarised in Table 6-7.

The area required for clearing is based on the NGBR Project realignment footprint containing a nominal 60 m final rail corridor and ancillary infrastructure.

Table 6-7 Vegetation clearing impacts on regional ecosystems

RE status	Clearing amount
Endangered	41.4 ha
Of concern	43.4 ha
Least concern	458.1 ha
Total	542.9 ha

Vegetation clearing will require removal of a number of high conservation status REs (i.e. endangered, of concern and threshold REs). The individual REs that will undergo the greatest extent of clearing are 11.9.2 (104 ha), 11.8.5 (88 ha) and 11.5.3 (62 ha). Together they equate to approximately 18 per cent of the total clearing extent required during construction (including non-remnant land), and 47 per cent of the 453 ha of mapped remnant vegetation expected to be cleared. Table 6-8 summarises the extent of clearing for the NGBR Project realignment footprint compared to the amount of RE present within the bioregion and subregion. REs listed as least concern have not been included in Table 6-8.

Table 6-8 Vegetation clearing impacts on high conservation status REs

RE	Area of proposed clearing	Bioregion current extent[1]	Current extent within subregion[2]	% of subregion extent[3]
Endangered REs				
11.3.1	21.48	80,877	8,199	<0.01
11.4.9	3.99	95,498	9,920	<0.001
11.8.13	7.49	6,623	5,163	<0.01
11.9.1	7.52	55,028	5, 326	<0.01
11.9.5	0.94	166,571	11,117	
Of concern REs				
11.3.2	20.20	521,054	34,828	<0.001
11.3.4	9.61	183,756	28,957	<0.001
11.8.3	4.14	26,262	2,674	<0.01
11.8.11	0.84	178,562	21,869	<0.001
11.9.10	8.56	82,524	17,122	<0.001

[1] Figures calculated from DEHP 2013; 'current extent' is from 2009

[2] Current extent within subregion is the sum of each RE's current extent from all subregions traversed by the NGBR Project realignment: Bogie River Hills and Northern Bowen Basin

[3] % - proposed clearing extent as % of subregion current extent

In addition to the area of remnant vegetation and regulated regrowth vegetation that will be impacted within the NGBR Project realignment footprint, a further 262.8 ha of non-remnant land (currently utilised for predominantly grazing purposes) will be utilised for construction of the NGBR Project realignment footprint. This equates to a total of 33 per cent of the total clearing area of the NGBR Project realignment footprint.

For the purposes of understanding the general vegetation patterns within the NGBR Project realignment footprint, the 27 mapped REs were reduced to six BVCs based on similarities in the species composition and vegetation communities recorded in the desktop search extent (refer Section 6.3.3). As each BVC corresponds with a broad fauna habitat type (refer Table 6-2) the extent of each BVC potentially impacted by vegetation clearing is assessed in Section 6.3.3.

The NGBR Project realignment will require clearance of EPBC Act listed threatened ecological communities. These impacts are discussed separately in the Revised MNES Report (Volume 2 Appendix D Revised MNES). An application for a permit to clear native vegetation under the *Vegetation Management Act 1999* (VM Act) will be required for all construction activities associated with the NGBR Project, including the NGBR Project realignment. This will need to consider Module 8 of the State Development Assessment Provisions (SDAP) which outlines clearing performance requirements for coordinated projects. These requirements are presented in NGBR Project EIS Volume 1 Chapter 6 Nature conservation.

Terrestrial flora and flora habitat

As described in Section 6.3.5, a number of flora species were identified as occurring within one kilometre of the NGBR Project realignment. Additionally, database searches identified a number of flora species that are likely to occur within the NGBR Project realignment.

Individuals and/or populations of some of these species will be lost from the local environment due to vegetation clearing during construction of the NGBR Project realignment. This has the potential to reduce genetic diversity within populations of these species, and population dynamics and ecosystem function may be altered as suitable habitat for dispersal and germination will be lost. In addition, isolation of some populations of flora species (particularly those that require outcrossing for viable seed production) may increase the risk of inbreeding depression.

One threatened species, bluegrass (*Dichanthium setosum*), was confirmed present during field surveys for the Drake Coal Project EIS in proximity to the NGBR Project realignment. An additional single flora species, black ironbox (*Eucalyptus raveretiana*) was assessed as being likely to occur.

Bluegrass (Dichanthium setosum)

Key threatening processes for bluegrass are identified as heavy grazing by domestic stock, loss of habitat through clearing for pasture improvement and cropping, changes in fire regime (e.g. regular burning for agricultural purposes, invasion by introduced grasses and road widening.

Bluegrass has been observed in grassland habitat within one kilometre of the NGBR Project realignment (Hancock Prospecting Pty Ltd 2010). Within the NGBR Project realignment footprint, potential habitat for the species includes areas of native grassland and open-woodland

with a predominately native ground layer, where the ground layer has not been invaded by exotic pasture grasses. The estimated construction impact on mapped habitat within the NGBR Project realignment that is potentially suitable for this species is 354.2 ha. This is likely to represent an over-estimation of the actual occurrence of bluegrass within the NGBR Project realignment footprint. This is because the species is not certain to be present within every occurrence of the mapped REs within the footprint based on previous surveys conducted in the region.

It is therefore considered unlikely that the clearance will result in significant impacts to an important population of the species, either through causing long-term decreases in population sizes or significantly reducing the area of overall occupancy available to that species. Direct impacts on *Dichanthium setosum* will be minimised through the implementation of the mitigation measures outlined in Section 6.5

Black ironbox (Eucalyptus raveretiana)

Key threatening processes for black ironbox are identified as the loss of individuals (for example through timber harvesting), the proliferation of invasive weed species, and changes to water resources (TSSC 2012au). The loss of individuals is dealt with below, with weeds and water resources discussed within operational impacts.

Black ironbox has been observed within the region within riparian vegetation, including the Bowen River which intersects the NGBR Project realignment footprint at its northern extent. Within the NGBR Project realignment footprint, potential habitat areas include riparian habitat along a total of seven creek and river corridors (Rosella Creek, Stony Creek, Plum Creek, Bowen River, Cerato Creek, Suttor River and Rockingham Creek) comprising REs 11.3.25 and 11.3.37, where black ironbox is generally found to be co-dominant with other Eucalypt species. A total of 125.1 ha of potential habitat for the species is mapped within the NGBR Project realignment footprint and will be cleared to facilitate construction. This is likely to represent an over-estimation of the actual occurrence of black ironbox within the NGBR Project realignment. This is because the species is not certain to be present within every occurrence of the mapped REs within the investigation corridor based on previous surveys conducted in the region.

Furthermore, in terms of the actual impact to black ironbox during construction, clearance at creek crossings is only likely to result in the loss of a few individual black ironbox trees, at most, at each crossing point where RE 11.3.25 is present. Given that the REs will be present as a fringing band along the creek or river, it will remain present on either side of the cleared footprint, as will individual black ironbox trees within those areas.

It is therefore considered unlikely that the clearance will result in significant impacts to an important population of the species, either through causing long-term decreases in population sizes or significantly reducing the area of overall occupancy available to that species.

Terrestrial fauna and faunal habitat

Vegetation clearing during construction of the NGBR Project realignment will result in the direct loss of habitat for a variety of birds, reptiles, mammals and frogs. Direct loss of vegetation includes the removal of structural features (i.e. mature vegetation, hollow-bearing trees and hollow logs) that provide microhabitats and resources for fauna. Loss of these habitat features creates a loss of perching, foraging and den/nesting resources for native species. This is likely to reduce the number of individual animals that can be accommodated in a given area and will likely increase competition for resources such as food and shelter in remaining remnant habitats. Hollow-bearing trees are recognised as a limited resource in most grazing lands due to

previous clearing and therefore the loss of these habitat features is considered to be a major threat to Australia's biodiversity (Gibbons and Lindenmayer 2002). The types of fauna habitat and total area that would be cleared during construction within the NGBR Project realignment footprint will include:

- 85.8 ha of native pastures or grasslands
- 15.9 ha of vine thicket
- 34.8 ha of Acacia dominated woodland/shrubland
- 387.3 ha of eucalypt woodlands
- 19.3 ha of fringing riparian vegetation
- 2.2 ha of mixed species shrubland/low woodland
- 292.9 ha of non-remnant and cleared land.

In addition to these habitat types, three major watercourses are likely to be impacted by construction activities. These natural and artificial water bodies provide a source of water for birds and mammals. Consequently, construction activities will reduce the local availability of these habitats.

The loss of terrestrial fauna habitat as a result of the NGBR Project realignment will reduce localised resource availability for a range of fauna species, including:

- Amphibians – particularly suitable habitat types include: open woodland fringing watercourses and on flood plains; wetland vegetation and mapped watercourses
- Reptiles – particularly suitable habitat types include: brigalow shrubland to open forest; eucalypt open woodland; mixed species shrubland/low woodland; and open woodland fringing watercourses and on flood plains
- Birds – suitable habitat types include: native pastures or grasslands; vine thicket; brigalow shrubland to open forest; eucalypt open woodland; mixed species shrubland/low woodland; open woodland fringing watercourses and on flood plains; wetland vegetation; and open cleared land and regrowth
- Mammals – suitable potential habitat types include: native pastures or grasslands; vine thicket; brigalow shrubland to open forest; eucalypt open woodland; mixed species shrubland/low woodland; open woodland fringing watercourses and on flood plains; wetland vegetation; and open cleared land and regrowth.

The loss of terrestrial fauna habitat for the NGBR Project realignment will result in the direct loss of potential habitat for four EPBC Act-listed threatened fauna species confirmed present or considered likely to occur within the NGBR Project realignment (refer Table 6-9). The potential impact of the NGBR Project on these species is discussed in Section 7.

Three of the EPBC-Act listed threatened fauna species that were confirmed present or are likely to occur within the NGBR Project realignment are also listed under the NC Act. These three species, along with five other NC Act-listed threatened fauna species, were confirmed present or considered likely to occur within the footprint. The loss of terrestrial fauna habitat will thus result in the direct loss of potential habitat for eight NC Act-listed threatened fauna species. The direct impact on potential habitat for fauna species listed under the NC Act is summarised in Table 6-9.

Table 6-9 Loss of potential habitat for threatened fauna

NC Act-listed fauna species	EPBC Act status	NC Act status	Total clearing extent within of the NGBR Project realignment footprint[1]
Confirmed present			
Squatter pigeon (southern)	Vulnerable	Vulnerable	320.5 ha
Ornamental snake	Vulnerable	Vulnerable	174.7 ha
Likely to occur			
Black-throated finch (southern)	Endangered	Endangered	495.5 ha
Koala (QLD, NSW and ACT populations)	Vulnerable	Special least concern	514.2 ha
Cotton pygmy-goose	Not listed	Near threatened	15.1 ha
Little pied bat	Not listed	Near threatened	524.8 ha
Black-necked stork	Not listed	Near threatened	158.8 ha
Black-chinned honeyeater	Not listed	Near threatened	417.5 ha
Common death adder	Not listed	Near threatened	524.8 ha

[1] Total clearing extent is based on the broad vegetation community/fauna habitat types as they apply to each species. However, the exceptions are black throated finch (which had its mapped potential habitat refined through mapping only those REs that known records of species have been obtained) and the squatter pigeon (which had its habitat mapped based on REs characterised by open woodland and forest vegetation).

Dust, noise and light impacts on terrestrial fauna

Other than the direct loss of habitat due to vegetation clearing, construction activities have the potential to indirectly degrade the quality of adjacent habitats and habitat edges, through exposure to increased noise, vibration, light, dust, sedimentation and erosion. Exposure to these impacts may alter habitat composition (i.e. reduced flora diversity and simplified ecosystem structure) and quality (i.e. reduced availability of forage resources, increased exposure to predators), thereby potentially changing species diversity in the altered habitat. Where increased light, noise and dust degrade or simplify habitat at the edge, it is possible the species diversity and habitat utilisation in this edge habitat will be altered and the diversity of native species reduced. Indirect construction impacts on habitat quality will vary in their spatial extent. Dust and sedimentation impacts caused by road activity are typically restricted to within 40 m of a road edge, while noise impacts can penetrate further than 200 m from the road (Goosem 2007).

The operation of plant and equipment during construction may disrupt local fauna behaviour, largely as a result of increased exposure to light, noise, dust, vehicles and people. Behavioural disruption may have both direct and indirect consequences. Direct consequences include increased susceptibility to predation due to increased noise reducing prey vigilance, or

increased light increasing prey detectability. Indirect consequences include habitat degradation reducing local resource availability therefore increasing foraging dispersal distances for fauna. In addition, there is potential for localised disturbance to wildlife behaviours and dynamics such as foraging, breeding and nesting.

Mitigation and management measures that would be implemented to minimise and avoid potential dust, light, noise and sedimentation impacts during construction of the NGBR Project realignment are discussed in Section 9, Section 4, Section 10 and Section 5 respectively.

Terrestrial habitat fragmentation

Much of the NGBR Project realignment runs immediately adjacent to the existing Newlands line. As such, much of the Project Area has already been exposed to a level of habitat fragmentation. Nevertheless, by increasing the width of rail infrastructure, the NGBR Project realignment has the potential to exacerbate barrier effects on local wildlife by restricting their capacity for movement. Fragmentation will occur during active construction. However the indirect impacts on native fauna will be ongoing.

Fragmentation can increase the isolation of wildlife populations, by reducing their capacity to move between habitat remnants. Wildlife subject to high levels of habitat fragmentation typically become more reliant on local resources and more vulnerable to impact from local catastrophes such as fires and localised flooding (Gilpin and Soule 1986). Habitat fragmentation tends to have a delayed and cumulative impact, resulting in a gradual decline in species diversity. The nature and severity of habitat fragmentation impacts also tends to vary depending on the level of existing fragmentation within the landscape. When landscapes are relatively intact, species declines are moderate, and directly attributed to habitat loss (Andren 1994). At high levels of fragmentation, losses are more severe and attributed to the reduced size and increased isolation of habitat remnants (Andren 1994; Marsh and Trenham 2001).

The NGBR Project realignment impacts an environment that is already highly fragmented by decades of broadscale vegetation clearing. Within that context, habitat fragmentation resulting from the NGBR Project realignment is unlikely to have a regional impact on fauna diversity. However, it is likely to cause localised impacts, by intersecting corridors that are important for local wildlife movement (e.g. along watercourses) and isolating and reducing the size of individual habitat patches.

Terrestrial fauna mortality and injury

The clearing of native vegetation during construction has the potential to directly impact fauna if they are accidentally struck by vehicles, machinery or falling vegetation. Fauna particularly at risk include those that shelter in hollow-bearing trees, beneath logs, rocks and bark (i.e. arboreal mammals, nocturnal birds, reptiles and frogs), ground animals that typically hide rather than flee in response to approaching danger (i.e. bandicoots, quails and pigeons) and nocturnal species that are inactive during daylight hours and therefore less inclined to disperse away from diurnal clearing activities. This includes conservation significant species, such as the ornamental snake and brigalow scaly-foot.

Other activities associated with construction, such as vehicle movements and operation of machinery, have the potential to cause additional sources of wildlife mortality wherever an interaction between vehicle/machinery and fauna occurs. Livestock and wildlife that are highly mobile are also at increased risk of being trapped or injured in open pits or trenches within

construction areas. The potential incidence of direct mortality would be minimised during construction through the implementation of the mitigation measures outlined in Section 6.5.

Aquatic habitat degradation

As discussed in Section 6.3.8, the NGBR Project realignment footprint crosses a variety of aquatic habitats including three major waterways and 26 minor waterways. Construction activities within or near to these waterways will potentially impact riparian vegetation and aquatic habitats. In particular, the construction of bridge structures, pipe culverts and box culverts will require the clearing of riparian vegetation and potential disturbance of in-stream habitat. Further information on the construction of infrastructure within and adjacent to watercourses is provided in the Volume 2 Appendix B Revised Project description.

The impacts of the construction phase on aquatic habitats are expected to be consistent with those presented in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation. The construction process is also expected to be consistent with that presented in the aforementioned document. Further detail regarding site specific information for waterway barriers including compliance with self-assessable codes and the duration of the disturbance will be developed during detailed design. In total, 26.8 ha of mapped riparian vegetation and 47.0 ha of mapped wetland vegetation will require clearing.

The majority of aquatic habitats within the NGBR Project realignment footprint are already exposed to a number of existing disturbances, including:

- Erosion and scouring of stream banks due to vegetation clearing
- Cattle and pig disturbance within riparian habitat
- Disturbance generated by the movement of farm vehicles through or alongside waterways
- Increased chemical and nutrient loading and runoff from nearby roads and agricultural activities.

The existing turbidity and total suspended solids in the Suttor and Bowen River catchments are up to four times the value of the relevant water quality objective for the protection of aquatic ecosystems (refer Section 8). The loss of riparian vegetation, land-use practices and presence of cattle and pig disturbance may contribute to the high turbidity. Although aquatic ecosystems in ephemeral systems are likely to be adapted to peaks in high turbidity during some periods, an increase in the magnitude or the frequency of these peaks in turbidity due to construction activities has the potential to have a detrimental effect on aquatic habitats.

The NGBR Project realignment footprint is located approximately 13.5 km upstream (waterway length) of the DIWA listed Bowen River: Birralee – Pelican Creek wetland. In addition, the NGBR Project realignment footprint passes through a WPA trigger area and close to a cluster of WPAs on the southern end of the footprint. Construction activities may have the following indirect impacts on the Bowen River: Birralee – Pelican Creek wetland and/or nearby WPA:

- Disturbance of riparian and aquatic habitat also has the potential to lead to increased erosion and sediment transport to downstream habitats during rainfall events, which can impact on water quality and the suitability of aquatic habitat
- Contaminants (e.g. chemical spills) also have the potential to impact on the water quality of local waterways and sensitive downstream aquatic habitats

- Flow paths may be temporarily and permanently diverted by changes to landscape topography as a result of earthworks during construction. Changes to the flow patterns to the Bowen River: Birralee – Pelican Creek wetland and/or nearby WPA has the potential to impact aquatic habitats and communities in these wetlands.

Extraction of water for construction activities from rivers and surface water storage has the potential to impact aquatic communities including sensitive downstream aquatic habitats on the Bowen River: Birralee – Pelican Creek wetland and/or nearby WPA.

The impacts on aquatic habitats during the construction phase are expected to be consistent with those presented in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation.

Barriers to dispersal of aquatic taxa

Many of the aquatic fauna species expected (and known) to occur within the Suttor and Bowen River catchments undertake migration and dispersal within watercourses for breeding and non-breeding purposes. Wholly aquatic species are especially vulnerable to the impacts of artificial barriers as the physical (i.e. hydrological) connectivity is reduced (Hughes 2007). Barriers to aquatic movement have the potential to:

- Reduce connectivity, where aquatic fauna are physically unable to undertake migratory or dispersal events that are essential components of their lifecycle
- Exclude aquatic fauna from critical habitats, that is, habitats that are essential for the continuation of the population/species
- Reduce population connectivity, which can reduce genetic diversity (Allendorf 1983; Marsden and Power 2007).

The construction of waterway crossings has the potential to disturb and impair the movement of aquatic fauna within a waterway by creating temporary barriers to migration up and downstream. Temporary barriers to fish movement may be required during construction of bridge and culvert structures, to create suitably stable and dry working conditions. An application under the *Fisheries Act 1994* will be obtained where culvert or bridge installation requires works within a defined waterway. The impacts on aquatic habitat connectivity and fauna movement during the operation phase are expected to be consistent with those presented in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation.

Aquatic fauna and communities

Construction activities within and adjacent to waterways within the NGBR Project realignment footprint may have a range of impacts on aquatic communities. In general, the construction activities may impact aquatic communities in the following ways:

- Vegetation clearing or contaminant spills have the potential to impact on the water quality of local waterways and aquatic fauna. Increased suspended sediment loads can clog fish and invertebrate gills, smother bottom dwelling invertebrates (Dunlop et al. 2005) while chemical spills may result in direct fauna mortality.
- Water extraction will be required for a number of activities as part of the NGBR Project realignment (refer Volume 2 Appendix B Revised project description). The extraction of water from rivers and surface water storage can reduce the base flow of the watercourses and potentially impact aquatic communities including sensitive downstream aquatic habitats (in particular, the Bowen River: Birralee – Pelican Creek wetland). However, the NGBR Construction Water Supply Strategy (NGBR Project EIS Volume 2 Appendix H3) concluded that impacts to surface water will be negligible. Therefore the associated

impacts on aquatic communities are expected to be minimal, depending on the timing, method and amount of water extracted from aquatic ecosystems. A construction water supply strategy will be further developed during detailed design to identify water supply requirements and to determine adequate water supply sources.

- Direct injury or mortality to aquatic fauna due to machinery strike, particularly during vegetation clearing in riparian areas or construction of watercourse crossings, will be avoided and minimised through the implementation of a Flora and Fauna Management Plan.

The impacts on aquatic communities during the construction phase are expected to be consistent with those presented in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation.

Groundwater dependent ecosystems

Extraction of water from groundwater bores during construction has the potential to cause minor localised drawdown of groundwater with potential impacts on groundwater dependent ecosystems. Watercourses within the NGBR Project realignment footprint are likely to interact with groundwater, and so are susceptible (along with GDEs) to any changes in baseflow. The Bowen River and Suttor River were identified in studies completed for the NGBR Project EIS as having high potential for groundwater interaction. Impacts to groundwater elevations will potentially occur in the vicinity of water supply bores established for the construction of the NGBR Project realignment. The construction water supply strategy for the NGBR Project EIS (Volume 2 Appendix H3 Construction water supply strategy) concludes that extractions have potential for short-term, localised impacts on shallow groundwater. Significant impacts to groundwater quality are not expected.

The impacts of reduced base flow as a result of drawdown of the groundwater table on groundwater dependent ecosystems may include:

- Alteration of environmental flow and in-stream conditions for aquatic communities
- Changes in vegetation composition, creating conditions favourable to the introduction of grasses, forbs and weed species
- A general reduction or loss of refugia, breeding, roosting and foraging habitat for fauna.

Introduction or spread of weeds

Increased access to areas during construction activities and associated construction practices, such as vegetation clearing and soil disturbance, can facilitate the introduction and spread of weed species. Weed species may have adverse impacts on the flora and fauna diversity of a region and disrupt ecosystems by outcompeting and replacing native species, thereby altering species diversity and potentially disrupting ecosystem function. Twenty-nine introduced flora taxa, including six listed Weeds of National Significance and nine LP Act-listed declared weeds were recorded within one kilometre of the NGBR Project realignment.

New weed species can also be introduced through activities associated with construction, such as the use of contaminated materials (i.e. for fill required for construction) or machinery.

While six declared weeds under the LP Act have been previously recorded near the NGBR Project realignment during field surveys of the Alpha Coal Project EIS and Drake Coal Project EIS, they were not found to be prevalent across much of the NGBR Project realignment. Watercourses and associated riparian vegetation in particular are sensitive receptors for weeds

and small infestations can be spread over long distances if seeds enter waterways. An increase in the prevalence of weeds within the construction footprint and potentially beyond to the surrounding landscape may in turn reduce the quality of habitats for some fauna species.

Aquatic weeds may be transported during construction of water crossings. Machinery and vehicles working within waterways have the potential to disperse aquatic weeds between waterways and catchments if not managed in the appropriate manner. Twenty-four introduced aquatic dependent flora species were identified as occurring in riverine and/or non-riverine wetlands within the Burdekin River Basins (Inglis and Howell 2009a; Inglis and Howell 2009b). These species and aquatic weeds from other catchments could be transported to waterways where weeds are not currently present. Subsequent weed infestations can affect waterways by disrupting natural flood regimes, changing aquatic habitats, reducing visual amenity and degrading water quality (DERM, 2011).

In order to reduce the dispersal and potential introduction of new weed species, active weed management will be implemented during construction of the NGBR Project realignment (refer Section 6.5).

Pest fauna

Food waste produced in construction camps may provide additional resources for feral animals such as pigs, rats, mice, cats and dogs. These animals, confirmed present within the study area, may increase in abundance if food and water become more accessible (refer to NGBR Project EIS Volume 1 Chapter 13 Waste). There is also potential for pest animals such as ants to be introduced to sites through importation of vehicles, equipment, soils and similar media. Disturbance to aquatic habitats during construction may result in the inadvertent introduction of aquatic pest species. An increase in pest fauna species may lead to increased competition for resources, increased predation, increased habitat degradation (e.g. erosion caused by rabbits and damage to riparian areas by pigs) and the introduction and spread of diseases or parasites (DEEDI 2013).

Vegetation clearing through areas of continuous habitats (i.e. at watercourses) and along linear corridors can create the potential for fauna pests and feral predators to penetrate further into bushland areas. No aquatic pest species were recorded during surveys within the Suttor and Bowen River catchments, with the exception of mosquitofish (*Gambusia holbrooki*) which were identified during surveys for the Drake Coal Mine EIS (GHD 2012). Tilapia (*Oreochromis mossambicus*) and three spot gourami (*Trichogaster trichopterus*) have also been recorded within the Burdekin River Basin (Allen *et al.* 2002; Pusey *et al.* 2004).

Active management will be undertaken during construction to manage pest fauna species as outlined in Section 6.5.

6.4.2 Operation

Terrestrial habitat connectivity and fauna movement

Operation of the NGBR Project realignment has the potential to create long-term habitat fragmentation. The persistence of a cleared easement to accommodate rail infrastructure will deter some fauna movement and act as an ongoing barrier to movement, except where culverts, bridges and other underpass structures provide an appropriate means of movement across the final rail corridor. In addition, regular movements of trains and maintenance vehicles

create a mortality risk that may act as a sink for local wildlife populations. These localised impacts on habitat connectivity and fauna movement are expected to be more significant along the NGBR Project realignment where the footprint runs directly adjacent to the existing Newlands line. The occurrence of two rail corridors in close proximity, and the resulting increase in train movements are likely to deter fauna movement in some ground-dwelling species.

Despite this, the impacts of fragmentation attributed to operation of the NGBR Project realignment are considered to be relatively minor, within a regional context. The NGBR Project realignment footprint is located in a landscape that has been extensively fragmented by historical broadscale vegetation clearing. In addition, much of the native vegetation is naturally open in nature (i.e. open woodland or native grassland). In this context, fragmentation effects are less severe, as native fauna are typically adapted to moving through open landscapes.

The fragmentation impacts resulting from the NGBR Project realignment are therefore unlikely to have regional consequences. Nevertheless, fragmentation of habitat may have localised impacts, particularly where wildlife corridors, watercourses and other linear habitat links are affected.

Weeds and pest fauna

Movement of people, vehicles and machinery during operation of the NGBR Project realignment may facilitate the spread or increase the prevalence of weeds. Furthermore, there is potential for pest species to use the rail corridor as a linear pathway for movement, leading to the introduction of pest species or the spread of existing pest species to previously pest-free habitats. An increase in the prevalence of these animals may adversely impact native fauna through:

- Increased competition for resources
- Increased predation (of native species by introduced animals)
- Habitat degradation (i.e. pig damage of riparian areas).

Impacts of weeds and pests are expected to be manageable, provided that the mitigation and management measures outlined in the weed and pest management plan are implemented (refer Section 6.5).

Dust, noise and light impacts on terrestrial fauna

The NGBR Project realignment runs adjacent to the existing Newlands line for much of its length. The dual rail corridors introduce substantial potential for localised dust, noise and light impacts on terrestrial fauna. The increased activity associated with daily movement of trains and irregular visits to the rail corridor by maintenance vehicles and service personnel will cause localised, temporary and transient increases in light, noise, vibration and dust. Without mitigation measures, these factors have the potential to adversely affect local fauna by disrupting their normal behavioural activities and potentially compromising their foraging, breeding, sleeping and nesting efficiency.

Noise can have a range of adverse impacts on native fauna. Noise can adversely affect wildlife by interfering with communication, masking the sounds of predators and prey and causing stress or avoidance reactions that may increase the risk of injury or predation, or reduce the efficiency of normal behaviours (i.e. feeding, breeding, nesting, sleeping) (Fletcher and Busnel

1978). Noise exposure, particularly if it endures, can have physiological and behavioural impacts on fauna. The nature and intensity of these impacts can vary between species and between individuals of a given species depending on the individuals' age, sex and prior exposure to noise (Fletcher and Busnel 1978). Disruption of wildlife behaviour is most ecologically damaging when it affects critical behaviours (i.e. nesting or breeding) in areas of high ecological importance (e.g. breeding colonies).

Noise impacts on wildlife will also vary depending on the nature and frequency of the noise. Studies have shown that some animals can habituate to loud noises that do not have a direct adverse outcome for the individual (Larkin 1996). Attempts at using noise to deliberately scare birds away from an area, for example to protect farming crops, have been shown to grow less effective over time as birds habituate to the noise. Larkin suggests that keeping the noise as consistent as possible both in the sound produced and the frequency with which it occurs may also help mitigate its effects on birds. Algers *et al.* (1978) shows that birds tend to adapt to steady state noise levels, even of a relatively high level (in the order of 70 dB(A)). Trains will pass the NGBR Project realignment up to 28 times each day, and the Newlands line has approximately 21 train movements per day. As such, the potential for wildlife to habituate to noise is relatively high.

Artificial light sources can have adverse impacts on native fauna by disrupting their capacity to forage, breed, nest and sleep, interrupting circadian rhythms and altering normal predator-prey relationships (Rich and Longcore 2006). Light sources can create an artificial foraging source for birds, amphibians and insectivorous bats, by attracting large concentrations of insects (Rich and Longcore 2006). Species that benefit from these types of artificial feeding sources are typically opportunistic, generalist species which are generally widespread and abundant (Lockwood and McKinney 1999). The NGBR Project realignment footprint will not be lit during operation.

Dust impacts, while wind dependent, are also typically localised in their extent, generally affecting areas within 40 m of unsealed access roads (Goosem 2007). Dust coated on leaves can reduce the photosynthetic capacity of the plants and impede plant growth. Such an impact could degrade the function and health of the vegetation community; cause plant dieback with prolonged exposure; and reduce food resource availability for fauna species utilising the affected vegetation community. As such, impacts on flora from dust have the potential to occur where vegetation is growing immediately adjacent to the final rail corridor. The NGBR Project realignment will operate for 90 years. Long term exposure to dust may result in changes to vegetation communities immediately adjacent to the rail line, which may in turn alter habitat type and quality for fauna. Excessive dust settling on water bodies has the potential to decrease aquatic habitat value within the immediate and downstream areas as a result of reduced water quality.

An environmental evaluation, commissioned by Queensland Rail, reviewed the available literature for the impacts of coal dust on flora and fauna, crops and livestock. Connell Hatch (2008) concluded that a dust deposition rate of 500 mg/m²/day can be used as a suitable threshold for negative impacts on crops, livestock and vegetation. With respect to deposition distance adjacent to the final rail corridor centreline, records indicate that the highest coal deposition rates, of about 90 mg/m²/day, are likely to occur within the final rail corridor with rates dropping rapidly as distance from the tracks increases (i.e. 30 mg/m²/day at 10 metres from the tracks) (Connell Hatch 2008).

Modelling of cumulative dust deposition rates for the NGBR Project Realignment, existing Newlands rail line and background dust deposition rates have been undertaken in relation to two sensitive receivers associated with the NGBR Project realignment (refer Section 9). Modelled cumulative dust deposition rates showed that peak dust deposition, of between 4.5 and 5 g/m²/month, occurs within 50 m of the western side of the NGBR Project realignment centreline. Dust deposition west of this distance rapidly decrease and meet the DEHP criterion for residential amenity, 2 g/m²/month, within a distance of 300 m. Dust deposition rates east of the NGBR Project realignment are lower with dust deposition rates not exceeding 3 g/m²/month immendiately adjacent to the rail corridor and similarly decrease as distance from the rail corridor is increased. These measured values are substantially lower than the values noted in literature as being likely to have an impact on crops and livestock. The impact on native flora and fauna is expected to be similar (refer to NGBR Project EIS Volume 1 Chapter 10 Air quality and Volume 2 Appendix I Air quality).

Given the research outlined above, and with the implementation of the management and mitigation measures outlined in Section 6.5, it is unlikely that dust deposition, including coal dust, will have a noticeable impact on the flora and fauna adjacent to the NGBR Project realignment.

Impacts of light, noise and vibration are expected to have low level and localised adverse effects on wildlife. Provided the mitigation measures outlined in Section 6.5 are implemented, the impacts are anticipated to be minimal.

Operational impacts on aquatic fauna

Operational activities including coal dust emissions, ongoing maintenance and chemical spills have the potential to impact on the water quality of local waterways. These physical changes in water quality have the potential to reduce the suitability of the aquatic environment for aquatic flora and fauna species. Consequently, changes to the water quality of waterways may result in a loss of sensitive species, mass mortality events and a change in community structure. In general, the potential operational impacts on aquatic fauna include:

- Coal dust emissions from coal trains – excessive dust has the potential to reduce water quality and decrease habitat value. Aquatic habitats may also become contaminated by heavy metals associated with deposited coal dust particles (Swer and Singh 2003). There is low potential for significant impacts on aquatic fauna from coal dust in the NGBR Project realignment footprint. Further discussion on the potential coal dust generated during operation is provided in the NGBR Project EIS Volume 1 Chapter 10 Air quality and Section 9.
- Contaminated runoff – runoff may contain dust, fuel, dissolved metals and other contaminants that can alter water quality and reduce aquatic habitat values.
- Increased vehicle traffic – increased vehicle traffic for the purpose of operational maintenance may also result in a minor increase in dust generation from the movement of maintenance vehicles along dirt access tracks, particularly during dry and windy conditions. Due to the low frequency in which access tracks will be utilised, it is considered unlikely that dust deposition impacts will occur.
- Increased rail traffic – increased rail traffic alongside the Newlands line will occur, which will result in an increase in the coal dust emissions (discussed above), but also in noise and vibration.

- Leaks and spills – works involving operational maintenance within and adjacent to the waterways have the potential to introduce contaminants to the aquatic environment. If introduced, these compounds can result in both short- and long-term degradation of water quality. Any introduction of contaminants has the potential to influence both the local surface water quality at the point source as well as downstream (refer to NGBR Project EIS Volume 1 Chapter 18 Hazard risk, health and safety).

Mitigation and management measures to minimise the potential impacts of the NGBR Project realignment on water quality are provided in the NGBR Project EIS Volume 1 Chapter 9 Water resources. Dust mitigation and management measures are provided in the NGBR Project EIS Volume 1 Chapter 10 Air quality.

Fauna mortality

Throughout the operation phase of the NGBR Project, movement of trains and maintenance vehicles present a risk of fauna mortality through direct collision with wildlife. The risks of collision with trains are likely to be exacerbated within the NGBR Project realignment, where the final rail corridor runs directly adjacent to the Newlands line. This area will receive up to 49 train movements per day (28 from the NGBR Project realignment and 21 from the existing Newlands line).

The rail corridor will be fenced along its length to exclude wildlife and livestock, and fauna-friendly infrastructure will be incorporated where required within the design of bridges and culverts to allow fauna passage at designated crossing locations.

Altered fire regime on flora and fauna

Increased human activity may alter the fire regime of the local landscape. For example, the rail corridor may act as a fire break and consequently reduce the natural fire frequency and in turn increase the fuel load which would increase the fire risk for the region. The potential for accidentally lit fires is increased through the operation phase as a result of sparking during rail operation. The incidence of regulated management burns may also change in frequency. Accidental or uncontrolled fires have the potential to negatively impact upon vegetation (and habitat) within, and adjacent to, the final rail corridor in particular.

6.5 Mitigation and management measures

The mitigation and management measures that will be implemented to minimise and avoid the potential impacts on terrestrial and aquatic ecology during construction and operation of the NGBR Project realignment are consistent with those provided in the NGBR Project EIS Volume 1 Chapter 6 Nature conservation.

These mitigation and management measures will be implemented in combination with measures outlined in other chapters, of the NGBR Project EIS including:

- Volume 1 Chapter 4 Scenic amenity and lighting
- Volume 1 Chapter 5 Topography, geology, soils and land contamination
- Volume 1 Chapter 9 Water resources
- Volume 1 Chapter 10 Air quality
- Volume 1 Chapter 18 Hazard, risk, health and safety.

6.6 Conclusion

This chapter assesses the potential impacts of the NGBR Project realignment on terrestrial and aquatic habitats and associated communities, and identifies mitigation measures to manage potential impacts. The assessment considers the NGBR Project realignment footprint and the wider landscape in which this occurs, including potentially impacted downstream areas.

The NGBR Project realignment footprint crosses a diverse range of vegetation communities, including five endangered REs (regulated under the *Vegetation Management Act 1999*), five of concern REs and the constituent REs of three endangered threatened ecological communities (as listed under the EPBC Act – natural grassland, brigalow and semi-evergreen vine thicket (only the latter two were confirmed present, natural grassland TEC may occur).

During construction, the NGBR Project realignment will require clearing of approximately 806 ha of vegetation, of which approximately 543 ha is mapped remnant vegetation (VM Act). The mapped remnant vegetation encompasses 27 RE types within the Brigalow Belt bioregion.

The individual REs that will likely undergo the greatest extent of clearing are 11.9.2 (104 ha), 11.8.5 (88 ha) and 11.5.3 (62 ha) which together equate to approximately 18 percent of the total mapped clearing extent required during construction (including non-remnant land), and 47 percent of the 453 ha of mapped remnant vegetation expected to be cleared for the NGBR Project realignment footprint.

A total of 213 least concern (NC Act) flora species were recorded within one kilometre of the NGBR Project realignment footprint during field surveys for the Alpha Coal Project EIS and the Drake Coal Project EIS (refer Section 6.3.5). Individuals and/or populations of some of these species will be lost from the local environment due to vegetation clearing during construction of the NGBR Project realignment. One conservation significant species has been recorded within one kilometre of the NGBR Project realignment footprint, *Dichanthium setosum*, which is listed as vulnerable under the EPBC Act. The estimated construction impact on mapped habitat that is potentially suitable for this species is 354.2 ha.

A likelihood of occurrence assessment for threatened flora species was undertaken in accordance with the methodology outlined in Section 6.2.2. One conservation significant flora species, *Eucalyptus raveretiana*, listed as vulnerable under the EPBC Act and NC Act, was considered 'likely to occur' based on previous records and potentially suitable habitat present within the NGBR Project realignment footprint. The estimated construction impact on habitat that is potentially suitable for this species is 125.1 ha.

The NGBR Project realignment will result in the direct loss of potential habitat for four EPBC Act-listed threatened fauna species confirmed present or considered likely to occur within the NGBR Project realignment footprint (refer Table 6-9). The potential impact of the NGBR Project realignment on these species is discussed in Section 7.

The NGBR Project realignment will also result in the direct loss of potential habitat for eight NC Act-listed threatened fauna species that were confirmed present or considered likely to occur within the NGBR Project realignment footprint. The direct impact on potential habitat for fauna species listed under the NC Act is summarised in Table 6-9.

A total of 29 introduced flora taxa were recorded within one kilometre of the NGBR Project realignment footprint, four of which are listed as Weeds of National Significance and six of which

are declared weeds under the LP Act. Tilapia (*Oreochromis mossambicus*), three spot gourami (*Trichogaster trichopterus*) and mosquitofish (*Gambusia holbrooki*) currently occur within the Burdekin River Basin (Pusey *et al.* 2004; Carter and Tait 2008). Tilapia (*Oreochromis mossambica*) has been observed in previous surveys of the Suttor River, Bowen River, each of which is intersected by the NGBR Project realignment footprint.

Operation of the NGBR Project realignment has the potential to create long-term habitat fragmentation. The impacts of fragmentation attributed to operation of the NGBR Project realignment are considered to be relatively minor within a regional context, as it is located in a landscape that has been extensively fragmented by historical broadscale vegetation clearing. However, the local effects of fragmentation and restrictions of fauna movement may be more severe, given the rail corridor runs directly adjacent to the existing Newlands line. Careful consideration will need to be given to provide suitable fauna crossings at areas of high ecological value, watercourses and areas of high habitat connectivity that may act as natural corridors for wildlife movement.

The NGBR Project realignment crosses a total of three major and 26 minor waterways. The final design and size of required waterway crossing structures (including bridges, pipe culverts and box culverts) will take into the consideration the ability of fish, turtles and other aquatic fauna to move within the watercourse in accordance with the Department of Agriculture, Fisheries and Forestry *Fish Habitat Management Codes and Policies*, which require the maintenance of aquatic fauna connectivity. An application under the *Fisheries Act 1994* will be sought where culvert or bridge installation works within a watercourse has the potential to disturb and impair the movement of aquatic fauna within a waterway. No aquatic habitat within DIWA listed nationally important wetlands will be directly disturbed. In total, 26.8 ha of mapped riparian vegetation and 47.0 ha of mapped wetland vegetation will require clearing.

Many control measures have been identified to address impacts attributed to the loss of habitat and resources, restriction of fauna movement, injury and mortality of fauna, sedimentation and erosion, invasion of pests and weeds and degradation of terrestrial and aquatic habitats. By implementing the construction and operation mitigation and management measures outlined in this section the impacts on the identified nature conservation values are not expected to be significant in magnitude, extent or duration.

Where impacts are unavoidable, offsets will be required to compensate for the residual impacts of the NGBR Project realignment on terrestrial ecological values where these cannot otherwise be mitigated. Both Commonwealth and State government offset requirements are applicable to the NGBR Project realignment for a range of ecological impacts including, but not limited to, vegetation clearing and threatened species potential habitat loss. An offset strategy for the NGBR Project realignment is provided in Volume 2 Appendix E Revised Offsets strategy.

7. MNES

7.1 Purpose of section

The purpose of this section is to assess the potential impacts of the NGBR Project realignment on matters of national environmental significance (MNES).

A referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* was submitted in May 2013, and the NGBR Project was determined by the Commonwealth to be a controlled action that required an Environmental Impact Statement. The NGBR Project EIS Volume 1 Chapter 7 MNES was prepared to address MNES in accordance with the final Guidelines for an EIS for the North Galilee Basin Rail Project (EPBC 2013/6885) (refer NGBR Project EIS Volume 2 Appendix G). This section is intended to provide information in relation to the NGBR Project realignment only where it varies from the alignment considered in the NGBR Project EIS. Relevant controlling provisions have been addressed, these being listed threatened species, threatened ecological communities and listed migratory species. The other controlling provisions (World Heritage properties, Natural Heritage Places, Commonwealth Marine Areas and Great Barrier Reef Marine Park) are not considered here, as they are not considered relevant due to the geographical separation between the marine environment and the NGBR Project realignment.

An updated protected matters search was undertaken and calculations for areas of potential habitat intersected by the NGBR Project realignment for MNES confirmed or likely to occur are provided. The Department of the Environment (DotE) has been made aware of the need for this realignment change as a result of submissions received on the NGBR Project EIS and ongoing stakeholder engagement conducted by Adani with State Government agencies and affected resource tenement holders.

Details in relation to the NGBR Project, including proponent, project rationale and alternatives are included in the Volume 2 Appendix B Revised project description, while the project description for the NGBR Project realignment is provided in Section 2.

A revised version of NGBR Project EIS Volume 1 Chapter 7 MNES report is provided at Volume 2 Appendix D Revised MNES.

7.2 Methodology

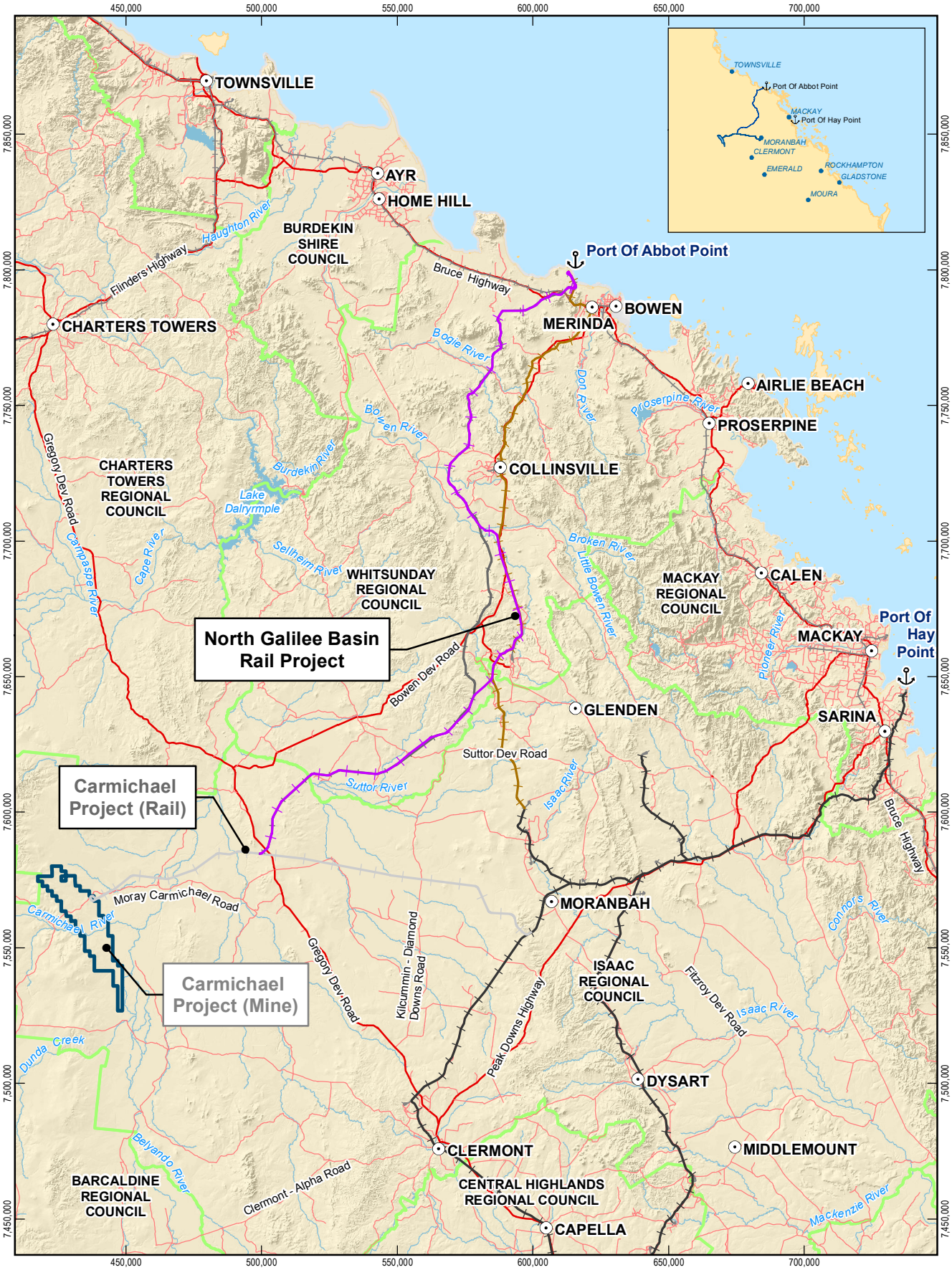
A desktop assessment was conducted to assess the MNES relevant to the NGBR Project realignment. Steps in the methodology were consistent with that employed for the NGBR Project EIS Volume 1 Chapter 7 MNES (with the exception of field surveys) and included:

- Review of existing studies and available data relevant to MNES within the NGBR Project realignment
- Describe the potential MNES values of the NGBR Project realignment footprint and, where their presence is uncertain, assign a likelihood of their occurrence
- Describe the potential MNES values within a wider study area and, where their presence is uncertain, assign a likelihood of their occurrence
- Define the potential direct (realignment footprint) and indirect (wider study area) impacts associated with the NGBR Project realignment

- Identify appropriate avoidance, mitigation and management measures to minimise potential impacts (where these were not previously described in the NGBR Project EIS Volume 1 Chapter 7 MNES)
- Assess the significance of residual impacts on MNES in accordance with the EPBC Act Matters of National Environmental Significance Significant Impact Guidelines 1.1 (DEWHA 2009, hereafter referred to as the Significant Impact Guidelines).

7.2.1 Study area

For the purposes of this MNES assessment, the study area comprises the NGBR Project realignment footprint and associated infrastructure as depicted in Figure 7-1.



LEGEND

- Population centres
- Major Port
- Other Rail Network
- Goonyella System
- Newlands System
- Major road
- Local road
- Watercourse
- Local Government area
- Carmichael Project (Rail)
- Carmichael Project (Mine)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:2,000,000 (at A4)

0 10 20 30 40 50

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number 41-26457
Revision B
Date 26 Feb 2014

Project location

Figure 7-1

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. While GHD Pty Ltd has taken care to ensure the accuracy of this product, GHD Pty Ltd, DME, GA, ADANI and DNRM make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD Pty Ltd, DME, GA, ADANI and DNRM cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DNRM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); DME: EPC1690 (2010), EPC1080 (2011); Adani: Option 9 Rev1 Final rail corridor (2014), NGBR 100m Corridor Option 6 Rev2/2013, Carmichael Project (Rail) (2012). Created by: AJ

7.2.2 Desktop assessment

A desktop assessment was undertaken to characterise the environmental values of the study area. This provided an understanding of the regional diversity in these values and assisted in identifying the key values of conservation significance that may be of relevance to the NGBR Project realignment. For the purposes of the desktop database queries, an additional 10 km buffer was added to the NGBR Project realignment footprint, in order to capture all ecological information of potential relevance to the NGBR Project.

This desktop assessment relied upon publicly available sources for information on the ecological values which were consistent with those utilised for the Volume 2 Appendix D Revised MNES report Section 1.4.2, with the exception of those specifically related to coastal areas. A list of documents reviewed is presented in Table 7-1 along with information on the nature of the source and known limitations to its use.

Table 7-1 Data sources utilised

Source and name (alphabetical)	Description of information source	Database/mapping search extent (if applicable)	Limitations of use	Relevant information
Aquatic Conservation Assessments, using Aquatic Biodiversity Assessment and Mapping Methodology (AquaBAMM), for the Riverine and Non-Riverine Wetlands of the Great Barrier Reef Catchment *Inglis and Howell (2009a); Inglis and Howell (2009b)*	The Aquatic Conservation Assessments (ACAs) focus on the Great Barrier Reef (GBR) catchments. Assessments utilise the aquatic Biodiversity Assessment and Mapping Methodology (AquaBAMM) (Clayton *et al.* 2006), which uses available data and expert opinion to identify ecological values within a given catchment.	N/A – no search conducted – species lists and other information consulted.	This publication relies on results based on the opinions of an experienced panel of ecologists, without additional field survey.	Aquatic values identified by a panel of experts for the Burdekin catchment, in which the NGBR Project realignment footprint occurs.
Bird Atlas data *Birds Australia*	Birds Australia maintains a database of bird sighting records from across Australia.	A rectangular search extent encompassing the NGBR Project realignment footprint was provided to Birds Australia for the purposes of searching the Bird Atlas database.	The age and lack of spatial precision of species records limits the accuracy of these records. In addition, these sightings are by Birds Australia members and the general public, whose levels of expertise vary greatly. These records are not confirmed by experts.	These records provide a list of birds previously recorded by Birds Australia in the landscape encompassing the NGBR Project realignment footprint.

Source and name (alphabetical)	Description of information source	Database/mapping search extent (if applicable)	Limitations of use	Relevant information
Biodiversity planning assessment (BPA) expert panel report and **BPA mapping – Brigalow Belt bioregion** *Department of Environment and Resource Management (DERM) (2008)*	Expert panel reports provide information on the landscape-scale values of bioregions, and in some instances identify bioregional priority taxa. This information is mapped at varying levels of significance (local, regional, state). This mapping utilises Department of Natural Resources and Mines (DNRM) regional ecosystem (RE) mapping in identifying the location and extent of vegetation communities and habitats.	Mapping was obtained for the NGBR Project realignment footprint and surrounding landscape in an electronic data layer using a Geographic Information System (GIS).	BPA mapping is heavily reliant on regional ecosystem (RE) mapping, which in the Brigalow Belt may not be ground-truthed. Therefore, if the underlying RE polygon on which a BPA map unit is based is incorrect, the BPA map unit may also be incorrect.	BPA expert reports and the associated mapping are primarily terrestrial. They discuss and map corridors and wildlife refugia identified by the expert panel in the preliminary investigation corridor and adjacent areas. This information is used in the report to identify potentially sensitive environmental areas within the NGBR Project realignment footprint and adjacent areas.
Burdekin NRM Region Back on Track Actions for Biodiversity report *Department of Environment and Resource Management (2010)*	These documents identify priority species in the Burdekin NRM region, detail the regional threatening processes impacting upon these species, and propose a range of actions to address regional threats. Priority taxa are identified through the DERM (2010) 'back on track' species prioritisation framework, in consultation with a range of stakeholders from the region. The documents seek to guide priority species conservation in the respective regions over the period 2010 – 2015.	N/A – no search conducted – species lists and other information consulted.	Some species/impacts listed in this document do not occur in the study area, as the NRM region encompasses the entire Burdekin catchment.	Identifies priority species and threatening processes for these species.

Source and name (alphabetical)	Description of information source	Database/mapping search extent (if applicable)	Limitations of use	Relevant information
Directory of Important Wetlands *Department of Sustainability, Environment, Water, Population and Communities (SEWPaC, 2011)*	This mapping identifies the location of wetlands that satisfy at least one criterion agreed upon by the Australian and New Zealand Environment and Conservation Council (ANZECC) Wetlands Network in 1994. The DotE Protected Matters Search Tool lists nationally important wetlands occurring within or related to prescribed search extents.	Line search approximating with the centreline of the NGBR Project realignment footprint with a 10 km buffer.	The mapping is now almost 20 years old.	The location of wetlands within the NGBR Project realignment footprint and adjacent areas listed and mapped as important wetlands under this directory.
Essential habitat mapping (Version 3) *Department of Natural Resources and Mines (2013)*	Essential habitat is defined as 'vegetation in which a species that is endangered, vulnerable or near threatened under the *Nature Conservation Act 1992* has been known to occur' (DNRM 2013). DNRM maps essential habitat (and essential regrowth habitat) in conjunction with remnant and regrowth vegetation.	Mapping was obtained for the NGBR Project realignment footprint and surrounding landscape in an electronic data layer for GIS analysis.	As essential habitat and essential regrowth habitat mapping is underpinned by RE/regrowth mapping, the constraints associated with mapping scale and lack of ground-truthing are applicable to this information source.	Essential habitat factors are determined by an expert panel as those basic factors that define essential habitat for a threatened species, and are used to ground truth essential habitat. Essential habitat layers for remnant and regrowth vegetation were investigated to map the location of essential habitat. Essential habitat factors were collected to assist in the understanding of the habitat requirements of threatened species for which these factors have been published.

Source and name (alphabetical)	Description of information source	Database/mapping search extent (if applicable)	Limitations of use	Relevant information
Freshwater Fishes of North-Eastern Australia *Pusey* et al. *2004*	The text includes the fish species composition of all the rivers in north-eastern Australia. Species are listed for each river basin.	N/A - no search conducted - species lists and other information consulted.	Known distributions of species has been developed using historical through to relatively recent (2004 at time of publication) times, and so may be out-dated. Some species distributions may have been based on anecdotal evidence.	The specific fish communities of the Burdekin River Basin were used to determine potential fish communities within or near to the NGBR Project realignment footprint.
Freshwater Fish of Burdekin Dry Tropics Natural Resource Management (NRM) Region *Carter and Tait (2008)*	This report documents the diversity and distribution of freshwater fish species within the Burdekin Dry Tropics NRM Region.	N/A	The sub-catchments covered in this report include many outside the NGBR Project realignment footprint and only those relevant to the NGBR Project realignment footprint have been consulted. Species distribution mapping in the report has been developed using pre-2008 data and so may not accurately represent current distribution patterns.	This report was used to assist in determining likely fish communities within the NGBR Project realignment footprint.
HERBRECS specimen database *Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts (DSITIA)*	The HERBRECS database catalogues the label and location information from all flora specimens held by the Queensland Herbarium collection.	A rectangular search extent encompassing the NGBR Project realignment footprint was provided to the Queensland Herbarium for purposes of searching the HERBRECS database.	This database catalogues records of flora specimens held in the Queensland Herbarium collection – and so is subject to herbarium collection policies and decisions. This means the geographic spread of records may not be indicative of actual on-ground abundance/ occurrence. In some instances the age and lack of spatial precision of species records that pre-date GPS may limit their locational value.	The species list provides an indication of the diversity of flora species, and the previously recorded presence of conservation-significant species in the landscape encompassing the preliminary investigation corridor. Label notes from threatened species provide information and observations on the habitats and locations in which those species have been recorded by previous collectors.

Source and name (alphabetical)	Description of information source	Database/mapping search extent (if applicable)	Limitations of use	Relevant information
Publically available EIS documents for projects in the region	EIS documents for projects in the region: Carmichael Coal Mine and Rail Project (EIS) (Adani Mining Pty Ltd 2012) Galilee Coal (Northern Export Facility) Project (Rail) EIS (Waratah Coal Pty Ltd 2011) Alpha Coal Project (Rail) EIS (Hancock Prospecting Pty Ltd 2010) Water for Bowen EIS (SunWater 2009) Drake Coal Project EIS (Drake Coal Pty Ltd 2012)	N/A - no search conducted - species lists and other information consulted	The limitations of using these documents are various and are associated with the accuracy of the initial research reported in these reports, and the limitations declared in each document,	Data relating to survey methods and results, in particular the location of threatened species and their habitats, where it relates to the NGBR Project realignment footprint.
Queensland Museum data search *Queensland Museum (QM) (2013)*	The Queensland Museum catalogues vertebrate fauna specimen records obtained throughout Queensland.	A rectangular search extent encompassing the NGBR Project realignment footprint was provided to Queensland Museum for purposes of search of internal Queensland Museum database.	This database catalogues known records of species in a defined area. The age and lack of spatial precision of species records may limit their value for inclusion in current studies in some instances.	Results consolidated into single species list to provide an indication of vertebrate fauna species previously recorded in the landscape encompassing the NGBR Project realignment footprint.

Source and name (alphabetical)	Description of information source	Database/mapping search extent (if applicable)	Limitations of use	Relevant information
Regional ecosystem and regrowth mapping version 6.1 (including the Regional Ecosystem Description Database or REDD) *DNRM (2013)*	Mapping of regional ecosystems (vegetation communities) prepared by the Queensland Herbarium (DSITIA) and held by DNRM. This includes remnant and regrowth vegetation. The REDD contains the descriptions of the RE units.	Mapping was obtained for the NGBR Project realignment footprint and surrounding landscape in an electronic data layer for GIS analysis.	Regional ecosystem mapping is primarily based on remote-sensing techniques and is not 100% ground truthed. It is produced at 1:100,000 scale and is not accurate at scales commonly utilised for the location of built infrastructure.	This mapping provides an indication of the potential diversity and location of vegetation communities in the preliminary investigation corridor. RE units as described in the REDD provide an outline of the vegetation communities present in the investigation corridor, their clearing extent and representation in the protection area, and some of the major values of these communities.
Wetland mapping *DEHP (2013)*	Various mapping layers produced by DEHP (including wetland protection areas and wetland management areas).	Mapping obtained for the NGBR Project realignment footprint and wider study area.	Wetlands are identified using the DEHP AquaBAMM (Clayton *et al.* 2006) which is primarily based on existing literature and expert opinion. Designation does not reveal the relative value of these systems for local flora and fauna. This mapping is most useful in identifying location of wetlands, not in assessing wetland values.	These layers are used to produce maps of the location of wetlands in the NGBR Project realignment footprint and wider study area.

7.2.3 Previous field surveys

Terrestrial flora and fauna assessment

Field surveys were previously conducted within the vicinity of the NGBR Project realignment for the Alpha Coal Project EIS (Hancock Prospecting Pty Ltd 2010) and Drake Coal Project EIS (Drake Coal Pty Ltd 2012) are relevant to the 77 km NGBR Project realignment. Habitat types, vegetation communities and species were identified to assess the likelihood of occurrence of EPBC Act listed flora and fauna species based on direct observations of flora, regional ecosystems, fauna, fauna traces or suitable habitat.

Field surveys for the Alpha Coal Project (Rail) EIS and Drake Coal Project EIS identified habitats, communities and species in the study area to verify the likelihood of occurrence of EPBC Act listed flora and fauna species. Verification was based on direct observations of flora, REs, fauna, fauna traces or suitable habitat. The approximate locations of these survey sites have been shown in Volume 2 Appendix D Revised MNES Report Figures 7-10 to 7-19.

The Alpha Coal Project EIS dry season terrestrial flora and fauna surveys were conducted in spring during November to December 2009 and wet season terrestrial flora and fauna surveys were conducted in the late wet season during April 2010 (Hancock Prospecting Pty Ltd 2010). Sites relevant to the NGBR Project realignment are listed in Table 7-2 and identified in Figure 9-1 of the Alpha Coal Project Terrestrial Ecology Chapter (Volume 3 Section 9).

Table 7-2 Alpha Coal EIS sites relevant to NGBR Project realignment

Alpha Coal EIS sites	Type of survey
AD7	Detailed dry season fauna survey
AD8	Detailed wet season fauna survey
AR28	Rapid fauna survey
AR29	Rapid fauna survey
FR47	Rapid flora survey
FR48	Rapid flora survey
FR49	Rapid flora survey
FR50	Rapid flora survey

Terrestrial flora and fauna field surveys were undertaken for the Drake Coal Project EIS (Drake Coal Pty Ltd 2012) to the north of the NGBR Project realignment in the post-wet season in April 2010 and in the dry season 2007. Additional flora and fauna surveys were undertaken in February 2012 to validate the Queensland Herbarium map assessment completed in November 2011 and to sample additional fauna habitats. The location of flora and fauna surveys are identified in Figure 13.1 in the Drake Coal Project EIS Volume 1 Section 13 Ecology.

7.2.4 Likelihood of occurrence assessment

In a manner consistent to that employed for the NGBR Project EIS, the ecological values identified during the desktop assessment were assigned a likelihood of occurrence. For each species, the likelihood of occurrence was designated using the following categories as defined in Volume 2 Appendix D Revised MNES Report Section 7.4.5 Likelihood of occurrence assessment:

- Unlikely to occur

- May occur
- Likely to occur
- Confirmed present.

Species considered 'unlikely to occur' or 'may occur' have not been assessed further due to the low likelihood of significant impacts to these species.

7.2.5 Potential habitat mapping for threatened species

The method of predictive modelling utilised for the Volume 2 Appendix D Revised MNES report Section 7.4.3 Potential habitat mapping for threatened species was applied to the NGBR Project realignment footprint. Maps that display the distribution of potential habitat for individual EPBC Act listed species were produced. No field verification was undertaken for the NGBR Project realignment, and therefore the potential habitat mapping should be considered to be indicative only. As such, the predictive habitat mapping produced for the NGBR Project realignment is considered to be conservative.

7.2.6 Assessment of potential impacts

The approach undertaken to identify, evaluate and provide mitigation measures for the potential environmental impacts of the NGBR Project realignment is consistent with that outlined in Volume 2 Appendix D Revised MNES report Section 7.4.6 Assessment of potential impacts.

7.3 Existing environment

This section provides a general overview of the existing environment of the study area. Existing environment information is provided in the following sections as relate to relevant MNES:

- Listed threatened species (refer Section 7.4)
- Threatened ecological communities (refer Section 7.5)
- Listed migratory species (refer Section 7.6).

As indicated, controlling provisions related to the marine environment have not been considered in this Section as consistent and equivalent potential impacts to those previously described are expected, and there is sufficient geographical separation between the marine environment and the NGBR Project realignment that significant impact would be unlikely.

7.4 Listed threatened species

7.4.1 Overview

Species

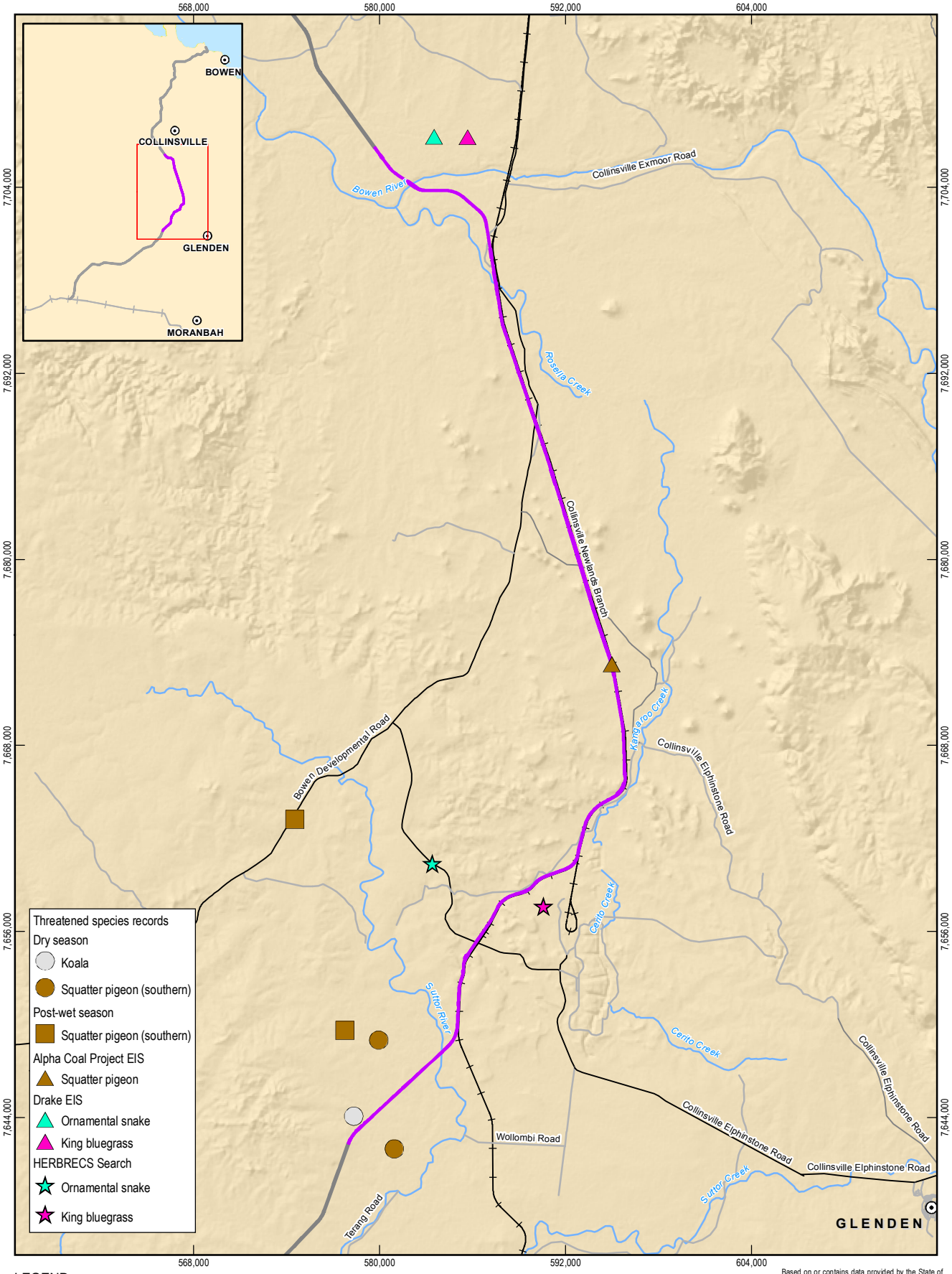
Sixteen threatened species listed under the EPBC Act were predicted to occur within the NGBR Project realignment footprint (refer Appendix A).

Three threatened species, bluegrass (*Dichanthium setosum*), squatter pigeon (southern) (*Geophaps scripta scripta*) and ornamental snake (*Denisonia maculata*) were recorded within one kilometre of the NGBR Project realignment during field surveys for the Alpha Coal Project EIS or Drake Coal Project EIS (Figure 6-10). In addition, the koala (*Phascolarctos cinereus) and* squatter pigeon (southern) (*Geophaps scripta scripta*) were recorded in surveys for the NGBR Project EIS near the southern extent of the NGBR Project realignment (refer Section 6).

Likelihood of occurrence

Of the 16 threatened species predicted to occur (four flora and 12 fauna), three species have been considered to be confirmed present (as indicated above). On the basis of the likelihood of occurrence assessment (refer Section 7.2.4), four species were considered 'likely to occur', six species as 'may occur', and four species 'unlikely to occur' within the NGBR Project realignment footprint.

A summary of the likelihood of occurrence assessment for threatened flora and fauna species is provided in Table 7-3 and Table 7-4 respectively.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number 41-26457
Revision A
Date 27 Feb 2014

Threatened species records

Figure 7-2

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1217_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Herbarium, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani:AEIS Option 9 Rev1 final rail corridor (2014); DNRM: Physical Road Network (2010);
GHD: Threatened Species Records (2013), Drake EIS Threatened Species (2012), Hancock EIS Threatened Species (2013); Herbarium: HERBRES Searches (2014). Created by: AJ

Table 7-3 Likelihood of occurrence for threatened flora species

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Bluegrass *Dichanthium setosum*	Vulnerable	x	x	✓	In Queensland, *Dichanthium setosum* has been reported from the Leichhardt, Morton, North Kennedy and Port Curtis regions. This species occurs in the Mistake Range, in Main range National Park, and possibly in Glen Rock Regional Park, adjacent to the Main Range National Park (TSSC 2008agn).	**Confirmed present** Recorded for the Drake Coal Project EIS within one kilometre of the NGBR Project realignment footprint AND potential habitat (natural grassland) may occur within the NGBR Project realignment footprint.
Black ironbox *Eucalyptus raveretiana*	Vulnerable	✓	HERBRECS	x	Black ironbox occurs in riparian woodlands on alluvial flats along creek and river banks on sandy or alluvial soils. It is commonly associated with *Melaleuca* spp., *Casuarina cunninghamiana* and *Eucalyptus tereticornis* in the canopy layer (Calvert *et al* 2005). It has been recorded from within the corridor in the Elliot, Bogie and Bowen Rivers, and from Pelican and Sandy Creek. It was recorded during the surveys within the preliminary investigation corridor in Strathmore and Crush Creeks, where it was co-dominant in the canopy with other eucalypts.	**Likely to occur** Previously recorded in the desktop search extent AND known to occur in the region, specifically along Bowen River AND suitable habitat is present within the NGBR Project realignment footprint.
King bluegrass *Dichanthium queenslandicum*	Endangered	✓	WO, HERBRECS	x	King bluegrass can be found throughout central Queensland on black cracking clay soils derived from basalt, in association with other *Dichanthium* and *Bothriochloa* spp. within native grasslands and some open woodlands (Simon 1982). It has been recorded approximately 15 km from the NGBR Project realignment footprint in the desktop search extent (Council of Heads of Australasian Herbaria 2013).	**Likely to occur** Previously recorded in the desktop search extent AND potential suitable habitat (natural grassland) likely to occur within the NGBR Project realignment footprint.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Cycas ophiolitica	Endangered	✓	x	x	*Cycas ophiolitica* (Marlborough blue cycad) inhabits eucalypt open forest and woodland communities with a grassy understorey and occur on hill tops or steep slopes, at altitudes of 80-620 m above sea level. It grows on shallow, stony, red clay loams or sandy soils.	**Unlikely to occur** This species has not previously been recorded within the NGBR Project realignment footprint. However, the NGBR Project realignment footprint is within the species distribution, and suitable habitat may exist based on a desktop assessment of the NGBR Project realignment footprint.

Predicted to occur within approximately a 10 km area around the Study Area: DotE Protected Matters Search Tool

* Previously recorded within desktop search extent from sources including Wildlife Online (WO), HERBRECS, Queensland Museum (QM), Birds Australia (BA) and essential habitat mapping (EH)

Table 7-4 Likelihood of occurrence for threatened fauna species

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Squatter pigeon (southern) *Geophaps scripta scripta*	Vulnerable	✓	WO	✓	The squatter pigeon (southern) is locally abundant within the northern part of its range (i.e. Brigalow Belt (North) and Desert Uplands Bioregions) (TSSC 2008agp). It is considered to be common in grazing country north of the Tropic of Capricorn (TSSC 2008agp). The species occurs in a wide range of habitats wherever there is a grassy understorey. It is often found within close proximity of water bodies (TSSC 2008agp). The squatter pigeon (southern) has been historically recorded within 10 km of the NGBR Project realignment (Wildlife Online).	**Confirmed present** Historically recorded in the desktop search extent. Suitable habitat occurs in parts of NGBR Project realignment. This species was recorded during field surveys for the NGBR Project, Alpha Coal Project (Rail) EIS (Hancock Prospecting Pty Ltd 2010) and the Drake Coal Project EIS (QCoal 2012).
Ornamental snake *Denisonia maculata*	Vulnerable	✓	WO, QM	✓	The ornamental snake's distribution is confined to the Brigalow Belt North bioregion and parts of the Brigalow Belt South bioregion (DotE 2014b). This species is typically found in areas of brigalow, riverside woodland and open forest on natural levees (DotE 2014b). Habitats featuring cracking clay and sandy substrates are known to be utilised by the species.	**Confirmed present** Predicted to occur and historically recorded in the desktop search extent. The NGBR Project realignment is within the SEWPaC modelled 'known/likely to occur' distribution for this species. Suitable habitat is likely to exist within the NGBR Project realignment, particularly in remnant vegetation north and south of the Bowen River. Ornamental snake was recorded during field surveys for the Drake Coal Project EIS.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Black-throated finch (southern) *Poephila cincta cincta*	Endangered	✓	x	x	This subspecies is now known from three general areas, namely Townsville, Ingham and scattered sites in central Queensland. The sub-species typically occurs in native grasslands and woodlands along creeks and riverbanks. Mosaics of habitat types that provide sufficient foraging resources (i.e. seed) through the wet season are thought to be required by this species (TSSC 2005s).	**Likely to occur** Predicted to occur, but not recorded in the desktop search extent. However, a black-throated finch (southern) record from the Birds Australia database, dated April 2012, is located on the Bowen Developmental Road approximately 12 km from the NGBR Project realignment. The NGBR Project realignment occurs within the distribution of this species (Pizzey and Knight 2007). Suitable habitat occurs in open woodland habitat featuring an understorey of native grasses, where water is locally available.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Koala *Phascolarctos cinereus*	Vulnerable (combined populations of Queensland, NSW and the ACT)	✓	WO	x	In Queensland, the species contains scattered populations throughout moist forests along the coastline, subhumid woodlands in central and southern regions and within Eucalypt woodlands along watercourses within semi-arid areas further west (Melzer et al. 2000). The greatest density of koalas occur through central and eastern areas including the Brigalow Belt, Mitchell Grass Downs, Mulga lands and the Desert Uplands (Patterson 1996).	**Confirmed present** Predicted to occur, but not historically recorded in the desktop search extent. Koala was recorded during field surveys of the NGBR Project. Additionally, the NGBR Project realignment is mapped within the SEWPaC modelled 'likely to occur to known to occur' distribution for this species (DotE 2014e). Suitable habitat occurs within the NGBR Project realignment within eucalypt woodland and fringing riparian vegetation, based on species known habitat requirements. Recorded during dry season surveys near the southern extent of the NGBR Project realignment.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Australian painted snipe *Rostratula australis*	Endangered Marine Migratory wetland	✓	x	x	The Australian painted snipe has a scattered distribution across eastern and northern Australia (TSSC 2013as). Shallow freshwater wetlands are the main habitat for the species (Marchant and Higgins 1993). Such wetlands may include lakes, swamps, claypans, inundated / waterlogged grassland, dams, irrigated crop land and sewage ponds (Marchant and Higgings 1993). Preferred wetland habitats boast emergent vegetation (including tussocks, grasses, sedges, rushes, reeds, canegrass and/or Melaleuca) (Marchant and Higgins 1993). Nesting occurs amongst vegetation in or adjacent to wetlands (TSSC 2013as).	**May occur** Not recorded in the desktop search extent. The NGBR Project realignment occurs within the distribution of this species (Pizzey and Knight 2007). Potentially suitable habitat occurs within the NGBR project realignment where wetlands are present.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Masked owl (northern) *Tyto novaehollandiae kimberli*	Vulnerable	✓	x	x	The masked owl (northern) occurs across northern Australia and is a conventionally accepted subspecies of the masked owl. In Queensland, the northern subspecies occurs across Cape York Peninsula, to a southern distribution limit along the central Queensland coast, with records from Mackay and near Duaringa, west of Rockhampton (DotE 2014a). Habitat for the subspecies includes riparian forest, rainforest, open forest Melaleuca swamps, edges of mangroves and the margins of sugar cane fields (DotE 2014a). This species is territorial, occupies a large home range and requires large old growth trees with large hollows for nesting (DotE 2014a).	**May occur** Predicted to occur, but not recorded in the desktop search extent. The NGBR Project realignment is within the species known distribution. Potentially suitable habitat occurs in NGBR Project realignment, particularly where tall riparian vegetation occurs along larger watercourses.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Red goshawk *Erythrotriorchis radiatus*	Vulnerable	✓	x	x	The red goshawk prefers landscapes containing a mosaic of habitats including coastal and sub-coastal tall open forest, woodland and rainforest edges (Marchant and Higgins 1993). Forests of intermediate density are particularly favoured, as are ecotones between variably dense habitats (i.e. ecotone between rainforest and sclerophyll forest) (DERM 2012). Large bird populations (the primary prey of this species) are also an important determinant of red goshawk habitat utilisation (DERM 2012). It generally avoids open habitats, and is only rarely encountered over agricultural land (Marchant and Higgins 1993). Nesting occurs in tall trees within one kilometre of permanent water, generally in open, biologically rich forest or woodland (Marchant and Higgins 1993). The species is sparsely dispersed across approximately 15 per cent of coastal and sub-coastal Australia. The species occurs at low densities occupying home ranges estimated between 50 – 220 km^2 (DERM 2012).	**May occur** Predicted to occur, but not recorded in the desktop search extent. The NGBR Project realignment is within the species known distribution. Potentially suitable habitat occurs in NGBR Project realignment, particularly where tall riparian vegetation occurs along larger watercourses (possible nesting habitat).

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Northern quoll *Dasyurus hallucatus*	Endangered	✓	x	x	Species distribution covers much of north eastern Australia, although the current range has contracted considerably such that it is now restricted to six discrete areas across northern Australia (Strahan 1995). The species has no highly specific habitat requirements, though rocky areas associated with open woodland and open forest are considered optimal habitat (Hill and Ward 2010). The preference for rocky habitat may be related to reduced exposure to threatening processes (i.e. vegetation clearing, fire, cane toads, reduced competition with cats) and the diversity of micro-habitats available (Hill and Ward 2010). The modelled distribution of the species, as presented in the Referral Guidelines for the Northern Quoll *Dasyurus hallucatus* (TSSC 2005x), indicates that the NGBR Project realignment coincides with the modelled 'may occur' distribution area for the species.	**May occur** Not previously recorded in the desktop search extent. The NGBR Project realignment is within the SEWPaC modelled 'may occur' distribution for this species. Suitable habitat may occur within the NGBR Project realignment where areas of rocky eucalypt woodland are present.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Yakka skink *Egernia rugosa*	Vulnerable	✓	x	x	The yakka skink is endemic to dry open forests, woodlands and rocky areas of central and eastern Queensland. Yakka skinks live in communal borrow complexes, and often take refuge among low vegetation or under heaped dead timber, logs, rocks and in deep rock crevices (Wilson 2005; DotE 2014d). The species occurs in a wide variety of vegetation types including poplar box (*Eucalyptus populnea*), ironbark (*Eucalyptus* spp.), brigalow (*Acacia harpophylla*), white cypress pine (*Callitris* spp.), mulga (*Acacia aneura*), bendee (*Acacia catenulata*) and lancewood (*Acacia shirleyi*) woodland and open forest (DotE 2014d).	**May occur** Predicted to occur, but not recorded in the desktop search extent. The NGBR Project realignment is within the SEWPaC modelled 'may occur' distribution for this species. Suitable habitat may occur within the NGBR Project realignment in eucalypt woodland where suitable timber microhabitats are present.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Star finch (eastern sub species) *Neochima ruficauda ruficauda*	Endangered	✓	x	x	The distribution of the subspecies of the star finch is poorly known, however it is restricted to eastern Queensland (and distribution is likely to be severely fragmented (TSSC 2008cu). Areas of permanently occupied habitat or permanent populations have not been identified (TSSC 2008cu). An estimate puts the extant wild population of the subspecies at 50 birds (TSSC 2008cu). Habitat preferences include grasslands and grassy woodlands near water, sedgelands, swamps and wetlands (Higgins et al. 2006; TSSC 2008cu). The subspecies is also known from disturbed habitats including farmland (Higgins et al. 2006; TSSC 2008cu).	**Unlikely to occur** Predicted to occur, but not previously recorded in the desktop search extent. This subspecies has disappeared from much of its former eastern and central Queensland range, with a lack of recent records (Higgins et al. 2006).
Retro slider, Allan's Lerista *Lerista allanae*	Endangered	✓	x	x	The retro slider has only been recorded from three locations at Clermont, Logan Downs Station and Retro Station. The most recent specimen was collected in 1960. Despite extensive searches, the species has not been found and may be extinct (Wilson 2005).The original habitats of this species have been substantially altered by agriculture. The original habitat preferences of the species are therefore unclear (Wilson 2005).	**Unlikely to occur** Predicted to occur, but not previously recorded in the desktop search extent. The NGBR Project realignment is not within the SEWPaC modelled distribution for this species. Limited suitable habitat is available within NGBR Project realignment.

Species	EPBC Act listing status	Predicted to occur by PMST#	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Mount Cooper striped lerista *Lerista vittata*	Vulnerable	✓	x	x	The Mount Cooper striped lerista is found in Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions, which is not predicted to occur in the NGBR Project realignment (TSSC 2008dt).	**Unlikely to occur** Predicted to occur, but not recorded in the desktop search extent. Limited suitable habitat is available within NGBR Project realignment.

Predicted to occur within approximately a 10 km area around the Study Area: DotE Protected Matters Search Tool

* Previously recorded within desktop search extent from sources including Wildlife Online (WO), Queensland Museum (QM), Birds Australia (BA) and essential habitat mapping (EH)

7.4.2 Potential impacts and management measures

The potential impacts of the NGBR Project on threatened species are described in NGBR Volume 2 Appendix D Revised MNES report. In summary, these are:

- Vegetation clearing and habitat loss
- Fauna mortality and injury
- Habitat fragmentation
- Degradation of vegetation and habitat
- Increased prevalence of weeds and pests
- Construction and operational emissions, habitat alteration and fauna disturbance.

The general environmental mitigation and management measures that will be implemented on site during construction and operation of the NGBR Project are described in the Volume 2 Appendix D Revised MNES report Section 7.8 Listed threatened species and these will be applied to the NGBR Project realignment.

7.4.1 Bluegrass

Species overview

Bluegrass is described in detail in Volume 2 Appendix D Revised MNES report Section 7.8.3.1 Species overview.

Desktop results

Bluegrass was predicted to occur in the NGBR Project realignment footprint by the Protected Matters Search Tool. Bluegrass was recorded for the Drake Coal Project EIS within one kilometre of the NGBR Project realignment footprint and potential habitat (natural grassland) may occur within the NGBR Project realignment footprint.

Significance of NGBR Project realignment footprint

Individuals of this species were recorded for the Drake Coal Project EIS within native grassland communities at three discrete locations. The soil types within the NGBR Project realignment footprint are suitable for this species; however its occurrence is restricted due to the dominance of buffel grass and other introduced grasses that have encroached and out-competed native species throughout most of the NGBR Project realignment footprint. The NGBR Project realignment footprint is unlikely to contain an important population under the Significant Impact Guidelines; the region may potentially be part of an important population within the greater Burdekin catchment. The potential habitat available for the species within and adjacent to the NGBR Project realignment footprint is shown in Figure 7-3. Potential habitat comprises REs 11.3.25, 11.8.5, 11.9.2 and 11.9.9.

Threatening processes

The primary processes threatening bluegrass is habitat clearing and disturbance associated with agricultural development, including high intensity livestock grazing, pasture improvement and cropping. Other potential threatening processes identified for the species includes:

- Frequent fires and regular burning associated with agricultural practices

- Invasion by exotic grass species, including Coolatai grass (*Hyparrhenia hirta*), lippia (*Phyla canescens*) and African lovegrass (*Eragrostis curvula*)
- Road widening.

Potential impacts

Construction impacts

A total of 257.8 ha of potential habitat for the species is mapped within the NGBR Project realignment footprint and will be cleared to facilitate construction. These potential habitat areas comprising REs 11.3.25, 11.8.5, 11.9.2 and 11.9.9, are where bluegrass is generally found to be co-dominant with other grassland species. This is likely to represent an over-estimation of the actual occurrence of bluegrass within the NGBR Project realignment, as it is not certain that the species will be present within every occurrence of the mapped REs within the NGBR Project realignment.

It is considered unlikely that the clearance will result in significant impacts to an important population of the species, either through causing long-term decreases in population size or reducing the area of overall area of occupancy available to that species.

No indirect impacts to bluegrass are likely to occur during the construction phase of the NGBR Project realignment.

Operational impacts

No direct or indirect impacts to bluegrass are likely to occur during the operational phase of the NGBR Project realignment.

Avoidance, mitigation and management measures

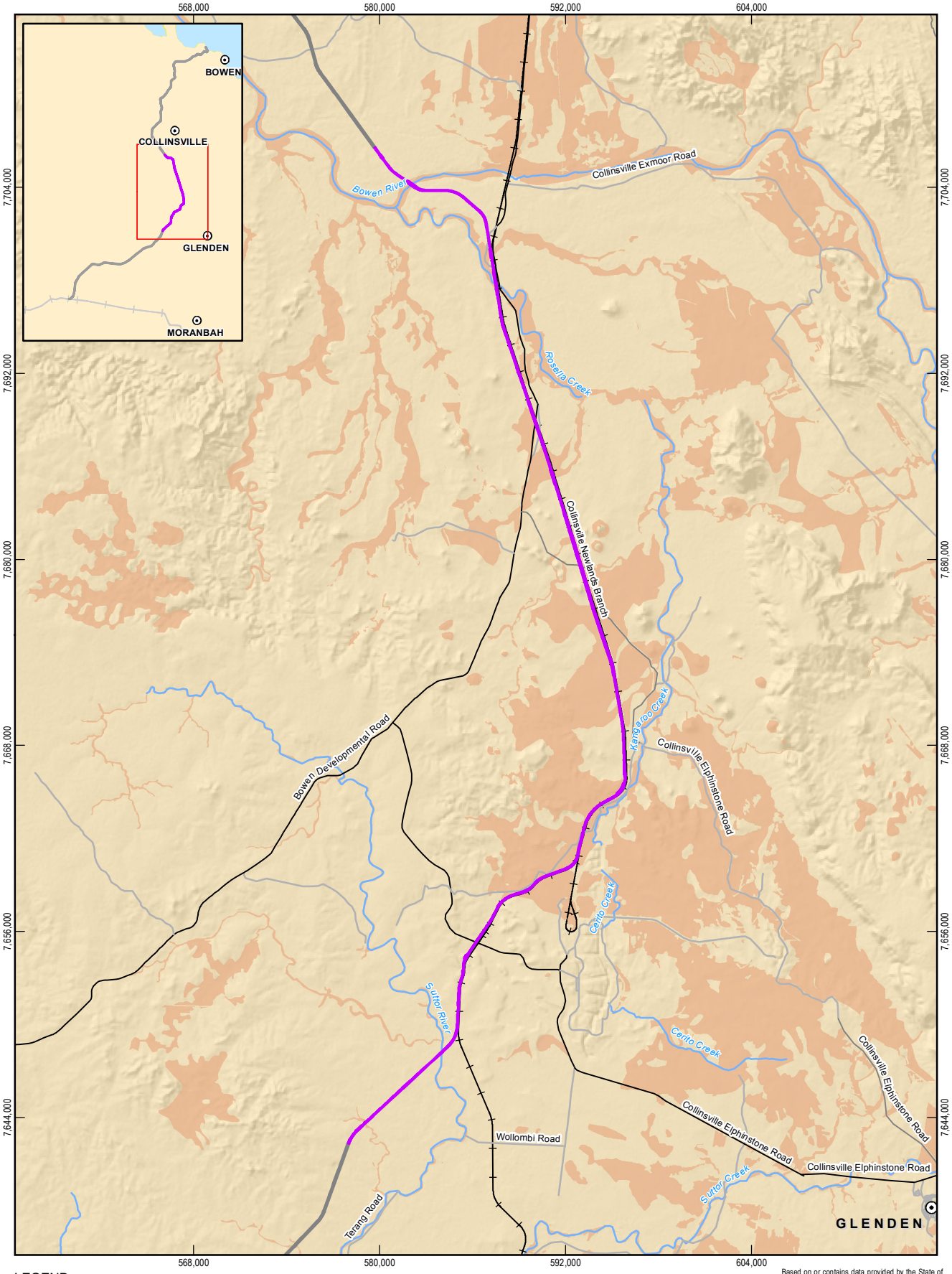
Local and regional priority actions for bluegrass have been identified as follows (TSSC 2008b):

3. Identify populations of high conservation priority
4. Manage threats to areas of vegetation that contain populations/occurrences/remnants of bluegrass
5. Minimise adverse impacts from land use at known sites.
6. Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impacts on bluegrass
7. Ensure road widening and maintenance activities (or other infrastructure or development activities as appropriate) in areas where bluegrass occurs do not adversely impact on known populations.
8. Investigate formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure.
9. Develop and implement a management plan for the control of introduced grasses, such as Coolatai, African Lovegrass and Lippia, in the local region.
10. Identify and remove weeds in the local area, which could become a threat to bluegrass, using appropriate methods.
11. Manage sites to prevent introduction of invasive weeds, which could become a threat to bluegrass, using appropriate methods.

12. Develop and implement a stock management plan for roadside verges and travelling stock routes.
13. Manage known sites on private property to ensure appropriate cattle and/or sheep grazing regimes are conducted outside the growing season, i.e. when plants are not fertile.
14. Prevent grazing pressure at known sites on leased crown land through exclusion fencing or other barriers.
15. Develop and implement a suitable fire management strategy for bluegrass.
16. Identify appropriate intensity and interval of fire to promote seed germination.
17. Provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigation measures in bush fire risk management plans, risk register and/or operation maps.
18. Raise awareness of bluegrass within the local community, particularly among landholders with the species on their properties.
19. Undertake appropriate seed collection and storage.
20. Undertake seed germination and/or vegetative propagation trials to determine the requirements for successful establishment.
21. Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
22. Investigate options for linking, enhancing or establishing additional populations.
23. Implement national translocation protocols (Vallee *et al*., 2004) if establishing additional populations is considered necessary and feasible.

Avoidance, mitigation and management measures for bluegrass will be achieved through the implementation of a Species Management Plan, to include the following:

- During detailed design, a targeted threatened species survey for bluegrass will be undertaken by a suitably qualified botanist to locate and map areas of bluegrass, and gain greater information of the population within the final rail corridor for ongoing adaptive management.
- During detailed design, and using the information from the targeted survey, the extent of the species' distribution to be cleared will be restricted to the minimum area necessary for the construction of the final rail corridor and ancillary infrastructure.
- During detailed design, temporary construction areas, such as site offices, stockpiles, machinery/equipment laydown areas, etc., will be preferentially located outside areas identified as known habitat for bluegrass.
- During pre-construction, in response to priority action #3, a management plan for bluegrass will be developed to manage further impacts for the species, including ecological equivalence assessments and potential offsets.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential bluegrass habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Bluegrass potential habitat

Figure 7-3

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1224_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ

- During construction, in response to priority action #12, areas of bluegrass will be fenced to remove stock grazing pressure. These areas will be managed through watering and health monitoring to aid bluegrass to establish; these measures will be undertaken in accordance with the provisions of a detailed management plan to be developed prior to the commencement of construction activities.
- During construction, in response to priority action #2, monitoring and management programs will be implemented to identify, observe and track any changes in vegetation and habitat structure that occur as a result of construction activities. The approach to management will need to be adaptive. Where significant variations from the changes predicted to occur are identified, this information will be reported and corrective actions implemented as necessary.
- During construction, rehabilitation activities will commence as soon as possible once temporary construction areas are no longer required. Rehabilitation will involve revegetating disturbed areas to a state consistent with their original condition and with the adjacent landscape. Long term management plans for land disturbed as a result of construction works will be developed to detail how disturbed land will be managed and rehabilitated, including (but not limited to) details regarding seed collection (if applicable), flora regeneration, landscape architecture (i.e. topography) and creation of supplementary habitats where necessary. The objective of land rehabilitation will be to provide habitat resources for those localised flora and fauna assemblages impacted or affected by construction and operation activities of the NGBR Project.
- During operation monitoring of the species complexity and condition of vegetation adjacent to constructed areas will be undertaken by a suitably qualified person, at a practicable frequency throughout the operational phase. Where edge effects are identified to be affecting and reducing vegetation condition, replanting with relevant native species is recommended.
- During operation, in response to priority actions #7, #8 and #9, ongoing yearly monitoring for the presence of weeds and new weed infestations will be undertaken within known populations, particularly in relation to potential rubber vine colonisation. Monitoring and management of existing weeds and any new infestations will be undertaken in accordance with a Weed and Pest Management Plan.
- During operation, in response to priority action #13, areas mapped as known or potential habitat for bluegrass within the final NGBR Project footprint that are not subject to vegetation clearing will be protected from frequent fire regimes (defined as burning at intervals of less than five years) to the extent the fire regime is controllable by Adani.

Conclusion

An assessment of residual impacts to bluegrass against the Significant Impact Guidelines is provided in Table 7-5.

Table 7-5 Significance of residual impacts on bluegrass

Impact criteria	Project response
Lead to a long term decrease in the size of an important population of the species	Unlikely. Clearance is likely to only impact a small percentage of the species' potential habitat present in the region, and may result in impact to a number of individuals, although the species is not certain to be present within every occurrence of the mapped natural grassland. It is considered unlikely that the proposed clearance will result in significant impacts to an important population of the species through causing long-term decreases in population size.
Reduce the area of occupancy of an important population	Unlikely. Clearance is likely to only impact a percentage of the species' potential habitat, natural grassland, present in the region. The species is not certain to be present within every occurrence of the mapped grassland. The natural grassland occurring outside of the final NGBR Project footprint will not be cleared, and therefore will continue to be available to support the species where it occurs. It is considered unlikely that the proposed clearance will result in significant impacts to an important population of the species through a reduction in the area of occupancy.
Fragment an existing important population into two or more populations	Unlikely. Pollination and seed dispersal will not be affected by the NGBR Project realignment.
Adversely affect habitat critical to the survival of a species	Unlikely. The NGBR Project realignment is unlikely to contain habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	Unlikely. Pollination and seed dispersal will not be affected by the NGBR Project realignment.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely. Although the NGBR Project realignment will impact 257.8 ha of potential habitat it is unlikely to impact the species to the extent it is likely to decline.

Impact criteria	Project response
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely. Buffel grass and other introduced grasses were noted as abundant where bluegrass was recorded. Mitigation and management measures to be implemented for the NGBR Project, such as the Weed and Pest Management Plan, are expected to result in a net decrease in introduced grasses in proximity of the NGBR Project realignment.
Introduce disease that may cause the species to decline	Unlikely
Interfere substantially with the recovery of the species	Unlikely

7.4.2 Squatter pigeon (southern)

Species overview

The squatter pigeon is described in detail in Volume 2 Appendix D Revised MNES Report Section 7.8.1.1 Species overview.

Desktop results

The squatter pigeon was predicted to occur in the NGBR Project realignment footprint by the Protected Matters Search Tool and was previously recorded in the Wildlife Online database from the desktop search extent. Two squatter pigeons were recorded within one kilometre of the NGBR Project realignment during field surveys for the Alpha Coal Project EIS (Figure 6-10).

Significance of NGBR Project realignment footprint

This species is likely to be common in suitable habitat within the NGBR Project realignment, and is also likely to be present wherever suitable habitat occurs in the surrounding landscape. The distribution of the squatter pigeon (southern) is expected to be limited by the availability of drinking water, but it is likely to be present wherever such water resources are present in conjunction with suitable habitat.

The potential habitat available for the species within and adjacent to the NGBR Project realignment footprint is shown in Figure 7-4. Potential habitat comprises:

- REs and high value regrowth vegetation within the region likely to contain habitat resources for foraging or breeding for the species
- Areas in proximity (three kilometres) of major and minor waterways and palustrine, lacustrine and riverine areas.

Threatening processes

Key threatening processes are listed in the Volume 2 Appendix D Revised MNES report Section 7.8.4.5.

Potential impacts

Construction impacts

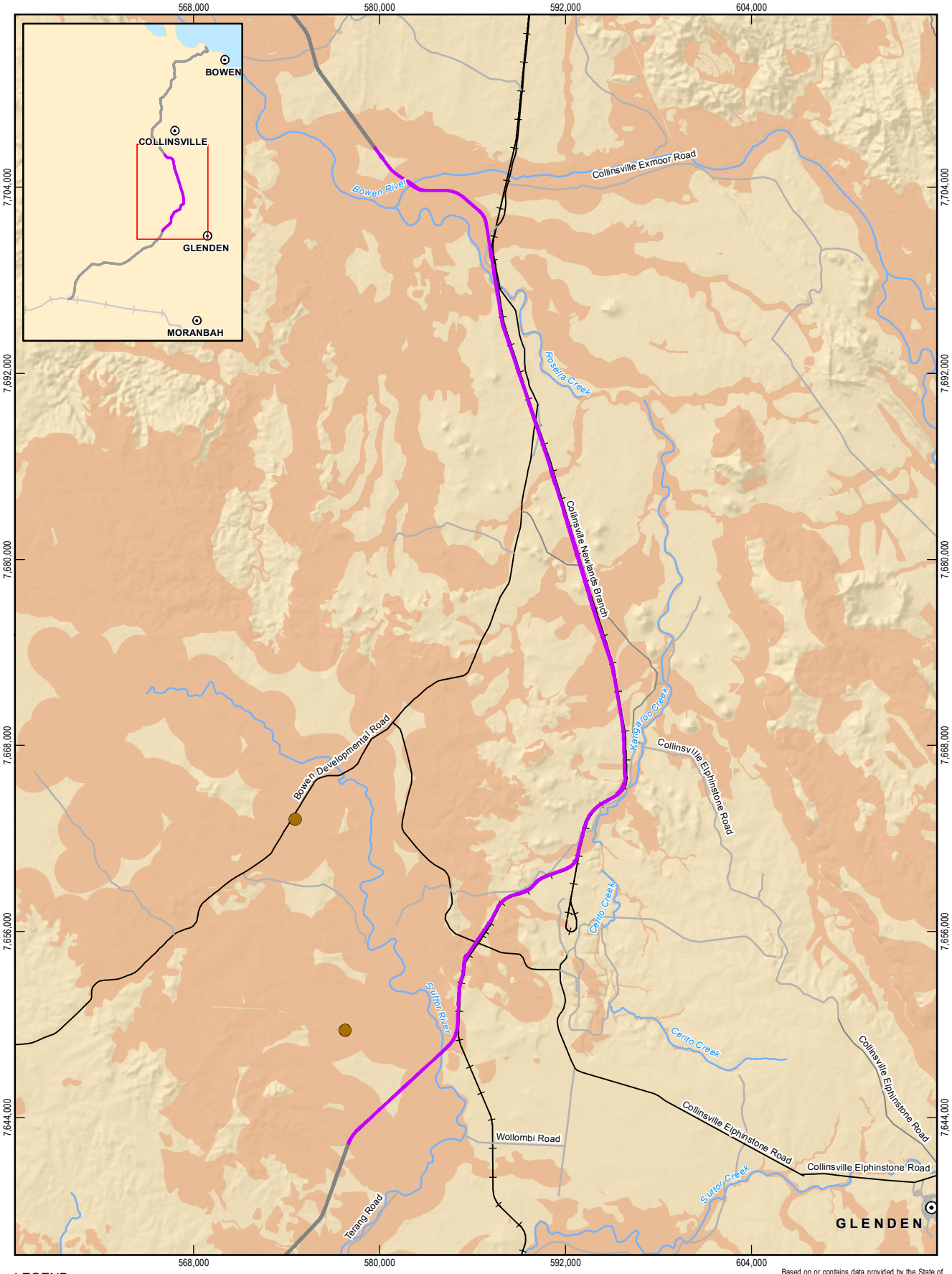
A total of 320.5 ha of potential habitat for the subspecies has been mapped within the NGBR Project realignment footprint and will be cleared. Implications of clearing are further described in the Volume 2 Appendix D Revised MNES report Section 7.8.4.6 Potential Impacts.

Indirect impacts relating to habitat degradation and edge effects are consistent with those described in the Appendix D Revised MNES report Section 7.8.4.6 Potential Impacts.

Operational impacts

The two primary threats to squatter pigeon (southern), that are potentially relevant to the operational phase of the NGBR Project, are those relating to habitat degradation from weed species, and predation, particularly by foxes and cats (TSSC 2008agp).

Direct and indirect operation impacts identified in the Volume 2 Appendix D Revised MNES report Section 7.8.4.6 Potential impacts are also relevant to the NGBR Project realignment.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Squatter pigeon (southern)
- Potential squatter pigeon (southern) habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Squatter pigeon potential habitat

Figure 7-4

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1173_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011); GHD: Threatened Species Sightings (2013). Created by: AJ

Avoidance, mitigation and management measures

The avoidance, mitigation and management measures for squatter pigeon are outlined in the Volume 2 Appendix D Revised MNES report Section 7.8.4.7 Avoidance, mitigation and management measures.

Conclusions

An assessment of residual impacts to the squatter pigeon against the Significant Impact Guidelines is provided in Table 7-6.

Table 7-6 Significance of residual impacts on squatter pigeon

Impact criteria	Project response
Lead to a long term decrease in the size of an important population of the species	Unlikely. The NGBR Project realignment footprint is not considered to support an important population of squatter pigeon.
Reduce the area of occupancy of an important population	Unlikely. The NGBR Project realignment footprint is not considered to support an important population of squatter pigeon.
Fragment an existing important population into two or more populations	Unlikely. The NGBR Project realignment footprint is not considered to support an important population of squatter pigeon.
Adversely affect habitat critical to the survival of a species	Potentially. Although the NGBR Project realignment footprint may result in direct impacts to 320.5 ha of potential squatter pigeon habitat, there is equally suitable habitat available outside the NGBR Project realignment footprint which will not be impacted.
Disrupt the breeding cycle of an important population	Unlikely. The NGBR Project realignment footprint is not considered to support an important population of squatter pigeon.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely. Although the NGBR Project realignment footprint will result in impacts to potential squatter pigeon habitat, it is not considered to be to the extent that will cause the species to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely following the implementation of the Weed and Pest Management Plan.
Introduce disease that may cause the species to decline	Unlikely
Interfere substantially with the recovery of the species	Unlikely

7.4.3 Ornamental snake

Species overview

The ornamental snake is described in the Volume 2 Appendix D Revised MNES report Section 7.8.6.1 Species overview.

Desktop results

The ornamental snake was predicted to occur in the NGBR Project realignment footprint by the Protected Matters Search Tool. The Wildlife Online and Queensland Museum databases also identified records of this species within the desktop search extent. One ornamental snake was recorded within one kilometre of the NGBR Project realignment during field surveys for the Drake Coal Project EIS.

Significance of NGBR Project realignment footprint

The significance of the NGBR Project realignment on the ornamental snake is consistent with that described for the species in the Volume 2 Appendix D Revised MNES report Section 7.8.6.4 Significance of the NGBR Project footprint. The habitat within the NGBR Project realignment is not considered to constitute habitat for key source populations (being predominantly fragmented and isolated remnants) and it does not occur at or near the limit of the species' distributional range. Ornamental snakes within the NGBR Project realignment are not considered to be a part of a population that is necessary for the species' long-term survival and recovery, or habitat critical to the survival of the species.

The potential habitat available for the ornamental snake within and adjacent to the NGBR Project realignment is shown in Figure 7-5.

Threatening processes

Ornamental snake populations have experienced declines in abundance throughout recent decades. The key threatening processes are listed in the Volume 2 Appendix D Revised MNES report Section 7.8.6.5 Threatening processes.

Potential impacts

Construction impacts

Approximately 174.7 ha of potential habitat for the species have been mapped within the NGBR Project realignment footprint and will be cleared to facilitate construction. Potential habitat for this species was mapped based on the presence of a range of brigalow community REs known to support the species. The presence of this species within the NGBR Project realignment footprint will be limited by the co-existence of various habitat features including gilgais and cracking clay soils among others.

Of the threatened species potentially present within the NGBR Project footprint, ornamental snake is the most likely to be at risk of injury or mortality during construction, particularly during earthworks, because of their propensity to shelter within felled timber materials, cracking clay soils and underground. As they are most active between dawn and dusk, the risk of being struck by construction vehicles is relatively low.

Indirect impacts are consistent with those previously described in the Volume 2 Appendix D Revised MNES report Section 7.8.6.6 Potential impacts.

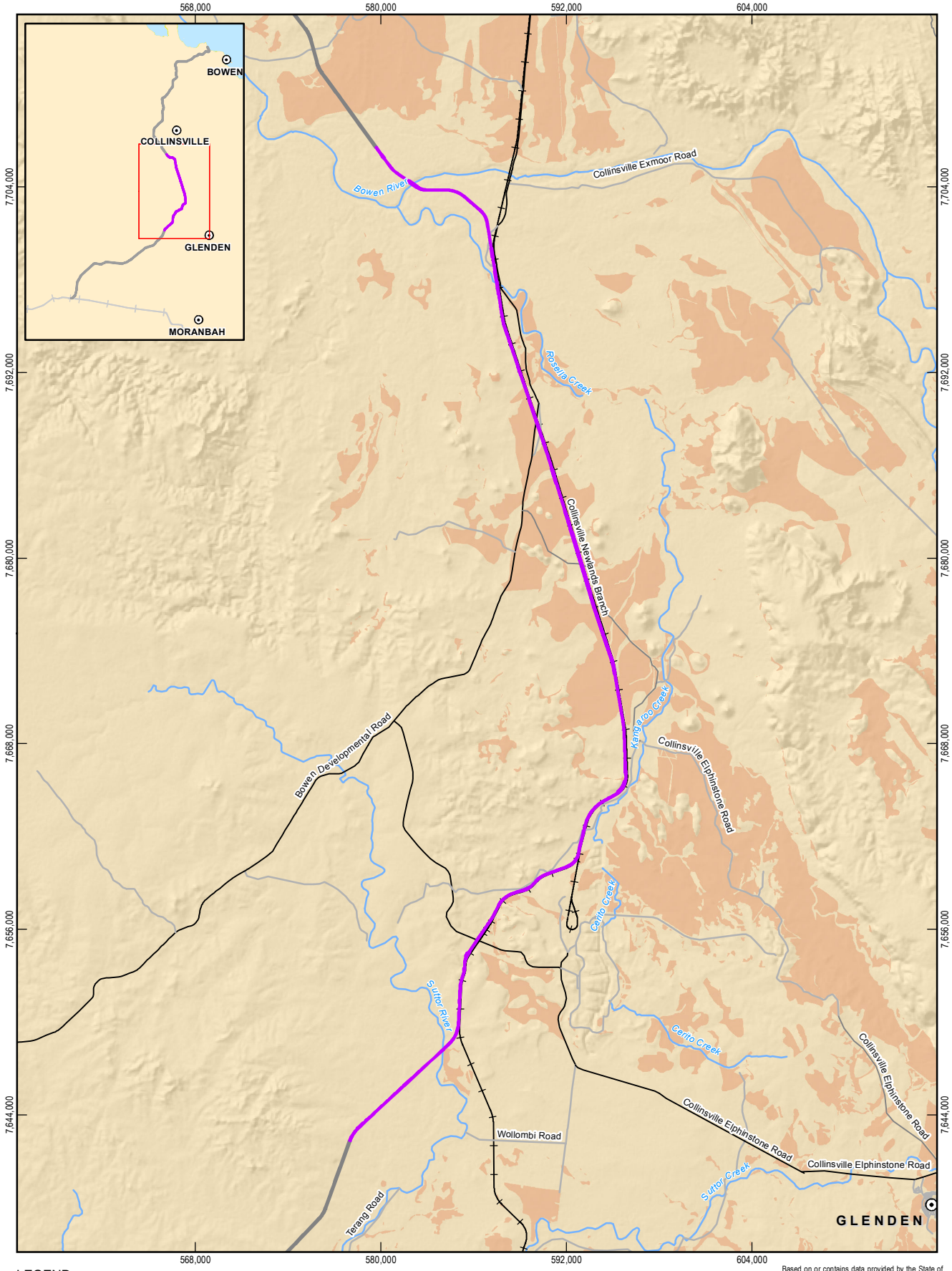
Operational impacts

The key operational threats to the ornamental snake are the potential alteration of hydrology and water quality within habitats in which the species is present, the potential spread of invasive weed species, and predation by and contact with pest species (primarily the cane toad).

Operational impacts identified in the Volume 2 Appendix D Revised MNES report Section 7.8.6.6 Potential impacts are relevant to the NGBR Project realignment.

Avoidance, mitigation and management measures

Avoidance, mitigation and management measures for the ornamental snake are outlined in Volume 2 Appendix D Revised MNES report Section 7.8.6.7 Avoidance, mitigation and management measures.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential ornamental snake habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Ornamental snake potential habitat

Figure 7-5

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1181_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ

Conclusions

An assessment of residual impacts to the ornamental snake against the Significant Impact Guidelines is provided in Table 7-7.

Table 7-7 Significance of residual impacts on ornamental snake

Impact criteria	Project response
Lead to a long term decrease in the size of an important population of the species	Unlikely, as the NGBR Project realignment footprint is not considered to support an important population of ornamental snake.
Reduce the area of occupancy of an important population	Unlikely, as the NGBR Project realignment footprint is not considered to support an important population of ornamental snake.
Fragment an existing important population into two or more populations	Unlikely, as the NGBR Project realignment footprint is not considered to support an important population of ornamental snake.
Adversely affect habitat critical to the survival of a species	Unlikely. The NGBR Project realignment footprint is not considered to contain habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	Unlikely, as the NGBR Project realignment footprint is not considered to support an important population of ornamental snake.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely. Although 174.7 ha of potential habitat will be directly impacted by the NGBR Project realignment footprint, no evidence of the species was detected and is not considered to be to an extent that will lead to a decline in the species.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely, with implementation of the Weed and Pest Management Plan.
Introduce disease that may cause the species to decline	Unlikely
Interfere substantially with the recovery of the species	Unlikely

7.4.4 Black ironbox

Species overview

Black ironbox is described in the Volume 2 Appendix D Revised MNES report Section 7.8.2.1 Species overview.

Desktop results

Black ironbox was predicted to occur in the NGBR Project realignment footprint by the Protected Matters Search Tool. The HERBRECS database also identified records of this species within

the desktop search extent. In the landscape in which the NGBR Project realignment occurs, the HERBRECS data indicates this species has been found in the Bowen River catchments.

Significance of NGBR Project realignment footprint

While it is listed as vulnerable under the EPBC Act, its wide distribution and locally common abundance mean that the species is likely to be present along numerous creek lines within the NGBR Project realignment and across the broader region. While the NGBR Project realignment is unlikely to contain an important population under the Significant Impact Guidelines, the region may potentially be part of an important population within the greater Burdekin catchment. The potential habitat available for the species within and adjacent to the NGBR Project realignment is shown in Figure 7-6. Potential habitat comprises REs 11.3.25 and 11.3.37 along major watercourses within the NGBR Project realignment.

Threatening processes

The primary process threatening black ironbox is habitat disturbance through the introduction and proliferation of exotic weeds species, particularly rubber vine (*Cryptostegia grandiflora*), this, and other threatening processes are identified in the Volume 2 Appendix D Revised MNES report Section 7.8.2.5 Threatening processes.

Potential impacts

Construction impacts

A total of 125 ha of potential habitat for the species is mapped within the NGBR Project realignment footprint and will be cleared. These potential habitat areas are those areas of riparian habitat along creek and river corridors (Bowen River and Rosella Creek) comprising REs 11.3.25 and 11.3.37, where black ironbox is generally found to be co-dominant with other Eucalypt species. This is likely to represent an over-estimation of the actual occurrence of black ironbox within the NGBR Project realignment, as it is not certain that the species will be present within every occurrence of the mapped REs within the NGBR Project realignment. Based on previous survey experience in the region, it is considered less likely to occur south of the Bowen River.

Furthermore, in terms of the actual impact to black ironbox during construction, clearance at creek crossings is only likely to result in the loss of a few individual black ironbox trees at each crossing point where RE 11.3.25 or 11.3.37 is present. Given that the REs will be present as a fringing band along the creek or river, it will remain present on either side of the cleared footprint, as will individual black ironbox trees within those areas. Pollination and seed dispersal are unlikely to be affected by construction activities.

No indirect impacts to black ironbark are likely to occur during the construction phase of the NGBR Project realignment.

Operational impacts

Operational impacts identified in the Volume 2 Appendix D Revised MNES report Section 7.8.2.6 Potential impacts.

Avoidance, mitigation and management measures

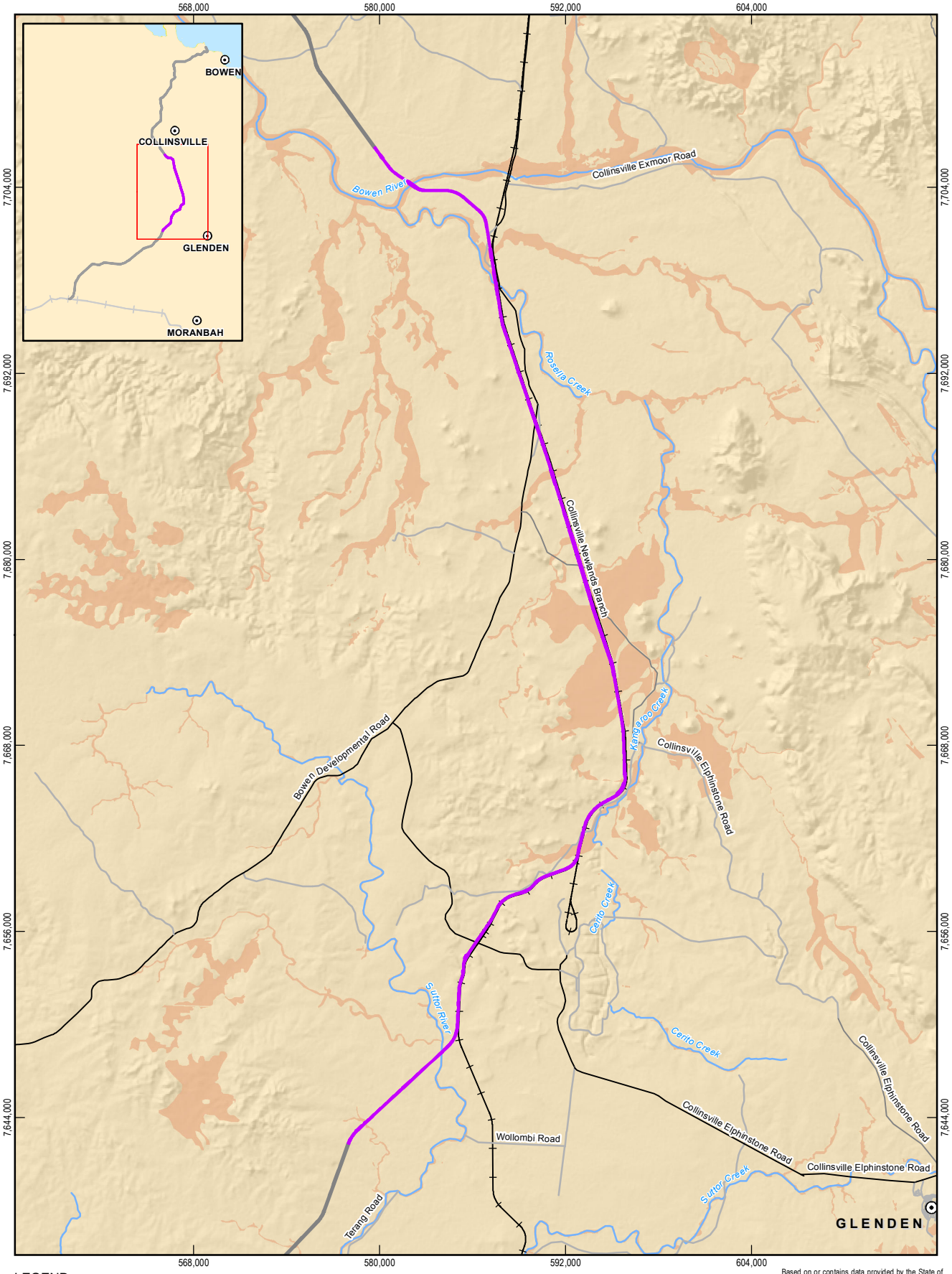
Avoidance, mitigation and management measures for black ironbox are outlined in the NGBR Volume 2 Appendix D Revised MNES report Section 7.8.2.7 Avoidance, mitigation and management measures.

Conclusion

An assessment of residual impacts to the black ironbark against the Significant Impact Guidelines is provided in Table 7-11.

Table 7-8 Significance of residual impacts on black ironbox

Impact criteria	Project response
Lead to a long term decrease in the size of an important population of the species	Unlikely. Due to the narrow fringing band of vegetation present at creek crossings, the NGBR Project realignment is only likely to impact small numbers of individuals and is unlikely to cause long-term decreases in populations in the region.
Reduce the area of occupancy of an important population	Unlikely. Due to the narrow fringing band of vegetation present at creek crossings, the NGBR Project realignment is only likely to impact a few individuals and is unlikely to reduce the area of occupancy for an important population of the species.
Fragment an existing important population into two or more populations	Unlikely. Pollination and seed dispersal will not be affected by the NGBR Project realignment.
Adversely affect habitat critical to the survival of a species	Unlikely. The NGBR Project realignment footprint is unlikely to contain habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	Unlikely. Pollination and seed dispersal will not be affected by the NGBR Project realignment.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely. Although the NGBR Project realignment will impact 125 ha of potential habitat it is unlikely to impact the species to the extent it is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely. Rubber vine was noted as already abundant at both creek locations where black ironbox was recorded. Mitigation and management measures to be implemented for the NGBR Project realignment, such as the Weed and Pest Management Plan, are expected to result in a net decrease in rubber vine in proximity of the final rail corridor.
Introduce disease that may cause the species to decline	Unlikely
Interfere substantially with the recovery of the species	Unlikely



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential black ironbox habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Black ironbox potential habitat

Figure 7-6

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1185_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ

7.4.5 Black-throated finch (southern)

Species overview

The black-throated finch (southern) is described in the Volume 2 Appendix D Revised MNES Section 7.8.8.1 Species overview.

Desktop results

The black-throated finch (southern) was predicted to occur in the NGBR Project realignment by the Protected Matters Search Tool.

Significance of NGBR Project realignment footprint

The significance of the NGBR Project realignment is consistent with that described for the species in the Volume 2 Appendix D Revised MNES Report Section 7.8.8.4 Significance of the NGBR Project footprint.

The potential habitat available for the species within and adjacent to the NGBR Project realignment is shown in Figure 7-7. Potential habitat comprises REs and high value regrowth vegetation within the region likely to contain habitat resources for foraging or breeding for the species. The large extent of potential habitat corresponds to a wide range of mapped woodland and grassland habitat types that could be used by the subspecies. An area of five kilometres around each confirmed sighting is arbitrarily classified as being important habitat for the species. Because of the species' requirements for permanent water sources for drinking, native grasslands for feeding and eucalypt species (and associated woodlands) for nesting, it is only likely to occur within the NGBR Project realignment where these three features exist in close proximity to each other.

Threatening processes

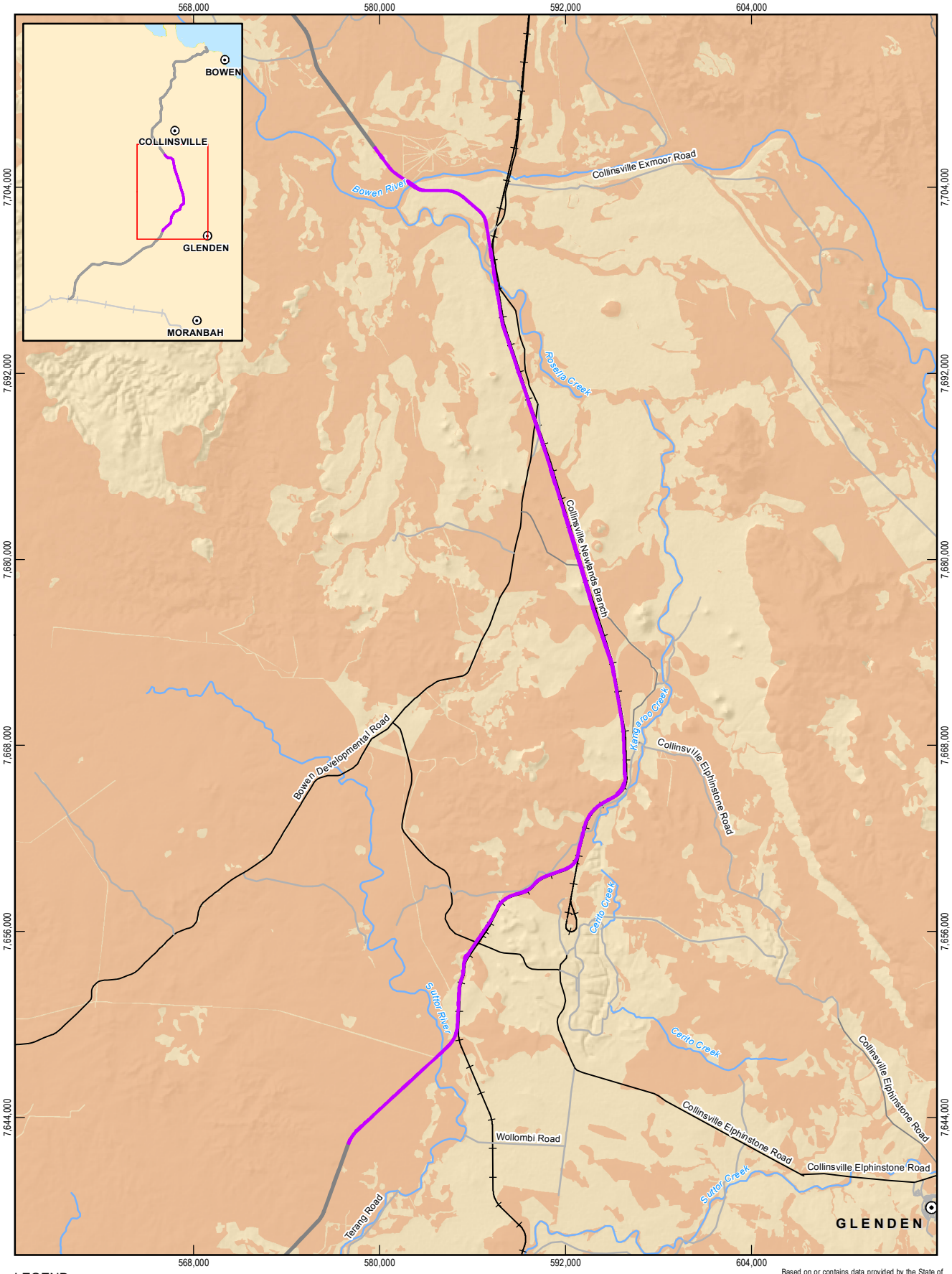
Numerous threatening processes have been identified as contributing to the decline of the black-throated finch (southern). These are listed in the Volume 2 Appendix D Revised MNES report Section 7.8.8.5 Threatening processes.

Potential impacts

Construction impacts

A total of 481.7 ha of potential habitat for the black-throated finch (southern) has been mapped within the NGBR Project realignment footprint and will be cleared to facilitate construction.

If present, the black-throated finch (southern) is likely to occupy much smaller areas of the footprint, due to both the rarity of the subspecies and the localised and generally sedentary nature of populations; as well as the combination of habitat factors that need to co-exist at the micro-scale (native grassland understorey, nesting trees/scrub and available water) in order to support a viable population of the subspecies.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential black-throated finch habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Black-throated finch potential habitat

Figure 7-7

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1178_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ

An overall reduction in the local availability of potential habitat for the subspecies will occur as a result of the construction of the NGBR Project. It is possible that the subspecies may disperse away from the developed parts of the preliminary investigation corridor to alternative suitable habitat within the surrounds. Whilst the loss of habitat may impact black-throated finch (southern), if present, the severance or fragmentation of habitat is likely to be less significant as the subspecies is known to occur within or move between areas of seemingly unsuitable non-remnant vegetation.

No known populations of black-throated finch (southern) occur specifically within the NGBR Project realignment footprint. On that basis, it is considered unlikely that the removal of potentially suitable habitat within the proposed NGBR Project realignment footprint will result in a significant impact to the subspecies, in terms of the likelihood of causing long-term population decline, fragmentation of populations, disruption of breeding cycles of populations, or otherwise adverse impacts to habitats critical to the survival of the subspecies.

Indirect impacts identified in the Volume 2 Appendix D Revised MNES report Section 7.8.8.6 Potential impacts are relevant to the NGBR Project realignment.

Operational impacts

The key threats relevant to the operation of the NGBR Project realignment are habitat degradation and alteration, weed species invasion (especially exotic pasture grasses) and predation by introduced pest species (TSSC 2005s).

Operational impacts identified in the Volume 2 Appendix D Revised MNES report Section 7.8.8.6 Potential impacts are relevant to the NGBR Project realignment.

Avoidance, mitigation and management measures

Avoidance, mitigation and management measures for the black-throated finch outlined in the Volume 2 Appendix D Revised MNES report Section 7.8.8.7 Avoidance, mitigation and management measures are considered applicable to the NGBR Project realignment.

Conclusions

An assessment of residual impacts to the black-throated finch against the Significant Impact Guidelines is provided in Table 7-9.

Table 7-9 Significance of residual impacts on black-throated finch

Impact criteria	Project response
Lead to a long term decrease in the size of a population of the species	Unlikely. The black-throated finch (southern) was predicted to occur, however, no known populations of black-throated finch (southern) are known to occur within the NGBR Project realignment footprint.
Reduce the area of occupancy of the species	Potentially. While an overall reduction in the local availability of habitat for the subspecies will occur as a result of the construction of the NGBR Project, no known populations of black-throated finch (southern) are known to occur within the NGBR Project realignment footprint.

Impact criteria	Project response
Fragment an existing population into two or more populations	Unlikely. The NGBR Project will not inhibit movement of the species between habitats and no known populations occur within the final NGBR Project footprint.
Adversely affect habitat critical to the survival of a species	Potentially. An overall reduction in potentially suitable habitat for the subspecies will occur as a result of the construction of the NGBR Project realignment.
Disrupt the breeding cycle of a population	Unlikely. Although the species has been found to be present within areas already subject to comparable disturbance impacts from noise, vehicles and people, no known populations occur within the NGBR Project realignment footprint.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely. Although the NGBR Project will result in impacts to 481.7 ha of potential habitat, no known populations occur within the final rail corridor and it is not considered to be to the extent that will cause the species to decline.
Result in invasive species that are harmful to an endangered or critically endangered species becoming established in the endangered species' habitat	Unlikely, with implementation of the Weed and Pest Management Plan.
Introduce disease that may cause the species to decline	Unlikely
Interfere substantially with the recovery of the species	Unlikely

7.4.6 Koala

Species overview

The koala is described in the Volume 2 Appendix D Revised MNES report Section 7.8.5.1 Species overview.

Desktop results

The koala was predicted to occur in the preliminary investigation corridor by the Protected Matters Search Tool. One historical record of this species was recorded within the Wildlife online database for the desktop search extent. The species was recorded during dry season surveys near the southern extent of the NGBR Project realignment.

Significance of NGBR Project realignment footprint

The significance of the NGBR Project realignment on the koala is consistent with that described for the species in the Volume 2 Appendix D Revised MNES report Section 7.8.5.4 Significance of the NGBR Project footprint.

The potential habitat available for the species within and adjacent to the NGBR Project realignment footprint is shown in Figure 7-8. Potential habitat comprises REs within the region likely to contain habitat resources for foraging or breeding for the species.

Threatening processes

Koala populations within eastern Australia have suffered substantial decline over three generations. Key threatening processes are listed in the Volume 2 Appendix D Revised MNES report Section 7.8.5.5 Threatening processes.

Potential impacts

Construction impacts

A total of 514.2 ha of potential habitat for this species is mapped within the NGBR Project realignment footprint and will be cleared to facilitate construction. These potential habitat areas are broad areas of eucalypt woodland REs and are likely to represent a substantial over-estimation of the actual occurrence of koala within the footprint, as it is extremely unlikely that the species will be present within all of these RE areas in the NGBR Project realignment footprint. Koala populations are likely to be scattered and generally restricted to creek and river crossings where areas of intact, mature eucalypt woodland intersect with the NGBR Project realignment footprint.

Local koala populations are likely to occur in low densities. The presence of potentially suitable habitat beyond the NGBR Project realignment footprint suggests that the koala is likely to be present in low densities across the wider landscape. No defined ‘important populations’ have been listed by DotE (DotE 2014e) within Queensland. If present in mature trees within the NGBR Project realignment footprint at the time of vegetation clearance for construction (if not successfully relocated during pre-clearing surveys), koala could be at risk of injury or mortality. As they are most active between dawn and dusk, the risk of being struck by construction vehicles is relatively low.

With respect to the Significant Impact Guidelines (DEWHA 2009a), it is not considered that the likely occurrence of koala within the NGBR Project realignment footprint defines it as part of an ‘important population’ of an EPBC Act listed vulnerable species. The koalas that occur within the footprint are not likely to be a part of a population that is necessary for a species’ long-term survival and recovery. Based on the low estimated density of koalas within the region and the availability of similarly suitable habitat in the landscape surrounding the NGBR Project realignment footprint, it is not considered that the removal of potentially suitable habitat within the proposed NGBR Project realignment footprint will result in a significant impact to the species, in terms of the likelihood of causing long-term population declines, fragmentations of populations, disruption of breeding cycles of populations, or otherwise adverse impacts to habitats critical to the survival of the species.

Areas of potential habitat for koalas, particularly riparian areas bordering watercourses and eucalypt communities, may be indirectly impacted by increased weed and pest prevalence, disturbances to and displacement of the species during construction.

Operational impacts

Operational impacts identified in the Volume 2 Appendix D Revised MNES report Section 7.8.5.6 Potential impacts are relevant to the NGBR Project realignment.

Avoidance, mitigation and management measures

Avoidance, mitigation and management measures for the koala are outlined in the Volume 2 Appendix D Revised MNES report Section 7.8.5.7 Avoidance, mitigation and management measures. These are relevant to the NGBR Project realignment.

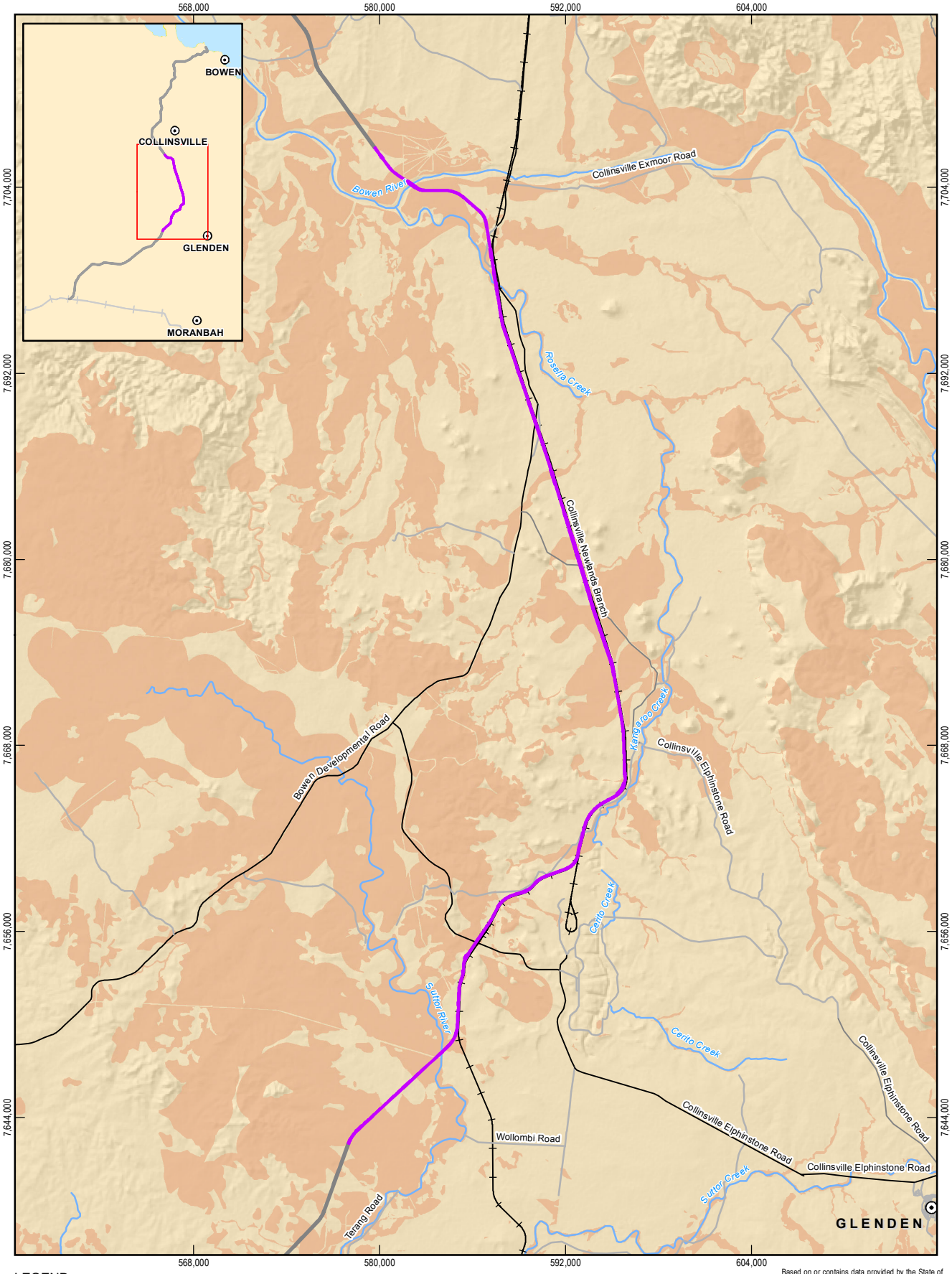
Conclusions

An assessment of residual impacts to the koala against the Significant Impact Guidelines is provided in Table 7-13. No significant impact is expected.

Table 7-10 Significance of residual impacts on koala

Impact criteria	Project response
Lead to a long term decrease in the size of an important population of the species	Unlikely, as the final NGBR Project footprint is not considered to support an important population of koala.
Reduce the area of occupancy of an important population	Unlikely, as the NGBR Project realignment footprint is not considered to support an important population of koala.
Fragment an existing important population into two or more populations	Unlikely, as the NGBR Project realignment footprint is not considered to support an important population of koala.
Adversely affect habitat critical to the survival of a species	Potentially. Approximately 514.2 ha of potential habitat occurs within the NGBR Project realignment footprint. However, although suitable habitat will be impacted, this should be considered in the context of the low estimated density of koalas across the region and the availability of similarly suitable habitat in the landscape surrounding the NGBR Project.
Disrupt the breeding cycle of an important population	Unlikely, as the NGBR Project realignment footprint is not considered to support an important population of koala.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely. Although suitable habitat will be impacted, the low estimated density of koalas and the availability of similarly suitable habitat in the landscape surrounding the NGBR Project, it is not considered to be 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	Unlikely, with implementation of the Weed and Pest Management Plan.

Impact criteria	Project response
Introduce disease that may cause the species to decline	Unlikely
Interfere substantially with the recovery of the species	Unlikely



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential koala habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Koala potential habitat

Figure 7-8

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1183_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ

7.4.7 King bluegrass

Species overview

Bluegrass is described in detail in Volume 2 Appendix D Revised MNES report Section 7.8.9.1 Species overview.

Desktop results

King bluegrass was predicted to occur within the final NGBR Project footprint by the Protected Matters Search Tool. The species has also been previously recorded within the desktop search extent by the Wildlife Online and HERBRECS databases.

Significance of NGBR Project realignment footprint

Particular vegetation communities and soil types within the NGBR Project realignment footprint are suitable for this species; however the occurrence of king bluegrass is likely to be limited by the dominance of buffel grass and other introduced grasses that are present throughout much of the final NGBR Project footprint. Accordingly, the final NGBR Project footprint is unlikely to contain an important king bluegrass population under the Significant Impact Guidelines (DEWHA 2009a).

The potential habitat available for the species within and adjacent to the final NGBR Project footprint is shown in Figure 7-9. Potential habitat comprises REs 11.3.2, 11.3.31, 11.4.4, 11.4.11, 11.8.5, 11.8.11, 11.9.2, 11.9.3, 11.9.12 and 11.11.17.

Threatening processes

The primary processes threatening king bluegrass is loss of habitat through agricultural and mining activities, and weed invasion resulting in competition and potential displacement (TSSC, 2013n).

Potential impacts

Construction impacts

A total of 263.3 ha of potential habitat for the species is mapped within the final NGBR Project footprint and will be cleared. These potential habitat areas, comprising REs 11.3.2, 11.3.31, 11.4.4, 11.4.11, 11.8.5, 11.8.11, 11.9.2, 11.9.3, 11.9.12 and 11.11.17, are where king bluegrass is generally found to be co-dominant or associated with other grassland species. However, this is likely to represent an over-estimation of the actual occurrence of king bluegrass within the final NGBR Project footprint, as the species is unlikely to be present within every occurrence of the potentially suitable REs, particularly taking in to consideration the extent of buffel and other introduced grass within the final NGBR Project footprint.

It is considered unlikely that the proposed clearance will result in significant impacts to an important population of the species, either through causing long-term decreases in population size or reducing the area of overall area of occupancy available to that species. Direct impacts on king bluegrass will be minimised through the implementation of the mitigation measures.

No indirect impacts to kingbluegrass are likely to occur during the construction phase of the NGBR Project realignment.

Operational impacts

No direct or indirect impacts to bluegrass are likely to occur during the operational phase of the NGBR Project realignment.

Avoidance, mitigation and management measures

The following regional priority recovery and threat abatement actions have been identified to support the recovery of king bluegrass (TSSC, 2013n):

1. Monitor known populations to identify key threats.
2. Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
3. Identify populations of high conservation priority.
4. Ensure there is no disturbance in areas where king bluegrass occurs, excluding necessary actions to manage the conservation of the species/ecological community.
5. Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate and/or secure inclusion in reserve tenure if possible.
6. Manage any other known, potential or emerging threats, including mining practices, grazing, weed invasion and climate change.
7. Develop and implement a management plan for king bluegrass for the control of parthenium (*Parthenium hysterophorus*) and parkinsonia (*Parkinsonia aculeata*) in the region.
8. Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on king bluegrass.
9. Develop and implement a stock management plan for roadside verges and travelling stock routes.
10. Raise awareness of king bluegrass within the local community, for example distribute fact sheets/information brochures or conduct field days in conjunction with known industry or community interest groups.
11. Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.
12. Enable recovery of additional sites and/or populations.
13. Undertake appropriate seed collection and storage.
14. Investigate options for linking, enhancing or establishing additional populations.
15. Implement national translocation protocols if establishing additional populations is considered necessary and feasible.

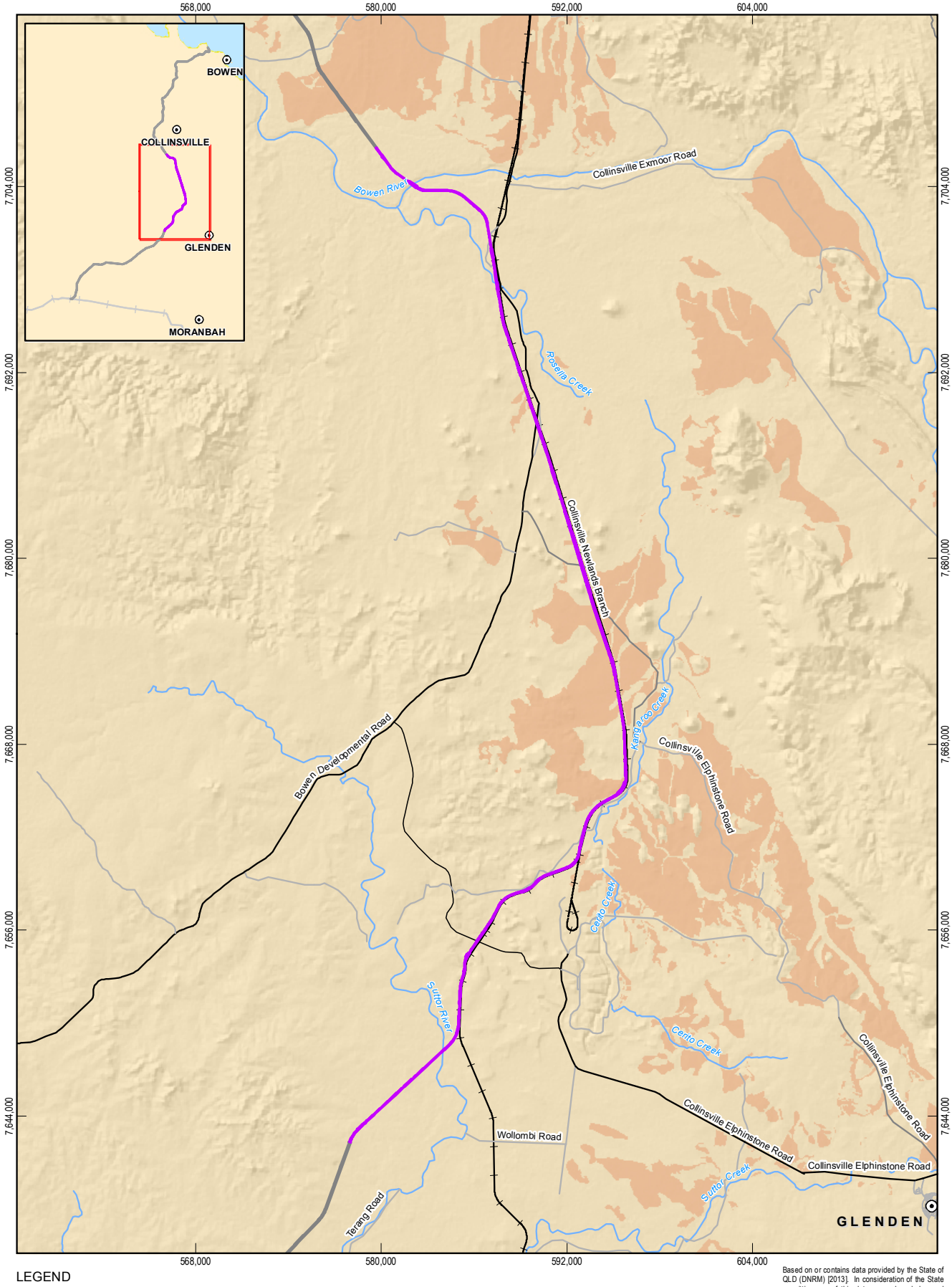
Avoidance, mitigation and management measures for bluegrass will be achieved through the implementation of a Species Management Plan, to include the following:

- During detailed design, a targeted threatened species survey for king bluegrass will be undertaken by a suitably qualified botanist to locate and map areas of king bluegrass, and gain greater information of the population within the final rail corridor for ongoing adaptive management.
- During detailed design, and using the information from the targeted survey, the extent of the species' distribution to be cleared will be restricted to the minimum area necessary for the construction of the final rail corridor and ancillary infrastructure.
- During detailed design, temporary construction areas, such as site offices, stockpiles, machinery/equipment laydown areas, etc., will be preferentially located outside areas identified as known habitat for bluegrass.

- During pre-construction, a management plan for king bluegrass will be developed to manage further impacts for the species. This will include the requirement to undertake ecological equivalence assessments and potentially provision of offsets.

7.4.8 Summary

A summary of potential direct and indirect impacts, proposed mitigation measures and residual impact assessment on listed threatened species confirmed present or likely to occur within the NGBR Project realignment footprint is provided in Table 7-11.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential king bluegrass habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

King bluegrass potential habitat

Figure 7-9

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1223_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ

Table 7-11 Summary of impacts, threats and mitigation measures for species

Threatened species	Direct impacts	Indirect impacts	Mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Bluegrass (*Dichanthium setosum*)	**Construction** • Direct loss of 257.8 ha of potential habitat • Potential direct loss of individuals	**Operation** • Proliferation of exotic weeds (particularly buffel grass and other introduced grasses)	Targeted surveys during detailed design to locate areas of bluegrass Manage potentially mobilised pollutants through the implementation of an Environmental Management Plan. Micro-scale adjustments of clearing footprints to avoid potentially suitable habitat. Establishment and implementation of the following: • Water Quality Management Plan • Fire Management Plan • Erosion and Sediment Control Plan • Weed and Pest Management Strategy Locate temporary structures and infrastructure within the construction footprint to avoid further clearing Salvage/translocation of seedlings Rehabilitation of temporarily disturbed areas On-going monitoring of vegetation communities along the NGBR Project realignment	The NGBR Project realignment footprint will reduce the extent of available habitat of known populations; however it is unlikely to contain an important population or habitat critical to the survival of the species. Offsets will be acquired to compensate losses of this listed species.	Yes

Threatened species	Direct impacts	Indirect impacts	Mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Squatter pigeon (southern) (*Geophaps scripta scripta*)	**Construction** • Direct loss of 320.5 ha of potential habitat • Individual mortality through vehicle collisions **Operation** • Individual mortality through train/maintenance vehicle collisions	**Construction** • Degradation of surrounding habitat through edge effects (e.g. weed spread and predation) • Noise, light, dust and vibration **Operation** • Habitat degradation due to weed spread, noise, light, dust and vibration.	Targeted surveys during detailed design, locating and marking key habitat features Micro-scale adjustments of clearing footprints to avoid potentially suitable habitat. Establishment and implementation of the following: • Water Quality Management Plan • Fire Management Plan • Dust Management Plan • Erosion and Sediment Control Plan • Weed and Pest Management Strategy Locate temporary structures and infrastructure within the construction footprint to avoid further clearing Maintain a register of wildlife incidents Sequential vegetation clearing to allow species to disperse away from cleared areas and clearing activities Fauna spotter-catcher present during vegetation clearing (to check/clear feeding areas, roosting or nesting sites) Salvage habitat features Rehabilitation of temporarily disturbed areas Vehicle speed limits imposed on associated maintenance tracks to reduce risk of fauna mortality On-going monitoring of vegetation communities along the final rail corridor	The NGBR Project realignment footprint may potentially have a significant impact on the species. While an important population is not considered to occur within the NGBR Project realignment footprint, potential habitat will be impacted that may be habitat critical to the survival of the species. Any impact to potential habitat critical to the survival of the species will be managed through the implementation of mitigation measures. Offsets will be acquired to compensate losses of this listed species.	Yes

Threatened species	Direct impacts	Indirect impacts	Mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Ornamental snake (*Denisonia maculata*)	**Construction** • Direct loss of 174.7 ha of potential habitat **Operation** • Individual mortality through train/maintenance vehicle collisions	**Construction** • Degradation of surrounding habitat through edge effects (e.g. weed spread and sedimentation) • Noise, light, dust and vibration **Operation** • Habitat degradation due to weed spread, noise, light, dust and vibration.	Targeted surveys during detailed design, locating and marking key habitat features Micro-scale adjustments of clearing footprints to avoid potentially suitable habitat. Establishment and implementation of the following: • Water Quality Management Plan • Fire Management Plan • Dust Management Plan • Erosion and Sediment Control Plan • Weed and Pest Management Strategy Locate temporary structures and infrastructure within the construction footprint to avoid further clearing Maintain a register of wildlife incidents Sequential vegetation clearing to allow species to disperse away from cleared areas and clearing activities Fauna spotter-catcher present during vegetation clearing (to check/clear feeding areas, roosting or nesting sites) Salvage habitat features Rehabilitation of temporarily disturbed areas Vehicle speed limits imposed on associated maintenance tracks to reduce risk of fauna mortality On-going monitoring of vegetation communities along the final rail corridor	The NGBR Project realignment footprint is unlikely to have a significant impact on the species. The final rail corridor is unlikely to contain an important population or habitat critical to the survival of the species. Any indirect impacts will be managed through the implementation of mitigation measures. Offsets will be acquired to compensate losses of this listed species	Yes

Threatened species	Direct impacts	Indirect impacts	Mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Black ironbox (*Eucalyptus raveretiana*)	**Construction** • Direct loss of 125 ha of potential habitat • Potential direct loss of individuals • Alteration of stream and floodplain hydrology	**Operation** • Proliferation of exotic weeds (particularly rubber vine)	Targeted surveys during detailed design, locating and marking any individual trees Manage potentially mobilised pollutants through the implementation of an Environmental Management Plan. Micro-scale adjustments of clearing footprints to avoid potentially suitable habitat. Establishment and implementation of the following: • Water Quality Management Plan • Fire Management Plan • Erosion and Sediment Control Plan • Weed and Pest Management Strategy Avoidance of large mature trees where practicable Locate temporary structures and infrastructure within the construction footprint to avoid further clearing Salvage/translocation of young saplings and seedlings Installation of culverts and erosion and sediment controls at stream crossings Rehabilitation of temporarily disturbed areas On-going monitoring of vegetation communities along the final rail corridor	The NGBR Project realignment footprint will reduce the extent of available habitat of known populations; however it is unlikely to contain an important population or habitat critical to the survival of the species. Offsets will be acquired to compensate losses of this listed species.	Yes

Threatened species	Direct impacts	Indirect impacts	Mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Black-throated finch (southern) (*Poephila cincta cincta*)	**Construction** • Direct loss of 481.7 ha of potential habitat **Operation** • Individual mortality through train/maintenance vehicle collisions	**Construction** • Degradation of surrounding habitat through edge effects (e.g. weed spread and sedimentation) • Noise, light, dust and vibration **Operation** • Habitat degradation due to weed spread, noise, light, dust and vibration.	Targeted surveys during detailed design, locating and marking key habitat features Micro-scale adjustments of clearing footprints to avoid potentially suitable habitat. Establishment and implementation of the following: • Water Quality Management Plan • Fire Management Plan • Dust Management Plan • Erosion and Sediment Control Plan • Weed and Pest Management Strategy Locate temporary structures and infrastructure within the construction footprint to avoid further clearing Maintain a register of wildlife incidents Sequential vegetation clearing to allow species to disperse away from cleared areas and clearing activities Fauna spotter-catcher present during vegetation clearing (to check/clear feeding areas, roosting or nesting sites) Salvage habitat features Rehabilitation of temporarily disturbed areas Vehicle speed limits imposed on associated maintenance tracks to reduce risk of fauna mortality On-going monitoring of vegetation communities along the final rail corridor	The NGBR Project realignment footprint may potentially have a significant impact on the species. While an important population is not considered to occur within the NGBR Project realignment footprint, potential habitat critical to the survival of the species will be impacted. Offsets will be acquired to compensate losses of this listed species	Yes

Threatened species	Direct impacts	Indirect impacts	Mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Koala (*Phascolarctos cinereus*)	**Construction** • Direct loss of 514.2 ha of potential habitat **Operation** • Individual mortality through train/maintenance vehicle collisions	**Construction** • Degradation of surrounding habitat through edge effects (e.g. weed spread and sedimentation) • Noise, light, dust and vibration **Operation** • Habitat degradation due to weed spread, noise, light, dust and vibration.	Targeted surveys during detailed design, locating and marking key habitat features Micro-scale adjustments of clearing footprints to avoid potentially suitable habitat. Establishment and implementation of the following: • Water Quality Management Plan • Fire Management Plan • Dust Management Plan • Erosion and Sediment Control Plan • Weed and Pest Management Strategy Locate temporary structures and infrastructure within the construction footprint to avoid further clearing Maintain a register of wildlife incidents Sequential vegetation clearing to allow species to disperse away from cleared areas and clearing activities Fauna spotter-catcher present during vegetation clearing (to check/clear feeding areas, roosting or nesting sites) Salvage habitat features possible Rehabilitation of temporarily disturbed areas Vehicle speed limits imposed on associated maintenance tracks to reduce risk of fauna mortality On-going monitoring of vegetation communities along the final rail corridor	The NGBR Project realignment footprint may potentially have a significant impact on habitat available for the species. While an important population is not considered to occur within the NGBR Project realignment footprint, potential habitat will be impacted that may be habitat critical to the survival of the species. Offsets will be acquired to compensate losses of this listed species.	Yes
King bluegrass (*Dichanthium queenslandicum*)	**Construction** • Direct loss of 263.3 ha of potential habitat • Potential direct	**Operation** • Proliferation of exotic weeds (particularly buffel grass and other introduced	Targeted surveys during detailed design to locate areas of king bluegrass Manage potentially mobilised pollutants through the implementation of an Environmental Management Plan. Micro-scale adjustments of clearing footprints to avoid	The NGBR Project realignment footprint will reduce the extent of available habitat of known populations; however it is unlikely to contain an	Yes

Threatened species	Direct impacts	Indirect impacts	Mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
	loss of individuals	grasses)	potentially suitable habitat. Establishment and implementation of the following: • Water Quality Management Plan • Fire Management Plan • Erosion and Sediment Control Plan • Weed and Pest Management Strategy Locate temporary structures and infrastructure within the construction footprint to avoid further clearing Salvage/translocation of seedlings Rehabilitation of temporarily disturbed areas On-going monitoring of vegetation communities along the NGBR Project realignment	important population or habitat critical to the survival of the species. Offsets will be acquired to compensate losses of this listed species.	

7.5 Threatened ecological communities

7.5.1 Overview

Existing information

Ecological communities are naturally occurring biological assemblages that comprise a particular habitat type. Threatened ecological communities (TECs) are ecological communities that have been assessed and assigned to one of five categories related to the status of the threat to the community, i.e. conservation dependent, vulnerable, endangered, critically endangered and extinct in the wild. TECs are protected under the EPBC Act.

The Protected Matters Search Tool identified that three TECs were predicted to occur within the NGBR Project realignment:

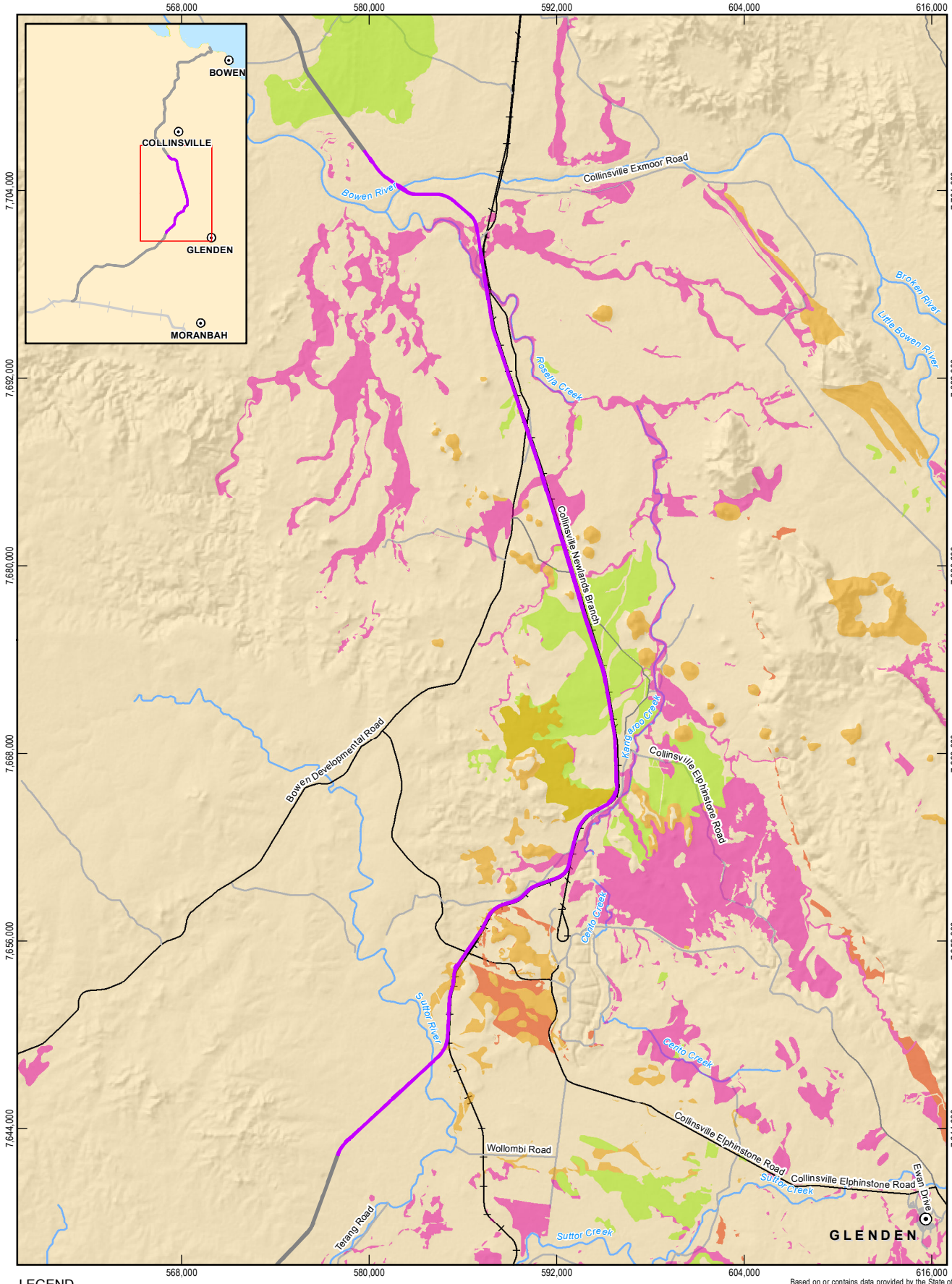
- Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered
- Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar Bioregions – endangered
- Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin – endangered.

The mapped occurrence of these TECs is shown in Figure 7-10. This was predicted based on the presence of TEC constituent regional ecosystems (REs) within the NGBR Project realignment footprint based upon DNRM version 6.1 certified RE mapping.

Based on previous experience within the region, it is likely that the mapped extent of these REs is an over-estimation of their actual presence on the ground. The values of these communities and their occurrence within NGBR Project realignment footprint are discussed below.

Two of the TECs were confirmed present within one kilometre of the NGBR Project realignment, during investigations for the Drake Coal Project EIS, these being:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Natural grasslands of the Queensland and central highlands and the northern Fitzroy Basin.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Semi-evergreen vine thickets of the brigalow Belt Bioregions (north and south)
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Threatened ecological communities

Figure 7-10

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1219_rev_a.mxd

Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse (2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Threatened Ecological Communities/2013. Created by:MS

Potential impacts

The potential impacts of the NGBR Project on listed TECs are described in Volume 2 Appendix D Revised MNES report Section 7.9.1.2. In summary these are:

- Reduction in TEC extents as a result of vegetation clearing
- Fragmentation
- Degradation of retained areas around infrastructure
- Increased spread and prevalence of introduced weeds and/or pest species
- Degradation through increased fire severity (as a result of altered fuel characteristics)
- Dust deposition impacting the photosynthetic ability of vegetation.

The potential impacts upon TECs in relation to the NGBR Project realignment are consistent with these, although the TEC likelihood of occurrence and areas of potential habitat intersected by the NGBR Project realignment vary from that described in the Volume 2 Appendix D Revised MNES report Section 7.9 Threatened ecological communities.

The impacts of clearing and fragmentation of TECs attributed to operation of the NGBR Project realignment are considered to be relatively minor within a regional context.

7.5.2 Brigalow

Species overview

Brigalow is described in the Volume 2 Appendix D Revised MNES report Section 7.9.2.1 Species overview.

Desktop results

The brigalow TEC was identified within the Protected Matters Search Tool as a ‘community known to occur within area’. The TEC was confirmed present for Drake Coal Project EIS and was represented by the RE 11.9.5. This RE, along with three of other constituent REs of the brigalow TEC (11.3.1, 11.4.9 and 11.9.1) is mapped within the NGBR Project realignment footprint.

Significance of NGBR project realignment footprint

Brigalow is represented by the RE 11.9.5. This RE, along with three of other constituent REs of the brigalow TEC (11.3.1, 11.4.9 and 11.9.1) is mapped within the NGBR Project realignment footprint (refer Figure 7-10).

Clusters of brigalow previously recorded were found to be dominated by collections of small, isolated remnants that are highly fragmented within a predominantly non-remnant landscape.

In total, 57.2 ha of brigalow TEC is mapped as occurring within the NGBR Project realignment footprint. The calculation of 57.2 ha of brigalow is based on the mapped presence of constituent REs and is a conservative estimation of the actual on-ground presence of this TEC.

Threatening processes

Brigalow communities have undergone a severe decline since the 1940s and now occupy 10 per cent of their former range. Key threatening processes for brigalow are listed in Volume 2 Appendix D Revised MNES Report Section 7.9.2.5 Threatening processes.

Potential impacts

Construction impacts

The construction of the NGBR Project realignment is likely to reduce the extent of the TEC present within the local landscape and increase fragmentation at a highly localised scale. However, this is not considered likely to result in a substantial change to the occurrence, composition or condition of the TEC within the local or regional landscape.

The 57.2 ha potential impact area is 0.006 per cent of the extent of Brigalow TEC (a total of 971,542.26 ha) in the bioregion, based on regional ecosystem data (DEHP 2009).

Operation impacts

Operational impacts identified in the Volume 2 Appendix D Revised MNES report Section 7.9.2.6 Potential impacts are relevant to the NGBR Project realignment.

Avoidance, mitigation and management measures

The avoidance, mitigation and management measures for the brigalow TEC are outlined in the Volume 2 Appendix D Revised MNES report Section 7.9.2.7 Avoidance, mitigation and management measures.

Conclusion

An assessment of residual impacts to the brigalow TEC against the Significant Impact Guidelines is provided in Table 7-12.

Table 7-12 Residual impacts on brigalow TEC

Significant impact criteria	Project response
Reduce the extent of an ecological community	Likely. The NGBR Project realignment is expected to clear approximately 57.2 ha of brigalow TEC. This criterion will be satisfied via the acquisition of offsets to maintain or increase the extent of this TEC. There will be no significant residual impact.
Fragment or increase fragmentation of an ecological community	Likely. The NGBR Project realignment is expected to clear approximately 57.2 ha of brigalow TEC, increasing fragmentation throughout the landscape. This criterion will be satisfied via the acquisition of offsets to maintain or increase the extent of this TEC. There will be no significant residual impact.
Adversely affect habitat critical to the survival of an ecological community	Unlikely. The NGBR Project realignment is not likely to impact any areas critical to the survival of this ecological community.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival,	Unlikely. Impacts arising as a result of the NGBR Project realignment are not expected to modify or destroy factors necessary for the

Significant impact criteria	Project response
including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	survival of the brigalow TEC.
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	Unlikely. Weed and pest incursions as a result of the NGBR Project realignment will be managed through the implementation of a Weed and Pest Management Plan.
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	Unlikely. Weed and pest incursions as a result of the NGBR Project will be managed through the implementation of a Weed and Pest Management Plan. Similarly, the mobilisation of fertilisers, herbicides or other chemicals or pollutants will be managed through the implementation of an Environmental Management Plan.
Interfere with the recovery of an ecological community	Likely. The NGBR Project realignment will involve the removal of approximately 57.2 ha of brigalow TEC. The removal of this area of TEC is likely to interfere with the recovery of this TEC at a regional scale. This criterion will be satisfied via the acquisition of offsets to maintain or increase the extent of this TEC. There will be no significant residual impact.

7.5.3 Semi-evergreen vine thicket

Species overview

The semi-evergreen vine thicket (SEVT) TEC is described in Volume 2 Appendix D Revised MNES report Section 7.9.3.1 Species overview.

Desktop results

The SEVT TEC was identified within the Protected Matters Search Tool as a ‘community likely to occur within area’. A total of one of the six constituent REs (11.8.13) for this TEC is mapped within the NGBR Project realignment footprint

Significance of NGBR Project realignment footprint

One SEVT constituent REs (11.8.13) is mapped within the NGBR Project realignment footprint (refer Figure 7-10) towards the southern portion of the realignment. In total, 31.6 ha of SEVT are mapped as occurring within the NGBR Project realignment footprint.

Threatening processes

The SEVT TEC is threatened by high levels of fragmentation, lack of connectivity between fragments, continued clearing, inappropriate fire regimes, invasion by introduced pasture species and increased grazing by domestic stock and native animals (SEWPaC 2013a).

Potential impact

Construction impacts

Highly localised fragmentation is likely to occur as a result of NGBR Project construction activities. No large swathes of well-connected or intact SEVT vegetation are proposed to be severed by the NGBR Project realignment footprint. Far larger areas of SEVT vegetation are mapped outside of the NGBR Project realignment, surrounding Glenden and Collinsville to the east, and along the Abbot Bay coastline to the north-west of the realignment. Overall, this is not considered likely to result in a substantial change to the occurrence, composition or condition of the TEC within that local landscape or in a regional context.

The 31.6 ha potential impact area is 0.014 per cent of the extent of SEVT TEC (a total of 231,694.44 ha) in the bioregion, based on regional ecosystem data (DEHP 2009).

Operational impacts

Operational impacts identified in the Volume 2 Appendix D Revised MNES report are relevant to the NGBR Project realignment.

Avoidance, mitigation and management measures

The avoidance, mitigation and management measures for the SEVT TEC are outlined in the Volume 2 Appendix D Revised MNES report Section 7.9.3.7 Avoidance, mitigation and management measures.

Conclusions

An assessment of residual impacts to the SEVT TEC against the Significant Impact Guidelines is provided in Table 7-13.

Table 7-13 Residual impacts on SEVT TEC

Significant impact criteria	Project response
Reduce the extent of an ecological community	Likely. The NGBR Project realignment footprint is expected to clear approximately 31.6 ha of SEVT TEC. Offsets will be acquired to maintain or increase the extent of this TEC, ultimately satisfying this criterion. There will be no significant residual impact.
Fragment or increase fragmentation of an ecological community	Likely. The NGBR Project realignment footprint is expected to clear approximately 31.6 ha of

Significant impact criteria	Project response
	SEVT TEC, increasing fragmentation at a highly localised scale within the landscape. This criterion will be satisfied via the acquisition of offsets to maintain or increase the extent of this TEC. There will be no significant residual impact.
Adversely affect habitat critical to the survival of an ecological community	Unlikely. The NGBR Project realignment footprint is not likely to be impacting any areas critical to the survival of this 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	Unlikely. Impacts arising as a result of the NGBR Project realignment footprint are not expected to modify or destroy factors necessary for the survival of the SEVT TEC.
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	Unlikely. Weed and pest incursions as a result of the NGBR Project realignment footprint will be managed through the implementation of a Weed and Pest Management Plan.
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	Unlikely. Weed and pest incursions as a result of the NGBR Project realignment footprint will be managed through the implementation of a Weed and Pest Management Plan. Similarly, the mobilisation of fertilisers, herbicides or other chemicals or pollutants will be managed through the implementation of an Environmental Management Plan.

Significant impact criteria	Project response
Interfere with the recovery of an ecological community	Potentially. The NGBR Project realignment footprint will involve the removal of approximately 31.6 ha of SEVT TEC. The removal of this area of TEC is likely to interfere with the recovery of this TEC at a highly localised scale. This criterion will be satisfied via the acquisition of offsets to maintain or increase the extent of this TEC. There will be no significant residual impact.

7.5.4 Natural grasslands

Species overview

The natural grasslands TEC is described in Volume 2 Appendix D Revised MNES report Section 7.9.4.1 Species overview.

Desktop results

The natural grasslands TEC were identified within the Protected Matters Search Tool as a 'community likely to occur within area'. It was confirmed some constituent REs (11.9.2 and 11.9.3) were present during field surveys for the Drake Coal Project EIS.

Significance of NGBR Project realignment footprint

The grassland TEC was confirmed present within 1 km of the NGBR Project realignment footprint. The constituent REs observed for the Drake Project EIS included, 11.9.2 and 11.9.3. One of these constituent REs is mapped within the NGBR Project realignment footprint, along with an additional RE, 11.8.11 (refer Figure 7-10).

A total of 83.6 ha of grassland REs that have the potential to be constituents of the natural grasslands TEC are mapped within the final rail corridor.

Threatening processes

The main identified threats to natural grasslands TEC are grazing, cropping and pasture improvement, weeds and pest animals, mining activities, construction of roads and other infrastructure (TSSC 2008adq)

Potential impacts

Construction impacts

Highly localised fragmentation is likely to occur as a result of NGBR Project construction activities. No large swathes of well-connected or intact natural grasslands are proposed to be severed by the NGBR Project realignment footprint.

The construction of the NGBR Project is likely to reduce the extent of the TEC present within one particular area of the final rail corridor and increase fragmentation at a highly localised scale, although the community at this location is already fragmented by existing road and rail infrastructure. Overall, this is not considered likely to result in a substantial change to the occurrence, composition or condition of the TEC within that local landscape or in a regional context.

The 83.6 ha potential impact area is 0.02 per cent of the extent of natural grassland TEC (a total of 404,861.75 ha) in the bioregion, based on regional ecosystem data (DEHP 2009).

Operational impacts

The fragmentation impacts resulting from the NGBR Project realignment are therefore unlikely to have substantial regional consequences.

Following clearing, buffel grass and other introduced species may build up along the edges of retained native vegetation and, over time, begin to out-compete other native species present. The natural grassland TEC observed within one kilometre of the NGBR Project realignment were reported to be generally subject to heavy infestations of weed species (refer Section 6 Nature conservation Section 4.2.2 Natural Grassland BVC).

The proliferation of weeds within or adjacent to areas of TEC also has the potential for flow on indirect impacts on TECs through fire. Where fuel characteristics have changed (i.e. the introduction of grass pasture species and subsequently fuel load), fire is considered to be a high threat to some TECs (SEWPaC, 2013a). Fire has been shown to cause rapid degradation of some TEC communities in Queensland, including SEVT (TSSC 2008adq).

Dust deposition is not anticipated to have an impact on TECs. The dust deposition predicted to occur as a result of the transport of coal is predicted to be at rates significantly below (<20% of) the thresholds identified as likely to have an impact upon crops and livestock, these rates are expected to be broadly similar for native flora and fauna (EIS Volume 2 Appendix I Air quality).

Avoidance, mitigation and management measures

The avoidance, mitigation and management measures for the natural grasslands TEC are outlined in the Volume 2 Appendix D Revised MNES report Section 7.9.4.7 Avoidance, mitigation and management measures.

Conclusion

An assessment of residual impacts to the natural grasslands TEC against the Significant Impact Guidelines is provided in Table 7-14.

Table 7-14 Residual impacts on natural grasslands TEC

Significant impact criteria	Project response
Reduce the extent of an ecological community	Likely. The NGBR Project realignment footprint is expected to clear approximately 83.6 ha of natural grasslands TEC. Offsets will be acquired to maintain or increase the extent of this TEC, ultimately satisfying this criterion. There will be no significant residual impact.
Fragment or increase fragmentation of an ecological community	Likely. The NGBR Project realignment footprint is expected to clear approximately 83.6 ha of natural grasslands TEC, increasing fragmentation at a highly localised scale within the landscape. This criterion will be satisfied via the acquisition of offsets to maintain or increase the extent of this TEC.

Significant impact criteria	Project response
	There will be no significant residual impact.
Adversely affect habitat critical to the survival of an ecological community	Unlikely. The NGBR Project realignment footprint is not likely to be impacting any areas critical to the survival of this 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	Unlikely. Impacts arising as a result of the NGBR Project realignment footprint are not expected to modify or destroy factors necessary for the survival of the natural grasslands TEC.
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	Unlikely. Weed and pest incursions as a result of the NGBR Project realignment footprint will be managed through the implementation of a Weed and Pest Management Plan.
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	Unlikely. The TEC has not been confirmed within the final rail corridor. Weed and pest incursions as a result of the NGBR Project realignment will be managed through the implementation of a Weed and Pest Management Plan. Similarly, the mobilisation of fertilisers, herbicides or other chemicals or pollutants will be managed through the implementation of an Environmental Management Plan.
Interfere with the recovery of an ecological community	Potentially. The NGBR Project realignment footprint will involve the removal of approximately 83.6 ha of natural grasslands TEC. The removal of this area of TEC is likely to interfere with the recovery of this TEC at a highly localised scale. This criterion will be satisfied via the acquisition of offsets to maintain or increase the extent of this TEC. There will be no significant residual impact.

7.5.5 Summary

A summary of potential direct and indirect impacts, proposed mitigation measures and residual impact assessment on TECs is provided below in Table 7-15.

Table 7-15 Summary of potential direct and indirect impacts, proposed mitigation measures and residual impacts

TEC	Potential direct impacts	Potential indirect impacts	Proposed mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Brigalow (*Acacia harpophylla* dominant and co-dominant)	**Construction:** Direct loss of 57.2 ha of brigalow TEC Fragmentation of previously intact areas of TEC	**Operation:** Degradation of retained areas of TEC Increased spread and prevalence of introduced weeds and/or pest species	Additional survey to refine areas of actual TEC occurrence and refine impacts. Micro-scale adjustments of clearing footprints to avoid TEC vegetation. Implementation of a Weed and Pest Management Plan to manage weed and pest species. Manage potential impacts resulting from fire through the implementation of a Fire Management Plan. Manage potentially mobilised pollutants through the implementation of an Environmental Management Plan.	The NGBR Project realignment footprint is likely to have a significant impact on this TEC as it will reduce the extent, increase fragmentation and interfere with the recovery of this TEC. Offsets will be acquired to compensate losses of this TEC.	Yes
Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar regions	**Construction:** Direct loss of 31.6 ha of SEVT TEC Fragmentation of previously intact areas of TEC	**Operation:** Degradation of retained areas of TEC Increased spread and prevalence of introduced weeds and/or pest species	Additional survey in areas where access was previously unavailable, to confirm whether the TEC is present within the NGBR Project realignment footprint in those locations. Micro-scale adjustments of clearing footprints to avoid TEC vegetation. Implementation of a Weed and Pest Management Plan to manage weed and pest species Manage potential impacts resulting from fire through the implementation of a Fire Management Plan. Manage potentially mobilised pollutants through the implementation of an Environmental Management Plan.	The NGBR Project realignment footprint is likely to have a significant impact on this TEC as it will reduce the extent, increase fragmentation and interfere with the recovery of this TEC. Offsets will be acquired to compensate losses of this TEC.	Yes

TEC	Potential direct impacts	Potential indirect impacts	Proposed mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	**Construction:** Direct loss of 83.6 ha of natural grassland TEC Fragmentation of previously intact areas of TEC	**Operation:** Degradation of retained areas of TEC Increased spread and prevalence of introduced weeds and/or pest species	Additional survey to refine areas of actual TEC occurrence and refine impacts. Micro-scale adjustments of clearing footprints to avoid TEC vegetation. Implementation of a Weed and Pest Management Plan to manage weed and pest species. Manage potential impacts resulting from fire through the implementation of a Fire Management Plan. Manage potentially mobilised pollutants through the implementation of an Environmental Management Plan.	The NGBR Project realignment footprint is not likely to have a significant impact on this TEC as it has not been confirmed within or adjacent to the final rail corridor. Additional survey is areas where access was previously unavailable will confirm this.	Yes

7.6 Listed migratory species

7.6.1 Overview

Eleven listed migratory species listed under the EPBC Act were predicted to occur within the NGBR Project realignment footprint from the Protected Matters Search Tool (refer Appendix A). Of these, one listed migratory species; the rainbow bee-eater (*Merops ornatus*) was confirmed present within the NGBR Project realignment footprint. A further seven migratory bird species were considered likely to occur. Each of these is discussed individually below, in terms of their ecology and status, desktop and survey results and the predicted significance of the NGBR Project realignment footprint for that species.

Species confirmed present and likely to occur are discussed in subsequent sections only where they were not previously considered in the NGBR Project EIS Volume 1 Chapter 7 MNES or where the potential impact has changed as a result of the realignment.

In determining the significance of the NGBR Project realignment footprint to a listed migratory species, an area of 'important habitat' is defined as:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or
- Habitat that is of critical importance to the species at particular life-cycle stages, and/or
- Habitat utilised by a migratory species which is at the limit of the species range, and/or
- Habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include:

- The species' population status
- Genetic distinctiveness
- Species-specific behavioural patterns (for example, site fidelity and dispersal rates).

Likelihood of occurrence

The likelihood of occurrence assessment for migratory species is provided in Table 7-16.

Potential impacts

The potential impacts of the NGBR Project on migratory species are described in Appendix D Revised MNES report Section 7.10.1.2. The potential impacts upon migratory species in relation to the NGBR Project realignment are consistent with these.

Table 7-16 Likelihood of occurrence for migratory species

Species	EPBC Act listing status	Prediction of occurrence and previous records	Habitat preferences and known distributions	Likelihood of occurrence
Rainbow bee-eater *Merops ornatus*	Migratory terrestrial Migratory wetland	Predicted to occur by PMST# - yes Previously recorded* - WO	This species is generally widespread and abundant across eastern Australia, migrating locally and regionally, such that the majority of individuals are present during the summer months, moving northwards (to Northern Australia and beyond) for the winter (Pizzey and Knight 2007). Rainbow bee-eater generally inhabit and favour habitats including eucalypt woodlands, rainforest, damp gullies and coastal scrub, where they will breed, roost and forage on a wide variety of invertebrate prey.	**Confirmed present** Recorded for the Drake Coal Project EIS and Alpha Coal Project EIS within the NGBR Project realignment footprint. This species is considered to be regularly present and widely distributed within the NGBR Project realignment footprint.
Great egret *Ardea alba*	Migratory wetland Marine	Predicted to occur by PMST# - yes Previously recorded* - no	The great egret is a partially migratory species, with northern hemisphere birds moving south from areas with cold winters. This species breeds in colonies in trees close to large lakes with reed beds or other extensive wetlands. The great egret feeds in shallow water or drier habitats, spearing fish, frogs or insects with its long, sharp bill (Pizzey and Knight 2007).	**Likely to occur** Suitable habitat for this species occurs within the NGBR Project realignment footprint.
Cattle egret *Ardea ibis*	Migratory wetland Marine	Predicted to occur by PMST# - yes Previously recorded* - no	The cattle egret is often found in dry grassy habitats, unlike most herons which are associated with shallow water. It feeds on insects, especially grasshoppers, and is usually found with cattle and other large animals which disturb small creatures which the egrets then catch.	**Likely to occur** This species is common and widespread and is considered to be regularly present within the NGBR Project realignment footprint.
Fork-tailed swift *Apus pacificus*	Migratory Marine Marine	Predicted to occur by PMST# - yes Previously recorded* - WO	This species is widespread across eastern Australia, generally present during the summer (between the months of October and April), and forages over and above a wide variety of habitat types, including urban areas, open country, woodland, wetlands and coastlines (Pizzey and Knight 2007). They feed (and roost) on the wing, taking a wide variety of aerial invertebrate prey. The fork-tailed swift is likely to be regular non-breeding visitor to (the air space above) the preliminary investigation corridor. Populations of this species are believed to be relatively stable throughout much of its range.	**Likely to occur** Suitable habitat for this species occurs within the NGBR Project realignment footprint.
White-bellied sea-eagle *Haliaeetus leucogaster*	Migratory terrestrial Migratory wetland	Predicted to occur by PMST# - yes Previously recorded* - WO Recorded from field surveys^ - no	The white-bellied sea-eagle occurs from India through south-east Asia to Australia on coasts and major waterways (Pizzey and Knight 2007). It feeds mainly on aquatic animals, such as fish, turtles and sea snakes, but it takes birds and mammals as well. Impacts to this species are likely to occur through bioaccumulation of prey species or reduced foraging habitat.	**Likely to occur** Suitable habitat for this species occurs within the NGBR Project realignment footprint.

Species	EPBC Act listing status	Prediction of occurrence and previous records	Habitat preferences and known distributions	Likelihood of occurrence
Barn swallow *Hirundo rustica*	Migratory terrestrial Migratory wetland	Predicted to occur by PMST# - yes Previously recorded* - no	The preferred habitat of the barn swallow is open country with low vegetation, such as pasture, meadows and farmland, preferably near water (Pizzey and Knight 2007). This swallow avoids heavily wooded or precipitous areas and densely built-up locations. It feeds on insects, foraging in open country and over coastal and inland waters. Barn swallows are strongly migratory and their wintering grounds cover much of the Southern Hemisphere as far south as central Argentina, the Cape Province of South Africa, and northern Australia.	**Likely to occur** This species is common and widespread and is considered to be regularly present within the NGBR Project realignment footprint.
Satin flycatcher *Myiagra cyanoleuca*	Migratory terrestrial Migratory wetland	Predicted to occur by PMST# - yes Previously recorded* - WO	Satin flycatchers inhabit temperate forests and subtropical or tropical moist lowland forests. The satin flycatcher is an insectivorous woodland bird that is widespread in eastern Australia and vagrant to New Zealand (SEWPaC 2013aa). In central Queensland, the satin flycatcher is most common in coastal areas but is also scattered on the Great Divide and occasionally further west. The satin flycatcher overwinters in northern Australia and Papua New Guinea, returning to south-eastern Australia in the summer (DotE 2014f). Habitat for this species includes heavily vegetated gullies in forests, taller woodlands, trees in open country and coastal forests along eastern Australia (Pizzey and Knight 2007). The majority of individuals are recorded in wet sclerophyll eucalypt forests near wetlands or watercourses (DotE 2014f). Satin flycatchers forage in the canopy and sub-canopy of trees where they feed primarily on insects. Breeding occurs during the summer period with nests usually located in a fork on an outer tree branch. Satin flycatchers return to the same locality each year, often nesting in the same tree (DotE 2014f).	**Likely to occur** Suitable habitat for this species occurs within the NGBR Project realignment footprint. This species is considered occasionally present within the NGBR Project realignment footprint.
Latham's snipe *Gallinago hardwickii*	Migratory wetland Marine	Predicted to occur by PMST# - yes Previously recorded* - no	Latham's snipe is a medium sized migratory wader. This species spends the non-breeding season predominately in eastern Australia. Suitable habitat for this species includes shallow freshwater wetlands of various kinds with bare mud or shallow water for feeding, with good nearby vegetation cover for shelter form non breeding habitat areas. However, this species is also known to inhabit saline or brackish water, artificial habitats and areas close to human activity.	**Likely to occur** Suitable habitat for this species occurs within permanent and ephemeral wetlands within the NGBR Project realignment footprint.
Black-faced monarch *Monarcha melanopsis*	Migratory terrestrial Migratory wetland	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The black-faced monarch is found along the entire eastern seaboard of Australia (Pizzey and Knight 2008). This species occurs in a wide range of common habitats including coastal habitats and woodlands.	**May occur** Suitable habitat for this species may occur within the NGBR Project realignment footprint.

Species	EPBC Act listing status	Prediction of occurrence and previous records	Habitat preferences and known distributions	Likelihood of occurrence
Australian painted snipe *Rostratula australis*	Endangered Migratory wetland	Predicted to occur by PMST# - yes Previously recorded* - no	The Australian painted snipe has a scattered distribution across eastern and northern Australia (TSSC 2013as). Shallow freshwater wetlands are the main habitat for the species (Marchant and Higgins 1993). Such wetlands may include lakes, swamps, claypans, inundated / waterlogged grassland, dams, irrigated crop land and sewage ponds (Marchant and Higgings 1993). Preferred wetland habitats boast emergent vegetation (including tussocks, grasses, sedges, rushes, reeds, canegrass and/or Melaleuca) (Marchant and Higgins 1993). Nesting occurs amongst vegetation in or adjacent to wetlands (TSSC 2013as).	**May occur** Not recorded in the desktop search extent. The NGBR Project realignment occurs within the distribution of this species (Pizzey and Knight 2007). Potentially suitable habitat occurs within the NGBR project realignment where wetlands are present.
Estuarine crocodile *Crocodylus porosus*	Migratory marine	Predicted to occur by PMST# - yes Previously recorded* - no	The estuarine crocodile is the largest species of crocodile in the world, with an average male crocodile 5 m long and weighing 450 kg. This species occurs from Rockhampton in Queensland, throughout coastal areas of the Northern Territory to near Broome in Western Australia and inhabits coastal waters, estuaries, freshwater sections of lakes, inland swamps and marshes. This species has been recorded from the Burdekin River Basin (DotE 2014c).	**May occur** Predicted to occur, but not previously recorded in the desktop search extent. Potentially suitable habitat may occur where large permanent pools of water are present within the major rivers of the Burdekin Basin, including the Bowen River.

Predicted to occur within approximately a 10 km area around the Study Area: SEWPaC Protected Matters Search Tool

* Previously recorded within desktop search extent from sources including Wildlife Online (WO), Queensland Museum (QM), Birds Australia (BA) and essential habitat mapping (EH)

7.6.2 Rainbow bee-eater

Species overview

The rainbow bee-eater is described in Volume 2 Appendix D Revised MNES report Section 7.10.6.1 Species overview.

Desktop results

The rainbow bee-eater was previously recorded in the desktop search extent (Wildlife Online). Suitable habitat for this species occurs within the NGBR Project realignment footprint and the species is likely to occur regularly within this corridor. The rainbow bee-eater was recorded within one kilometre of the NGBR Project realignment footprint during the Drake Coal Project EIS (Drake Coal Pty Ltd 2012) and Alpha Coal Project EIS (Hancock Prospecting Pty Ltd 2010).

Significance of NGBR Project realignment footprint

The species is likely to be present in small numbers within a wide range of similar suitable habitat along the length of the NGBR Project realignment footprint. The scattering of small numbers of rainbow bee-eater within the NGBR Project realignment footprint is not considered to constitute an ecologically significant proportion of the population of the species. None of these areas are known to be of critical importance to the rainbow bee-eater during particular life cycle stages and the species is not at the limit of its range or in decline. The NGBR Project realignment is not considered to represent important habitat for the species.

Threatening processes

The only identified threat to the rainbow bee-eater is the introduced cane toad (*Bufo marinus*), which can reduce the breeding success and productivity of the bee-eater by feeding on eggs and nestlings, and occupying nesting burrows.

Potential impacts and avoidance, mitigation and management measures

Potential impacts to and mitigation for the rainbow bee-eater are assessed and discussed in the Volume 2 Appendix D Revised MNES report Section 7.10.33.4 Migratory woodland bird species. These are relevant to the NGBR Project realignment.

7.6.3 Great egret

Species overview

The great egret is described in Volume 2 Appendix D Revised MNES report Section 7.10.2.1 Species overview.

Desktop results

The great egret was not previously recorded within the desktop search extent. Suitable habitat for this species occurs within the NGBR Project realignment footprint.

Significance of NGBR Project realignment footprint

The species is likely to be locally common along the length of the NGBR Project realignment wherever suitable wetland habitat occurs. This will primarily be at farm dams, creek crossings, any other ephemeral wetlands.

The species is not in decline or at the limit of its range within the NGBR Project realignment footprint. The NGBR Project realignment footprint is considered to support an ecologically

significant proportion of the population of the species, or represent important habitat for the great egret.

Threatening processes

The great egret is under threat from the loss and/or degradation of foraging and breeding habitat. Threatening processes are identified in the Volume 2 Appendix D Revised MNES report Section 7.10.2.5 Threatening processes.

Potential impacts and avoidance, mitigation and management measures

Potential impacts to and mitigation for the great egret are assessed and discussed in the NGBR Volume 2 Appendix D Revised MNES report Section 7.10.33.6 Migratory wetland bird species,. These are relevant to the NGBR Project realignment.

7.6.4 Cattle egret

Species overview

The cattle egret is described in Volume 2 Appendix D Revised MNES report Section 7.10.3.1 Species overview.

Desktop results

The cattle egret was not previously recorded within the desktop search extent. Suitable habitat for this species occurs within a range of grassland and wetland habitats within the NGBR Project realignment footprint.

Significance of NGBR Project realignment footprint

Cattle egret is likely to occur in a number of locations within the NGBR Project realignment footprint in association with a broad range of pasture (dry and wet) and wetland (freshwater, brackish and coastal) habitats.

The species is not at the limit of its range and is not known to be in decline. Given the relative abundance of this species and the wide range of suitable habitats used by the species, the small numbers likely to be present in various areas of the NGBR Project realignment footprint are not likely to constitute an ecologically significant proportion of the population, nor do the habitats present represent important habitat for the cattle egret.

Threatening processes

Threatening processes for the species are identified in the Volume 2 Appendix D Revised MNES report Section 7.10.3.5 Threatening processes.

Potential impacts and avoidance, mitigation and management measures

Potential impacts to and mitigation for the cattle egret are assessed and discussed in Volume 2 Appendix D Revised MNES report Section 7.10.33.6 Migratory wetland bird species,. These are relevant to the NGBR Project realignment.

7.6.5 Fork-tailed swift

Species overview

The fork-tailed swift is described in Volume 2 Appendix D Revised MNES report Section 7.10.9.1 Species overview.

Desktop results

The fork-tailed swift was previously recorded within the desktop search extent (Wildlife Online). Suitable habitat for the species occurs within the NGBR Project realignment footprint and the species is likely to occur regularly as a non-breeding visitor to (the air space above) the NGBR Project realignment footprint and will range widely across this area.

Significance of NGBR Project realignment footprint

Because of the wide ranging nature of the fork-tailed swift and its transient occupancy of the air space above a variety of different habitat types (primarily those alongside the coastal zone), the NGBR Project realignment footprint is not considered to constitute important habitat for the species or to support an ecologically significant proportion of the population of the species.

Threatening processes

There are no documented significant threats to the fork-tailed swift in Australia.

Potential impacts and avoidance, mitigation and management measures

Potential impacts to and mitigation for the fork-tailed swift are assessed and discussed in the Volume 2 Appendix D Revised MNES report Section 7.10.33.3 Migratory aerial bird species. These are relevant to the NGBR Project realignment.

7.6.6 White-bellied sea eagle

Species overview

The white-bellied sea-eagle is described in Volume 2 Appendix D Revised MNES report Section 7.10.5.1 Species overview.

Desktop results

The white-bellied sea-eagle was previously recorded in the desktop search extent (Wildlife Online). Potentially suitable habitat for the species occurs within the NGBR Project realignment footprint.

Significance of NGBR Project realignment footprint

As the presence of this species is likely to be limited by the occurrence of large wetlands and waterbodies, it is only likely to be present along the NGBR Project realignment at major creek crossing points, or large farm dams.

Wide-ranging individuals, or single pairs, may be present in the vicinity of the NGBR Project realignment around suitable wetland habitat features.

Threatening processes

The main threats to the white-bellied sea-eagle are:

- The loss of habitat due to land development
- The disturbance of nesting pairs by human activity.

Potential impacts and avoidance, mitigation and management measures

Potential impacts to and mitigation for the white-bellied sea eagle are assessed and discussed in the Volume 2 Appendix D Revised MNES report Section 7.10.33.5 Migratory bird of prey species. These are relevant to the NGBR Project realignment.

7.6.7 Barn swallow

Species overview

The barn swallow is described in Volume 2 Appendix D Revised MNES report Section 7.10.12.1 Species overview.

Desktop results

The barn swallow has not been previously recorded within the desktop search extent. However, the species was predicted to occur through the Protected Matters Search Tool and is considered to be common and widespread; it is therefore likely to occur regularly within the NGBR Project realignment.

Significance of NGBR Project realignment footprint

Whilst the species is likely to be regularly present within the NGBR Project realignment, its presence will be broadly limited to areas of suitable pasture grassland and associated waterbodies. Given its wide-ranging nature and dispersal behaviour, it is unlikely to be regularly present in significant numbers within the footprint and therefore an ecologically significant proportion of the population is not considered to be supported by the NGBR Project realignment footprint. The barn swallow is not at the limit of its range or known to be in decline and the NGBR Project realignment footprint does not represent important habitat for the species.

Threatening processes

The principal threats to the barn swallow are habitat loss and the use of pesticides.

Potential impacts and avoidance, mitigation and management measures

Potential impacts to and mitigation for the barn swallow are assessed and discussed in the Volume 2 Appendix D Revised MNES report Section 7.10.33.4 Migratory woodland bird species. These are relevant to the NGBR Project realignment.

7.6.8 Satin flycatcher

Species overview

The satin flycatcher is described in Volume 2 Appendix D Revised MNES report Section 7.10.15.1 Species overview.

Desktop results

The satin flycatcher was previously recorded within the desktop search extent (Wildlife Online). Suitable habitat for the satin flycatcher occurs within the NGBR Project realignment and it is likely to occur occasionally within the corridor, particularly within the more wet forested and riparian habitats adjacent to major creek crossings.

Significance of NGBR Project realignment footprint

The satin flycatcher is most likely to occur, as individuals or in small numbers, within suitable wet forested and riparian habitats. Individuals or small numbers within the footprint are not considered to constitute an ecologically significant proportion of the population of the species and the NGBR Project realignment is not considered to contain important habitat for the species.

Threatening processes

The satin flycatcher is under threat from the loss of mature forests through clearing and logging, as the species is generally absent from regrowth vegetation.

Potential impacts and avoidance, mitigation and management measures

Potential impacts to and mitigation for the satin flycatcher are assessed and discussed in the Volume 2 Appendix D Revised MNES report Section 7.10.33.4 Migratory woodland bird species. These are relevant to the NGBR Project realignment.

7.6.9 Latham's snipe

Species overview

Latham's snipe is described in Volume 2 Appendix D Revised MNES report Section 7.10.21.1 Species overview.

Desktop results

The Latham's snipe was not previously recorded within the desktop search extent. Suitable habitat for this species occurs within a range of permanent and ephemeral wetlands within the preliminary investigation corridor. It may also be present at the larger farm dams, creeks and pools, where suitable vegetated margins occur, or within areas of flooded pasture.

Significance of NGBR Project realignment footprint

The NGBR Project realignment contains habitat of a comparable scale or complexity that will be considered to constitute important habitat for the species, or support an ecologically significant proportion of the population of the species.

Threatening processes

Threatening processes relevant to Latham's snipe are identified in the Volume 2 Appendix D Revised MNES report Section 7.10.21.5 Threatening processes.

Potential impacts and avoidance, mitigation and management measures

Potential impacts to and mitigation for Latham's snipe are assessed and discussed in the Volume 2 Appendix D Revised MNES report Section 7.10.33.7 Migratory shorebird species. These are relevant to the NGBR Project realignment.

7.6.10 Potential impacts and avoidance, mitigation and management measures

Grouping species

The migratory bird species discussed in previous sections have been grouped according to their individual ecologies, life cycles and behaviours. It is predicted that similar threats apply and

impacts could occur to each species within a particular group and therefore these have been assessed and discussed collectively, as follows. Potential habitat for these species (or species groups) has not been mapped, but is discussed, where required.

The groupings are as follows:

- Migratory aerial bird species
- Migratory woodland bird species
- Migratory bird of prey species
- Migratory wetland bird species
- Migratory shorebird species.

Defining significant impacts

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a 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
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

Migratory aerial bird species

This section covers the following species that are likely to occur above the area of the NGBR Project realignment footprint: fork-tailed swift. This species is defined as aerial because it spends most of the time in the air, only using habitat at ground level when breeding, which they do outside of Australia.

The NGBR Project realignment will not have significant residual impacts on migratory aerial bird species. These species are predominantly aerial in nature and will not experience measurable direct losses or degradation of habitat as a result of the NGBR Project realignment footprint. Although vegetation clearance could result in localised depletion in invertebrate food availability, the loss is unlikely to have an impact on feeding efficiency, given the mobility and nomadism of the species concerned and the abundance of suitable foraging habitat within the surrounding landscape. An assessment against the Significant Impact Guidelines is provided in Table 7-17.

Table 7-17 Significance of residual impacts on migratory aerial bird species

Impact criteria	Project response
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Unlikely. These species are predominantly aerial in nature and do not directly utilise habitats impacted during the construction and operation phases of the NGBR Project realignment.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	Unlikely. Migratory aerial bird species rarely roost or venture close to the ground and are therefore not subject to predation from exotic predators such as cats, foxes and dogs.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	Unlikely. Loss and degradation of habitat could have indirect impacts by causing localised depletion of invertebrate food availability. However this impact is likely to be negligible given the abundance of suitable habitat remaining within the surrounding environment adjacent to the NGBR Project realignment.

Migratory woodland bird species

This section covers the following species that are likely to occur within the NGBR Project realignment footprint: barn swallow, rainbow bee-eater, black-faced monarch and satin flycatcher.

Residual impacts on migratory woodland bird species resulting from the NGBR Project realignment are likely to be relatively minimal. Although the NGBR Project realignment will result in the direct loss and degradation of potential habitat for a small number of migratory woodland bird species, the area of habitat impacted represents a small proportion of that available to the species across the wider landscape. The loss and degradation of habitat is therefore unlikely to impact an ecologically significant proportion of the population of these species.

The NGBR Project realignment also has the potential to increase predation pressures on migratory woodland species by increasing the local abundance of exotic predators such as cats, dogs and foxes. However, the impacts will be reduced to low levels through the implementation of Weed and Pest Management Plan and Waste Management Plan. Residual impacts associated with the construction and operation of the NGBR Project realignment is therefore unlikely to result in a significant impact to these species. An assessment against the Significant Impact Guidelines is provided below in Table 7-18.

Table 7-18 Significance of residual impacts on migratory woodland bird species

Impact criteria	Project response
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Unlikely. These species are relatively abundant and widespread in distribution. Although the NGBR Project realignment will result in localised loss and degradation of habitat, this affects a very small proportion of the total area of habitat available within the region. The NGBR Project realignment will therefore not result in substantial modification, destruction or isolation of important habitat for migratory woodland bird 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	Unlikely. Although the NGBR Project realignment has the potential to increase local densities of exotic plants and/or predators, a Weed and Pest Management Plan and Waste Management Plan will be implemented to reduce the potential for invasive species incursions into potential habitat for migratory woodland birds.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	Unlikely. Loss and degradation of habitat could cause localised reductions in breeding, nesting and feeding efficiency. However, the area impacted is minor compared with the area of habitat available in the region and will therefore not disrupt the lifecycle of an ecologically significant proportion of these species.

Migratory bird of prey species

This section covers the following species that is likely to occur within the NGBR Project realignment footprint: white-bellied sea-eagle.

The NGBR Project realignment has the potential to result in the removal of known (formerly occupied) or potential nesting sites, and the degradation of foraging habitat, as well as temporary noise and light disturbances to the species. The management and mitigation measures outlined will minimise these impacts, particularly with respect to the management of potential noise and light disturbances during construction; however, low level residual impacts are likely to remain.

Based on the ecology of this species (i.e. common, widespread, wide-ranging) and the removal of habitat in relation available habitat in the surrounding landscape, the NGBR Project realignment is not likely to remove important habitat for this species. It is highly unlikely that the construction and operation of the NGBR Project realignment will impact upon an ecologically significant proportion of the population of this species.

Residual impacts associated with the construction and operation of the NGBR Project realignment is unlikely to result in a significant impact to this species. An assessment against the Significant Impact Guidelines is provided below in Table 7-19.

Table 7-19 Significance of residual impacts on migratory bird of prey species

Impact criteria	Project response
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Unlikely. The NGBR Project realignment is not likely to impact an area of 'important habitat' for this 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	Unlikely. The NGBR Project realignment is not like to result in the establishment of any invasive species that may be harmful to the white-bellied sea-eagle. A Weed and Pest Management Plan with be implemented to manage invasive species incursions into potential white-bellied sea-eagle habitat.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	Unlikely. Loss of potential foraging and nesting habitat is not likely to seriously disrupt an ecologically significant population of this species. Similarly suitable habitats are common throughout the broader landscape. Noise and light disturbance will be managed through an Environmental Management Plan to avoid any serious disruption to this species.

Migratory wetland bird species

This section covers the following species confirmed present or likely to occur within the NGBR Project realignment footprint: great egret and cattle egret. These species are generally widespread and abundant species that are not particularly under threat at this time. They are also species that are not overly-susceptible to disturbance (with the exception of tern species at breeding colonies, of which none are known to occur within the preliminary investigation corridor) and will habituate to some level of disturbance (noise, light, dust, movement, human activity, etc.). Furthermore, they are relatively generalist in their habitat requirements, using a range of different open and closed wetlands across freshwater, brackish and coastal environments, and there is a broad availability of comparable habitats within the wider landscape adjacent to the NGBR Project realignment footprint.

Given their abundance and wide range across the region, their general tolerance to background disturbance, and the availability of similar habitat within adjacent landscapes, the areas to be subject to clearance within the NGBR Project realignment are not considered to constitute important habitat for these migratory wetland bird species.

Residual impacts associated with construction and operation of the NGBR Project realignment are unlikely to result in a significant impact to migratory wetland species discrete wetland locations (such as large farm dams) along the final rail corridor. An assessment against the Significant Impact Guidelines is provided below in Table 7-20.

Table 7-20 Significance of residual impacts on migratory wetland bird species

Impact criteria	Project response
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Unlikely. The NGBR Project realignment is not likely to substantially modify, destroy or isolate an area of 'important habitat' for these migratory wetland bird 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	Unlikely. The NGBR Project realignment is not like to result in the establishment of any invasive species that may be harmful to these migratory wetland bird species. A Weed and Pest Management Plan with be implemented to manage invasive species incursions into adjacent wetland habitat.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	Unlikely. A relatively minor loss of potential foraging and nesting habitat is not likely to seriously disrupt an ecologically significant population of these migratory wetland bird species. Similarly suitable habitats are common throughout the broader landscape. Noise, light, vibration and dust disturbance will be managed through an Environmental Management Plan to avoid any serious disruption to these species.

Migratory shorebird species

This section covers the following likely to occur species: Latham's snipe.

The construction and operation of the NGBR Project realignment is unlikely to have a significant impact on migratory shorebird species, based on the Significant Impact Guidelines and as outlined in Table 7-21.

Table 7-21 Significance of residual impacts on migratory shorebird species

Impact criteria	Project response
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Unlikely. No part of the NGBR Project realignment footprint is considered to be important habitat for migratory shorebirds.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	Unlikely. The NGBR Project's EMP and, in particular, Weed and Pest Management Plan will minimise the risk of the establishment of invasive species.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an	Unlikely. None of these are known to occur within the NGBR Project realignment footprint.

Impact criteria	Project response
ecologically significant proportion of the population of a migratory species	

7.6.11 Summary

A summary of potential direct and indirect impacts, proposed mitigation measures and residual impact assessment on listed migratory species is provided in Table 7-22.

Table 7-22 Summary of potential impacts, mitigation measures and residual impacts – migratory species

MNES	Potential direct impacts	Potential indirect impacts	Proposed mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Migratory aerial bird species	**Construction**: Very low potential for collision with infrastructure.	**Construction:** Localised depletion of invertebrate prey food availability as a result of vegetation clearing.	Any new powerline infrastructure should be fitted with high visibility markings to reduce collision risk to migratory aerial bird species	Unlikely	No
Migratory woodland bird species	**Construction:** Loss and fragmentation of woodland habitats. **Operation:** Very low potential for collision with vehicles or permanent infrastructure.	**Construction:** Disturbance through noise, light, dust and vibration. Increased localised abundance of pest species as a result of poor waste management. **Operation**: Noise and dust disturbance from coal trains, loading facilities and maintenance vehicles.	Undertake vegetation clearing outside of breeding season wherever possible to minimise disruption of breeding and nesting activities. Implement Weed and Pest Management Plan to manage incursion of invasive species and reduce the risk of habitat degradation.	Unlikely	No
Migratory bird of prey species	**Construction:** Loss of nesting sites and foraging habitat. **Operation:** Very low potential for collision with vehicles or permanent infrastructure.	**Construction:** Potential for disturbance through noise, light, dust and vibration to impact nesting activities. **Operation:** Potential for disturbance through noise, light, dust and vibration to impact nesting activities.	Avoidance of active nests during construction and establishment of management areas around such features.	Unlikely	No

MNES	Potential direct impacts	Potential indirect impacts	Proposed mitigation measures	Residual impact assessment against the Guidelines	Offsets required?
Migratory wetland bird species	**Construction:** Loss of foraging and nesting habitat for migratory wetland bird species. Destruction of active nests could lead to loss of eggs or mortality of young. **Operation:** Very low potential for collision with vehicles or permanent infrastructure.	**Construction**: Disturbance through noise, light, dust and vibration. Increased localised abundance of pest species as a result of poor waste management. **Operation**: Disturbance through noise, light, dust and vibration. Increased localised abundance of pest species as a result of poor waste management.	Construction works should be timed to avoid wet season. Alterations to waterways will be avoided, such that impacts on water quality and downstream flows are minimised to the greatest extent practicable. Any watercourse areas crossed will be restored and rehabilitated with measures to improve connectivity and provide enhancements to suitable habitat. Dust generated by vegetation clearing will be managed by dust suppression activities.	Unlikely	No
Migratory shorebird species	**Construction:** Loss of foraging and roosting habitat for migratory shorebird species. **Operation:** Risk of degradation in water quality. Very low potential for collision with vehicles or permanent infrastructure.	**Construction:** Disturbance through noise, light, dust and vibration in a localised area. **Operation**: Low level disturbance through noise and light in a localised area.	Construction works should be timed to avoid wet season. Alterations to waterways will be avoided, such that impacts on water quality and downstream flows are minimised to the greatest extent practicable. Any watercourse areas crossed will be restored and rehabilitated with measures to improve connectivity and provide enhancements to suitable habitat. Dust generated by vegetation clearing will be managed by dust suppression activities.	Unlikely	No

7.7 Conclusion

This section assesses the potential impacts of the NGBR Project realignment on MNES and identifies mitigation measures to manage potential impacts.

Sixteen threatened species listed under the EPBC Act were predicted to occur within the NGBR Project realignment footprint (refer Appendix A). Three threatened species, bluegrass (*Dichanthium setosum*), squatter pigeon (southern) (*Geophaps scripta scripta*) and ornamental snake (*Denisonia maculata*) were recorded within one kilometre of the NGBR Project realignment during field surveys for the Alpha Coal Project EIS or Drake Coal Project EIS. A further four species were assessed as being likely to occur (refer Section 7.4). Quantification of potential impacts to EPBC Act mapped potential habitat of listed threatened species within the NGBR Project realignment footprint are provided in Table 7-11.

The desktop assessment confirmed the presence or potential presence of two TECs within the NGBR Project realignment footprint (refer Section 7.5):

- Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered
- Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin – endangered.

Quantification of potential impacts to these TECs within the NGBR Project footprint is presented in Table 7-15.

One listed migratory (bird) species was confirmed present within the NGBR Project realignment footprint, with a further seven bird species being likely to occur (refer Section 7.6). Quantification of potential impacts to these migratory species within the NGBR Project footprint are presented in Table 7-22.

Operation of the NGBR Project has the potential to create long-term habitat fragmentation. However, the impacts of fragmentation attributed to operation of the NGBR Project are considered to be relatively minor, within a regional context, as it is located in a landscape that has been extensively fragmented by historical broadscale vegetation clearing.

By implementation the construction and operation mitigation and management measures outlined in this section the impacts on the identified MNES values are not expected to be significant in nature.

Where impacts are unavoidable offsets will be required to compensate for the residual impacts of the NGBR Project on terrestrial ecological values where these cannot otherwise be mitigated. Both Commonwealth and State government offset requirements are applicable to the NGBR Project for a range of ecological impacts including, but not limited to, vegetation clearing and threatened species potential habitat loss. The direct, indirect impacts and whether an offset is required are presented in Table 7-23. An offset strategy for the NGBR Project is provided in Volume 2 Appendix E Revised offsets strategy.

Table 7-23 Impacts on MNES and whether an offset is required

MNES	Direct impacts	Indirect impacts	Offsets required?
Threatened species			
Bluegrass (*Dichanthium setosum)*	**Construction** • Direct loss of 257.8 ha of potential habitat • Potential direct loss of individuals	**Operation** • Proliferation of exotic weeds (particularly buffel grass and other introduced grasses)	Yes
Black ironbox (*Eucalyptus raveretiana*)	**Construction** • Direct loss of 125 ha of potential habitat • Potential direct loss of individuals • Alteration of stream and floodplain hydrology	**Operation** • Proliferation of exotic weeds (particularly rubber vine)	Yes
Black-throated finch (southern) (*Poephila cincta cincta*)	**Construction** • Direct loss of 481.7 ha of potential habitat **Operation** • Individual mortality through train/maintenance vehicle collisions	**Construction** • Degradation of surrounding habitat through edge effects (e.g. weed spread and sedimentation) • Noise, light, dust and vibration **Operation** • Habitat degradation due to weed spread, noise, light, dust and vibration.	Yes
Koala (*Phascolarctos cinereus*)	**Construction** • Direct loss of 514.2 ha of potential habitat **Operation** • Individual mortality through train/maintenance vehicle collisions	**Construction** • Degradation of surrounding habitat through edge effects (e.g. weed spread and sedimentation) • Noise, light, dust and vibration **Operation** • Habitat degradation due to weed spread, noise, light, dust and vibration.	Yes

MNES	Direct impacts	Indirect impacts	Offsets required?
Ornamental snake (*Denisonia maculata*)	**Construction** • Direct loss of 174.7 ha of potential habitat **Operation** • Individual mortality through train/maintenance vehicle collisions	**Construction** • Degradation of surrounding habitat through edge effects (e.g. weed spread and sedimentation) • Noise, light, dust and vibration **Operation** • Habitat degradation due to weed spread, noise, light, dust and vibration.	Yes
Squatter pigeon (southern) (*Geophaps scripta scripta*)	**Construction** • Direct loss of 320.5 ha of potential habitat • Individual mortality through vehicle collisions **Operation** • Individual mortality through train/maintenance vehicle collisions	**Construction** • Degradation of surrounding habitat through edge effects (e.g. weed spread and predation) • Noise, light, dust and vibration **Operation** • Habitat degradation due to weed spread, noise, light, dust and vibration.	Yes
King bluegrass (*Dichanthium queenslandicum)*	**Construction** • Direct loss of 263.3 ha of potential habitat • Potential direct loss of individuals	**Operation** • Proliferation of exotic weeds (particularly buffel grass and other introduced grasses)	Yes
Threatened ecological communities			
Brigalow (*Acacia harpophylla* dominant and co-dominant)	**Construction:** Direct loss of 57.2 ha of brigalow TEC Fragmentation of previously intact areas of TEC	**Operation:** Degradation of retained areas of TEC Increased spread and prevalence of introduced weeds and/or pest species	Yes
Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar regions	**Construction:** Direct loss of 31.6 ha of SEVT TEC Fragmentation of previously intact areas of TEC	**Operation:** Degradation of retained areas of TEC Increased spread and prevalence of introduced weeds and/or pest species	Yes

MNES	Direct impacts	Indirect impacts	Offsets required?
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	**Construction:** Direct loss of 83.6 ha of natural grassland TEC Fragmentation of previously intact areas of TEC	**Operation:** Degradation of retained areas of TEC Increased spread and prevalence of introduced weeds and/or pest species	Yes
Migratory species			
Migratory aerial bird species	**Construction**: Very low potential for collision with infrastructure.	**Construction:** Localised depletion of invertebrate prey food availability as a result of vegetation clearing.	No
Migratory woodland bird species	**Construction:** Loss and fragmentation of woodland habitats. **Operation:** Very low potential for collision with vehicles or permanent infrastructure.	**Construction:** Disturbance through noise, light, dust and vibration. Increased localised abundance of pest species as a result of poor waste management. **Operation**: Noise and dust disturbance from coal trains, loading facilities and maintenance vehicles.	No
Migratory bird of prey species	**Construction:** Loss of nesting sites and foraging habitat. **Operation:** Very low potential for collision with vehicles or permanent infrastructure.	**Construction:** Potential for disturbance through noise, light, dust and vibration to impact nesting activities. **Operation:** Potential for disturbance through noise, light, dust and vibration to impact nesting activities.	No

MNES	Direct impacts	Indirect impacts	Offsets required?
Migratory wetland bird species	**Construction:** Loss of foraging and nesting habitat for migratory wetland bird species. Destruction of active nests could lead to loss of eggs or mortality of young. **Operation:** Very low potential for collision with vehicles or permanent infrastructure.	**Construction**: Disturbance through noise, light, dust and vibration. Increased localised abundance of pest species as a result of poor waste management. **Operation**: Disturbance through noise, light, dust and vibration. Increased localised abundance of pest species as a result of poor waste management.	No
Migratory shorebird species	**Construction:** Loss of foraging and roosting habitat for migratory shorebird species. **Operation:** Risk of degradation in water quality. Very low potential for collision with vehicles or permanent infrastructure.	**Construction:** Disturbance through noise, light, dust and vibration in a localised area. **Operation**: Low level disturbance through noise and light in a localised area.	No

8. Water resources

8.1 Purpose of section

The purpose of this section is to assess the potential impacts of the NGBR Project realignment on surface water and groundwater values.

8.2 Methodology

This assessment of water resources is based on a desktop review of work undertaken for the NGBR Project EIS, the Alpha Coal Project EIS and other desktop data sources. Further detail on the methodologies applied is provided in Sections 8.2.5, 8.2.6, 8.2.7 and 8.2.8.

8.2.1 Study area

The NGBR Project realignment lies within the Suttor and Bowen River catchments, which fall within the Burdekin Basin (refer Figure 8-1). These were the southern two of four catchments included in the study area defined in the NGBR Project EIS Volume 1 Chapter 9 Water resources, which also included the Lower Burdekin River catchment and the Don River Basin.

8.2.2 Data sources

The existing environment and potential impacts of the NGBR Project were previously assessed in the following documents:

- NGBR Project EIS Volume 1 Chapter 9 Water resources
- NGBR Project EIS Volume 2 Appendix H1 Water resources
- NGBR Project EIS Volume 1 Appendix H2 Hydrology and hydraulics.

In addition, the following data sources were reviewed as part of the NGBR Project EIS and are relevant to the NGBR Project realignment:

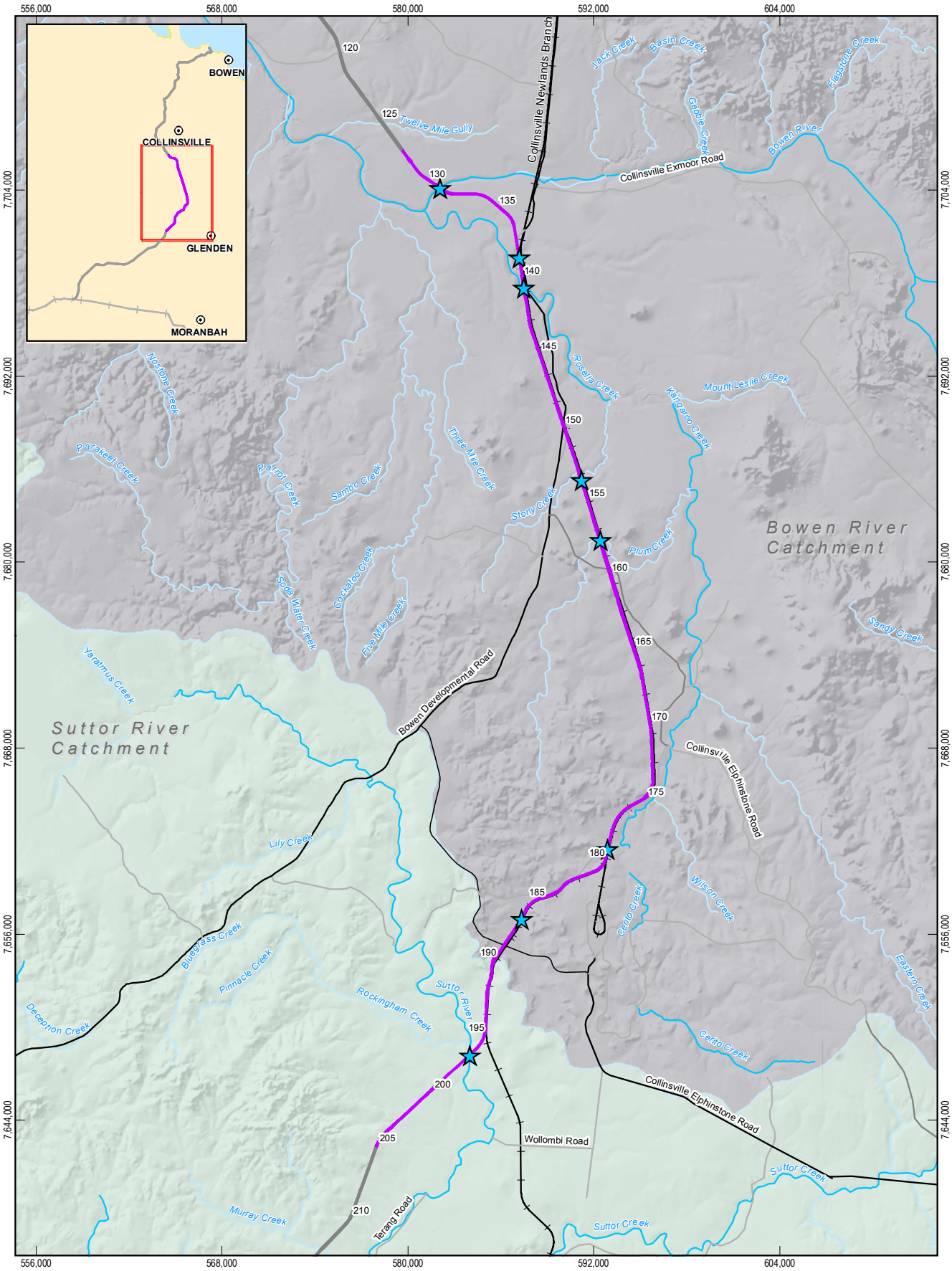
- Galilee Coal Project EIS (E3 Consulting 2011)
- Newlands Coal Extension Project EIS (Kellogg Brown and Root 2012)
- Watercourse maps (Geoscience Australia 2007)
- Groundwater bore database (DNRM 2013)
- Rainfall data (BOM 2013a)
- Stream gauge data (BOM 2013b).

The NGBR Project realignment coincides with the approved Alpha Coal Project for approximately 64 km. This section of the NGBR Project realignment was previously assessed through the Alpha Coal Project EIS and SEIS. The following documents were referred to in assessing the NGBR Project realignment:

- Alpha Coal Project EIS Volume 3 Section 12 Groundwater
- Alpha Coal Project EIS Volume 3 Section 11 Surface Water
- Alpha Coal Project SEIS Volume 2 Appendix Y BFS Drainage Engineering Report.

8.2.3 Legislation and guidelines

The legislation and guidelines relevant to the NGBR Project realignment are consistent with those detailed in NGBR Project EIS Volume 1 Chapter 9 Water resources.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Watercourse (Major)
- Watercourse (Minor)
- NGBR Project final rail corridor
- NGBR Project realignment
- Major drainage areas
  - Suttor river catchment
  - Bowen river catchment
- Waterway crossing

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 (at A4)

0 6 12

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Study area and waterway crossings

Figure 8-1

G:\41\26457\06 GIS\Maps\MXD\0600_Hydrology\41-26457_0614_rev_a.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. While GHD Pty Ltd has taken care to ensure the accuracy of this product, GHD Pty Ltd, GA, ADANI and DNRM make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD Pty Ltd, GA, ADANI and DNRM cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data Source: © Commonwealth of Australia (Geoscience Australia): Population centres, Railways, Watercourses (2007); DNRM: Hillshade, River Basins (2009); DMR: Roads (2010); Adani: AEIS Option 9 Rev1 final rail corridor (2014); GHD: Water Crossings (2014). Created by: MS

8.2.4 Hydrology and hydraulics

The assessment of cross drainage structures for this assessment is based on review of desktop information, including the Alpha Coal Project SEIS (Hancock Prospecting 2011) to determine waterway crossings and potential treatments.

A hydrology and hydraulics assessment was undertaken for the NGBR Project to assess the impacts of cross drainage structures of surface water flow and flooding. This assessment will continue to be refined during detailed design of the NGBR Project. An assessment of this type has not been undertaken for the NGBR Project realignment at this time.

A hydrology and hydraulics assessment that includes the NGBR Project realignment will be conducted during detail design to further assess the impacts of cross drainage structures on surface water flow and flooding and identify potential treatments for waterway crossings. The configurations of the crossings (culverts and bridges) will be determined using similar design criteria adopted for the NGBR Project EIS.

8.2.5 Surface water quality

The surface water quality studies that informed the Galilee Coal Project EIS (E3 Consulting) and Xstrata Coal Newlands Coal Extension Project EIS (Kellogg Brown and Root 2012) are relevant to understanding the existing water quality conditions applicable to the NGBR Project realignment. Water quality was sampled in October 2009 and March/April 2010 across 28 sites for the Galilee Coal Project EIS. Water quality was sampled between 2007 and 2011 within the Bowen River catchment at 26 sites for the Newlands Coal Extension Project EIS. The sites relevant to the NGBR Project realignment are shown in Figure 8-2.

A number of field assessment sites visited for the NGBR Project EIS are relevant to the NGBR Project realignment. The sites relevant to the NBGR Project realignment are listed in Table 8-1 and shown in Figure 8-2. Physiochemical parameters were sampled at each site in accordance with the Monitoring and Sampling Manual 2009 (DERM 2009) and ANZECC Guidelines (ANZECC and ARMCANZ 2000).

Table 8-1 Water quality sampling sites

Site number	Basin/catchment	Watercourse
9	Bowen River Catchment	Pelican Creek
10		Bowen River
11	Suttor River Catchment	Suttor River (upper)
12		Lily Creek (dry)
13		Rockingham Creek
14		Gunn Creek
15		Suttor River (lower)

8.2.6 Waterway geomorphology

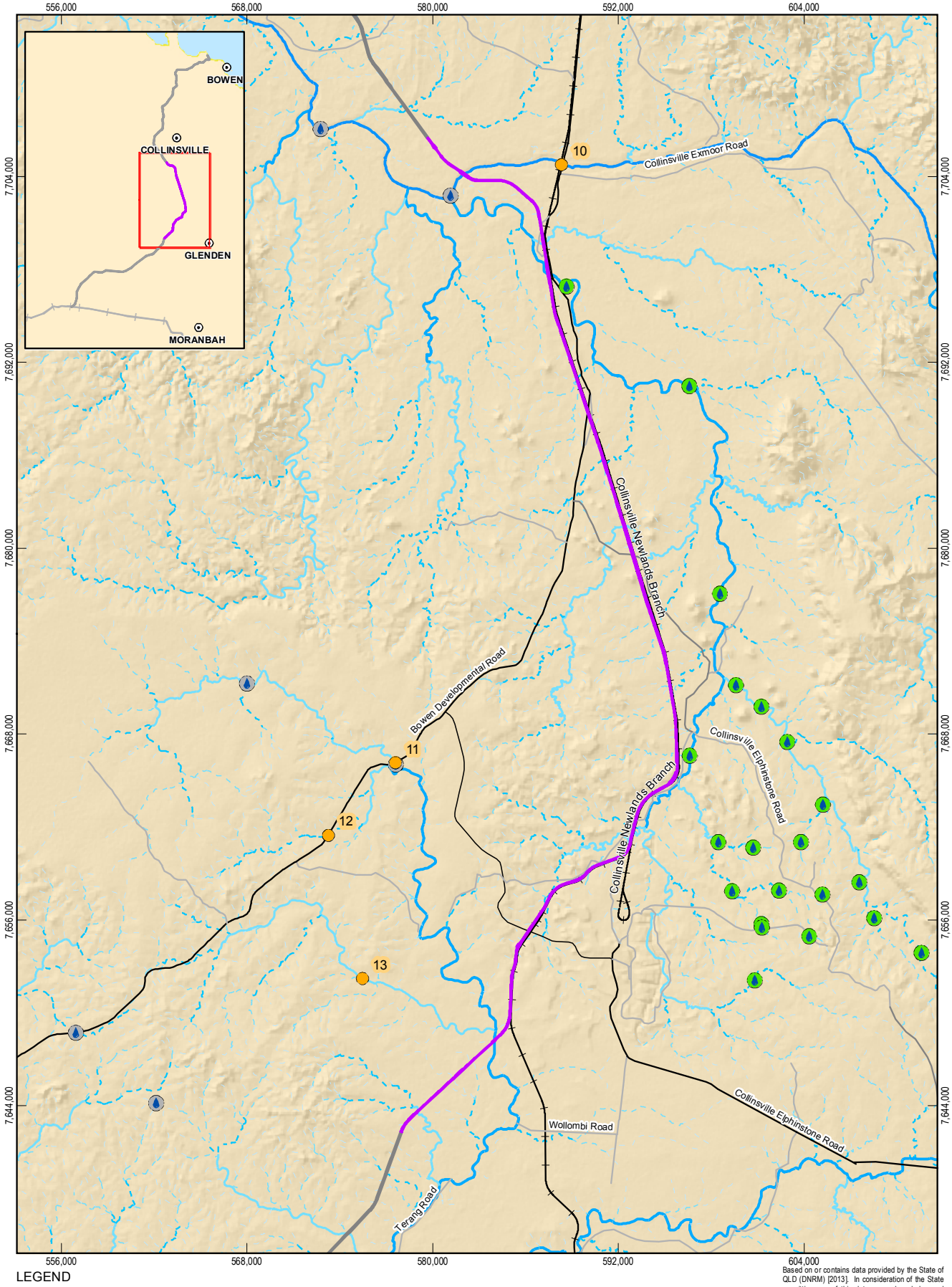
Physical characteristics of waterways were recorded at the water quality sampling sites (refer Table 8-1). The waterway geomorphology assessment was based on the methods and principles of the River Styles® framework (Brierley and Fryirs 2005).

8.2.7 Groundwater

Groundwater quality data from the Alpha Coal Project EIS (Hancock Prospecting 2010) was related to the NGBR Project realignment. Groundwater bore database information collected for the NGBR Project EIS was reviewed to identify groundwater bores within two kilometres of the NGBR Project realignment.

8.2.8 Hydrology and hydraulics

A high level review of cross-drainage structures was undertaken based on a desktop review of publically available information and previous environmental assessments (refer Section 8.2.2) to identify the potential impacts of the structures on the surface water flow paths and flooding regime.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Stream order: 1, 2, 3, 4, 5, 6
- NGBR Project final rail corridor
- NGBR Project realignment
- Previous surface Water quality sites
- Newlands Coal EIS
- Waratah
- Field assessment sites (NGBR EIS)

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Field assessment sites

Figure 8-2

G:\41\26457\06 GIS\Maps\MXD\0600_Hydrology\41-26457_0615_rev_a.mxd

Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014); Hancock, Waratah, Newlands Coal EIS, GHD: Previous WQ Sites (2010-2013); DNRM: Roads (2010), Stream Order(2011). Created by:MS

8.3 Existing environment

8.3.1 Catchment description

Both the Suttor and Bowen River catchments lie within the Burdekin Basin. Catchment descriptions are detailed in the NGBR Project EIS Volume 1 Chapter 9 Water resources.

The Suttor River catchment has an area of approximately 18,000 km^2 and is characterised by wide floodplains with reasonably well defined channels. The terrain is similar to a drier, typically semiarid western landscape. Cattle grazing is the dominant land use within the catchment, while a small percentage is used for dry land cropping of cereals. The waterways of the catchment are ephemeral and may have zero flow in any month.

The Bowen River has a catchment area of approximately 8,200 km^2 and is a major tributary of the Burdekin Basin with flowing water for most of the year. Grazing is the dominant land use within this catchment.

8.3.2 Climate

The NGBR Project realignment falls within the area previously described in the NGBR Project EIS Volume 1 Chapter 9 Water resources for climate. Climate conditions would be consistent with those previously described for rainfall, stream flow, temperature and evaporation.

8.3.3 Geomorphology

The majority of waterways assessed in field surveys for the NGBR Project EIS, which included a an investigation of locations along the Bowen and Suttor Rivers upstream of the NGBR Project realignment, were considered to be in moderate to poor geomorphic condition, with many exhibiting excessive sedimentation due to upstream disturbances.

Most of the larger catchment waterways are however considered to be relatively stable, although bank instability was observed along some waterways including the Suttor River.

8.3.4 Flooding

The NGBR Project realignment falls within the area previously described in the NGBR Project EIS Volume 1 Chapter 9 Water resources for flooding. Relevant available data to 2009 for recorded flood heights within the Burdekin Basin for the Suttor and Bowen Rivers is provided in Table 8-2. As noted, recent major flood events occurred in February 1991, 2010, 2011, 2012 and 2013. The Queensland Interim Floodplain Overlay (QRA 2011), which is based on the 2010/2011 flood event, indicates that flooding occurred along the Bowen River, Rosella Creek, and the Suttor River (refer NGBR Project EIS Volume 2 Appendix H2 Water resources).

Table 8-2 Stream gauge record

River	Stream gauge	Stream height (m)												
		1958	1968	1972	1974	1991			1998	2009	2010	2011	2012	2013
		Apr.	**Feb.**	**Jan.**	**Jan.**	**Jan.**	**Early Feb.**	**Late Feb.**	**Jan.**	**Feb.**	**Dec**	**Jan**	**March**	**Jan**
Suttor River	St Anns	-	8.17	-	8.69	7.71	8.16	-	-	5.03	7.12	7.53	7.62	-
Bowen River	Jacks Creek	-	9.88	10.01	8.93	16.05	16.28	7.00	4.08	10.12	12.20	10.72	13.04	14.69
Bowen River	Birralee	22.00	8.76	8.46	7.93	15.90	16.80	-	-	-	-	-	-	-
Bowen River	Myuna	15.64	5.97	5.61	5.62	11.09	12.34	-	-	6.93	6.17	-	8.40	7.50

Source: BOM 2013b; DNRM 2013b

8.3.5 Groundwater

Hydrogeological units

The following hydrogeological units are relevant to the NGBR Project realignment. Further detail is described in the NGBR Project EIS Volume 1 Chapter 9 Water resources:

- Unconsolidated flood plain alluvium would be associated with the Suttor River. These sediments may form localised aquifers of varying yields. The Bowen River channel deposits are noted to be dominated by sand and gravel deposits.
- Colluvium and residual soil deposits, generally associated with weathering of underlying and outcropping bedrock are present through the Leichhardt Range. It is not anticipated that these would form extensive aquifer systems, although at the base of hillslopes where in contact with alluvium, they may form part of larger alluvial aquifer systems.
- Igneous intrusive deposits are associated with the Leichhardt Range. The upper profile would be variably weathered and some fracturing may be present. The most permeable zones are expected to be located at shallow depths. Unconfined systems would be located where upper weathered sediments occur, while deeper fractured systems may contain unconfined to confined systems. Sedimentary deposits of the Back Creek Group, Blackwater Group and Suttor Formation, that comprise interbedded mudstones, siltstones, shales sandstones, lacustrine sediments and coal measures. The upper profile of these is anticipated to have varying degrees of weathering and some fracturing. Most permeable zones are expected to be located at shallow depth.

Groundwater use

A total of 23 bores are within 2 km of the NGBR Project realignment (refer Table 8-3). The NGBR Project realignment does not cross a declared subartesian area under the *Water Act 2000*. As such, no water licences and/or development permits are required for groundwater extraction is required.

Table 8-3 Groundwater bores

Registered number	Name	Facility role	Facility status
22742	TEP Rosella Creek 1	-	Existing
25633	Roadtek Bore	-	Existing
25636	3 Ways Bore	-	Existing
25666	Stragglers	-	Existing
25668	Plum	-	Existing
25670	Bald Hill	-	Existing
25672	-	-	Existing
25673	-	-	Existing
25677	House	-	Existing
60458	AGC 26	-	Existing

Registered number	Name	Facility role	Facility status
12020026	-	Water resources investigation	Existing
12020027	-	Water resources investigation	Existing
125971	Roadtek Bore	Mineral or coal exploration	Abandoned and destroyed
125972	Roadtek Bore	Other exploration / Investigation	Existing
125973	Roadtek Bore	Other exploration / Investigation	Abandoned and destroyed
125974	Roadtek Bore	Other exploration / Investigation	Existing
125975	Roadtek Bore	Other exploration / Investigation	Abandoned and destroyed
125977	Roadtek Bore	Other exploration / Investigation	Existing
125978	Roadtek Bore	Other exploration / Investigation	Existing
153231	Q Coal site No 7B	-	Existing
153230	Q Coal site No 7A	-	Existing
153237	Q Coal site No 1	-	Existing
153238	Q Coal site No 10	-	Existing

Groundwater quality

The quality of groundwater in the Bowen unincorporated area is generally described as marginal (borderline fresh to brackish water). Poorer quality groundwater is typically encountered within coal bearing strata whereas alluvial and fractured basalt aquifers contain groundwater of a higher quality.

The Alpha Coal Project EIS (Hancock Prospecting 2010) included an assessment of potential impacts to groundwater as a result of the construction and operation a rail line, based on a search of the DNRM Groundwater Bore Database. Bores were identified within a 5 km radius of the Alpha Coal Project and levels, yields and quality were identified. For the purpose of describing groundwater at a broad scale, the Alpha Coal Project was divided into four sections. The NGBR Project realignment falls within section 1 and section 2. Groundwater quality in sections one and two is described in Table 8-4.

Table 8-4 Alpha Coal Project EIS groundwater quality

Section	pH	TDS (ppm)	EC (uS/cm)
1	7.4 – 8.2	293 – 4,529	545 – 7,700
2	6.7 – 8.8	495 – 37,140	870 – 49,500

Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDE) can be inferred from BOM data, based upon high level probability assessment. These are often associated with wetlands or rivers, where flows may be persistent and during extended dry periods the systems may maintain semi-permanent to permanent waterholes that support vegetation and fauna. Mapping included in NGBR Project EIS Volume 1 Chapter 9 Water resources, indicates that the NGBR Project realignment crosses the Bowen River, which has 'high potential for groundwater interaction', and areas mapped as 'reliant on surface expression of groundwater', which have 'moderate potential for groundwater interaction' in the south proximal to the Suttor River.

Groundwater levels and flow regime

Depth to groundwater mapped for the NGBR Project EIS (NGBR Project EIS Volume 1 Chapter 9 Water resources) in the region of the NGBR Project realignment indicates that groundwater was shallower in the north near the Bowen River, and increased in depth in a southward direction.

8.3.6 Surface water quality

The NGBR Project realignment falls within the area previously described in the NGBR Project EIS Volume 1 Chapter 9 Water resources for surface water quality. Water quality of the Bowen River catchment and the Suttor River catchment have been described.

Water quality data collected for the NGBR Project EIS, the Galilee Coal Project EIS (E3 Consulting) and the Newlands Coal Extension Project EIS (Kellogg Brown and Root 2012) from sampling in the Suttor River catchment and Bowen River catchment were compared with nominated water quality objectives, based on the Queensland Water Quality Guidelines and the ANZECC Guidelines (ANZECC and ARMCANZ 2000). In general it was found that water quality did not meet water quality objectives. In the Bowen River catchment, water quality objectives for nutrients, sulphate, aluminium, copper, iron, conductivity, pH and total suspended solids were exceeded at a number of sites. In the Suttor River catchment, water quality objectives for nutrients, sulphate, aluminium, copper, iron, zinc, conductivity, ammonia and nitrogen were exceeded at a number of sites (refer Figure 8-2). Further detail on water quality is provided in NGBR Project EIS Volume 2 Appendix H1 Water resources.

8.3.7 Water supply infrastructure

Water resources infrastructure within the study area includes channels, pipelines, pumps, pumping stations, and weirs such as the Bowen Weir.

Water use in the Bowen River catchment is dominated by industry. The Bowen River Weir supplies mining operations at Newlands and Collinsville, and Collinsville Power Station. The weir also provides town water supply for Collinsville and Glendon.

Water use in the Suttor River catchment is associated with farm and domestic use on pastoral properties, industrial uses and cultural and spiritual uses in the case of traditional owners.

8.3.8 Waterways

A preliminary identification of waterway crossings and proposed crossing structures for the NGBR Project realignment is provided in Table 8-5.

Identification of major waterways and crossing structures for the NGBR Project realignment was undertaken with reference to existing crossing structures on the Newlands line, and crossing structures identified in the Alpha Coal Project SEIS (Hancock Prospecting 2011). Further refinement of crossing structures and identification of additional minor waterways will be undertaken to support detailed design.

Generally, the design criteria defined in the NGBR Project EIS will apply equally to the NGBR Project realignment. Bridge and culvert design criteria, afflux design criteria and flood immunity criteria are shown in Volume 2 Appendix B Revised project description.

It is noted that the proposed afflux and flood criteria are generally consistent with those proposed for the Alpha Coal Project, as referenced in the Coordinator-General's Evaluation Report on the environmental impact statement (State of Queensland 2012).

The preliminary list of crossings (including location and type of crossing) provided in Table 8-5 are subject to change once a detailed hydraulic assessment has been undertaken to determine the most feasible method of flow conveyance. Flow diversions may be provided where the installation of cross drainage culverts are not achievable due to embankment restrictions and the vertical formation of the rail. The diversions will be required to divert flow to the nearest downstream catchment where a cross drainage structure could be installed. Earth levees may also be required to contain water levels within each catchment to a minimum level to ensure that the proposed cross drainage structures operate efficiently.

All crossing structures for the NGBR Project, including the NGBR Project realignment will be required to meet the relevant design criteria. Flood modelling and analysis will continue during detailed design to further refine hydrological estimates and design of structures.

Table 8-5 Major waterways and crossing structures

Chainage (km)	Waterway	Crossing structure
131	Bowen River	Bridge (16 span)[1]
138.8	Station Creek	Bridge (4 span)[2]
140.9	Rosella Creek	Bridge (6 span)[2]
153.6	Unnamed creek	Bridge (2 span)[2]
158	Unnamed creek	Bridge (4 span)[2]
179.5	Unnamed creek	Bridge (4 span)[2]
187.1	Unnamed creek	Bridge (3 span)[2]
196.8	Suttor River	Bridge (4 span)

1 Proposed in Alpha Coal Project Supplementary Environmental Impact Statement 2011 Appendix Y BFS Drainage Engineering Report (Hancock Prospecting 2011)

[2] Matched with existing structures on the Newlands line

8.4 Potential impacts and mitigation measures

The potential construction and operation impacts of the NGBR Project realignment on water resources are detailed in the NGBR Project EIS Volume 1 Chapter 9 Water resources. In summary these were:

- Impacts to surface water flow
- Impacts to flood regime
- Impacts to surface water quality
- Impacts to surface water users
- Impacts to groundwater quality and users.

The previously identified impacts and mitigation measures can be applied to the NGBR Project realignment. There were no additional impacts identified. Potential impacts to water resources are similar to those identified in the Alpha Coal Project EIS (Hancock Prospecting 2010).

A hydrology and hydraulics assessment that includes the NGBR Project realignment will be conducted during detail design to further assess the impacts of cross drainage structures on surface water flow and flooding and identify potential treatments for waterway crossings. The configurations of the crossings (culverts and bridges) will be determined using similar design criteria adopted for the NGBR Project EIS.

8.4.1 Construction

Surface water flow

During construction, temporary structures in watercourses will be required, such as:

- Culverts for construction access roads
- Coffer dams for construction bridge piers and culverts.

Dry river construction will be conducted in preference to the use of coffer dams.

These temporary structures have the potential to impact surface water flow, causing disturbance to bed and banks. These impacts have the potential to occur at the site of any temporary crossing structure (refer Table 8-5).

Temporary structures will be designed with the hydraulic capacity to minimise impacts to flood flows. Temporary structures that are defined as waterway barriers will be designed and approved in accordance with the *Fisheries Act 1994* and *Sustainable Planning Act 2009*.

At completion of construction, temporary structures will be removed and the bed and banks of affected waterways will be returned to their original profile.

Flood regime

Temporary structures will also have the potential to impact flood regimes, if the temporary structures have insufficient hydraulic capacity to convey flows, or cause build-up of debris. This may lead to associate upstream afflux, or the suppression of downstream flows. These impacts have the potential to occur at the site of any temporary crossing structure (refer Table 8-5).

Temporary structures will be designed with the hydraulic capacity to minimise impacts to flood flows. Temporary structures that are defined as waterway barriers will be designed and approved in accordance with the *Fisheries Act 1994* and *Sustainable Planning Act 2009*.

Surface water quality

The following construction activities have the potential to impact surface water quality:

- Vegetation clearing and earthworks
- Operation of machinery
- Storage of fuel and maintenance fluids
- Development of roads and laydown areas
- Construction in bed and banks of a waterway.

The above activities could lead to increased suspended solids, nutrients and other contaminants in waterways. Impacts to surface water flow may also create or exacerbate scouring and erosion.

Potential impacts may also occur due to leaks and spills of maintenance fluids. Sites where such spills may occur include the proposed construction yard at chainage 189 km.

The NGBR Project EIS identified disturbance of acid sulfate soils as a potential impact. Acid sulfate soils are not considered a risk for the NGBR Project realignment, due to the elevation of the land and distance from coastal areas (refer Section 5). The disturbance of contaminated land also has potential to impact water quality.

Potential water quality impacts during construction will be actively managed at the source through the implementation of:

- Erosion and Sediment Control Plan
- Water Quality Management Plan.

Water use

Potential surface water quality impacts due to erosion and sedimentation from exposed earthworks during construction of the NGBR Project realignment have the potential to impact water users. In the unlikely event of a significant spill, surface water quality would be diminished temporarily. As the NGBR Project will be constructed over two years, water quality impacts are expected to be temporary and transitory, as the construction front progresses along the final rail corridor.

Water will be required for a number of construction activities, including concrete batching, earthworks compaction and dust suppression. The construction camp situated on the NGBR Project realignment will also require a water source. Potential water extractions for the NGBR Project realignment include groundwater bores, surface water storages, local government supplies and waterway extraction. The extraction of water has the potential to reduce base flows. The level of impact will depend on the volume of water extracted and the timing of extraction.

A construction water supply strategy was prepared for the NGBR Project (refer EIS Volume 2 Appendix H3 Construction water supply strategy), based on the anticipated water requirement of the NGBR Project. Volumetric impacts to downstream users are expected to be minimal. It is also noted that the construction water supply strategy will be refined during detail design and no water sources have been confirmed along the NGBR Project realignment.

Groundwater

Impacts to groundwater levels may occur as a result of earthworks, bridge construction and associated dewatering. It is considered that groundwater infiltration rates into cuttings or bridge foundations will be minor and temporary. These impacts have the potential to occur at the site of any bridge structure (refer Table 8-5).

Impacts to groundwater levels will potentially occur in the vicinity of bores established for construction water supply. Groundwater extractions have potential for short-term, localised impacts on shallow groundwater (refer EIS Volume 2 Appendix H3 Construction water supply strategy).

Potential impacts may also occur due to leaks and spills of maintenance fluids. Sites where such spills may occur include the proposed construction yard at chainage 189 km.

The potential impacts described above are localised and temporary and are therefore not considered to result in significant impacts to groundwater resources. No significant impacts on groundwater resources or groundwater quality were identified in the Alpha Coal Project EIS (Hancock Prospecting 2010).

Groundwater bores for construction water supply will be situated in consideration of the expected cone of influence for groundwater drawdown.

8.4.2 Operation

Surface water flow

The NGBR Project realignment incorporates a number of permanent waterway crossing structures that have potential to impact surface water flow.

These structures have the potential to cause disturbance to bed and banks, or downstream infrastructure. Impacts to surface water flow may also create or exacerbate scouring and erosion. These impacts have the potential to occur at the site of any potential waterway crossing structure (refer Table 8-5). Impacts to downstream infrastructure are most likely to occur for the length of the NGBR Project realignment that runs adjacent to the Newlands line.

Detailed design of cross drainage structures will involve the refinement of appropriate types of crossings for waterways, including scour protection, taking into account design flow rates and existing geomorphic integrity.

Permanent structures that are defined as waterway barriers will be designed and approved in accordance with the *Fisheries Act 1994* and *Sustainable Planning Act 2009*.

Flood regime

Permanent structures will also have the potential to impact flood regimes, if they have insufficient hydraulic capacity to convey flows, or cause build-up of debris. Associated upstream afflux impacts also have the potential to occur.

Preliminary engineering design of drainage structures at identified waterway crossings was undertaken for the 50 year ARI event for the NGBR Project EIS. The preliminary design was based on hydrologic and hydraulic modelling, to assess the potential impacts of the design against the relevant design criteria. Further engineering will be undertaken for the NGBR Project realignment during detail design.

Preliminary crossing structures have been identified for the NGBR Project realignment based on assessment undertaken for the Alpha Coal Project SEIS (Hancock Prospecting 2011), and will

be subject to the same hydrologic and hydraulic modelling process in order to meet the relevant design criteria.

Detailed design of cross drainage structures will involve the refinement of appropriate types of crossings for waterways, including scour protection, taking into account design flow rates and existing geomorphic integrity.

Permanent structures that are defined as waterway barriers will be designed and approved in accordance with the *Fisheries Act 1994* and *Sustainable Planning Act 2009*.

Surface water quality

Surface water runoff attributable to the NGBR Project realignment may include suspended solids, fuel traces, dissolved metals and other contaminants. Contribution of such contaminants to the existing waterways traversed by the NGBR Project realignment is expected to be relatively minimal. Potential impacts to surface water quality may also occur due to leaks and spills of maintenance fluids. Sites where such spills may occur include the proposed maintenance yard at chainage 189 km.

Dust deposition and coal dust represent secondary sources of potential water quality contamination, particularly with regards to heavy metals. Coal dust emissions have been modelled for the NGBR Project realignment (refer Section 9). Based on modelled dust emissions, potential impacts to surface waters from dust emissions are expected to be minimal.

Potential water quality impacts during operation will be actively managed at the source through the implementation of:

- Erosion and Sediment Control Plan
- Water Quality Management Plan.

Surface water runoff attributable to the operation of the NGBR Project will be managed through a longitudinal drainage system, connecting cross drainage infrastructure.

Herbicides are expected to be used for weed control for the NGBR Project. Given the quantity that will be applied it is considered unlikely that any impact to surface water quality will result.

Water use

No impacts to the availability of surface water are expected as the NGBR Project, including the NGBR Project realignment, will not permanently extract or take surface water. Flow diversions may be proposed subject to the final vertical rail alignment. However, it is not envisaged that these will impact on the availability of surface water.

It is considered that the design criteria for waterway crossing structures will be sufficient to protect the environmental values, as defined under the *Environmental Protection (Water) Policy 2009*.

Groundwater

No impacts to the availability of groundwater are expected as the NGBR Project, including the NGBR Project realignment, will not permanently divert, extract or take groundwater. Any minor impacts to groundwater levels that occur during construction (refer Section 8.4.1) are expected to be temporary. Potential impacts may also occur due to leaks or spills of maintenance fluids. Sites where such spills may occur include the proposed maintenance yard at chainage 189 km.

Herbicides are expected to be used for weed control for the NGBR Project. Given the quantity that will be applied it is considered unlikely that any impact to groundwater quality will result.

8.4.3 Summary of mitigation and management measures

Mitigation and management measures to be implemented during construction and operation of the NGBR Project realignment to minimise and avoid impacts on water resources are consistent with those provided in the NGBR Project EIS (refer to NGBR Project EIS Volume 1 Chapter 9 Water resources).

Additional commitments

The following additional measures are considered to apply to the NGBR Project realignment, prior to commencement of construction, in order to provide a level of detail consistent with work undertaken to date for the NGBR Project EIS and Coordinator-General's Evaluation Report on the proposed Alpha Coal Project (State of Queensland 2012):

- Preparation of property-scale flood mapping for affected landholders
- Submission of detailed design report for flooding and drainage.

8.5 Conclusion

Construction and operation of the NGBR Project realignment has the potential to directly and indirectly impact water resources, although these are not likely to result in additional potential impacts, or change the order of magnitude of potential impacts.

Further hydrological studies during detailed design will provide more detailed information in relation to the specific treatments to be applied.

9. Air quality

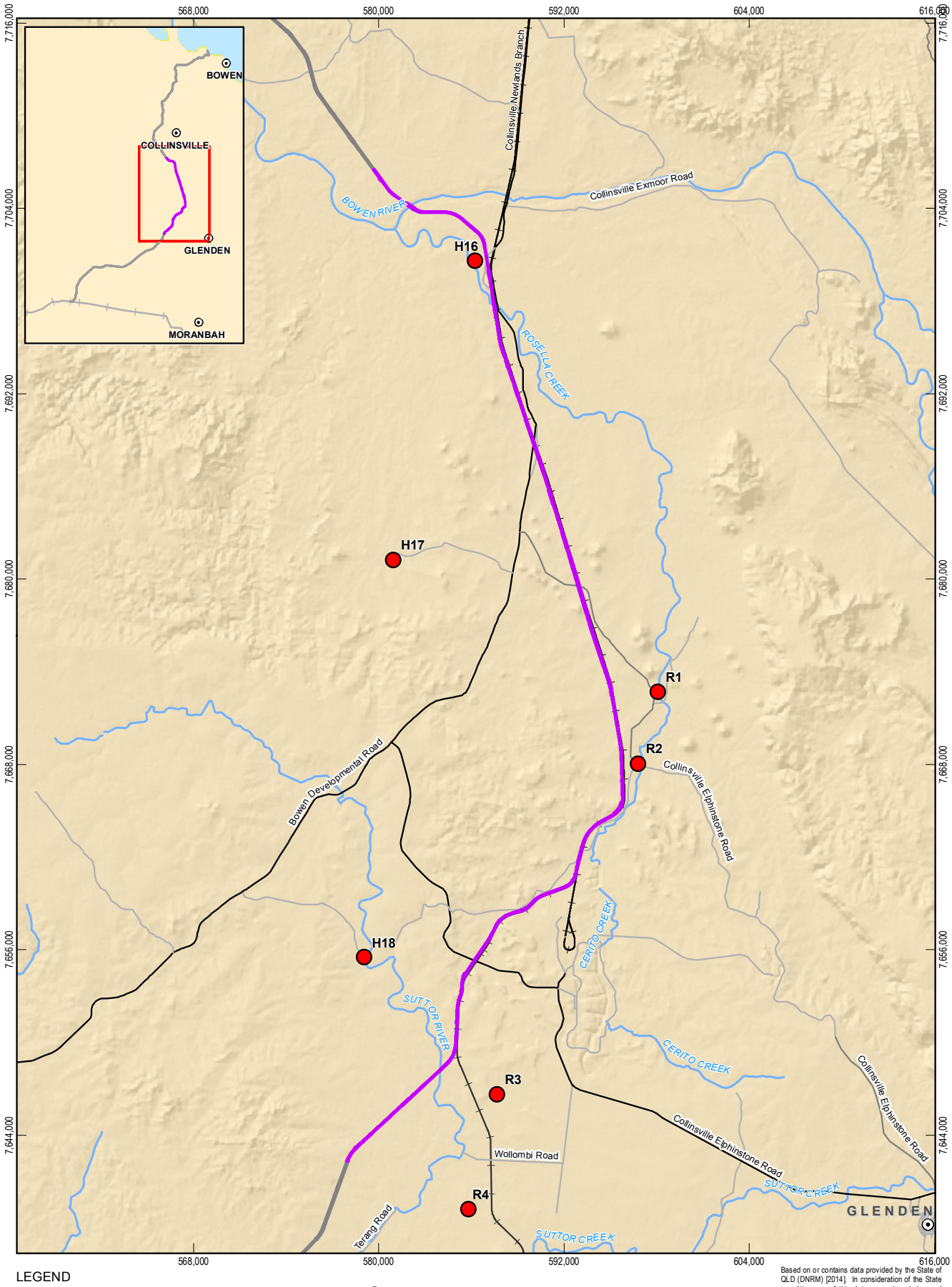
9.1 Purpose of section

This section provides a desktop assessment of potential air quality impacts arising from the construction and operation of the NGBR Project realignment. The assessment accounts for ambient regional background concentrations, emissions from the NGBR Project realignment and emissions from the existing Newlands line. Given the distance between the NGBR Project realignment and the closest sensitive receptors (the closest being 721 m), potential impacts are predicted to be minor and below the relevant criteria (refer Section 9.2.3). Potential dust mitigation and management measures for the NGBR Project realignment are discussed, consistent with those for the NGBR Project generally, as outlined in NGBR Project EIS Volume 1 Chapter 10 Air quality.

9.2 Methodology

9.2.1 Study area

Figure 9-1 provides an overview of the NGBR Project realignment, showing the locations of the nearest identified sensitive receptors. The NGBR Project realignment travels a distance of approximately 77 km, from chainage 128 km to chainage 205 km, in a broadly north-south direction to the east of the final rail corridor, as described in the NGBR Project EIS.



LEGEND

- Populated centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Sensitive Receptors

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

NGBR Project realignment and sensitive receptors

Figure 9-1

G:\41\26457\06 GIS\Maps\MXD\0300_AirQuality\41_26457_0304_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Physical Road Network (2010), GA/NGBR EIS: Sensitive Receptors (2014) Created by:MS

9.2.2 Data sources

This air quality assessment relies on the following data sources:

- Long term Bureau of Meteorology (BOM) observations at Collinsville Post Office (refer Section 9.3.2)
- Local site-representative meteorology developed using a prognostic meteorological model (refer Section 9.3.3)
- Existing background dust deposition rates and particle concentrations as applied in NGBR Project EIS Volume 1 Chapter 10 Air quality
- Publically available data for the Newlands rail line used to develop the emissions inventory (Aurizon 2013).

9.2.3 Legislation and guidelines

Commonwealth

National air quality standards and goals are specified by the Environment Protection and Heritage Council (formerly known as the National Environment Protection Council) in the form of National Environmental Protection Measures. Two measures have been developed that are relevant to this assessment – the National Environment Protection (Ambient Air Quality) Measures (Air NEPM) and the National Environment Protection (Air Toxics) Measure (Air Toxics NEPM). The Air NEPM specifies national ambient air quality standards and goals for six criteria air pollutants – nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), particulates (as PM_{10} and $PM_{2.5}$) and lead. The Air Toxics NEPM provides monitoring investigation guidelines, principally for large cities with significant traffic emissions, for five compounds classified as air toxics – benzene, benzo(a)pyrene, formaldehyde, toluene and xylenes.

State Government

The *Environmental Protection (Air) Policy 2008* (Air EPP) applies to the air environment of Queensland and identifies the following environmental values to be enhanced or protected in the state:

- The health and biodiversity of ecosystems
- Human health and wellbeing
- Aesthetics
- Agricultural use.

Schedule 1 of the Air EPP defines air quality objectives such that environmental values are enhanced or protected.

Air quality standards, goals and monitoring investigation levels specified in the Air NEPM and Air Toxics NEPM have been adopted as air quality objectives in the Air EPP.

Air quality objectives for deposited dust are not included in the Air EPP. A recent Department of Environment and Heritage Protection (DEHP) guideline, Application Requirements for Activities with Impacts to Air (DEHP 2013), provides an objective for assessing deposited dust measurements collected in accordance with the Australian Standard, AS/NZS 3580.10.1:2003 – Methods for sampling and analysis of ambient air. Method 10.1: Determination of particulate matter – Deposited matter – Gravimetric method. The amenity guideline of 120 mg/m^2/day, for a

one month collection period, is equivalent to 3.7 mg/m^2/month. The relevant DEHP guideline (DEHP 2013), notes that this method is frequently used in Queensland.

It is not possible to measure daily deposition values for each day of a one month collection period; however it is possible to model dust deposition on daily time scales. For a one month period where the monthly average deposition rate is equal to the amenity guideline, there will be many days where the guideline value is significantly exceeded. Previous project experience within GHD is that exceedances of monthly deposition criteria are usually related to short term deposition events, associated with adverse meteorology or increased activity, rather than a steady build-up of collected dust throughout a month. Use of this criterion to assess daily modelled data was therefore considered to be inappropriate.

The NSW Office of Environment and Heritage assessment criterion, contained within the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2005), provides assessment criteria for incremental contribution of deposited dust at a sensitive receptor that is more amenable to modelling. The criterion value is 2 g/m^2/month (insoluble solids, annually averaged) at a given sensitive receptor, as well as a maximum total deposited dust level of 4 g/m^2/month (insoluble solids, annually averaged) inclusive of background. These criteria were developed by the NSW Office of Environment and Heritage on the basis of complaints data in the Hunter Valley, and are widely accepted assessment criteria outside of NSW.

The Queensland DEHP has adopted an incremental impact assessment criterion for the maximum incremental dust deposition level equivalent to not exceeding 2 g/m^2/month to ensure adequate protection of dust levels for residential amenity.

The air quality objectives and criteria used in the assessment are presented in Table 9-1. The objectives adopted for the assessment of the NGBR Project realignment are identical to those that were applied in NGBR Project EIS Volume 1 Chapter 10 Air quality.

Table 9-1 Air quality objectives and assessment criteria

Indicator	Environmental value	Air quality objective	Period
TSP	Health and wellbeing	90 µg/m^3 (a)	1 year
PM_{10}	Health and wellbeing	50 µg/m^3 (a) (b)	24 hours
$PM_{2.5}$	Health and wellbeing	25 µg/m^3 (a)	24 hours
		8 µg/m^3 (a)	1 year
Deposited Dust	Protecting aesthetic environment	2 g/m^2 (c) (d)	1 month
		4 g/m^2 (c) (e)	1 month
Benzene	Health and wellbeing	10 µg/m^3 (a)	1 year
Carbon Monoxide	Health and wellbeing	11,000 µg/m^3 (a)	8 hours
Formaldehyde	Health and wellbeing	54 µg/m^3 (a)	24 hours
	Protecting aesthetic environment	110 µg/m^3 (a)	30 minutes
Nitrogen dioxide	Health and wellbeing	250 µg/m^3 (a) (f)	1 hour
		62 µg/m^3 (a)	1 year
	Health and biodiversity of ecosystems	33 µg/m^3 (a)	1 year
Sulphur dioxide	Health and wellbeing	570 µg/m^3 (a) (f)	1 hour
		230 µg/m^3 (a) (g)	1 day
		57 µg/m^3 (a)	1 year
	Protecting agriculture	32 µg/m^3 (a)	1 year
	Health and biodiversity of ecosystems (for forests and natural vegetation)	22 µg/m^3 (a)	1 year
Toluene	Health and wellbeing	4,100 µg/m^3 (a)	24 hours
		410 µg/m^3 (a)	1 year
	Protecting aesthetic environment	1,100 µg/m^3 (a)	30 minutes
Xylenes	Health and wellbeing	1,200 µg/m^3 (a)	24 hours
		950 µg/m^3 (a)	1 year

(a) Queensland Air EPP (2008)
(b) Five exceedances of the 24-hour average are allowed
(c) NSW Approved Methods for the modelling and assessment of air pollutants in NSW (2005)
(d) Maximum increase in deposited dust level, based on annual average of monthly observations
(e) Maximum total deposited dust level, based on annual average of monthly observations
(f) A one hour exceedance is allowed on one day each year
(g) One exceedance of the 24-hour average is allowed

9.2.4 Desktop assessment

This desktop assessment was conducted using the following approach:

- Define the local dispersion meteorology, site-representative, for the region using a prognostic meteorological model (TAPM)
- Develop an emissions inventory to characterise emissions from the existing Newlands line, and the NGBR Project realignment

- Determine background particle concentrations and dust deposition rates, on the basis of those applied in NGBR Project EIS Volume 1 Chapter 10 Air quality
- Use the AUSROADS dispersion model to predict dispersion of particle and gaseous contaminants arising from both rail sources, along east and west transects established normal to the NGBR Project realignment
- Use the AUSPLUME dispersion model to predict particle deposition rates arising from both sources, along the east and west transects previously established
- Assess the combined effect of emissions from both rail sources and the existing background concentrations in relation to relevant assessment criteria.

9.2.5 Impact Assessment

The NGBR Project realignment coincides with the approved Alpha Coal Project for approximately 64 km. The proposed Alpha Coal Project and the existing Newlands line have all been previously assessed and in each case have been assessed to have no exceedances of any ambient air quality criteria at distances beyond a few tens of metres from their respective corridors. The proposed NGBR Project realignment is in a low population density location and only passes by a limited number of sensitive receptor locations. For these reasons, the current assessment focusses on predicted dust deposition rates and pollution concentrations in the vicinity of the nearest identified sensitive receptors.

9.2.6 Limitations

The emissions inventories characterising the NGBR Project realignment and Newlands rail line have been conducted on the basis of concept design information provided by Adani and the Alpha Coal Project EIS (Hancock Prospecting 2010).

Background concentrations of particle concentrations and deposited dust rates were adopted from NGBR Project EIS Volume 1 Chapter 10 Air quality. In turn these had been determined on the basis of measurements made at a remote rural greenfield site in the Bowen Basin. Conservative choices were made to determine the most appropriate background values to apply. Local measurements of existing or background air quality have therefore not been made prior to the publication of this report.

The modelling results are subject to the limitations inherent in the use of the AUSPLUME and AUSROADS dispersion modelling software.

9.3 Existing environment

9.3.1 Sensitive receptors

Table 9-2 provides the locations of the nearest identified sensitive receptors along the NGBR Project realignment. All of these are homesteads associated with grazing properties in the district. The closest receptor is Homestead 16, which lies approximately 721 m from the NGBR Project realignment, in the vicinity of chainage 138 km. The next closest receptor is the Homestead R2 which is 1,062 m from the corridor at chainage 172 km. The remaining receptors are all greater than two kilometres from the NGBR Project realignment and are unlikely to be adversely affected by air emissions.

Table 9-2 Sensitive receptor locations

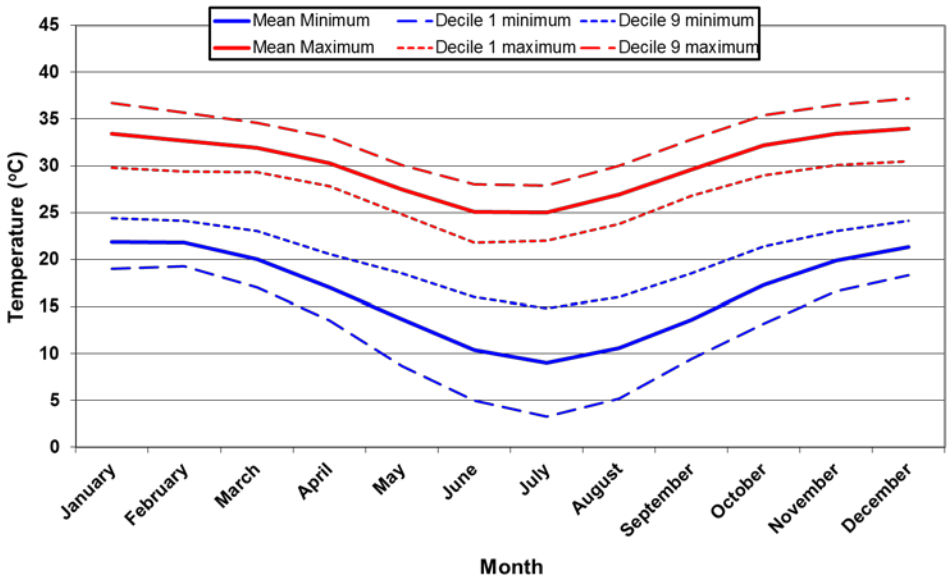
Sensitive Receptor Code	Approximate Chainage (km)	Easting (mE, GDA94)	Northing (mN, GDA94)	Distance from NGBR Corridor (m)
Homestead 16	138	586276	7700615	721
Homestead 17	155	580955	7681237	10,932
Homestead 18	191	579067	7655503	6,485
Homestead R1	167	598101	7672700	2,938
Homestead R2	172	596836	7668033	1,062
Homestead R3	196	587693	7646614	3,764
Homestead R4	202	585818	7639207	7,825

9.3.2 Regional meteorology

Long term temperature observations

Figure 9-2 graphs mean and decile temperature statistics for each month, on the basis of long term BOM observations collected at the Collinsville Post Office (BOM, 2014), approximately 26 km north of Homestead 16.

Figure 9-2 Monthly mean and decile maximum and minimum temperatures at Collinsville post office



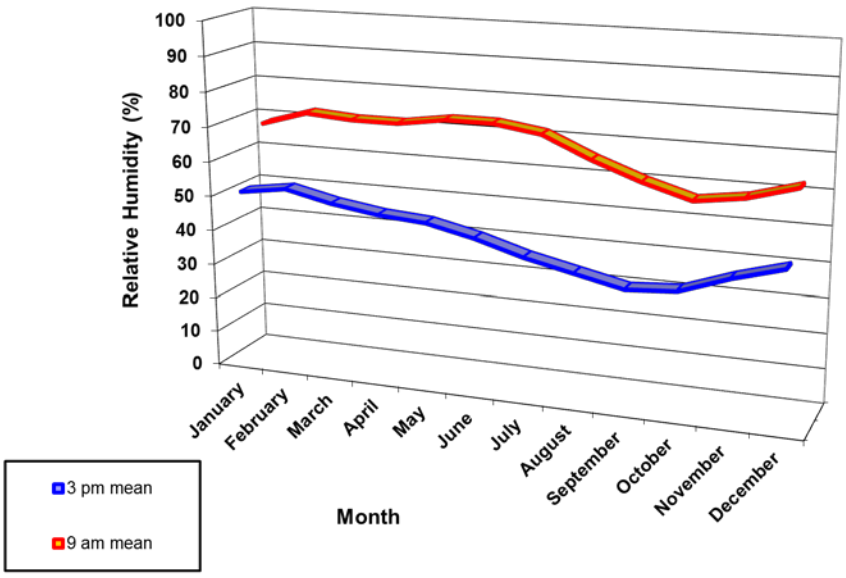
The long term monthly mean temperatures observed show that daytime summer temperatures are in the range of 21 to 37 °C, with winter overnight temperatures dropping to between three and 15 °C with a mean centred near 9 °C. Temperatures in this region vary between -3.3 °C and 37.2 °C.

'Hot days', those with temperatures exceeding 35 °C, can be expected up to 37 days per year at the Collinsville Post Office. 'Frost days', those with screen temperatures below 2 °C are rare occurring on average 2.1 days per year.

Long term relative humidity observations

Figure 9-3 shows the corresponding 9 am and 3 pm relative humidity statistics for the Collinsville Post Office (BOM 2014). Relative humidity is highest in the mornings and lowest in the afternoons. The highest humidity tends to occur during May and June in the morning, with the lowest during the afternoon in September.

Figure 9-3 Monthly mean 9 am and 3 pm relative humidity at Collinsville post office

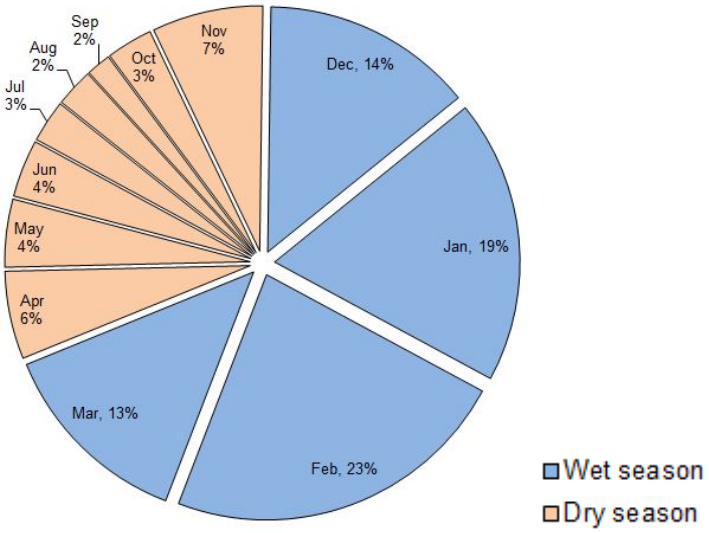


Long term rainfall observations

Long term rainfall records show an annual mean rainfall of 718 mm/year at Collinsville (BOM 2014). The maximum annual rainfall recorded at Collinsville was 1,584 mm/year (in 1956).

The annual mean rainfall (Figure 9-4) is dominated by the wet season (December to March) producing convectively driven rainfall. Summertime rainfall (December through February) accounts for 56 per cent of the annual rainfall at Collinsville Post Office.

Figure 9-4 Rainfall proportion by month Collinsville post office (033013)



9.3.3 Dispersion meteorology

In order to characterise the dispersion meteorology, the NGBR Project realignment was divided into a northern section and a southern section. The prognostic meteorological model TAPM (V4.0.3) was used to generate year-long datasets of meteorological parameters that could be used in a dispersion model (AUSROADS for downwind concentrations and AUSPLUME for dust deposition). Both simulations were centred over locations on the NGBR Project realignment that were nearest to identified sensitive receptors. The dispersion modelling for each site was conducted using TAPM data extracted at the closest available grid point.

Meteorology was simulated for the year 2008 based on the availability of appropriate data, as explained in NGBR Project EIS Volume 2 Appendix I Air quality. Table 9-3 describes the TAPM configuration utilised for each section.

Table 9-3 TAPM configuration for the northern and southern prognostic meteorological model simulations

Parameter	Northern TAPM run	Southern TAPM run
Grid centre latitude (GDA94)	20° 52.0’ S	21° 13.0’ S
Grid centre longitude (GDA94)	147° 51.1’ E	147° 49.5’ E
Grid centre easting (GDA94)	589287 mE	585619 mE
Grid centre northing (GDA94)	7692370 mN	7653650 mN
Columns	26	26
Rows	26	26
Vertical levels	25	25
Nesting	30 km; 10 km; 3 km; 1 km	30 km; 10 km; 3 km; 1 km
Modelled year	2008	2008

Parameter	Northern TAPM run	Southern TAPM run
Model “spin-up” days	2	2

The key atmospheric dispersion characteristics of wind regime, stability and mixing height are expected to be broadly similar throughout the region of the NGBR Project realignment, however subtle differences are expected. The descriptions below focus on meteorological data extracted from the model run for the northern section of the NGBR Project realignment, at a site located in the vicinity of Homestead 16. For comparison purposes, in order to show the maximum degree of change in the wind regime expected throughout the NGBR Project realignment, a wind rose has also been provided for the southern section, summarising the wind regime in the vicinity of Homestead 18. Site specific meteorological data was used to conduct the dispersion modelling for each site selected.

Wind speed and direction

Annual wind roses for the northern and southern sections of the NGBR Project realignment are provided in Figure 9-5. The wind regimes in both sections are broadly similar but with some subtle changes due to a topographical feature of some low-range hills north-west of Homestead 18 and south-west of Homestead 16. At Homestead 16 winds are largely confined to the southeast quadrant, with a lesser proportion arriving from the northeast quadrant. The prevailing winds arrive from the south-southeast. Winds with a westerly component are virtually non-existent. Wind speed varies between 0.5 and 8.0 m/s with mean and median speeds of 2.7 and 2.1 m/s respectively.

The wind regime at Homestead 16 is broadly like that of Homestead 18, and shows a similar lack of westerly winds. Winds with an easterly component are more evenly distributed throughout the north-eastern and south-eastern quadrants however, and the prevailing winds arrive from the east-southeast rather than the south-southeast. The wind speed range is virtually identical, with winds varying between 0.5 and 8.2 m/s. The mean and median speeds are slightly higher at 3.0 and 2.6 m/s respectively

Figure 9-5 and Figure 9-6 show annual and seasonal wind roses for Homestead 16. During spring and summer winds are evenly divided throughout the north-northwest to south-southeast sectors, and virtually always have an easterly component. During autumn, the range of wind directions is largely restricted to the south-east quadrant. In winter south-easterly winds predominate, with the remaining winds once again confined to the south-east quadrant.

Figure 9-5 Annual wind roses at Receptors H16 (LHS) and H18 (RHS)

Receptor H16

Receptor H18

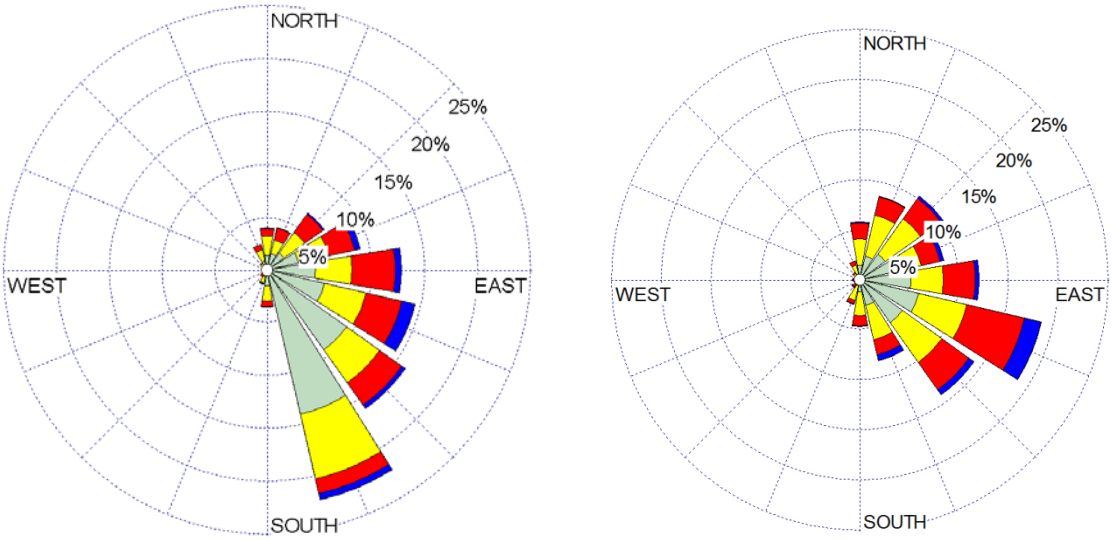
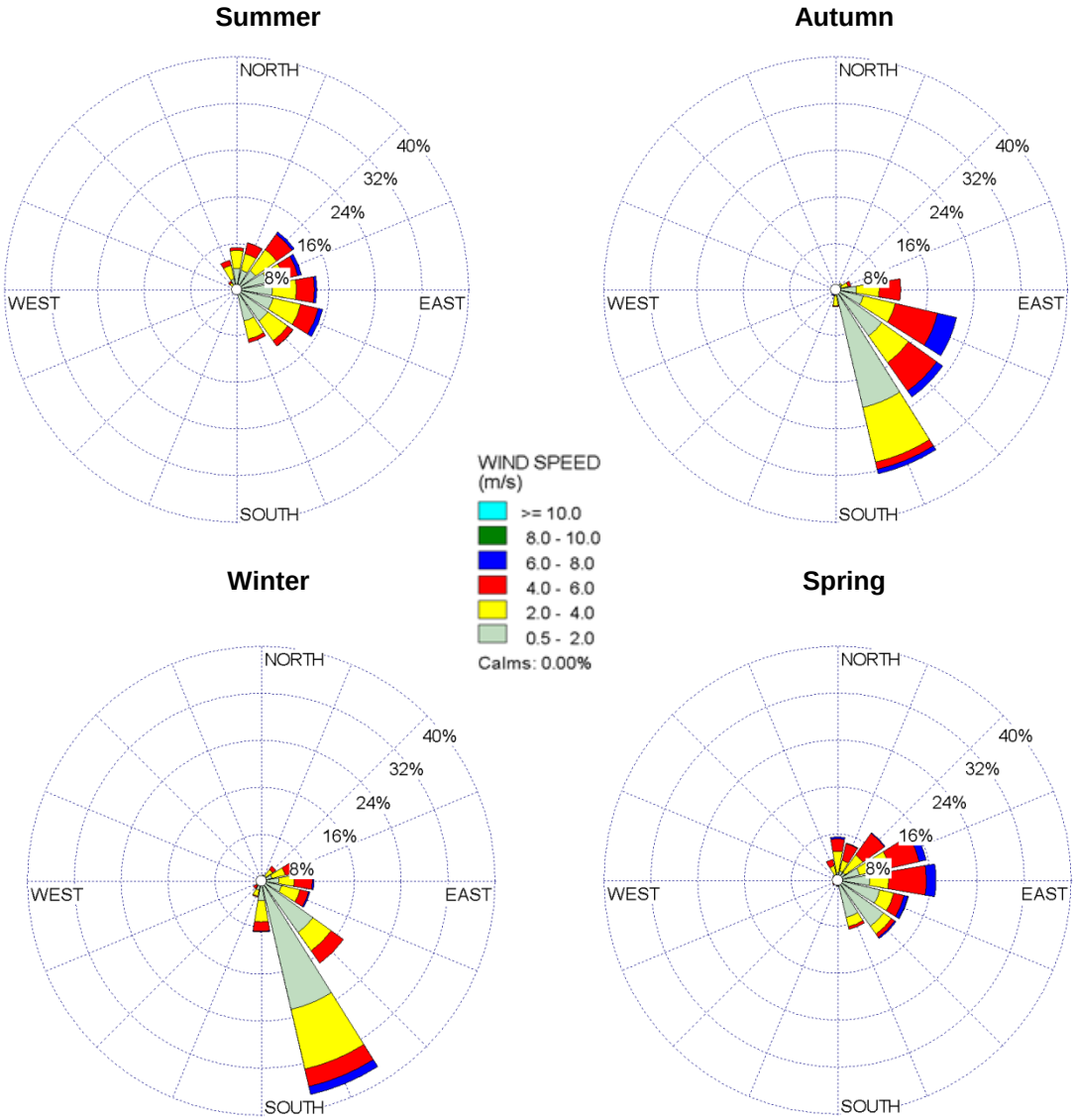


Figure 9-6 Seasonal wind roses at Receptor H16



9.3.4 Atmospheric stability

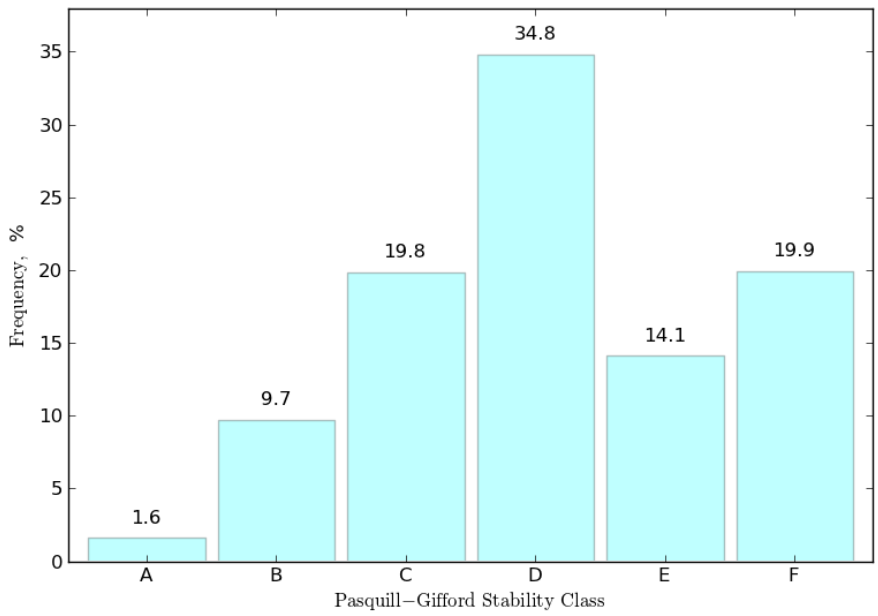
Atmospheric stability also has a strong influence on the ability of pollutants to disperse downwind from their respective sources. Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical dilution. The Pasquill-Gifford stability scheme (Pasquill 1961), defines seven stability classes, "A" to "F", to categorise the degree of atmospheric stability:

- A — very unstable
- B — unstable
- C — slightly unstable
- D — neutral
- E — slightly stable
- F — stable
- G — very stable.

Stability classes A, B, and C refer to unstable conditions occurring during daytime hours. D class stability represents neutral conditions occurring during overcast days or nights, and is associated with moderate to strong winds. E, F, and G class stabilities refer to night-time stable conditions. F and G classes are normally grouped together and are referred to as F class stability.

Figure 9-7 shows the distribution of atmospheric stability class predicted for Homestead 16. Neutral conditions occur most commonly, with a frequency of 34.8 per cent. Stable conditions are also common with E and F-class stability occurring 34 per cent of the time. Strongly unstable conditions (class A) are rare, however unstable conditions (classes A to C) account for 31 per cent of predictions.

Figure 9-7 Pasquill-Gifford atmospheric stability classes at Receptor H16

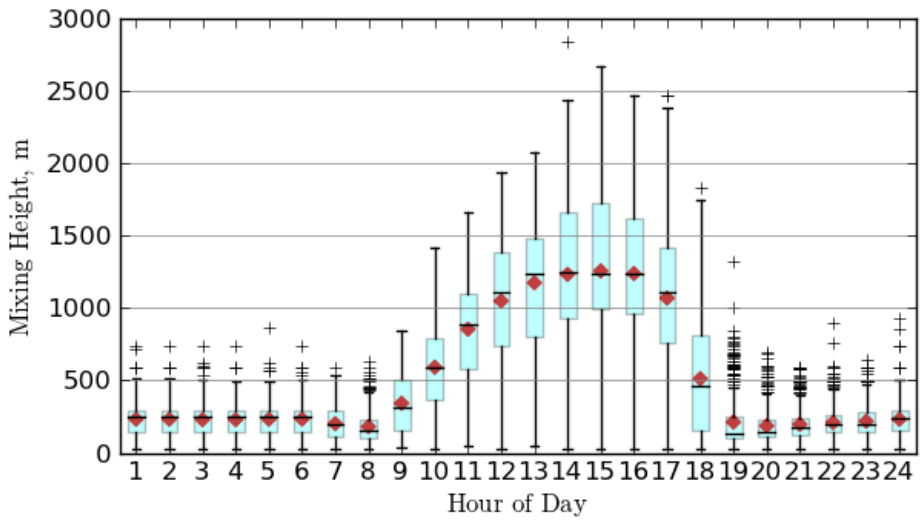


9.3.5 Mixing height

The depth of the mixing height is an indicator of vertical dispersion potential of the atmosphere and arises from a mixture of mechanical and convective influences. Convective conditions dominate during the day in a near desert climate, especially as temperatures are often high in summer. Even the sub-tropical climate in winter has daytime temperatures which are often above 20 °C. Conversely, the night-time mixing height is dominated by the formation of temperature inversions on the vast majority of nights, with associated F-class stability.

Predicted mixing height at Homestead 16 varies between 25 m and 2,832 m, with mean and median mixing heights of 513 m and 296 m respectively. Figure 9-8 indicates the diurnal variation in mixing height, showing that low mixing heights occur during the nocturnal hours, with convective mixing occurring during the day. This variation in mixing height is expected to be similar throughout the NGBR Project realignment.

Figure 9-8 Diurnal variation in mixing height at Receptor H16



9.3.6 Background air quality

Background concentrations were applied in accordance with those developed for the inland regions described in NGBR Project EIS Volume 1 Chapter 10 Air quality. It is assumed that in this remote inland region, the only existing airborne contaminants are deposited dust and the various size fractions of particulate matter. Table 9-4 summarises the existing background concentrations of these contaminants in relation to their assessment criteria.

Table 9-4 Background concentrations and criteria for deposited dust and particles

	Deposited Dust (g/m^2/month)	TSP ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
Averaging Time	Annual mean	Annual mean	24 hour maximum	24 hour maximum	Annual mean
Background	1.6	30	15	6.6	5.8
Criterion	2	90	50	25	8

9.4 Potential impacts and mitigation measures

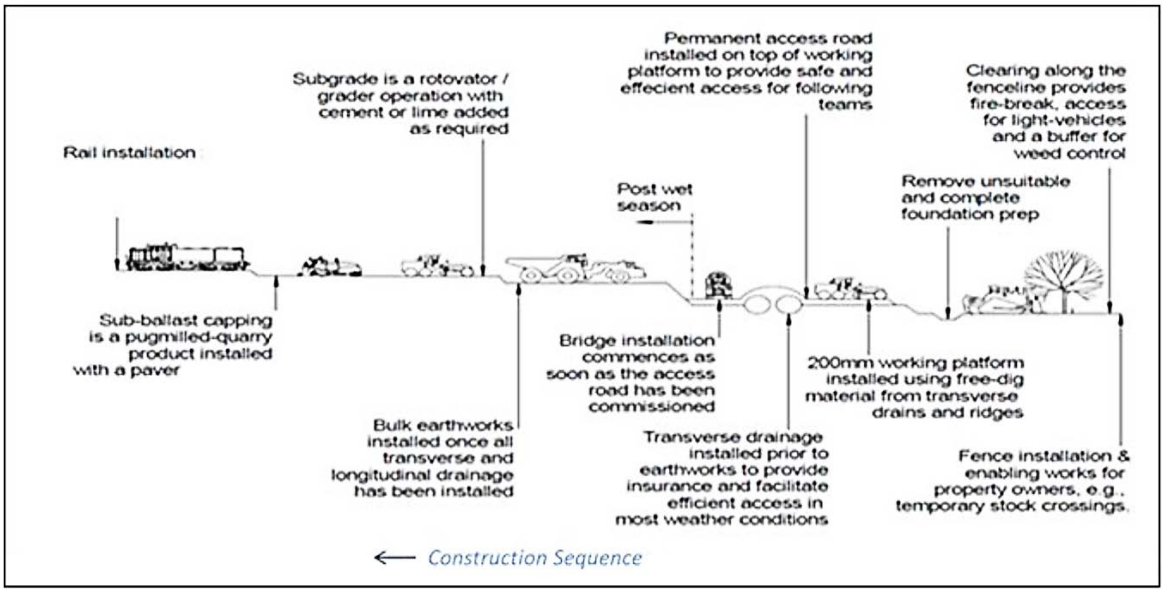
9.4.1 Construction

The emissions during the construction phase of the NGBR Project will primarily consist of:

- Dust emissions from mechanical disturbance by vehicles and equipment; from quarrying activities at sites close to the final rail corridor; and from concrete batching operations
- Dust emissions from exposed disturbed soil surfaces under high wind speeds
- Exhaust emissions from vehicles and mobile plant.

Figure 9-9 provides a high level overview of the construction sequence at any point on the final rail corridor.

Figure 9-9 High level overview of civil works sequencing during rail construction



Source: Figure 5.1, Aarvee Associates (2013)

General construction activities

The major dust sources during the construction of the NGBR Project realignment are:

- Clearing for site preparation
- Quarrying activities
- Earthworks and excavation and where required, pneumatic rock breaking
- Stockpiling, loading and dumping of cut and fill material
- Levelling and grading of disturbed soil surfaces
- Placement of ballast
- Concrete batching plant operations
- Laying of concrete sleepers and rail
- Vehicle movements on unsealed construction access and haul roads or localised unconsolidated surfaces

- Wind erosion of unconsolidated surfaces such exposed clearing and stockpiles.

The dominant sources of dust emissions during the construction phase will be activities involving operation of heavy machinery such as bulldozers, graders, scrapers and haul trucks. Track laying processes are considered to have minimal dust generating potential compared to the corridor clearing and bulk earthworks phase. The Western Regional Air Project Fugitive Dust Handbook (Countess Environmental 2006) provides an estimate of PM_{10} emission factors for construction activity. A Level 1 emission factor, based only on known area for known duration, is 0.11 tonne/acre-month. This converts to 0.0002958 tonne per square metre on an annual basis. This is for 'average conditions' which would be applicable here as 'active large-scale earth moving operations' will not be a 24/7 operation. This also assumes that the activity is occurring continuously day and night.

If the above annual emission factor is used for an indicative one kilometre long construction zone of 100 m width (a conservative parameter given the nominal 60 m width of the final rail corridor in the vicinity of the NGBR Project realignment), indicative AUSPLUME modelling suggests worst case downwind daily PM_{10} levels (for the expected meteorological conditions for this project) are:

- An increment of 100 µg/m^3 at about 100 m
- An increment of 50 µg/m^3 at 200-230 m.

Assuming there is no mitigation with the above emission factor, PM_{10} levels above regulatory criteria are unlikely beyond the range of 500 m. This is consistent with experience on similar construction projects. Accordingly, dust fallout from PM_{10} (dust deposition) would be expected to be well below 2 g/m^2 at this distance. Emissions from these sources are readily controllable and due to the temporary nature of the construction activities are not expected to be significant in either magnitude or duration. The criteria of the Air EPP are not expected to be exceeded at any of the nearest identified sensitive receptors, given the nearest (Homestead 16) is 721 m from the NGBR Project realignment.

Quarries

Adani plans to source material from two existing licenced quarries to develop the NGBR Project realignment: the Umina Quarry (586784 mE, 7733476 mN GDA94) and the Byerwen Quarry (589581 mE, 7659344 mN GDA94). Both quarries are located in isolated to remote regions. As these are existing established quarries air quality assessment of these quarries is not necessary for the NGBR Project realignment.

9.4.2 Operation

Overview

The anticipated operational emission sources and the methodology used to calculate their emissions are consistent with those identified in the NGBR Project EIS Volume 1 Chapter 10 Air quality. Table 9-5 summarises the proposed train configurations at the maximum coal transport rates for the NGBR and Newlands projects.

Table 9-5 Proposed train consist configurations for the NGBR Project realignment and Newlands line

Parameter	NGBR	Newlands
Locomotive Type	5000 bhp diesel	4000 bhp diesel

Parameter	NGBR	Newlands
	locomotive	locomotive
Manufacturing Standard	Tier 0	Tier 0
Number of locomotives per consist	4	3
Number of wagons per consist	240	82
Payload per wagon (t)	108	106
Total payload per train (t)	25,920	8,692
Loaded (up) trains per day	14	21
Empty (down) trains per day	14	21
Total trains per day	28	42
Loaded (up) trains per hour	0.58	0.88
Empty (down) trains per hour	0.58	0.88

Modelled track alignments

The application of AUSROADS to modelling the train line emissions was made by considering the emissions from typical one kilometre long track alignment sections located closest to sensitive receptor locations.

Hourly emissions were modelled at varying lateral distances up to 500 m to the west of the NGBR Project realignment and to the east of the existing Newlands line. It is assumed that no sensitive receptor locations will ever exist between the two track orientations.

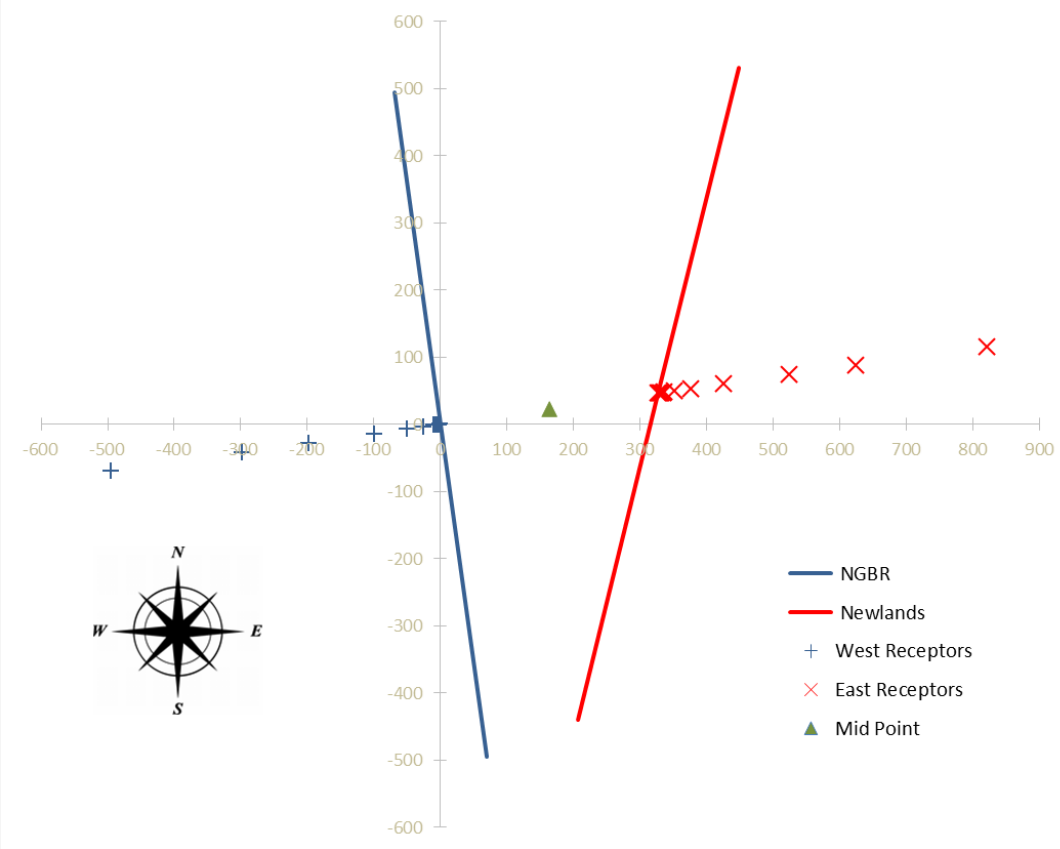
Homestead R16

Figure 9-10 shows the modelled track alignment in the vicinity of Homestead 16, which is located 721 m to the west of the NGBR Project realignment. The blue line, representing a one km section of rail centred at point (0,0), is oriented at an angle of 8 degrees west of north following the orientation of the proposed NGBR Project realignment at this location. A transect is established normal to the rail line (blue plus signs), heading in a direction toward Homestead 16 at distances of 2; 3; 5; 7.5; 10; 25; 50; 100; 200; 300; and 500 m from the line. Model predictions are made at each identified point on the transect.

A one kilometre section of the existing Newlands line is shown in red. The two rail lines diverge at this point, with the Newlands line orientated 14 degrees east of north. The centre points of the two lines are 330 m apart. An easterly transect (red crosses) is established, following the orientation and lateral distances established in the westerly transect. The green triangle is located midway between both lines, and provides an additional modelling location for deposited dust.

Atmospheric dispersion modelling was conducted using TAPM meteorology extracted from the simulation of the northern section of the NGBR Project realignment at the closest model grid point in the vicinity of Homestead 16.

Figure 9-10 Modelled track alignment for Receptor H16

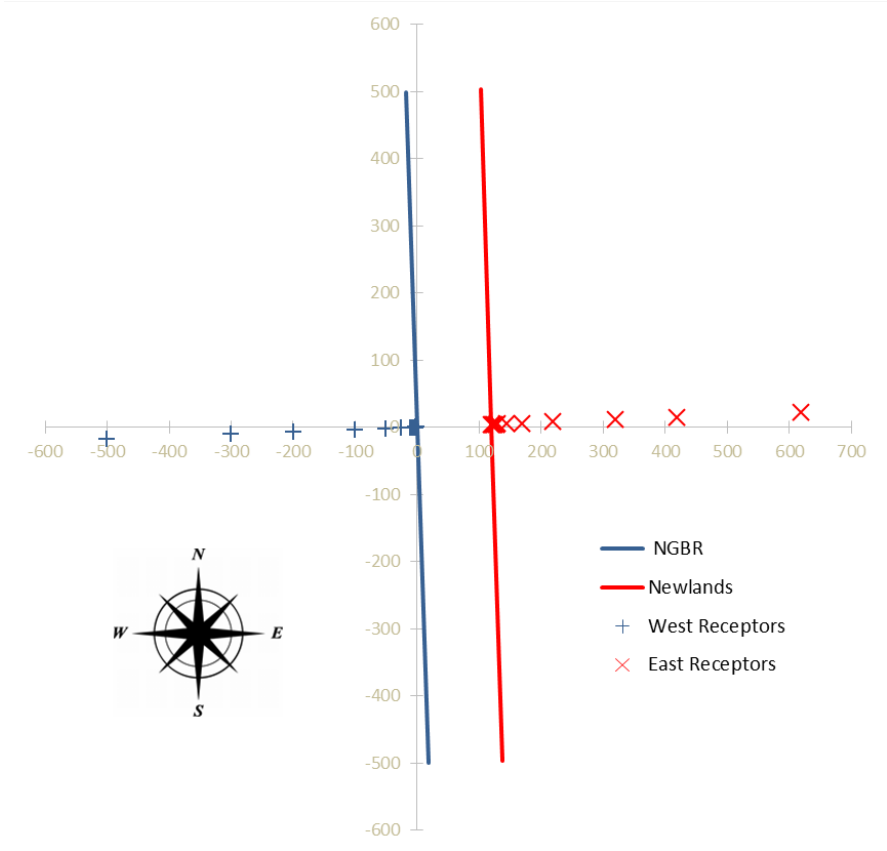


Homestead R2

The next closest sensitive receptor is Homestead R2, which is 1,062 m distant from the NGBR Project realignment. At this point, the Newlands line and the NGBR Project realignment are parallel, each orientated two degrees west of north, and separated by an approximate distance of 120 m. Figure 9-11 shows the modelled track alignment for the rail at this location. Once again the blue line represents a one kilometre section of the proposed NGBR Project realignment whilst the red line represents the existing Newlands line. The westerly transect, which is normal to the lines is orientated towards Homestead R2.

Dispersion modelling for this location used TAPM meteorology extracted from the Northern simulation at the closest model grid point to the NGBR Project realignment in the vicinity of Homestead R2.

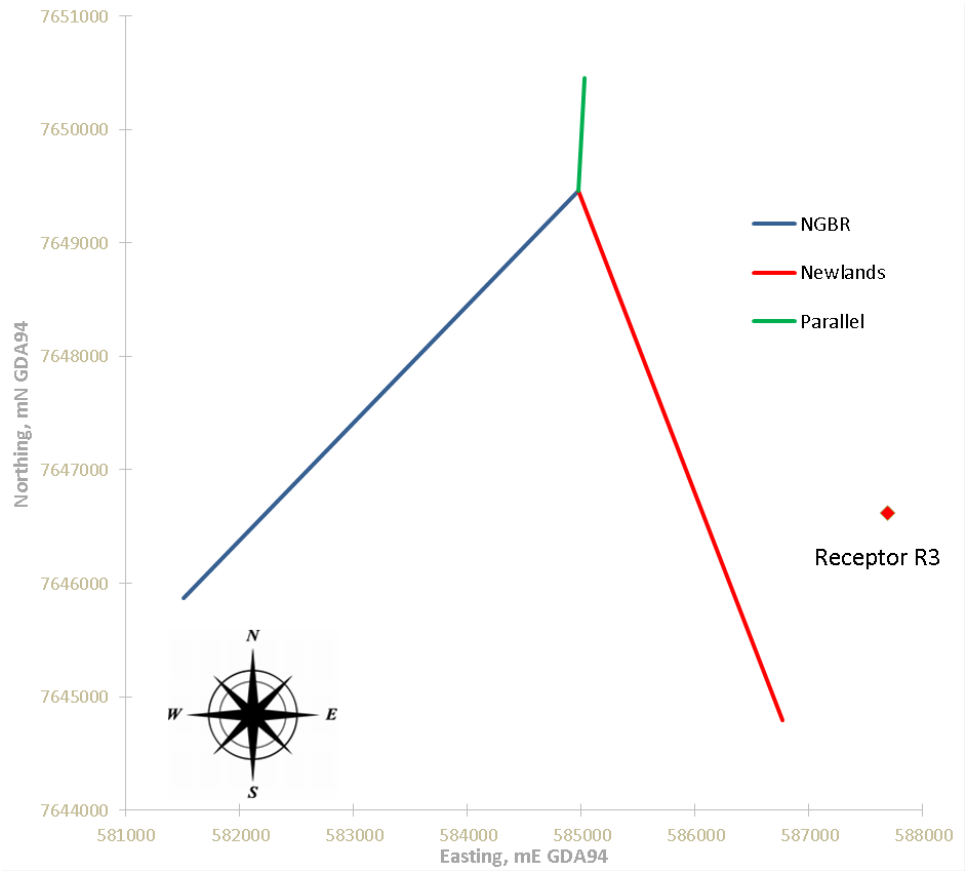
Figure 9-11 Modelled track alignment for Receptor R2



Other sensitive receptors

All other sensitive receptor locations are far more distant from the NGBR Project realignment, and are expected to receive only small impacts, if any, from proposed NGBR Project realignment operations. One further rail configuration has been modelled however, representing the proposed NGBR Project realignment and existing Newlands lines in the vicinity of Homestead R3 (Figure 9-12).

Figure 9-12 Modelled track alignment for Receptor R3



For this scenario, only daily mean PM_{10} concentrations are modelled, and these solely for the location of Homestead R3. The existing Newlands line is modelled as a five kilometre long section (red) followed by a one kilometre section (green) which runs parallel to the NGBR Project realignment. The NGBR Project realignment is similarly modelled as separate five kilometre (blue) and one kilometre (green) sections.

Dispersion modelling for this location used TAPM meteorology extracted from the southern simulation at the closest model grid point to Homestead R3.

Dispersion model configuration

The line-source Gaussian model AUSROADS V1.0 was selected to model dispersion of locomotive emissions and airborne dust from loaded coal wagons, as this model is specifically designed for near field impact from linear transport sources. Deposited dust dispersion was modelled using the Gaussian plume model AUSPLUME V6.0. Both are industry recognised techniques for modelling emissions and dust deposition.

The parameters and input data used for the AUSROADS simulations were:

- Site representative 12-month meteorological files
- Anemometer readings at height of 10 m (BOM standard)
- Meteorological site surface roughness of 0.3 m
- Sigma-theta averaging period of 60 minutes
- Pasquill-Gifford horizontal dispersion
- Irwin rural wind exponent

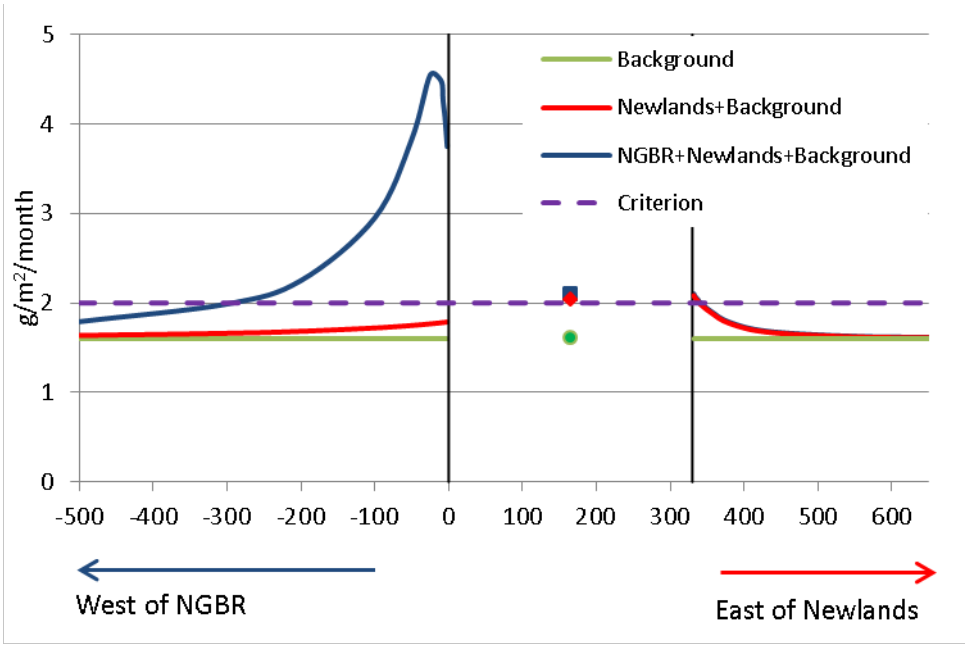
- Link geometry – one single track set to a width of 6 m to allow for turbulent mixing from a fast moving train
- Link geometry consisted of a 1 km track section with varying orientations
- Averaging periods of 1-hour, 8-hours, 24-hours and one year were selected as appropriate for assessment against Air EPP criteria
- Hourly emissions were recorded along 500 m transects perpendicular to the modeled track sections
- Emissions data derived from emission estimation in grams per vehicle-kilometer-travelled (g/VKT) for a one kilometer straight track segment ('link') assuming a fixed number of loaded standard gauge trains per hour on all days (weekdays and weekends)
- Separate model simulations at each site for the NGBR and Newlands lines, with results being added together at each receptor location during the post processing phase.

Background concentrations were incorporated into the predictions, as described in Section 9.3.6. Full model configuration details are displayed in Appendix E.

Model results: Homestead 16

Figure 9-13 graphs the predicted annual mean dust deposition rate in the vicinity of Homestead 16, showing the contribution of each source to the total deposition. The naturally occurring background rate of 1.6 g/m^2/month is large in comparison with the 2 g/m^2/month criterion (although a total of 4 g/m^2/month is allowable with consideration of background – NSW Approved Methods), which applies at sensitive receptor locations. The contribution from the NGBR Project realignment is higher than the Newlands line due to the greater emissions per train and shorter distance to the NGBR Project realignment. The criterion is met within 300 m to the west (in the direction of Receptor Homestead 16) 25 m to the east. Total deposition in the non-populated zone between the NGBR Project realignment and the Newlands line was predicted to be a cumulative 2.1 g/m^2/month.

Figure 9-13 Predicted annual mean deposited dust in the vicinity of Receptor H16



Predicted annual TSP concentrations are graphed in Figure 9-14. The 90 µg/m^3 criterion is met within 100 m of the NGBR Project realignment.

Figure 9-14 Predicted annual TSP concentrations in the vicinity of Receptor H16

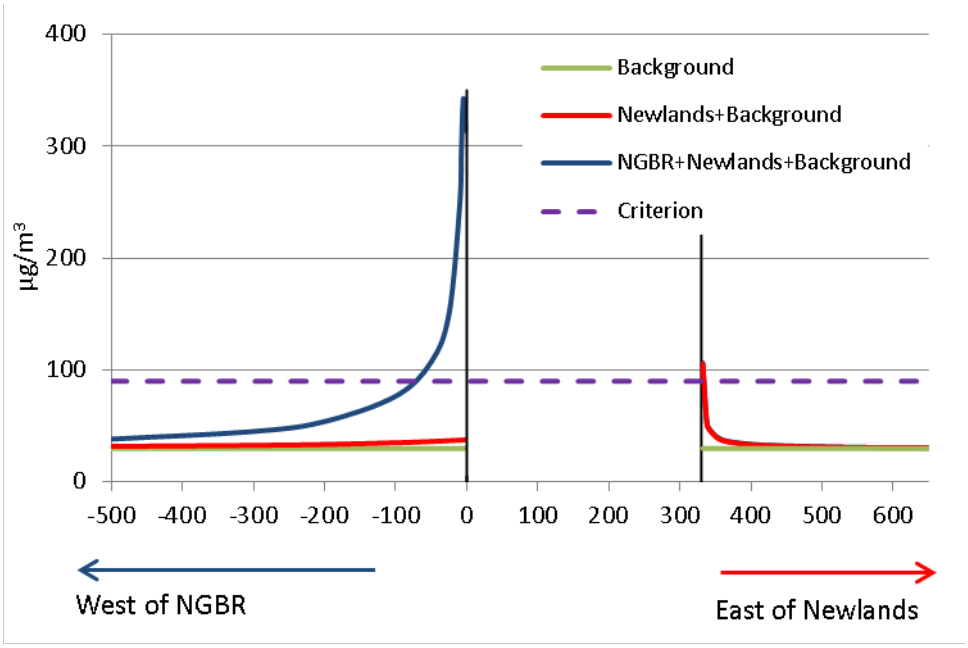


Figure 9-15 shows that the predicted maximum daily-mean PM_{10} concentrations also meet the criterion within 100 m of the NGBR Project realignment. The maximum daily-mean $PM_{2.5}$ concentrations are similarly low, falling below the 25 µg/m^3 criterion within approximately 150 m (Figure 9-16).

Figure 9-15 Predicted maximum daily-mean PM_{10} concentrations in the vicinity of Receptor H16

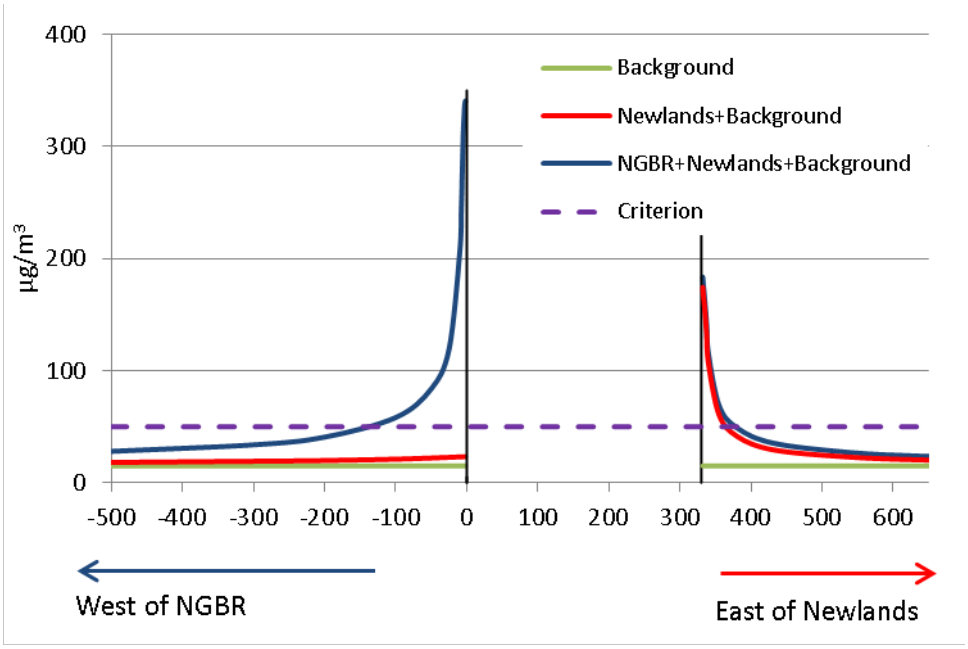
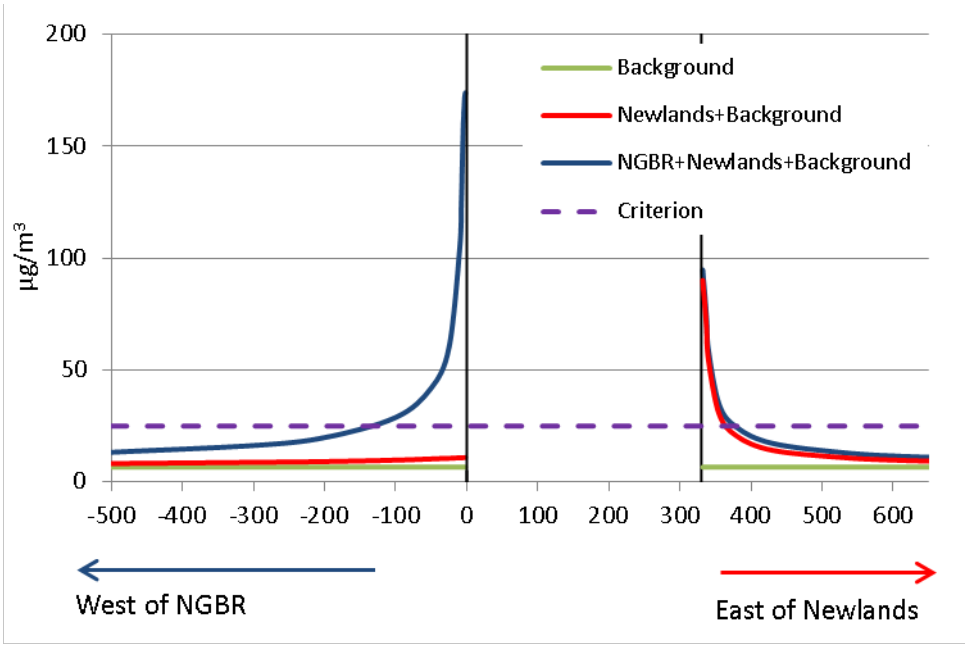


Figure 9-16 Predicted maximum daily-mean $PM_{2.5}$ concentrations in the vicinity of Receptor H16



The annual mean $PM_{2.5}$ criterion (8 µg/m^3) is the most difficult to achieve, given a natural background concentration of 5.8 µg/m^3. Despite that difficulty, Figure 9-17 reveals that the criterion is met at a distance of 500 m to the west of the NGBR Project realignment.

Table 9-6 and Table 9-7 summarise the cumulative impact of NGBR Project realignment and Newlands line, in the absence of background concentrations, along the western and eastern transects.

Concentrations of gaseous contaminants are all predicted to be well below their respective criteria, even within 2 m of the NGBR Project realignment (Table 9-8) and Newlands line (Table 9-9) with most predictions being many orders of magnitude below their criteria at this short-range distance.

Figure 9-17 Predicted annual-mean $PM_{2.5}$ concentrations in the vicinity of Receptor Homestead 16

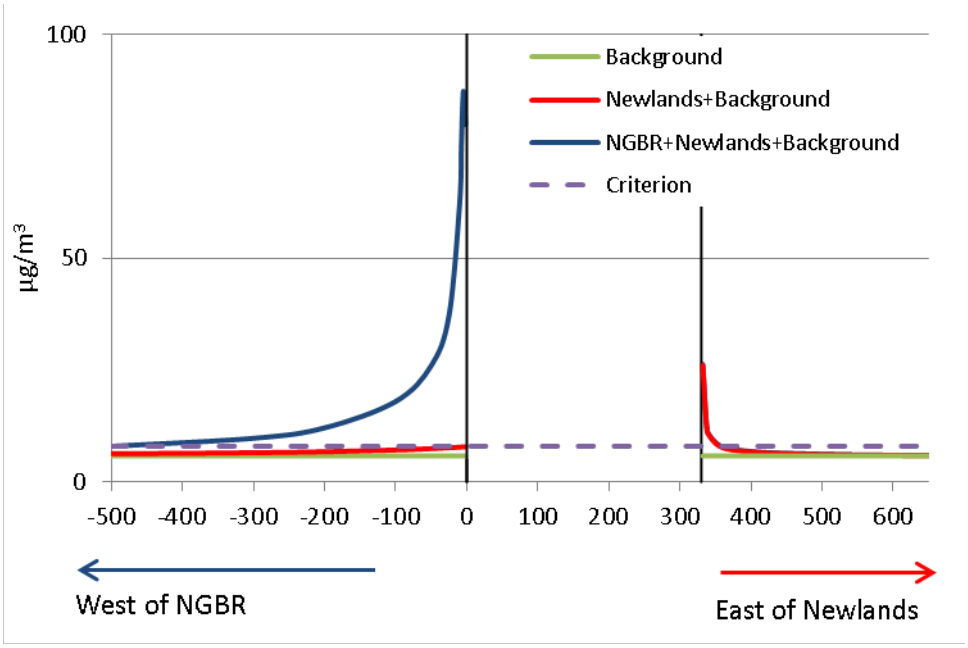


Table 9-6 Peak incremental deposited dust and particle predictions to the west of the NGBR Project realignment in vicinity of Homestead 16

Distance from NGBR (m)	Annual mean deposited dust (g/m^2/month)	Annual mean TSP ($\mu g/m^3$)	Maximum daily mean PM_{10} ($\mu g/m^2$)	Maximum daily mean $PM_{2.5}$ ($\mu g/m^2$)	Annual mean $PM_{2.5}$ ($\mu g/m^3$)
Background, $\mu g/m^3$	**1.6**	**30**	**15**	**6.6**	**5.8**
Criterion $\mu g/m^3$	**2**	**90**	**50**	**25**	**8**
-500	0.154	6.5	9.9	5.1	1.70
-300	0.328	12.4	14.6	7.5	3.22
-200	0.567	20.5	20.9	10.7	5.33
-100	1.230	41.6	37.2	19.1	10.84
-50	2.080	71.1	61.7	31.7	18.53
-25	2.780	113.5	96.5	49.6	29.55
-10	2.700	209.9	182.2	93.6	54.65
-7.5	2.470	259.7	223.7	114.9	67.62
-5	2.290	304.1	286.8	147.3	79.20
-3	2.070	290.3	313.9	161.2	75.58

Distance from NGBR (m)	Annual mean deposited dust (g/m^2/month)	Annual mean TSP ($\mu g/m^3$)	Maximum daily mean PM_{10} ($\mu g/m^2$)	Maximum daily mean $PM_{2.5}$ ($\mu g/m^2$)	Annual mean $PM_{2.5}$ ($\mu g/m^3$)
-2	1.960	276.4	317.5	163.0	71.97

Table 9-7 Peak incremental deposited dust and particle predictions to the east of the Newlands line in the vicinity of Homestead 16

Distance from NGBR (m)	Annual mean deposited dust (g/m^2/month)	Annual mean TSP ($\mu g/m^3$)	Maximum daily mean PM_{10} ($\mu g/m^2$)	Maximum daily mean $PM_{2.5}$ ($\mu g/m^2$)	Annual mean $PM_{2.5}$ ($\mu g/m^3$)
Background, $\mu g/m^3$	**1.6**	**30**	**15**	**6.6**	**5.8**
Criterion $\mu g/m^3$	**2**	**90**	**50**	**25**	**8**
2	0.016	0.7	9.1	4.7	0.18
3	0.016	0.7	9.0	4.6	0.18
5	0.016	0.7	9.0	4.6	0.17
7.5	0.016	0.7	8.9	4.6	0.17
10	0.015	0.7	8.8	4.5	0.17
25	0.014	0.6	8.3	4.3	0.16
50	0.012	0.5	7.5	3.8	0.14
100	0.009	0.4	6.0	3.1	0.11
200	0.006	0.3	4.3	2.2	0.07
300	0.004	0.2	3.4	1.8	0.05
500	0.002	0.1	2.4	1.2	0.03

Table 9-8 Predicted gaseous concentrations to the west of the NGBR Project realignment in the vicinity of Homestead 16

Distance from NGBR (m)	Maximum hourly mean NO_2 (µg/m^2)	Annual mean NO_2 (µg/m^2)	Maximum hourly mean SO_2 (µg/m^2)	Maximum daily mean SO_2 (µg/m^2)	Annual mean SO_2 (µg/m^2)	8-hour maximum CO (µg/m^2)	Annual mean benzene (µg/m^2)	Maximum 30-minute formaldehyde (µg/m^2)	Maximum daily mean formaldehyde (µg/m^2)	Maximum 30-minute toluene (µg/m^2)	Maximum daily mean toluene (µg/m^2)	Annual mean toluene (µg/m^2)	Maximum daily mean xylene (µg/m^2)	Annual mean xylene (µg/m^2)
Criterion µg/m^3	**250**	**62**	**570**	**230**	**57**	**11000**	**10**	**110**	**54**	**1100**	**4100**	**410**	**1200**	**950**
-500	9	1.0	0.02	0.01	0.003	17	0.2	0.001	0.000	0.021	0.007	0.002	0.010	0.003
-300	128	1.8	0.03	0.01	0.005	25	0.4	0.002	0.001	0.028	0.009	0.004	0.014	0.006
-200	15	2.8	0.04	0.02	0.007	32	0.6	0.002	0.001	0.037	0.013	0.006	0.019	0.009
-100	23	5.2	0.06	0.03	0.013	51	1.1	0.003	0.001	0.056	0.021	0.011	0.031	0.017
-50	34	8.5	0.09	0.04	0.022	74	1.8	0.005	0.002	0.082	0.032	0.018	0.048	0.027
-25	51	13.0	0.13	0.06	0.034	110	2.7	0.008	0.003	0.124	0.047	0.027	0.071	0.041
-10	90	23.1	0.23	0.10	0.059	187	4.9	0.013	0.005	0.218	0.084	0.049	0.127	0.073
-7.5	116	28.3	0.30	0.13	0.073	232	6.0	0.017	0.006	0.281	0.102	0.060	0.154	0.089
-5	151	33.0	0.39	0.16	0.085	319	7.0	0.022	0.008	0.365	0.130	0.069	0.194	0.104
-3	165	31.5	0.42	0.17	0.081	352	6.7	0.025	0.009	0.398	0.141	0.066	0.212	0.099
-2	167	30.1	0.43	0.18	0.077	357	6.4	0.025	0.009	0.405	0.143	0.063	0.214	0.095

Table 9-9 Predicted gaseous concentrations to the east of the Newlands line in the vicinity of Homestead 16

Distance from NGBR (m)	Maximum hourly mean NO_2 (µg/m^2)	Annual mean NO_2 (µg/m^2)	Maximum hourly mean SO_2 (µg/m^2)	Maximum daily mean SO_2 (µg/m^2)	Annual mean SO_2 (µg/m^2)	8-hour maximum CO (µg/m^2)	Annual mean benzene (µg/m^2)	Maximum 30-minute formaldehyde (µg/m^2)	Maximum daily mean formaldehyde (µg/m^2)	Maximum 30-minute toluene (µg/m^2)	Maximum daily mean toluene (µg/m^2)	Annual mean toluene (µg/m^2)	Maximum daily mean xylene (µg/m^2)	Annual mean xylene (µg/m^2)
Criterion µg/m^3	**250**	**62**	**570**	**230**	**57**	**11000**	**10**	**110**	**54**	**1100**	**4100**	**410**	**1200**	**950**
2	146	13.9	0.38	0.15	0.036	276	2.3	0.022	0.008	0.354	0.124	0.029	0.186	0.044
3	147	12.1	0.38	0.14	0.031	266	2.0	0.022	0.007	0.355	0.118	0.025	0.177	0.038
5	139	8.4	0.36	0.13	0.022	263	1.4	0.021	0.007	0.337	0.108	0.018	0.162	0.027
7.5	111	4.5	0.29	0.11	0.012	226	0.7	0.017	0.006	0.269	0.092	0.009	0.138	0.014
10	86	3.4	0.22	0.09	0.009	177	0.5	0.013	0.004	0.208	0.073	0.007	0.109	0.011
25	47	1.6	0.12	0.05	0.004	93	0.3	0.007	0.002	0.114	0.038	0.003	0.057	0.005
50	30	0.9	0.08	0.03	0.002	57	0.1	0.005	0.001	0.073	0.023	0.002	0.035	0.003
100	20	0.5	0.05	0.02	0.001	34	0.1	0.003	0.001	0.048	0.013	0.001	0.020	0.001
200	13	0.2	0.03	0.01	0.001	22	0.0	0.002	0.000	0.032	0.008	0.000	0.012	0.001
300	10	0.1	0.03	0.01	0.000	16	0.0	0.002	0.000	0.025	0.006	0.000	0.008	0.000
500	7	0.0	0.02	0.00	0.000	10	0.0	0.001	0.000	0.018	0.003	0.000	0.005	0.000

Model Results: Homestead R2

The Homestead R2 simulations show similar modelling results to those predicted for Homestead 16. Figure 9-18 to Figure 9-22 provide the modelling results for deposited dust and airborne particles, showing the contribution of each source to the total prediction. In each case, the respective criterion is met within 500 m of the NGBR Project realignment to the west, and 100 m to the east of the Newlands line in the direction of receptor R2.

Figure 9-18 Predicted annual mean deposited dust in the vicinity of Homestead R2

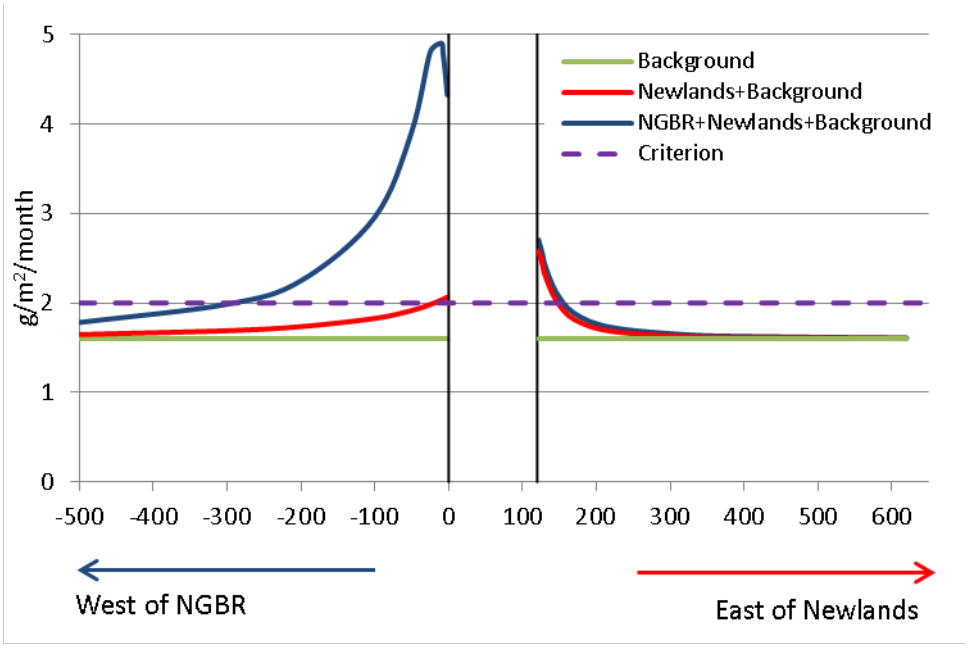


Figure 9-19 Predicted annual TSP concentrations in the vicinity of Homestead R2

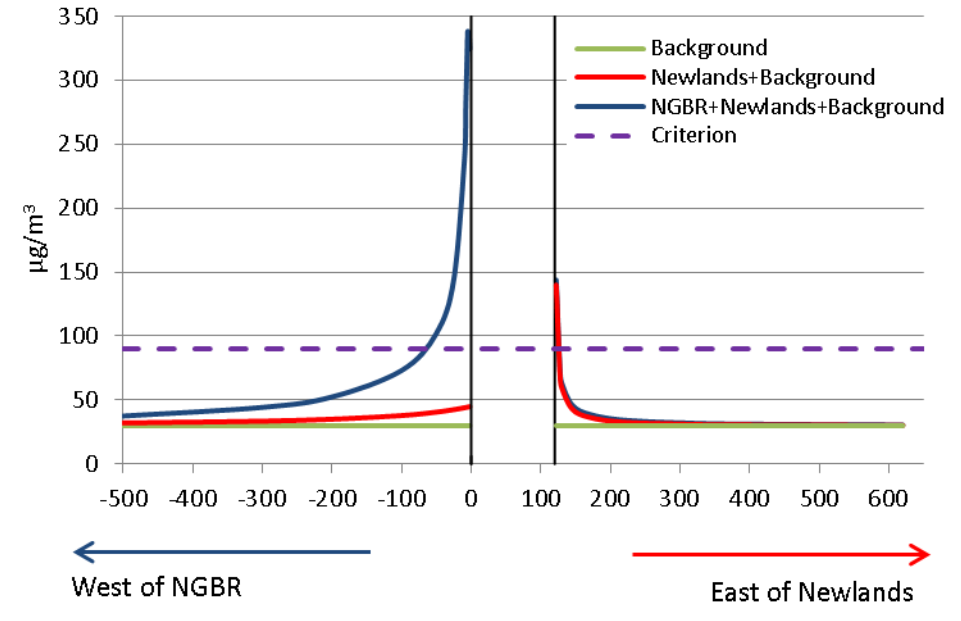


Figure 9-20 Predicted maximum daily-mean PM_{10} concentrations in the vicinity of Homestead R2

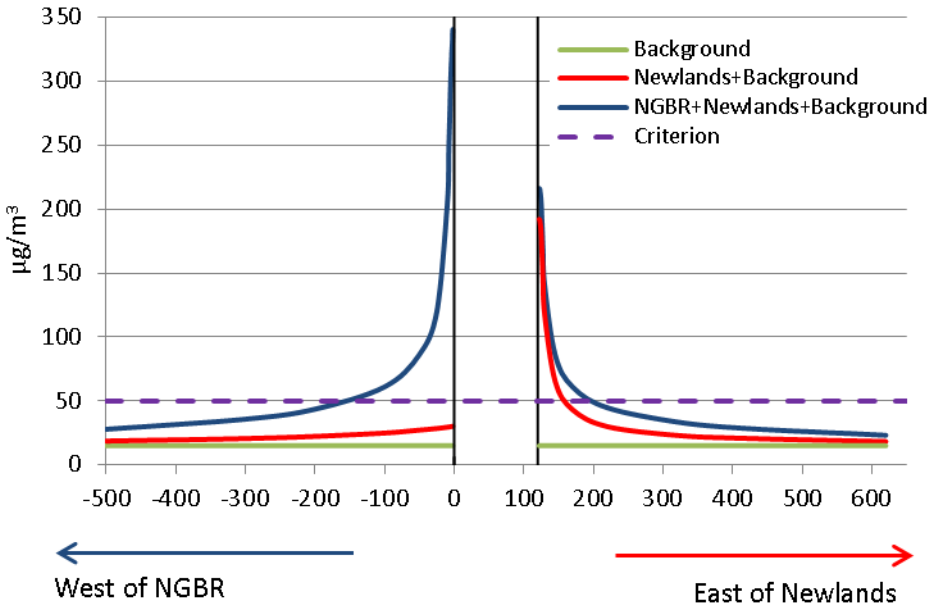


Figure 9-21 Predicted maximum daily-mean $PM_{2.5}$ concentrations in the vicinity of Homestead R2

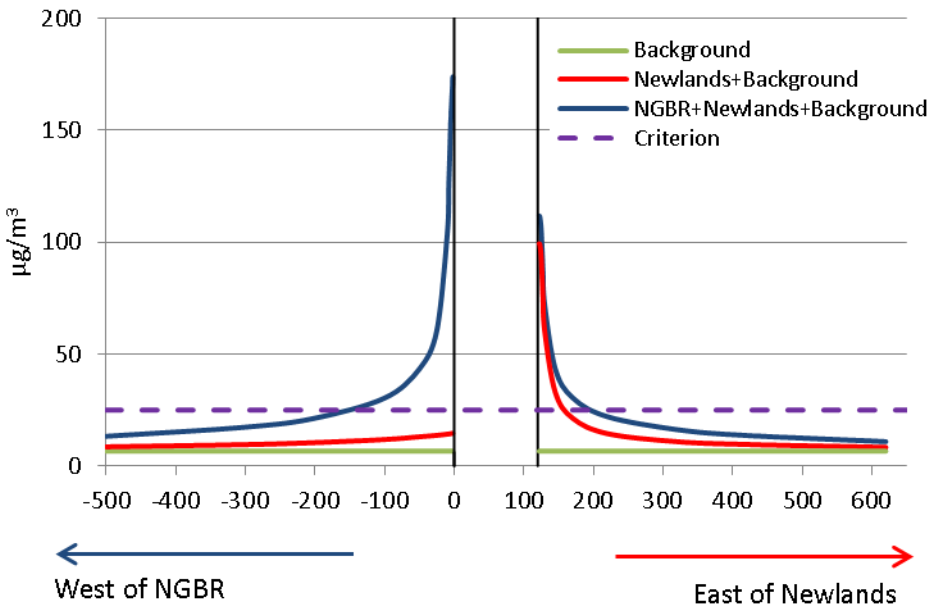


Figure 9-22 Predicted annual-mean $PM_{2.5}$ concentrations in the vicinity of Homestead R2

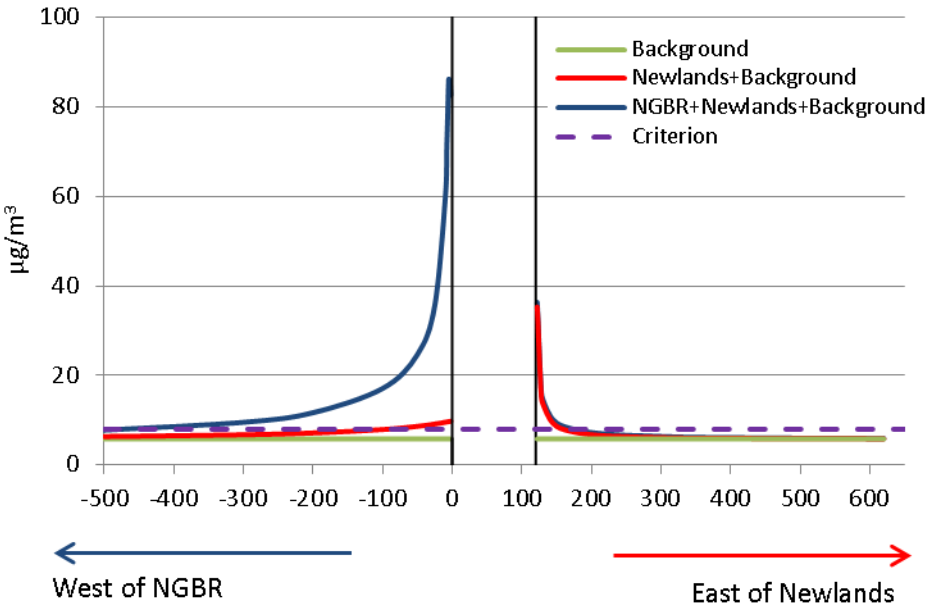


Table 9-10 and Table 9-11 summarise the cumulative impact of NGBR and Newlands operations, in the absence of background concentrations, along the western and eastern transects in the vicinity of Homestead R2.

Predicted gaseous contaminant concentrations for the Homestead R2 transects are provided in Table 9-12 (western transect) and Table 9-13 (eastern transect). Once again these are all predicted to be well below their respective criteria within 2 m of each rail line boundary.

Table 9-10 Peak incremental deposited dust and particle predictions to the west of the NGBR line in the vicinity of Homestead R2

Distance from NGBR (m)	Annual mean deposited dust (g/m^2/month)	Annual mean TSP ($\mu g/m^3$)	Maximum daily mean PM_{10} ($\mu g/m^2$)	Maximum daily mean $PM_{2.5}$ ($\mu g/m^2$)	Annual mean $PM_{2.5}$ ($\mu g/m^3$)
Background, $\mu g/m^3$	**1.6**	**30**	**15**	**6.6**	**5.8**
Criterion $\mu g/m^3$	**2**	**90**	**50**	**25**	**8**
-500	0.18	8	12.9	6.7	2.0
-300	0.39	14	20.8	10.7	3.7
-200	0.65	22	28.6	14.8	5.9
-100	1.36	43	46.1	23.8	11.3
-50	2.32	72	71.3	36.7	18.9
-25	3.20	114	104.6	53.9	29.9
-10	3.30	206	189.0	97.2	53.9
-7.5	3.18	254	234.8	120.7	66.3
-5	3.00	308	285.6	146.8	80.3
-3	2.82	304	312.9	160.8	79.3
-2	2.72	294	325.6	167.3	76.8

Table 9-11 Peak incremental deposited dust and particle predictions to the east of the Newlands line in the vicinity of Homestead R2

Distance from NGBR (m)	Annual mean deposited dust (g/m^2/month)	Annual mean TSP ($\mu g/m^3$)	Maximum daily mean PM_{10} ($\mu g/m^2$)	Maximum daily mean $PM_{2.5}$ ($\mu g/m^2$)	Annual mean $PM_{2.5}$ ($\mu g/m^3$)
Background, $\mu g/m^3$	**1.6**	**30**	**15**	**6.6**	**5.8**
Criterion $\mu g/m^3$	**2**	**90**	**50**	**25**	**8**
2	1.10	114	201.3	105.2	30.6
3	1.06	103	200.2	104.6	27.5
5	1.01	75	188.7	98.6	20.0
7.5	0.92	44	154.0	80.4	11.7
10	0.83	33	124.9	65.2	8.9
25	0.53	16	70.9	36.9	4.3
50	0.29	9	46.0	23.9	2.4
100	0.13	4	29.8	15.4	1.1
200	0.05	2	18.7	9.7	0.5
300	0.02	1	13.6	7.0	0.3
500	0.01	0	8.3	4.3	0.1

Table 9-12 Predicted gaseous concentrations to the west of the NGBR Project realignment in the vicinity of Homestead R2

Distance from NGBR (m)	Maximum hourly mean NO_2 (µg/m^2)	Annual mean NO_2 (µg/m^2)	Maximum hourly mean SO_2 (µg/m^2)	Maximum daily mean SO_2 (µg/m^2)	Annual mean SO_2 (µg/m^2)	8-hour maximum CO (µg/m^2)	Annual mean benzene (µg/m^2)	Maximum 30-minute formaldehyde (µg/m^2)	Maximum daily mean formaldehyde (µg/m^2)	Maximum 30-minute toluene (µg/m^2)	Maximum daily mean toluene (µg/m^2)	Annual mean toluene (µg/m^2)	Maximum daily mean xylene (µg/m^2)	Annual mean xylene (µg/m^2)
Criterion µg/m^3	**250**	**62**	**570**	**230**	**57**	**11000**	**10**	**110**	**54**	**1100**	**4100**	**410**	**1200**	**950**
-500	8.9	0.9	0.02	0.01	0.002	20	0.183	0.001	0.000	0.022	0.007	0.002	0.010	0.003
-300	12.1	1.8	0.03	0.01	0.005	31	0.345	0.002	0.001	0.029	0.011	0.004	0.016	0.006
-200	15.8	2.7	0.04	0.02	0.007	39	0.538	0.002	0.001	0.038	0.015	0.006	0.022	0.009
-100	23.9	5.1	0.06	0.03	0.013	61	1.022	0.004	0.001	0.058	0.023	0.011	0.035	0.016
-50	36.1	8.3	0.09	0.04	0.021	88	1.690	0.005	0.002	0.087	0.035	0.018	0.052	0.026
-25	53.6	12.8	0.14	0.06	0.033	127	2.647	0.008	0.003	0.130	0.049	0.027	0.074	0.041
-10	96.2	22.5	0.25	0.11	0.058	209	4.718	0.014	0.005	0.233	0.086	0.047	0.129	0.071
-7.5	121.4	27.5	0.31	0.13	0.071	258	5.784	0.018	0.007	0.294	0.106	0.058	0.159	0.087
-5	155.5	33.1	0.40	0.16	0.085	348	6.994	0.023	0.008	0.376	0.128	0.070	0.192	0.104
-3	168.6	32.7	0.43	0.17	0.084	379	6.905	0.025	0.009	0.408	0.140	0.069	0.209	0.103
-2	172.3	31.7	0.44	0.18	0.082	381	6.694	0.026	0.009	0.417	0.145	0.067	0.218	0.100

Table 9-13 Predicted gaseous concentrations to the east of the Newlands line in the vicinity of Homestead R2

Distance from NGBR (m)	Maximum hourly mean NO_2 (µg/m^2)	Annual mean NO_2 (µg/m^2)	Maximum hourly mean SO_2 (µg/m^2)	Maximum daily mean SO_2 (µg/m^2)	Annual mean SO_2 (µg/m^2)	8-hour maximum CO (µg/m^2)	Annual mean benzene (µg/m^2)	Maximum 30-minute formaldehyde (µg/m^2)	Maximum daily mean formaldehyde (µg/m^2)	Maximum 30-minute toluene (µg/m^2)	Maximum daily mean toluene (µg/m^2)	Annual mean toluene (µg/m^2)	Maximum daily mean xylene (µg/m^2)	Annual mean xylene (µg/m^2)
Criterion µg/m^3	**250**	**62**	**570**	**230**	**57**	**11000**	**10**	**110**	**54**	**1100**	**4100**	**410**	**1200**	**950**
2	157.6	20.6	0.41	0.18	0.053	313	3.353	0.024	0.009	0.381	0.144	0.043	0.216	0.065
3	155.9	18.5	0.40	0.17	0.048	299	3.019	0.023	0.009	0.377	0.143	0.039	0.215	0.059
5	143.8	13.4	0.37	0.16	0.034	287	2.185	0.021	0.008	0.348	0.135	0.028	0.202	0.042
7.5	112.7	7.7	0.29	0.13	0.020	238	1.275	0.017	0.007	0.273	0.109	0.016	0.163	0.024
10	89.3	5.8	0.23	0.11	0.015	193	0.961	0.013	0.005	0.216	0.087	0.012	0.130	0.018
25	52.1	2.7	0.13	0.06	0.007	115	0.454	0.008	0.003	0.126	0.047	0.006	0.070	0.009
50	33.6	1.4	0.09	0.04	0.004	69	0.245	0.005	0.002	0.081	0.029	0.003	0.043	0.005
100	22.3	0.7	0.06	0.02	0.002	46	0.116	0.003	0.001	0.054	0.018	0.001	0.026	0.002
200	14.4	0.3	0.04	0.01	0.001	32	0.048	0.002	0.001	0.035	0.011	0.001	0.016	0.001
300	11.0	0.1	0.03	0.01	0.000	24	0.027	0.002	0.000	0.027	0.008	0.000	0.012	0.000
500	7.9	0.1	0.02	0.01	0.000	15	0.012	0.001	0.000	0.019	0.005	0.000	0.007	0.000

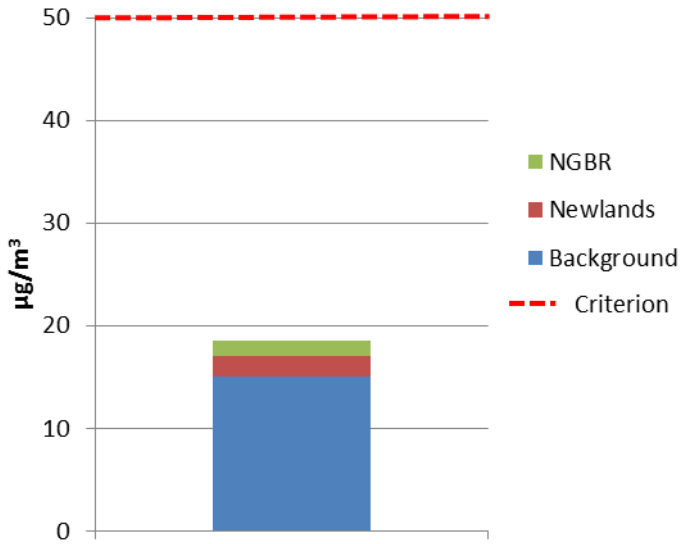
Model Results: Homestead R3

Only maximum daily-mean PM_{10} concentrations were predicted for Homestead R3. Table 9-14 and Figure 9-23 show that at this location, the existing particulate background is the dominant source of ambient PM_{10}, with the Newlands line contributing approximately 11 per cent of the total and the NGBR Project realignment only 8 per cent. The cumulative total of 18.5 µg/m^3 is well within the 50 µg/m^3 criterion.

Table 9-14 Maximum daily mean PM_{10} concentration at Homestead R3

PM_{10} component	Maximum daily mean PM_{10} (µg/m^3)
Criterion µg/m^3	50
Background, µg/m^3	15.0
Newlands line	2.0
NGBR Project realignment	1.5
Total	**18.5**

Figure 9-23 Maximum daily mean PM_{10} concentration at Homestead R3



9.4.3 Summary of mitigation and management measures

The results above show that all relevant criteria are met within 500 m of the NGBR Project realignment and Newlands line. With the nearest sensitive receptors being approximately 720 m and 1062 m from the NGBR Project realignment and the remaining identified sensitive receptors being at greater distances, no additional dust mitigation and management is proposed in addition to the NGBR Project EIS.

Additional commitments

Adani have commited to managing coal dust in a manner that will be generally consistent with the Aurizon Coal Dust Management Plan (refer NGBR Project EIS Volume 1 Chapter 10 Air quality). This commitment is consistent with the Coordinator-General's Evaluation report on the environmental impact statement for the proposed Alpha Coal Project railway (State of Queensland 2012).

9.5 Conclusion

Cumulative impacts have been determined for the combined effect of atmospheric emissions from the NGBR Project realignment and the nearby existing Newlands line, using the AUSROADS and AUSPLUME atmospheric dispersion models. Representative one kilometre long sections of the NGBR Project realignment and the Newlands line were modelled in the vicinity of the two closest sensitive receptors. In each case, 500 m long transects were established normal to the NGBR Project realignment, towards the nearest identified sensitive receptor. Transects extended to the west of the proposed NGBR Project realignment and the east of the existing Newlands line. In all cases the relevant particulate matter criteria were met within 500 m of the rail line and gaseous criteria within a few metres.

The nearest identified sensitive receptor, Homestead 16, is located 721 m to the west of the NGBR Project realignment. The annual TSP criterion was met within 100 m of the rail line (western transect), whilst the daily-mean PM_{10} and $PM_{2.5}$ criteria were met within 200 m. The predicted annual dust deposition rates fell below the identified criterion within 300 m. The annual $PM_{2.5}$ predictions were met farther from the NGBR Project realignment, given the high natural background in relation to the criterion. Despite this, the criterion was met within 500 m. As such, emissions levels at the identified sensitive receptors are expected to comply with the relevant criteria.

Predictions were also made of numerous gaseous contaminant concentrations arising from locomotive emissions. Predicted emissions were below the relevant criteria at 2 m from the NGBR Project realignment and Newlands line respectively, and in many cases were several orders of magnitude below the criteria.

The second most distant sensitive receptor, Homestead R2, is located 1,062 m to the east of the NGBR Project realignment. Cumulative dust deposition rates and particle concentrations along the eastern transect were lower than those for the western transect, with the PM_{10} and $PM_{2.5}$ criteria being met within 100 m, the deposited dust criterion within 50 m and the annual TSP criterion within 7.5 m.

Once again predicted gaseous contaminants were below the relevant criteria at 2 m from the NGBR Project realignment and Newlands line respectively.

A final modelling scenario was conducted to determine the maximum daily-mean PM_{10} concentration predicted at Homestead R3, which is located 3,764 m to the east of the NGBR Project realignment line and 1,470 m to the east of the Newlands line. Modelling found that the peak cumulative daily-mean PM_{10} concentration was 18.5 µg/m^3 which was within the relevant criterion and largely attributed to the 15 µg/m^3 background. The NGBR Project realignment was estimated to contribute only 8 per cent of the total PM_{10} concentration at this location.

It was considered that given no air quality criteria are exceeded at any sensitive location along the entire NGBR Project realignment, then additional dust mitigation measures to those identified in the NGBR Project EIS are not necessary and therefore are not proposed.

10. Noise

10.1 Purpose of section

This section assesses the potential noise and vibration impacts of the NGBR Project realignment. This section provides an overview of the existing noise and vibration environment, identification of sensitive receptors and consideration of potential construction and operation impacts. Mitigation and management measures are also proposed where predicted impacts indicate exceedance of noise and vibration criteria.

The existing noise and vibration environment was previously prepared for the NGBR Project EIS. The key findings of the existing environment report relevant to the NGBR Project realignment are summarised within this section.

10.2 Methodology

10.2.1 Study area

The study area for this noise and vibration assessment included the NGBR Project realignment footprint (nominally 60 m wide) and the nearest potential sensitive receptors. These potential sensitive receptors were identified within approximately six kilometres of the realignment footprint.

10.2.2 Data sources

This noise and vibration section relied on the following data sources:

- Noise source data for modelling input (refer NGBR Project EIS Volume 2 Appendix J Noise and vibration)
- Homestead locations (GA 2007)
- Topographic maps with 10 m contours (DERM, 2010)
- Aerial photography
- Northern Missing Link EIS (Queensland Rail 2006)
- Alpha Coal Project EIS (Hancock Prospecting Pty Ltd 2010)
- Aurizon 2013 Network Development Plan.

10.2.3 Legislation and guidelines

Legislation and guidelines relevant to this noise and vibration section are as follows.

- *Environmental Protection Act 1994* (Qld)
- *Environmental Protection (Noise) Policy 2008* (Qld).

An explanation of the *Environmental Protection Act 1994* and *Environmental Protection (Noise) Policy 2008* is provided in Volume 2 Appendix J Revised legislation and approvals.

In addition to the *Environmental Protection Act 1994*, a number of guidelines published by the then Queensland Environmental Protection Agency (EPA) or Department of Environment and Resource Management (DERM) (now the Department of Environment and Heritage Protection (DEHP)), the New South Wales Environmental Protection Authority (NSW EPA), Queensland

Rail (QR) and British and Australian Standards, were referred to in the development of noise and vibration assessment criteria, as listed below:

- Australian Standard AS 1055.1-1997 Acoustics – Description and Measurement of Environmental Noise General Procedures
- Australian Standard AS 2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives
- British Standard BS 5228-2:2009 Code of practice for noise and vibration on construction and open sites – Part 2: Vibration
- British Standard BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting
- Queensland Noise Measurement Manual (2000)
- Queensland EPA Noise and vibration from blasting guideline (2006)
- Queensland DERM Planning for Noise Control guideline (2004)
- QR Code of Practice - Railway Noise Management (2007)
- NSW EPA Interim Construction Noise Guideline (ICNG) (2009)
- NSW EPA Rail Infrastructure Noise Guideline (RING) (2013).

The noise and vibration criteria derived from these guidelines are listed in Table 10-1. Further detail on the selection of guidelines and the development of noise and vibration assessment criteria is provided in the NGBR Project EIS Volume 2 Appendix J Noise and vibration.

Table 10-1 Noise and vibration criteria summary at sensitive receptors

Phase	Emission	Timeframe	Criteria
Construction	Noise[1]	Standard working hours[2]	< 40 dB(A) $L_{Aeq(15min)}$
		Outside standard working hours	< 35 dB(A) $L_{Aeq(15min)}$
	Vibration[3]	24 hours	< 0.3 mm/s
	Overpressure (blasting)[4]	Monday to Friday 9 am to 3 pm	<115 dB(lin) peak for nine out of 10 blasts
		Saturday 9 am to 1 pm	120 dB(lin) maximum for any blast
	Vibration (blasting)[4]	Monday to Friday 9 am to 3 pm	<5 mm/s PPV for nine out of 10 blasts[5]
		Saturday 9 am to 1 pm	10 mm/s maximum for any blast[5]
Operation	Noise[5]	Monday to Sunday 7 am to 10 pm	60 dB $L_{Aeq,15\ hour}$ or 80 dB L_{AFmax}
		Monday to Sunday 10 pm to 7 am	55 dB $L_{Aeq,\ 9\ hour}$ or 80 dB L_{AFmax}

Phase	Emission	Timeframe	Criteria
	Vibration[6]	Monday to Sunday 7 am to 11 pm	Low probability for adverse comment: 0.2 to 0.4 $m/s^{1.75}$
		Monday to Sunday 11 pm to 7 am	Low probability for adverse comment: 0.1 to 0.2 $m/s^{1.75}$

1. Defined in ICNG
2. Defined in ICNG as Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm
3. Defined in BS 5228-2:2009
4. Defined in *Environmental Protection Act 1994*
5. Defined in RING
6. Defined in BS 6472-1:2008

10.2.4 Desktop assessment

The desktop assessment involved the following tasks:

- Collation and review of background noise and vibration monitoring relevant to the NGBR Project realignment (refer Section 10.3)
- Identification of the nearest sensitive receptors within approximately six kilometres of the NGBR Project realignment (refer Section 10.3.1)
- Prediction of noise and vibration levels at sensitive receptors
- Assessment of predicted noise and vibration levels against assessment criteria.

Construction Noise

Assessment of construction noise was undertaken as per the methodology outlined in the NGBR Project EIS Volume 1 Chapter 12 Noise and vibration. Technical information on the modelling parameters is provided in the NGBR Project EIS Volume 2 Appendix J Noise and vibration.

The construction of the NGBR Project realignment was considered to consist of the following stages, for the purpose of the noise and vibration assessment:

- Clearing and grubbing
- Cut and fill earthworks
- Drainage construction
- Capping layer application
- Bridge construction
- Haul road and access road maintenance
- Track laying.

A number of model parameters were assumed to present a ‘worst case’ scenario for noise impacts from these construction scenario activities.

Adani plans to source material from two existing licenced quarries to develop the NGBR Project realignment: the Umina Quarry (586784 mE, 7733476 mN GDA94) and the Byerwen Quarry (589581 mE, 7659344 mN GDA94). Both quarries are located in isolated to remote regions. As

these are existing established quarries, noise and vibration assessments of these quarries are not necessary for the NGBR Project realignment.

Construction will generally take place during daytime working hours (6 am to 7 pm). Night-time construction works may include those activities that would be inhibited during daytime working hours, such as:

- Embankment moisture conditioning
- Work within an operational rail corridor
- Road works where required to avoid peak traffic
- Materials delivery by oversize vehicles.

Other night-time construction works may be undertaken where they can be conducted safely and have limited noise and light impacts on sensitive receptors, such as:

- Welding to support track construction
- Concrete casting
- Utilities adjustment
- Investigations or testing.

The duration of night-works required during construction of the NGBR Project realignment is currently unknown and will be investigated further during detailed design.

Noise from traffic during construction was also estimated at the key road intersections for construction of the NGBR Project realignment. These intersections were selected based on the predicted increased vehicle movements as a result of the NGBR Project realignment (refer Section 11).

Operational noise

Operation of the NGBR Project realignment was considered at maximum capacity (100 mtpa), comprising 28 total train movements per 24 hour period.

The following assumptions were made with regard to the modelled rail movements and configuration for the NGBR Project realignment:

- Based on standard coal wagons each of 108 tonne payload capacity, about 240 wagons will be needed to be attached to each locomotive 4-unit set to carry the proposed 25,920 tonnes of coal per train, resulting in a total length of approximately four kilometres.
- The expected total of 28 coal train movements in a 24 hour period for peak production and transportation 100 mtpa, comprising:
  - nine loaded trains per day (7 am to 10 pm)
  - nine unloaded trains per day (7 am to 10 pm)
  - five loaded trains per night (10 pm to 7 am)
  - five unloaded trains per night (10 pm to 7 am)
- The design speeds for the NGBR Project realignment are:
  - 80 km/h for loaded trains (mainline)
  - 100 km/h for unloaded trains (mainline)
  - 50 km/h in passing loops

– 25 km/h in maintenance sidings.

Further information on the construction and operation of the NGBR Project realignment is provided in Section 2.

Modelling also considered the cumulative impacts due to operation of Aurizon trains on the Newlands line which runs adjacent to much of the NGBR Project realignment. The following assumptions were considered for the Newlands line and were based on information from the Northern Missing Link EIS (Queensland Rail 2006) and the Aurizon 2013 Network Development Plan:

- Locomotive type: 4000 bhp diesel locomotive
- Number of locomotives per train: 3
- Wagons per train: 82
- Train length: 1,402 m
- Train loaded speed: 80 km/h
- Train unloaded speed: 80 km/h
- Number of loaded trains per day: 21
- Number of unloaded trains per day: 21.

Rail traffic noise was modelled using the Nordic Rail Traffic Noise Prediction Method. Operation noise propagation was modelled using CadnaA.

A number of model parameters were assumed to present a 'worst case' scenario for noise impacts during operation, including:

- A ground absorption coefficient of 0.5
- Atmospheric conditions of 10°C and 70% humidity
- Existing surface topography.

Noise propagation was based on existing surface topography, which discounts the mitigating effect of cuttings on noise levels. It was not expected that fills would significantly affect noise propagation in comparison to noise at natural surface level.

Construction and operation vibration

Typical vibration levels for construction equipment were estimated with reference to the NSW Roads and Maritime Service Environmental Noise Management Manual 2001. Vibration from construction was estimated at sensitive receptors using a distance relationship calculation. Vibration from operation was assessed by a review of in situ vibration testing.

Blasting

Airblast overpressure and ground vibration were estimated at sensitive receptors using a distance relationship calculation, with reference to AS 2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives. A maximum instantaneous charge (MIC) of 50 kg was considered likely to be appropriate during construction and was therefore the modelled value.

10.2.5 Limitations

Construction noise has been modelled based on the construction methodology and indicative plant and equipment described in the North Galilee Basin Rail Concept Design Report (Aarvee Associates 2013), as outlined in Volume 2 Appendix B Revised project description.

Blasting is non-linear in nature and variability in ground type and meteorological conditions makes it difficult to accurately predict ground vibration and airblast overpressure without site specific measurement data - therefore the blasting predictions are provided here as a guide.

10.3 Existing environment

Both attended and unattended noise and vibration monitoring was undertaken at four monitoring locations along the NGBR Project alignment (refer NGBR Project EIS Volume 1 Chapter 12 Noise and vibration). Noise logger results from homestead 17 (location C) have been used for assessment of the NGBR Project realignment. As the nearest monitoring location, this is considered representative of the ambient noise environment in the vicinity of the NGBR Project realignment. The results of background monitoring at location C for noise are presented in Table 10-2 and vibration results are presented in Table 10-3.

Unattended monitoring results presented graphically and as daily overall values at each monitoring site, for each assessment period, throughout the entire monitoring program, are provided in the NGBR Project EIS Volume 2 Appendix J Noise and vibration.

Table 10-2 Summary of unattended noise monitoring (Location C)

Location	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day	Evening	Night	Day	Evening	Night
C	21	30	20	49	40	39

Table 10-3 Summary of vibration monitoring (Location C)

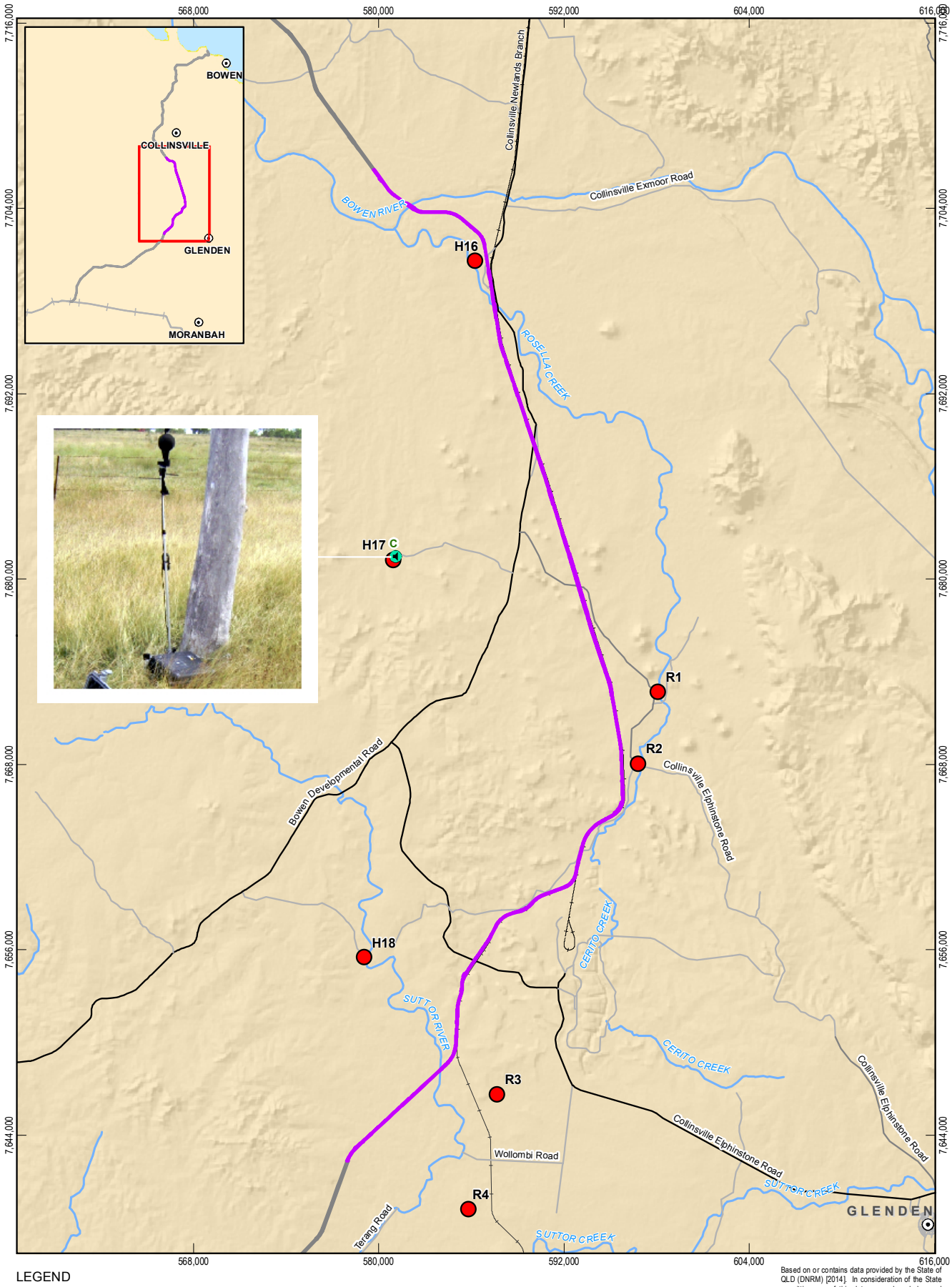
Location	Time (hours)	Sum (mm/s)	Observations
C	14:14-14:35	0.093	No perceptible ground vibration

10.3.1 Sensitive receptors

The nearest sensitive receptors were identified within approximately six kilometres of the NGBR Project realignment footprint, including seven homesteads. Distances between the identified homesteads and the centreline of the NGBR Project realignment footprint are provided in Table 2-4. The location of sensitive receptors and monitoring locations are shown in Figure 10-1.

Table 10-4 Potential sensitive receptors

Homestead	Lot on plan	Distance from realignment footprint (m)	Chainage (km)
Homestead 16	62SP195387	721	138
Homestead 17 (Location C)	4SP171921	10,932	155
Homestead 18	1510SP171920	6,485	191
Homestead R1	2CP866147	2,938	167
Homestead R2	3SP171922	1,062	172
Homestead R3	689SP251696	3,764	196
Homestead R4	1CP905226	7,825	202



LEGEND

- Populated centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Sensitive receptors
- Monitoring location

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Sensitive receptors and monitoring locations

Figure 10-1

G:\41\26457\06 GIS\Maps\MXD\0900_Noise_Vibration\41_26457_0906_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Physical Road Network (2010), GA/NGBR EIS: Sensitive Receptors (2014), Monitoring location (2013) Created by:MS

10.4 Potential impacts and mitigation measures

The construction and operation of the NGBR Project realignment will generate noise and vibration emissions with the potential for adverse impacts at nearby sensitive receptors, including the possibility of nuisance or harm to human health and wellbeing. An assessment of impacts of noise and vibration due to the NGBR Project realignment on receivers with a high sensitivity to changes in noise and vibration levels is detailed below.

10.4.1 Construction

Impact of construction noise

Noise prediction modelling of received noise levels due to NGBR Project realignment construction are presented in Table 10-5. Noise emissions have been conservatively assessed for each construction stage as per the methodology outlined in Section 10.2.4.

The ICNG noise affected level for works undertaken outside standard working hours (35 dB $L_{Aeq(15min)}$) and works undertaken within standard hours (40 dB $L_{Aeq(15min)}$) was predicted to be exceeded at Homesteads 16 and R2. Other identified residences are at sufficient distance from the works to be unaffected by the works in relation to the adopted construction noise criterion.

As noise is predicted to exceed the construction noise management levels, a number of standard mitigation measures are proposed that will be implemented where reasonable and feasible. These mitigation measures are presented in the NGBR Project EIS Volume 1 Chapter 12 Noise and vibration.

Table 10-5 Estimated construction noise dB(A) L_{Aeq} (including +2.5dB façade correction)

Receptor	Earthworks	Drainage	Capping	Structures	Haul roads	Track work
Homestead 16	53.0	39.3	39.7	40.8	41.0	43.8
Homestead 17 (Location C)	<10	<10	<10	<10	<10	<10
Homestead 18	22.1	12.8	11.9	14.5	12.5	11.7
Homestead R1	34.5	22.0	22.2	23.7	23.0	23.6
Homestead R2	48.4	34.8	35.3	36.3	36.5	38.8
Homestead R3	29.4	13.7	15.1	15.0	16.5	16.4
Homestead R4	20.3	11.5	10.5	13.2	11.1	10.2

Construction camp 4 will be established on a site adjacent to the NGBR Project realignment and is likely to be constructed within 500 m of noise emission sources. The construction camp facilities will be positioned to minimise external impacts from the NGBR Project final rail corridor or associated construction laydown or turning areas, as well as any internal emission sources such as generators or parking areas. Construction camp designs will meet the construction noise criteria by incorporating enclosed meal, living and sleeping quarters which will be

mechanically ventilated and insulated to protect camp residents from noise. Given that the construction camps will predominantly be occupied outside of general construction hours, when emission sources will be minimal, in addition to the transient or fleeting nature of construction activities in sections of the NGBR Project final rail corridor adjacent to the construction camps, the potential impacts to camp residents from noise will be minimal.

Impact of construction traffic noise

Noise from traffic during construction was also estimated at the following study road links:

- Bowen Developmental Road (near NGBR Project realignment chainage 150 km)
- Collinsville Elphinstone Road (near NGBR Project realignment chainage 189 km)
- Suttor Developmental Road (near NGBR Project realignment chainage 239 km).

Further detail on background annual average daily traffic (AADT) at study road links is provided in Section 11.

Study road links with potential increases in construction traffic due to the NGBR Project realignment are provided in Table 10-6.

Table 10-6 Study road links and nearest receptors

Road section	Background (AADT)	Increase (AADT)	Approximate noise increase (dB)	Nearest homestead
Bowen Developmental Road	551	66	0.5	H16,
Suttor Developmental Road	1717	41	0.1	R4
Collinsville Elphinstone Road	884	134	0.6	R3, H18

The predicted change to anticipated traffic noise (year 2015) as a result of the construction traffic from the NGBR Project realignment is predicted to be negligible. As such, no mitigation measures relating specifically to traffic noise are proposed.

Vibration

The peak particle velocity at distances from construction vibration sources are provided in Table 10-7. The results indicate that at a distance of 300 m from the NGBR Project realignment, vibration from activities excluding piling are unlikely to be perceptible in residential environments (refer Section 10.2.3). Given that the nearest sensitive receptor is more than 700 metres from the NGBR Project realignment footprint, it is conservatively expected that received vibration from impact piling will be less than 1 mm/s. At this level the activity may be perceptible, however is unlikely to impact the amenity of residences as the disturbance will be periodic and temporary in nature, should they occur at all in proximity to residences.

Given that the construction camps will predominantly be occupied outside of general building hours, when vibration sources will be minimal, in addition to the transient or fleeting nature of construction activities in sections of the NGBR Project final rail corridor adjacent to the construction camps, the potential impacts to camp residents from vibration will be minimal.

Vibration from blasting is considered separately in the following subsection.

Table 10-7 Estimated construction vibration

Source	Peak particle velocity (mm/s) at distance							
	5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m
Piling (vibratory)	52.2	30.0	17.2	8.3	4.8	3.4	2.7	2.0
15 tonne roller	13.9	8.0	4.6	2.2	1.3	0.9	0.7	0.5
15 tonne compactor	13.9	8.0	4.6	2.2	1.3	0.9	0.7	0.5
7 tonne compactor	10.4	6.0	3.4	1.7	1.0	0.7	0.5	0.4
Dozer	7.0	4.0	2.3	1.1	0.6	0.5	0.4	0.3
Excavator	4.4	2.5	1.4	0.7	0.4	0.3	0.2	0.2
Grader	4.4	2.5	1.4	0.7	0.4	0.3	0.2	0.2
Backhoe	1.7	1.0	0.6	0.3	0.2	0.1	0.1	0.1
Piling (boring)	1.4	0.8	0.5	0.2	0.1	0.1	0.1	0.1

Blasting

Blasting is anticipated to be used during construction within the NGBR Project realignment footprint as well as quarries and borrows outside the rail footprint.

The result of distance relationship calculations for airblast overpressure and ground vibration from blasting are presented in Table 10-8 for blasting in the NGBR Project realignment.

Table 10-8 Estimated airblast overpressure and ground vibration from blasting within the NGBR Project realignment (based on 50 kg MIC)

Receptor	Airblast overpressure dB(linear)		Ground vibration (mm/s)	
	Ka 10[1]	Ka 100[1]	Kg 800[2]	Kg 1600[2]
Homestead 16	107.5	**127.5**[3]	0.5	1.0
Homestead 17 (Location C)	73.4	93.4	0.0	0.0
Homestead 18	79.9	99.9	0.0	0.0
Homestead R1	89.8	109.8	0.1	0.1
Homestead R2	102.6	**122.6**[3]	0.3	0.5
Homestead R3	86.7	106.7	0.0	0.1
Homestead R4	77.5	97.5	0.0	0.0

1 Site constant

2 Ground constant

3 Greater than or equal to the *Environmental Protection Act 1994* criterion (refer Table 10-1)

For blasting along the NGBR Project realignment the results indicate that airblast overpressure levels have the potential to exceed the blasting criteria at Homesteads 16 and R2 if blasting is to occur within the NGBR Project realignment footprint near these sensitive receptors. Standard mitigation measures have been provided below to assist with preventing noise and vibration impacts from blasting.

It was not predicted that ground vibration would exceed the blasting criteria at any of the identified sensitive receptors for blasting in the NGBR Project realignment.

Airblast overpressure was estimated under the 'worst case' assumption that blasting would occur at the closest segment of the NGBR Project realignment to a given sensitive receptor. All other parameters were conservatively assumed (refer Section 10.2.4).

A number of standard mitigation measures are proposed to prevent impacts from blasting occurring. These mitigation measures will be incorporated into the Environmental Management Plan for the NGBR Project (refer Volume 2 Appendix H Revised environmental management plan framework). The mitigation measures to be included in the plan are listed in the NGBR Project EIS Volume 1 Chapter 12 Noise and vibration.

In addition to the above, the following will be undertaken to confirm the result of the impact assessment and inform blast design to prevent airblast overpressure or ground vibration impacts at sensitive receptors.

- Undertake airblast overpressure monitoring during initial blasts to assist with the optimisation of blast parameters and confirmation of predictions
- Modify blast design as necessary to prevent impact, including:
  - Reduce maximum instantaneous charge using delays, reduced hole diameter, or deck-loading
  - Changing the burden and spacing by altering the drilling pattern and/or delay layout, or altering the hole inclination
  - Spacing and orientation of blast drill holes
  - Use minimum practicable sub-drilling which gives satisfactory toe conditions.
  - Investigate alternative rock-breaking techniques
  - Establish times of blasting to suit local conditions
  - Direction of detonator initiation away from nearby residences.

Given that blasting will only occur during acceptable hours under the Environmental Protection Act 1994 (refer Section 10.2.3), where construction camps will be predominately unoccupied, it is unlikely that impacts from blasting will occur. All blasting will be undertaken with consideration to the health and safety of the NGBR Project workforce.

Night works

Any works required outside daytime working hours (i.e. 7 pm to 6 am) would be minimised where possible. Potentially affected sensitive receptors will be notified at least five days in advance of night works occurring in a particular location. Impact pile driving and blasting would not be undertaken outside of daytime working hours.

Any noise complaints regarding night-time works will be investigated immediately and measures will be developed in consultation with the affected sensitive receptor to minimise any confirmed

impacts. Measures for consideration may include provision of alternate temporary accommodation, use of alternate construction equipment or techniques and rescheduling of works to daytime working hours.

10.4.2 Operation

Impact of operation noise

The results of CadnaA noise modelling for operation of the NGBR Project realignment are provided in Table 10-9. These results also include the cumulative impacts from Aurizon trains operating on the Newlands line.

Table 10-9 Estimated operation noise

Receptor	Day (dB $L_{Aeq, 15h}$)	Night (dB $L_{Aeq,9h}$)	Maximum (dB L_{AFmax})
Homestead 16	61.0	**60.8**[1]	71.1
Homestead 17 (Location C)	30.8	30.6	32.8
Homestead 18	36.8	36.6	41.6
Homestead R1	48.4	48.2	56.1
Homestead R2	58.9	**58.7**[1]	67.5
Homestead R3	51.4	51.5	60.2
Homestead R4	49.9	50.0	59.6

[1] Exceeds RING night criterion (refer Table 10-1)

The relevant RING day criterion and maximum criterion were not predicted to be exceeded. The RING night criterion of 55 dB $_{LAeq,9h}$ was predicted to be exceeded at Homesteads 16 and R2 by 5.8 and 3.7 dB respectively.

It is noted that the less stringent QR criteria would not be exceeded at any identified sensitive receptor (refer Section 10.2.3).The result presented here is the product of a number of 'worst case' assumptions (refer Section 10.2.4). Actual noise experienced at a sensitive receptor is expected to be lower than predicted, given that:

- Conservative ground absorption and atmospheric conditions were used
- Noise emissions from trains within cuttings may be reduced.

As predicted levels indicate exceedances of the operational noise criteria at Homesteads 16 and R2, a number of standard mitigation measures are proposed to minimise impacts. These mitigation measures are presented in Section 10.4.3 and will be incorporated into the NGBR Project Noise and Vibration Management Plan (refer Volume 2 Appendix H Revised environmental management plan framework).

In addition to the above, the following will be undertaken to confirm the result of operational noise modelling and mitigate potential impacts, as necessary:

- Undertake operational noise monitoring to validate noise predictions
- Where operational noise monitoring identifies noise impact occurring at a sensitive receptor, employ additional mitigation, such as:

- Construction of screening and barriers or bunds
- Noise mitigating building works at sensitive receptors, such as double glazing, forced ventilation or air conditioning.

Impact of operation vibration

Recent vibration monitoring was undertaken for coal trains on the Australian Rail Track Corporation rail network in the Hunter Valley (Hunter8 Alliance 2010). Monitored trains included those operated by Pacific National and Aurizon. The monitoring indicated a low probability of human comfort or structural vibration criteria (refer Section 10.2.3) being reached more than 40 m from the rail line.

Additional rail vibration assessments of the same network (Hunter8 Alliance 2010) for trains similar to those used for the NGBR Project realignment resulted in similar findings, with negligible vibration levels at distances greater than approximately 50 m from the rail line. Vibration levels from the operation of the NGBR Project realignment are expected to be consistent with the above findings.

Given the nearest sensitive receiver (Homestead 16) is more than 700 metres from the NGBR Project realignment, no operational vibration impact is predicted.

10.4.3 Summary of mitigation and management measures

The mitigation and management measures to be implemented where noise is predicted to exceed management levels during construction and operation of the NGBR Project realignment are consistent with those provided in the NGBR Project EIS (refer NGBR Project EIS Volume 1 Chapter 12 Noise and vibration).

Operational noise monitoring at the nearest sensitive receivers (Homestead 16 and R2) to the NGBR Project realignment will be undertaken to validate noise predictions. Where operational noise monitoring exceeds the relevant criteria at a sensitive receptor, additional mitigation will be considered, such as:

- Construction of screening and barriers or bunds
- Noise mitigating building works at sensitive receptors, such as double glazing, forced ventilation or air conditioning.

10.5 Conclusion

This section describes the potential noise and vibration impacts of the NGBR Project realignment during the construction and operational phases, and provides recommended noise and vibration mitigation measures. Predicted noise and vibration levels provided in this section have been developed based on the construction methodology and proposed operations described in the NGBR Concept Design Report (Aarvee Associates 2013). They have also been based on conservative or 'worst case' assumptions which reflect the NGBR Project EIS Volume 2 Appendix J Noise and vibration report.

During construction and operation, actual noise and vibration levels will be monitored to validate the predictions in this section. Blasting in particular will be monitored to ensure that blast design is appropriate to site conditions and considers any potential sensitive receptors. A monitoring program will also be developed for operational noise and provide corrective actions where required.

It is expected that noise and vibration caused by the construction and operation of the NGBR Project realignment will be appropriately managed through the implementation of the mitigation and management measures identified within this section. Residual impacts after the implementation of the above mitigation and management measures are expected to be insignificant.

11. Transport

11.1 Purpose of section

The purpose of this section is to assess the potential impacts of the NGBR Project realignment on key roads and intersections that will facilitate access for construction and operational traffic to and from the final rail corridor, construction camp 4, the construction yard (chainage 187.8 km to chainage 189.0 km), and other ancillary infrastructure. This section includes an overview of the existing transport environment, consideration of potential construction and operation impacts, and identification of mitigation and management measures.

The key intersections (study intersections) assessed in this section are as follows:

- Bowen Developmental Road/Collinsville-Elphinstone Road
- Suttor Developmental Road/Collinsville-Elphinstone Road.

The key roads (study road links) assessed in this section are as follows:

- Bowen Developmental Road
- Suttor Developmental Road
- Collinsville-Elphinstone Road.

The transportation values that are considered in this section include:

- Study intersection performance
- Study road link performance
- Existing heavy vehicle network.

11.2 Methodology

11.2.1 Study area

For the purpose of this transport assessment, the study area is defined by the local and regional road network surrounding the NGBR Project realignment that will be utilised by construction and operations traffic to access the final rail corridor, construction camp 4, the construction yard and ancillary infrastructure.

11.2.2 Data sources

The following data sources were relied upon for the transport assessment included within the NGBR Project EIS and are relevant to the NGBR Project realignment:

- Physical road network (DNRM 2010)
- Heavy vehicle network (Queensland Government 2013)
- Vehicular demand data (DTMR 2012)
- Crash data (DTMR 2006-2010)
- Construction and operations traffic information (Aarvee Associates 2013).

11.2.3 Legislation and guidelines

This transport assessment has been conducted according to the Guidelines for the Assessment of Road Impacts of Developments (GARID), published by the Department of Transport and Main Roads (DTMR), 2006. GARID states that DTMR will not approve development unless any road impacts of the development can be managed to maintain a safe and efficient road system for all road users, as required by the *Transport Infrastructure Act 1994*. This approach is supported by the legislative powers of both the *Sustainable Planning Act 2009* and the *State Development and Public Works Organisation Act 1971* which enable DTMR to impose conditions to mitigate the road impacts of proposed developments as part of the development planning process. Other guidelines that were considered included:

- Austroads, "Guide to Traffic Engineering Practice - Part 2: Roadway Capacity"
- DTMR's Road Planning and Design Manual (RPDM), 2nd edition, 2013
- Queensland Road Safety Action Plan 2013 – 2015.

The applicability of legislation to approvals for the NGBR Project, including those relating to the NGBR Project realignment, is discussed in Volume 2 Appendix J Revised legislation and approvals.

11.2.4 Desktop assessment

A high-level desktop assessment was undertaken which included:

- Identification and review of background vehicular demand and percentage of heavy vehicles on the study road links
- Identification and review of the impact of the potential vehicular demand resulting from NGBR Project realignment on study intersections and study road links
- Determination of the existing road link capacity for study road links during the critical construction period
- Identification and review of historical crash statistics in proximity to the study intersections.

11.2.5 Road performance criteria

A Level of Service (LOS) analysis on all approach roads (or road links) to the study intersections has been conducted with and without the NGBR Project realignment traffic based on practical capacities determined from "Austroads Guide to Traffic Engineering Practice – Part 2: Roadway Capacity". The Austroads guideline defines LOS as a qualitative measure for describing the operational performance of a road. All the approach roads (or road links) to the study intersections can be classified as rural roads. The LOS performance criteria for rural roads are provided in Table 11-1.

Table 11-1 LOS for rural roads

LOS	Description	Performance
A	Free, unrestricted flow	Very good
B	Mostly free flow, few disruptions	Very good
C	Stable flow	Good

LOS	Description	Performance
D	Mostly stable flow, some delays	Acceptable
E	Congested flow, delays common	Poor
F	Forced flow	Poor

Source: Austroads Guide to Traffic Engineering Practice Part 2: Roadway Capacity

For the LOS assessment of selected roads within the study area, the road terrain was assumed to be level and the design hour volume to Annual Average Daily Traffic (AADT) ratio was assumed to be 0.13 (13 per cent) for all selected road sections. A value of 0.13 (13 per cent) was selected as it falls within the middle of the Austroads Guide to Traffic Engineering Practice Part 2 recommended range of 11 per cent to 16 per cent for rural situations where peak to AADT percentages are not available.

AADT data for 2012 was sourced from DTMR. The AADT data available at the closest location to the study area was used.

Table 11-2 shows the values for various LOS categories on rural roads in level terrain. For the purpose of the assessment, a practical capacity of 10,400 vehicles per day has been assumed as a threshold capacity limit (at LOS D) for rural roads. As per the Austroads guideline, LOS D is considered acceptable as it is an indication of generally stable flows with some delays. Remedial measures will be required for roads operating at LOS E or worse.

Table 11-2 Maximum AADT (vehs/day/2-way) for various LOS on rural roads on level terrain

Design hour volume to AADT ratio	Level of service				
	A	B	C	D	E
0.13	1,900	3,700	6,100	**10,400**	17,600

Source: Extract of Austroads Guide to Traffic Engineering Practice, Part 2: Roadway Capacity, Table 3.9, from TRB Highway Capacity Manual (1985) Table 8.10

Therefore, the threshold performance criteria adopted for the assessment of approach roads (road links) within the study area is LOS D. For the assessment of percentage increase in AADT on the State-controlled road (SCR), an increase of less than five per cent was considered acceptable. Should a percentage increase in AADT of more than five per cent occur on a SCR then a Pavement Impact Assessment (PIA) and a Traffic Impact Assessment (TIA) must be performed.

The assessment has been conducted for three study road links listed in Section 11.3.1.

11.2.6 Intersection analysis

Detailed intersection modelling and assessment has not been undertaken due to the relatively low (existing) traffic volumes at study intersections. However, each intersection has been assessed in terms of safety, and appropriate intersection treatments to mitigate any potential safety risks that may arise due to increased turn volumes. This assessment has been conducted according to DTMR's RPDM, Chapter 13.

For a conservative approach, the assessment of intersection treatment types is based on existing peak hour traffic volumes and potential construction traffic occurring at the same time.

11.2.7 Crash analysis

A high level desktop crash analysis was carried out for study road links and intersections within the study area to identify existing traffic safety issues. The following crash data was provided by DTMR:

- Fatal crashes to 31 May 2013 and hospitalisation crashes to 28 February 2013
- Medical treatment, minor injury and property damage crashes to 31 December 2010.

The full set of crash data was not available for 2011 to 2013; instead crash data for five years between 2006 and 2010 were used for the purpose of the assessment.

11.2.8 General assumptions

Transport of hazardous/explosive materials (such as fuel) during construction and operational phase is detailed in the NGBR Project EIS Volume 1 Chapter 18 Hazard, risk, health and safety.

11.3 Existing environment

A detailed description of the existing environment is provided in the NGBR Project EIS Volume 2 Appendix K Transport and summarised below.

11.3.1 Study road links

The roads that will be utilised during construction and operation of the NGBR Project realignment to access the final rail corridor, construction camp 4, the construction yard and ancillary infrastructure have been identified and described in Table 11-3.

Table 11-3 Study road links

Road name	Extent
Bowen Developmental Road	The Bowen Developmental Road is a sealed road that commences in the township of Delta. The Bowen Developmental Road is a State-controlled road (SCR) that runs in a north-south direction connecting the Bruce Highway at its northern end, Gregory Developmental Road at its southern end, and crossing Rutherford Road, Strathalbyn Road, Strathmore Road, Suttor Developmental Road and the Upper Don River Road. Bowen Developmental Road runs through Mount Coolon, Collinsville, Almoola, Briaba, Binbee and Armuna. At Delta, Bowen Developmental Road intersects with the Bruce Highway at a T-intersection. The road then proceeds in a south western direction passing Bogie and Mt. Coolon and the town of Collinsville. The road also crosses Mt. Wyatt Road, Power House Road, Corduroy Creek Road, Collinsville-Elphinstone Road, Cerito Road, and Ilamatha Road with a T-intersection at Gregory Developmental Road. It currently functions as a sub-arterial road between Bowen and Collinsville and has a posted speed limit of 100 km/h. Most of the Bowen Development Road south of Collinsville has undergone resurfacing works. Bowen Developmental Road will provide connectivity between Townsville (and its port) to the NGBR Project realignment, construction camp 4, the construction yard and ancillary infrastructure.

Road name	Extent
Suttor Developmental Road	The Suttor Developmental Road is a SCR under the jurisdiction of the DTMR. The road is partly sealed and connects from Mount Coolon to the west to near Nebo to the east. It stretches from the suburb of Mount Coolon at a T-intersection with Bowen Developmental Road. The road continues east passing Stratford Road and Glenavon Road and Eaglefield. The road continues east passing Red Hill Road, Ellensfield Road, Collinsville-Elphinstone Road and Elphinstone Suburb. The road continues east passing Hail Creek Road, Kemmis Creek Road and Turrawilla Road and Leggets Road. Suttor Developmental Road culminates in a T-intersection with Peak Downs Highway. Suttor Developmental Road will provide connectivity between Mackay (and its port) to the NGBR Project realignment, construction camp 4, the construction yard and ancillary infrastructure.
Collinsville-Elphinstone Road	The Collinsville-Elphinstone Road is SCR and intersects with Bowen Development Road at its northern end. The road continues in a south eastern direction passing Mount Leslie Road and Cerito Road. The road also passes beside Glenden Town and Glenden Newlands Road and Perry Drive. From Glenden Town, the road passes Mount Goodhart Road and terminates in an intersection with Suttor Developmental Road. The Collinsville-Elphinstone Road is a partially sealed road and connects Suttor Developmental Road in the south east to Bowen Developmental Road in the north west. Collinsville-Elphinstone Road will provide connectivity between Bowen Developmental Road and Suttor Developmental Road to the NGBR Project realignment, construction camp 4, the construction yard and ancillary infrastructure.

11.3.2 Road/rail crossings

The NGBR Project realignment includes eight road crossings as identified in Table 11-4. Proposed treatments for each crossing were determined in accordance with the criteria shown in Volume 2 Appendix B Revised project description. The proposed treatment criteria are subject to further consultation with the DTMR and local councils and will undergo further review during subsequent design stages.

Table 11-4 Proposed road treatments

Chainage (km)	Name	Treatment
137.87	Road reserve	At grade crossing
139.97 to 140.97	Road reserve	Closure
150.03	Bowen Developmental Road	Grade separated crossing
150.84	Road reserve	Closure
159.79	Old Collinsville Elphinstone Road	At-grade crossing

Chainage (km)	Name	Treatment
171.47	Road reserve	Closure
178.47	Road reserve	At-grade crossing
189.06	Collinsville Elphinstone Road	Grade separated crossing

11.3.3 Occupational and stock crossings

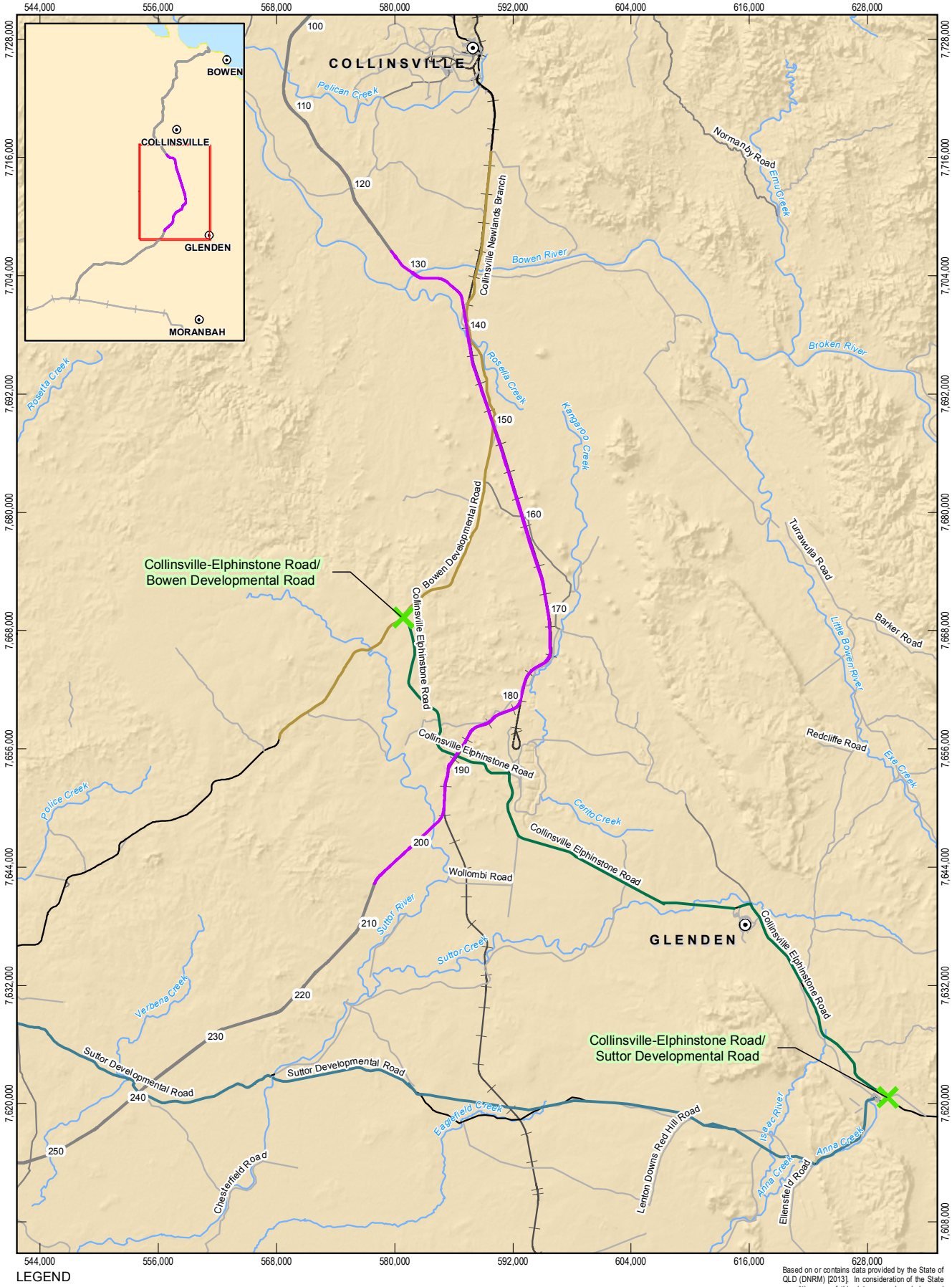
The NGBR Project realignment includes 17 occupational crossings and two national stock route crossings. Proposed treatments for each crossing were determined in accordance with crossing criteria for the NGBR Project (refer Volume 2 Appendix B Revised project description). The criteria are subject to further consultation with the Department of Natural Resources and Mines (DNRM), local government and landholders, and will undergo further review during subsequent design stages. Occupational and stock crossings are further detailed in Volume 2 Appendix B Revised project description.

11.3.4 Study intersections

Intersections that will facilitate access to the NGBR Project realignment are listed in Table 11-5. The locations of these study intersections are shown in Figure 11-1.

Table 11-5 Summary of study intersections

Study intersection	Extent and condition
Bowen Developmental Road/Collinsville-Elphinstone Road	An existing three-leg priority controlled intersection which consists of Collinsville-Elphinstone Road (an unsealed two-way, two-lane road) intersecting with Bowen Developmental Road (a sealed two-way, two-lane road). This intersection will provide access for vehicular traffic from the north of the NGBR Project realignment to construction camp 4, the construction yard and ancillary infrastructure.
Suttor Developmental Road/Collinsville-Elphinstone Road	An existing three-leg priority controlled intersection which consists of Suttor Developmental Road (a sealed two-way, two-lane road, which continues to the south) intersecting with Collinsville-Elphinstone Road (a sealed two-way, two-lane road), which terminates at this intersection. This intersection will provide access to vehicular traffic from the south of the NGBR Project realignment to construction camp 4, the construction yard and ancillary infrastructure.



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor

Key Roads

- Bowen Developmental road
- Collinsville Elphinstone road
- Suttor Developmental road

- Study intersections

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:550,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Study intersections

Figure 11-1

G:\41\26457\06 GIS\Maps\MXD\1000_Transport\41_26457_1021_rev_a.mxd

Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DNRM, Adani make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Population centres, Railway, Watercourse/2007; Adani: EIS Option 9 Rev1 final rail corridor /2014, Camichael Rail Project/2013, Chainage/ 2014; DNRM: Roads/2010; GHD: Study Intersections /2014. Created by:MS

11.3.5 Traffic volumes and capacity of study road links

A LOS approach was used to determine the existing performance of study road links within the study area. Table 11-6 provides the AADT and subsequent LOS on all the selected study road links. It should be noted that peak to AADT percentages were not available and therefore 13 per cent of AADT volumes used to estimate the peak hour volumes in accordance with the Austroads Guide to Traffic Engineering Practice Part 2.

Table 11-6 Existing traffic volumes and LOS (2012)

Road name (location)	2012 AADT (Light vehicles)	2012 AADT (Heavy vehicles)	Total (Vehicles /day)	LOS (2012)
Bowen Developmental Road (near intersection with Collinsville-Elphinstone Road)	432	72	504	A
Suttor Developmental Road (near intersection with Collinsville-Elphinstone Road)	1,311	260	1,571	A
Collinsville-Elphinstone Road (near chainage 189 km)	703	106	809	A

All the study road links in Table 11-6 are operating at an existing LOS A. The existing LOS at all the selected study road links indicates free and uninterrupted travelling conditions.

11.3.6 Heavy vehicle network

The percentage of heavy vehicles on study road links within the study area is provided in Table 11-7. The heavy vehicle data was based on 2012 AADT counts sourced from DTMR. A map of the DTMR heavy vehicle network is provided in Figure 14.2 of the NGBR Project EIS Volume 1 Chapter 14 Transport.

Table 11-7 Percentage heavy vehicles on study road links

Road name (location[1])	Heavy vehicles
Bowen Developmental Road (near chainage 140 km)	16.56%
Suttor Developmental Road (near intersection with Collinsville-Elphinstone Road)	19.80%
Collinsville-Elphinstone Road (near chainage 189 km)	15.13%

1. Location relates to where heavy vehicle traffic count data was collected

A review of the DTMR heavy vehicle route network shows that:

- Bowen Developmental Road between Collinsville, Mount Coolon and Belyando is an approved route for Type 1 (15 axle and 36.5 metres long) and Type 2 (16 axle and 53.5 metres long) vehicles. This will provide direct access for Type 1 vehicles from the Port of Abbot Point to construction camp 4, the construction yard, and ancillary infrastructure between the Newlands rail system and Mount Coolon within the Final NGBR Project footprint.

- Suttor Developmental Road between Mount Coolon, Eaglefield and Elphinstone is also an approved route for Type 1 and 2 vehicles. This route will be used by Type 1 vehicles to access construction camp 4, the construction yard and ancillary infrastructure in the vicinity.
- Collinsville-Elphinstone Road between Bowen Developmental Road and Suttor Developmental Road is an approved route for Type 1 vehicles. This route will provide direct access for Type 1 vehicles from Mackay or Townsville, and their associated ports, to bridge and track laydown areas and construction camp 4 and the construction yard.

11.3.7 Crash analysis

A crash analysis was performed for the study intersections (within a one kilometre radius). Additional analysis was also performed along Collinsville-Elphinstone Road due to a cluster of crashes within the vicinity of the Collinsville-Elphinstone Road/Newland Access Road intersection being identified. Findings of the crash analysis are provided in Table 11-8.

Table 11-8 Crash analysis

Location	Findings
Bowen Developmental Road/Collinsville-Elphinstone Road	Two crashes have been recorded at this intersection between 2006 and 2010. Out of these, one was “hospitalisation” which occurred due to a vehicle defect. The second crash was recorded as “property damage” and occurred as a result of poor road condition/fatigue.
Suttor Developmental Road/Collinsville-Elphinstone Road	Four crashes have been recorded at this intersection between 2006 and 2010. Out of these, one was “property damage” which occurred due to poor road surface, one was “minor injury” which occurred due to inattention, one was “fatal” which occurred due to drink driving and speed, and one was “medical treatment” which occurred due to fatigue.
Collinsville-Elphinstone Road/Newland Access Road	Eight crashes have been recorded at this intersection between 2006 and 2010. Out of these, two were “fatal” which occurred due to drink driving and speed, one was “minor injury” which occurred due to unknown/other circumstances, one was “hospitalisation” which occurred due to drugs and fatigue, one was “property damage” which occurred due to inattention/inexperience, and one was “hospitalisation” which occurred due to drug/drink driving and fatigue.

A number of fatal crashes were recorded at both the Suttor Developmental Road/Collinsville-Elphinstone Road and Collinsville-Elphinstone Road/Newlands Access Road intersections within a one kilometre radius. Further road safety studies are recommended at Suttor Developmental Road/Collinsville-Elphinstone Road and Collinsville-Elphinstone Road/Newlands Access Road intersections.

11.4 Development traffic generation

11.4.1 Construction

Construction of the NGBR Project realignment is anticipated to occur over a period of approximately two years and is scheduled to commence in late 2014. It is estimated that traffic will be generated both within the final rail corridor and on the external road network by the following four types of vehicles during construction:

- Material supply vehicles
- Service vehicles
- Construction workforce via Fly-in/Fly-out (FIFO)
- Construction workforce via Drive-in/Drive-out (DIDO).

Material supply vehicles

Construction materials for the NGBR Project realignment will be sourced from the same locations identified in the NGBR Project EIS Volume 1 Chapter 14 Transport with the exception of quarry and batching plant materials. The indicative haulage routes for quarry and batching plant materials have therefore been updated since the NGBR Project EIS Volume 1 Chapter 14 Transport and are assessed in this section. This update has affected the potential vehicular demand on study intersections and study road links.

The type and size of material supply vehicles that will be used for the NGBR Project realignment are also anticipated to be the same as those identified in the NGBR Project EIS Volume 1 Chapter 14 Transport. While these material supply vehicle types and configurations have been assumed for the purpose of this assessment, essentially representing a worst-case traffic generation model, there is potential to use other vehicle configurations during construction. These alternate vehicle types and configurations include the potential use of B-Double (two trailer) and/or B-Triple (three trailer) road trains to move general and structural fill, capping material, ballast, sleepers and culverts. The capacity of these vehicles could be in the order of approximately 166m^3 or 180 – 200 tonnes. The alternate vehicle types and configurations will result in lesser truck trips to move rail materials.

The estimated material supply traffic generation required during the construction phase, based on vehicle types assumed for the assessment, is tabulated in Table 11-9. This table also provides the indicative routes which these vehicles would take to travel between their origin and destinations.

Table 11-9 Estimated monthly material supply truck traffic generation – return trips

		Track	Bridges / Culverts and Concrete				Earthwork	
		Ballast	Girders Central	Culverts Central	Batching Plants Central (Aggregate)	Batching Plant Central (Cement and Sand)	Structural Fill Central	Capping Central
From		QR Quarry - Byerwen	Townsville	Townsville	Umina Quarry	Townsville/Mackay	Existing QR Quarry - Byerwen	Existing QR Quarry - Byerwen
To		Siding - Chainage 184 km	Bridge Sites X 13 SITES	Bridge Sites X 13 SITES	Batchingplant 4	Batchingplant 4	Within corridor through access road	Within corridor through access road
Indicative routes		Temp Haul Road	Bruce Highway, Bowen Developmental Road	Bruce Highway, Bowen Developmental Road	Bowen Developmental Road/Collinsville-Elphinstone Road	Peak Downs Highway/Suttor Developmental Road/Collinsville-Elphinstone Road/Bowen Developmental Road	Temp Haul Road	Temp Haul Road
Month 6	Jan-15						2,320	
Month 7	Feb-15				594	756	2,320	
Month 8	Mar-15				594	756	2,320	
Month 9	Apr-15				594	756	2,320	930
Month 10	May-15				594	756	2,320	930
Month 11	Jun-15				594	756	2,320	930
Month 12	Jul-15			147	594	756	2,320	930
Month 13	Aug-15		20	147	594	756	2,320	930
Month 14	Sep-15		24	147	594	756	2,320	930
Month 15	Oct-15	2,315	25		594	756	2,320	930

		Track	Bridges / Culverts and Concrete				Earthwork	
Month 16	Nov-15	2,315	22		594	756	2,320	930
Month 17	Dec-15	2,315	23		594	756		930
Month 18	Jan-16	2,315			594	756		930
Month 19	Feb-16	2,315			594	756		930
Month 20	Mar-16	2,315			594	756		930
Month 21	Apr-16	2,315						
Month 22	May-16	2,315						

Source: NGBR Project Concept Design Report (Aarvee Associates 2013) and Adani

Service supply vehicles

Service supply vehicle movements for the NGBR Project realignment will be the same as those identified in the NGBR Project EIS with the exception of vehicles supplying construction camp 4. It has been assumed that there will be 20 service vehicle movements (return trips) per week at construction camp 4. At this stage, trips which can be associated with vehicles supplying fuel, chemicals and explosive materials have not been considered in the trip estimation during construction. However, the number of vehicles supplying these materials is expected to be minimal and would not have any detrimental impact on the road network.

The route that service vehicles would take would be between Glenden and construction camp 4 at chainage 189 km via Collinsville-Elphinstone Road.

Construction workforce via FIFO and DIDO

The approximate size of the construction workforce and their movements during construction of the NGBR Project realignment will remain the same as that identified in the NGBR Project EIS with the exception of workers accessing construction camp 4.

The approximate size of construction camp 4 (chainage 189 km) is 400 workers. The route which FIFO vehicles would take would be between Moranbah Airport and construction camp 4 at chainage 189 km via Peaks Downs Highway/Suttor Developmental Road/Collinsville-Elphinstone Road.

The route which DIDO vehicles would take would be between Glenden and construction camp 4 at chainage 189 km via Collinsville-Elphinstone Road.

Construction traffic generation

Table 11-10 provides a summary of the estimated total number of construction vehicles that will be required during construction of the NGBR Project realignment. Table 11-10 shows that peak construction traffic is expected to occur in month 15 of the construction schedule.

Table 11-10 Estimated monthly construction vehicles (return trips)

Month	Material supply vehicles	Service vehicles	FIFO workforce vehicles	DIDO workforce vehicles	Total
3	0	20	4	80	104
4	0	80	16	320	416
5	0	80	16	320	416
6	2,320	80	16	320	2,736
7	3,670	80	16	320	4,086
8	3,670	80	16	320	4,086
9	4,600	80	16	320	5,016
10	4,600	80	16	320	5,016
11	4,600	80	16	320	5,016

Month	Material supply vehicles	Service vehicles	FIFO workforce vehicles	DIDO workforce vehicles	Total
12	4,747	80	16	320	5,163
13	4,767	80	16	320	5,183
14	4,771	80	16	320	5,187
15	6,940	80	16	320	7,356
16	6,937	80	16	320	7,353
17	4,618	80	16	320	5,034
18	4,595	80	16	320	5,011
19	4,595	80	16	320	5,011
20	4,595	80	16	320	5,011
21	2,315	80	16	320	2,731
22	2,315	60	12	240	2,627

Estimated construction traffic at study road links within study area

Indicative routes for all four construction vehicle types were used to identify the potential construction vehicle demand at the approach roads to the study intersections.

It should be noted that the periods of highest construction traffic volumes on study road links within the study area will vary according to the construction activities and location of works being undertaken during any given month. The estimated monthly construction traffic volumes for each key road within the study area are provided in Table 11-11. The highlighted cells in the table show the critical months (highest estimated construction traffic), which vary at each of the study road links.

Table 11-11 Estimated monthly construction traffic on study road links within the study area (single trips)

Month	Bowen Developmental Road (near intersection with Collinsville-Elphinstone Road)	Suttor Developmental Road (near intersection with Collinsville-Elphinstone Road)	Collinsville-Elphinstone Road (near chainage 189 km)
3	0	8	208
4	0	32	832
5	0	32	832
6	0	32	832
7	1,944	788	3,532
8	1,944	788	3,532

Month	Bowen Developmental Road (near intersection with Collinsville-Elphinstone Road)	Suttor Developmental Road (near intersection with Collinsville-Elphinstone Road)	Collinsville-Elphinstone Road (near chainage 189 km)
9	1,944	788	3,532
10	1,944	788	3,532
11	1,944	788	3,532
12	1,967	788	3,555
13	1,970	788	3,558
14	1,970	788	3,558
15	1,948	788	3,536
16	1,947	788	3,535
17	1,948	788	3,536
18	1,944	788	3,532
19	1,944	788	3,532
20	1,944	788	3,532
21	0	32	832
22	0	24	624

Note: Shaded cells represent months with highest estimated traffic volume for each approach road

11.4.1 Operation

An overview of the annual operational workforce traffic generation is provided in Table 11-12. The number of operations staff peaks in 2026 with 369 full-time equivalents. These figures are included in the NGBR Project EIS Volume 1 Chapter 14 Transport and have not changed as a result of the NGBR Project realignment.

Table 11-12 Annual operation workforce 2016 to 2026

Operation workforce profile	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Tonnage (mtpa)	4	20	30	40	50	60	70	80	90	95	100
Full-time equivalent	66	103	141	173	209	254	315	327	350	361	369

11.5 Potential impacts and mitigation measures

Construction and operation of the NGBR Project realignment has the potential to impact the existing transport network that will be utilised for transporting material and personnel, including:

- Study road links
- Study intersections
- Public and active transport
- Rail infrastructure.

Construction and operation of the NGBR Project realignment will require direct interaction and potential modification of existing transport infrastructure, including the road network (State and locally controlled), stock route network and rail network. As such, during detailed design and prior to commencement of construction, further consultation will be required with affected infrastructure owners and associated regulatory agencies to inform the following:

- Road Impact Assessment (RIA)
- Australian Level Crossing Assessment Model (ALCAM)
- Pavement Impact Assessment (PIA)
- Road Use Management Plan (RUMP).

These reports will identify vulnerable existing infrastructure such as pavements, intersections, bridges and structures and their ability to withstand the expected increase in traffic volumes and types of loads (oversize/indivisible) to be generated during construction of the NGBR Project. Findings from these reports will inform crossing treatment arrangements, impact management practices and the need for infrastructure agreements to be made between Adani and the infrastructure owners. Where required, infrastructure agreements will include relevant aspects pertaining to construction and operation phases of the NGBR Project, including authorities, responsibilities and commercial aspects for the respective parties.

11.5.1 Construction

The impact of construction traffic was examined on the approach roads of the study intersections. A LOS approach was used to determine the performance of these approach roads. The performance of the road was examined “with” and “without” construction traffic in peak construction year (i.e. 2015) to understand the impacts of the potential construction vehicles on the study road links.

In order to establish the AADT for year 2015, a compound growth rate of three per cent per annum was applied to the 2012 AADT, as used in the NGBR Project EIS Volume 1 Chapter 14 Transport.

The findings of the LOS analysis for the year 2015 are provided in Table 11-13 and indicate that construction traffic will increase the daily traffic volumes on all approach roads, with some anticipated to experience increases of over five per cent (i.e. Bowen Developmental Road and Collinsville-Elphinstone Road). However, due to the relatively low background traffic volumes on these roads it is expected that these approach roads will operate at LOS A, which is acceptable.

Table 11-13 Impact of construction traffic on study road links – 2015

Approach Road	Background traffic (AADT 2012)	Background traffic (AADT 2015)	Construction traffic (2015)	Total traffic (2015)	Percent increase	LOS-without construction traffic (2015)	LOS-with construction traffic (2015)
Bowen Developmental Road (near intersection with Collinsville-Elphinstone Road	504	551	66	616	12%	LOS A	LOS A
Suttor Developmental Road (near intersection with Collinsville-Elphinstone Road)	1571	1717	41	1758	2%	LOS A	LOS A
Collinsville-Elphinstone Road (near chainage 189 km)	809	884	134	1018	15%	LOS A	LOS A

The NGBR Project realignment will require the construction of crossings where the final rail corridor intersects with public roads, stock routes, road reserves and occupational crossings. The method for constructing crossings at public roads will typically require lane closures resulting in minor delays to traffic flows. However, these delays are anticipated to be minimal given the generally low volumes of daily traffic in the study area. To mitigate any potential impacts associated with construction of the crossings, site specific Traffic Management Plans will be developed in consultation with the Isaac Regional Council (IRC), Whitsunday Regional Council (WRC) and DTMR, where applicable, and implemented during construction. Consideration of adequate sight and emergency stopping distances will be included in any traffic management measures. Occupational crossing treatments will be determined during detailed design and in consultation with affected land holders.

The construction of grade-separated crossings along the NGBR Project realignment is unlikely to cause any significant delays to traffic travelling across the existing road network. Any impact on the road network during the construction of the proposed grade-separated crossings will be short-term and managed through the provision of site specific Traffic Management Plans highlighting specific treatments and staged works. Additionally, any impact on the vulnerable bridge structures will also be managed through the provision of site specific Traffic Management Plans. These will be developed in consultation with DTMR, WRC and IRC (as applicable) during detailed design of the NGBR Project. Proposed treatments of crossings are provided in Table 11-4.

Public and active transport

The existing number and frequency of school bus services within the study area are low due to the relatively low population density located along the final rail corridor. No public transport routes have been specifically identified within the study area, although it can be assumed that long-distance buses may travel through the study area and use SCR or local roads in the region. During detailed design, Adani will communicate with bus operators and the public to promote awareness of the impact and management of construction and operation activities. Existing bus services and routes are therefore unlikely to be impacted during construction.

There is currently no existing pedestrian or cyclist infrastructure along any study road links due to the rural setting, long distances from surrounding communities, the high speed environment of the road network and the low pedestrian and cyclist volumes.

Study intersections

The treatment types at study intersections have been assessed in accordance with the RPDM. The assessment of intersection treatment types is based on peak hour vehicular demand. The RPDM intersection treatment types that were considered are as follows:

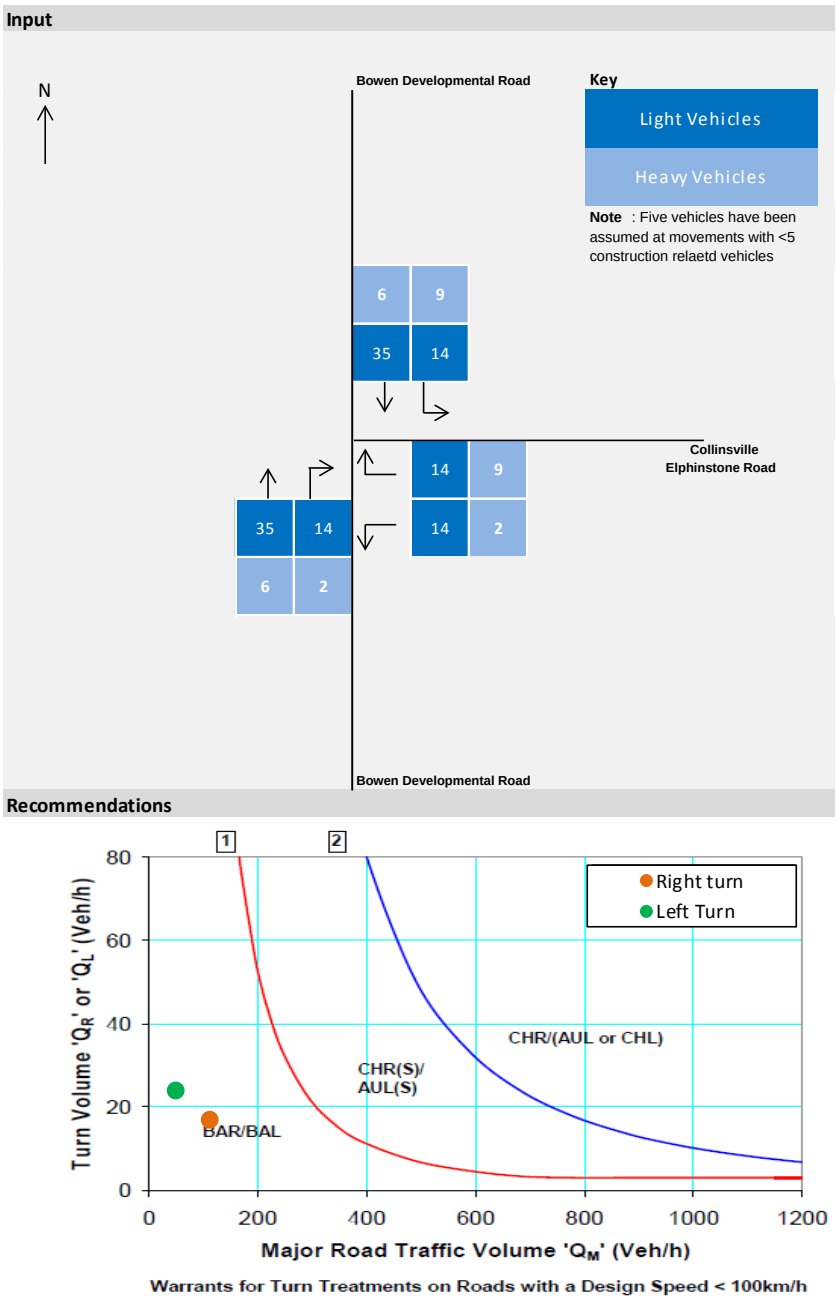
- Basic intersections (Type BA). These intersections are designed to be as compact (and inexpensive) as possible. They are most appropriately used where the volume of turning and traffic is low. The Type BA comprises the following treatments:
  - Basic right turn treatment (BAR) on major road
  - Basic left turn treatment (BAL) on the major and/or minor roads
- Intersections with auxiliary lanes (Type AU). Type AU intersections comprise short lengths of auxiliary lane to improve safety, especially on high speed roads. Such layouts allow traffic to bypass a vehicle waiting to turn right, or a lane for left turning traffic, or both. The AU intersections comprise the following treatments:
  - Auxiliary right turn treatment (AUR) on the major road

  - Auxiliary left turn treatment (AUL) on the major road and/or minor roads
- Channelised intersections (Type CH). A channelised intersection is one where conflicting vehicle travel paths are separated by raised, depressed, or painted medians and/or islands. Auxiliary lanes are often used in conjunction with channelisation. The CH intersections comprises the following treatments:
  - Channelised right turn treatment (CHR) on the major road
  - Channelised left turn treatment (CHL) on the major road and/or minor roads.

Bowen Developmental Road/Collinsville-Elphinstone Road

As per the RPDM criteria, BAL/BAR treatments are proposed at the Bowen Developmental Road/Collinsville-Elphinstone Road intersection due to the low volumes (refer Figure 11-2). However, due to the potential nature and size of construction vehicles (such as potential 35 m B-Triple trucks), a higher standard CHR(S)/AUL(S) treatment may be installed at this intersection. Such a treatment reduces the potential operational and safety risks associated with larger construction vehicles, particularly on an intersection with a SCR (i.e. Bowen Developmental Road and Collinsville-Elphinstone Road). The NGBR Project realignment will provide a priority controlled intersection permitting all turning movements (except U-turns) at the intersection.

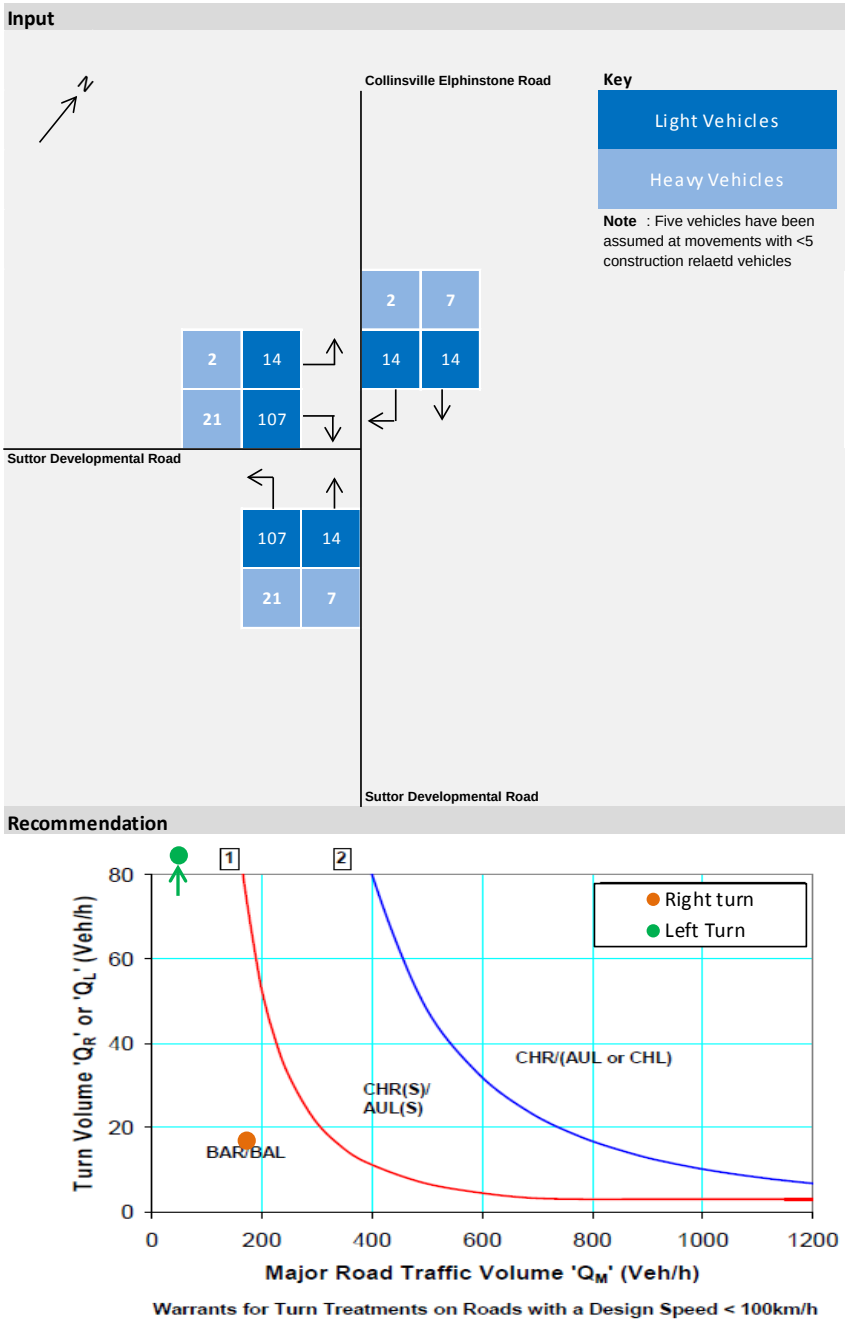
Figure 11-2 Bowen Developmental Road/Collinsville-Elphinstone Road treatment findings



Suttor Developmental Road/Collinsville-Elphinstone Road

As per the RPDM criteria, BAL/BAR treatments are proposed at the Suttor Developmental Road/Collinsville-Elphinstone Road intersection due to the low volumes (refer Figure 11-3). However, due to the nature and size of construction vehicles (such as potential 35 m B-Triple trucks), a higher standard CHR(S)/AUL(S) treatment may be installed at this intersection. Such a treatment reduces the potential operational and safety risks associated with larger construction vehicles, particularly on an intersection with a SCR (i.e. Suttor Developmental Road and Collinsville-Elphinstone Road). The NGBR Project realignment will provide a priority controlled intersection permitting all turning movements (except U-turns) at the intersection.

Figure 11-3 Suttor Developmental Road/Collinsville-Elphinstone Road treatment findings



11.5.2 Summary of mitigation and traffic management measures

The mitigation and management measures to be implemented during construction and operation of the NGBR Project realignment to minimise and avoid potential impacts to the local and regional road network are consistent with those provided in the NGBR Project EIS (refer NGBR Project EIS Volume 1 Chapter 14 Transport).

11.6 Conclusion

Construction traffic associated with the NGBR Project realignment, including heavy vehicle movements, will create short-term increases in traffic volumes on SCRs. However, due to the relatively low existing traffic volumes on these roads, the performance of all study road links is anticipated to operate satisfactorily at LOS A. Based on the nominal capacity of the road network, the additional construction traffic resulting from the NGBR Project realignment can be adequately accommodated at acceptable levels of service.

To minimise the potential impacts of the NGBR Project realignment on study intersections, the following treatment, in accordance with the Road Planning and Design Manual, 2nd edition, will be considered further during detailed design:

- CHR(S)/AUL(S) treatments at both of the Bowen Developmental Road/Collinsville-Elphinstone Road intersection (occurring in the proximity of chainage 189 km) to accommodate heavy traffic. A priority controlled intersection permitting all turning movements (except U-turns) at the intersection will be included
- CHR(S)/AUL(S) treatments at the Suttor Developmental Road/Collinsville-Elphinstone Road intersection to accommodate heavy traffic. A priority controlled intersection permitting all the turning movements (except U-turns) at the intersection will be included.

Due to the relatively small number of operational workforce, and the current capacity of the existing road network (LOS A), operations traffic is anticipated to have a minimal impact on the performance of study road links and key road intersections within the study area.

Due to the high number of fatal crashes identified in the crash analysis, a safety study is recommended at the Suttor Developmental Road/Collinsville-Elphinstone Road and Collinsville-Elphinstone Road/Newlands Access Road intersections.

Prior to construction commencing, a detailed Road Impact Assessment including a Pavement Impact Assessment and Road Use Management Plan will be completed in conjunction with DTMR (and its affected regional offices), WRC and IRC for the their review and approval as applicable.

12. Cultural heritage

12.1 Purpose of section

The purpose of this section is to assess the potential impacts of the NGBR Project realignment on Indigenous and non-Indigenous cultural heritage values.

This section describes existing cultural heritage values, assesses the potential impacts of the NGBR Project realignment on those values, and proposes mitigation measures where they vary from those previously detailed in NGBR Project EIS Volume 1 Chapter 15 Cultural heritage.

12.2 Methodology

12.2.1 Study area

The study area for this cultural heritage assessment was a two kilometre buffer from both sides of the centreline of the NGBR Project realignment. The resulting four kilometre wide study area encompasses the NGBR Project realignment footprint, which includes the rail line and ancillary infrastructure.

12.2.2 Data sources

The cultural heritage assessment relied on the following data sources:

- North Galilee Basin Rail Project Additional Environmental Impact Statement Cultural Heritage Technical Addendum Report (ELH 2014)(refer Appendix F)
- Publicly available literature and reports relevant to the study area
- Cultural Heritage Management Plans (CHMPs) between Adani and:
  - the Birriah People
  - the Jangga People
- Publicly available aerial and satellite imagery, such as Google Earth
- Indigenous cultural heritage databases:
  - Queensland Cultural Heritage Database and Register
  - Australian Heritage Database
  - National Native Title Register
- Non-Indigenous cultural heritage databases:
  - Australian Heritage Database, including National and Commonwealth Heritage Lists
  - Queensland Heritage Register.

12.2.3 Legislation and guidelines

Legislation and guidelines relevant to cultural heritage are consistent with those listed and further detailed in the NGBR Project EIS, including:

- *Aboriginal Cultural Heritage Act 2003*
- *Queensland Heritage Act 1992*
- *Torres Strait Islander Cultural Heritage Act 2003*.

12.2.4 Desktop assessment

A desktop assessment was undertaken to identify and classify the existing Indigenous and non-Indigenous cultural heritage within the study area. The method for identification and classification was consistent with that utilised in the NGBR Project EIS and summarised below.

Identification of Indigenous cultural heritage

A desktop Indigenous cultural heritage assessment was undertaken to identify known cultural heritage values in the study area in accordance with the *Aboriginal Cultural Heritage Act 2003*, associated guidelines and standard industry archaeological practice. The desktop assessment involved a review of publicly available literature and reports relevant to the study area, and Indigenous cultural heritage databases (refer Section 12.2.2).

Classification of significance of Indigenous cultural heritage

For the purposes of this assessment, and in the absence of consultation with Traditional Owner groups or field investigations, all places identified through a search of Indigenous cultural heritage database (refer Section 12.2.2) were considered to be of 'potentially high' cultural heritage significance, and of 'unknown' scientific significance.

Identification of non-Indigenous cultural heritage

A desktop non-Indigenous cultural heritage assessment was undertaken to identify known cultural heritage values in the study area. The desktop assessment involved a review of publicly available aerial and satellite imagery, and non-Indigenous cultural heritage databases. As previously indicated in the NGBR Project EIS, Whitsunday Regional Council and Issac Regional Councils do not currently have a local heritage register

Classification of significance of non-Indigenous cultural heritage

Classification of significance of non-Indigenous cultural heritage was undertaken based on the criteria derived from the *Queensland Heritage Act 1992* as detailed in the NGBR Project EIS.

12.2.5 Stakeholder engagement

Traditional Owners

Of the four Native Title (Traditional Owner) groups identified in relation to the final rail corridor of the NGBR Project EIS, two are of relevance to the NGBR Project realignment study area (refer Figure 12-1), these being the Birriah People (referred to in NGBR Project EIS as Birri) and the Jangga People.

CHMPs have been negotiated between Adani and both of the Traditional Owner groups, and consultation regarding the NGBR Project realignment is being undertaken by Adani.

Consultation has been held with Birrah and Jangga representatives in relation to the impacts of the NGBR Project realignment on identified Aboriginal cultural heritage.

Adani has consulted with Birrah and Jangga representatives and undertaken to extend the Birriah and Jangga CHMPs to include the NGBR Project realignment and to undertake a survey of the NGBR Project realignment area in accordance with the requirements of the CHMPs.

Surveys will be undertaken in order to identify any Aboriginal cultural heritage values in those areas and following consideration of the survey reports by Adani and both the Birriah and

Jangga, any Aboriginal cultural heritage management arrangements in relation to any Aboriginal cultural heritage issues identified during the surveys will be agreed.

Meetings will be held with Birriah representatives to progress negotiations and reach agreement in relation to the proposed Project ILUA and associated ancillary agreement within the Birriah native title claim areas.

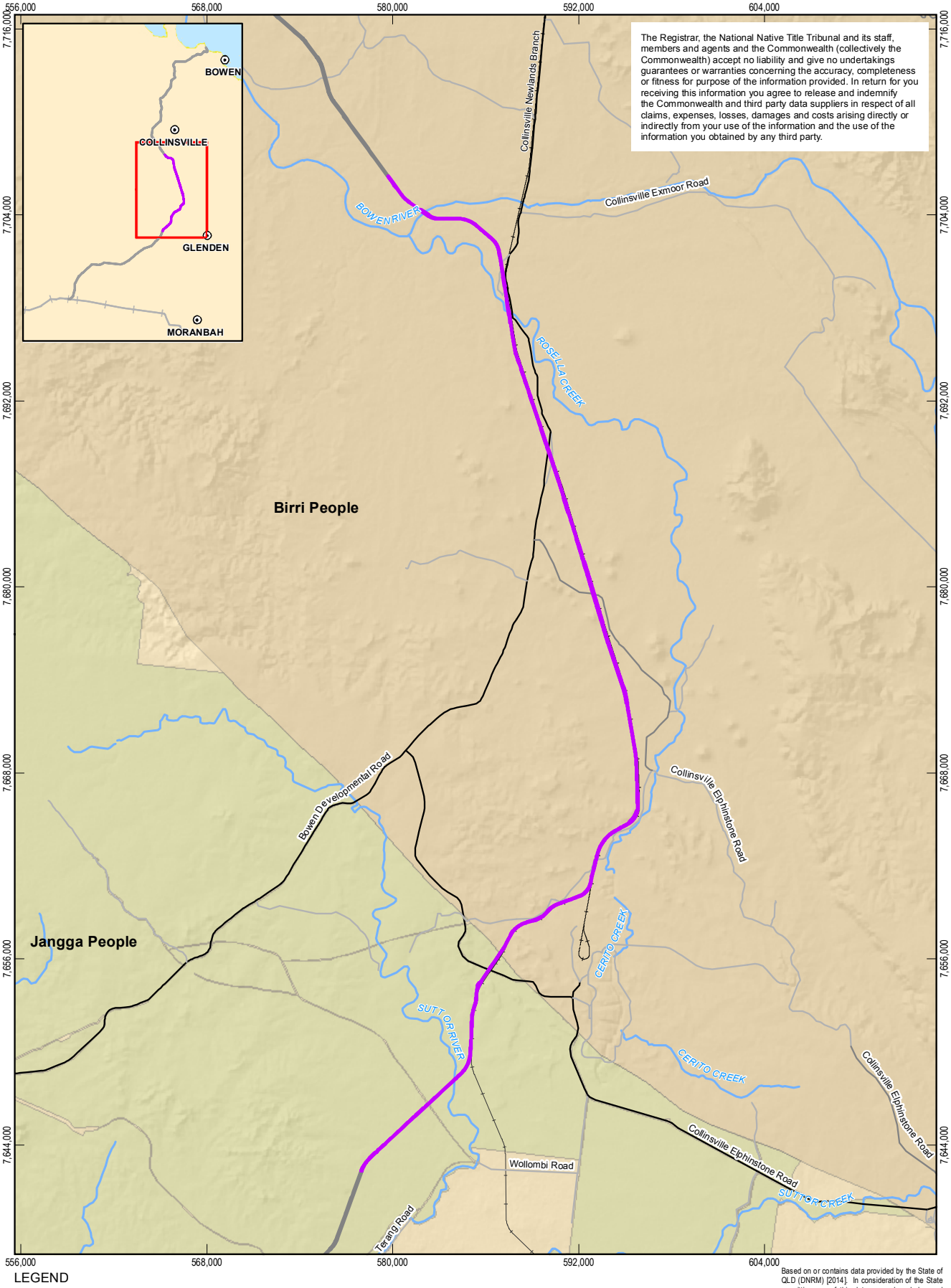
Adani will continue to negotiate the terms of an ILUA with the Birriah representatives which will cover both the original NGBR Project alignment and the NGBR Project realignment, as well as other Project construction requirements within the Birriah RNTC area.

A Project ILUA between Bulganunna Aboriginal Corporation (Jangga) and Adani was executed on 19 December 2013, covering the original NGBR Project alignment. As part of the abovementioned consultation, Adani has informed Jangga that the existing ILUA will need to be extended to include the NGBR Project realignment area.

Adani has commenced action to implement the appropriate amendments to the Jangga ILUA to incorporate the NGBR Project realignment, and once the amended ILUA is executed, Adani will seek registration of the ILUA by the National Native Title Tribunal to give full effect to it.

Non-Indigenous community groups

No stakeholder engagement with respect to the non-Indigenous cultural heritage was conducted in relation to NGBR Project realignment.



The Registrar, the National Native Title Tribunal and its staff, members and agents and the Commonwealth (collectively the Commonwealth) accept no liability and give no undertakings guarantees or warranties concerning the accuracy, completeness or fitness for purpose of the information provided. In return for you receiving this information you agree to release and indemnify the Commonwealth and third party data suppliers in respect of all claims, expenses, losses, damages and costs arising directly or indirectly from your use of the information and the use of the information you obtained by any third party.

LEGEND

- Population centres
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment
- Birri People
- Jangga People

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12 Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Native title claims

Figure 12-1

G:\41\26457\06 GIS\Maps\MXD\0800_Landuse\41_26457_0826_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Pipelines, Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Nature Refuge (2010), Physical Road Network (2010); GA/NTT: Native title claims (EIS) (2013). Created by:MS

12.2.6 Limitations

This cultural heritage assessment relied upon a number of publicly available data sources, including cultural heritage registers. Cultural heritage registers do not represent an exhaustive list of cultural heritage for a given site. The absence of recorded cultural heritage for a given area may reflect a lack of prior cultural heritage surveys having taken place rather than an actual absence of cultural heritage.

12.3 Existing environment

12.3.1 Environmental context

The current and historical environmental context of the study area can indicate potential sites for cultural heritage. The environmental context of the NGBR Project realignment is generally consistent with that described in the NGBR Project EIS.

High creek banks and ridges overlooking creeks hold the highest potential to contain archaeological material for both Indigenous and non-Indigenous cultural heritage outside of settled areas and transport routes. The NGBR Project realignment crosses a number of creeks and rivers and is within reasonable proximity to rural homesteads, townships and other longstanding transport corridors, therefore, has high potential for Aboriginal cultural heritage material at those locations. As early settlers and their associated livestock were also highly dependent on water (L'Oste-Brown *et al.* 1998), creeks and rivers are also likely to be sites of non-Indigenous cultural heritage.

12.3.2 Indigenous cultural heritage

Indigenous historical land use within the study area

Indigenous historical land use within the study area is detailed in the NGBR Project EIS. As described, Aboriginal people occupied the wider region, and as part of a nomadic lifestyle may have inhabited areas including the study area, temporarily and on a seasonal basis.

Historical accounts reveal that Aboriginal people have maintained a close association with their country despite settlement. Hence there remains considerable potential for historical and contemporary Aboriginal cultural heritage places to be identified within the study area, although the potential for discovery of *in situ* or largely undisturbed archaeological deposits may be low due to extensive clearing, animal grazing, and erosion within the study area.

Previous archaeological investigations

A review of previous archaeological investigations conducted within the study area and wider region was outlined in the NGBR Project EIS. This demonstrated a pattern of archaeological site distribution that was influenced by the occurrence of raised terraces associated with rivers and permanent watercourses. Sites with these features were often found to be characterised by diffuse surface scatters or isolated occurrences of stone artefacts. Site frequency and size tended to decrease with distance from permanent fresh water.

The reviewed archaeological investigations conducted in closer proximity to the NGBR Project realignment included:

- L'Oste-Brown *et al.* (1998), which summarised archaeological investigations of the Bowen Basin, including those within the catchments of the Suttor and Bowen Rivers, both of which are crossed by the NGBR Project realignment

- Hill (1978), which investigated the Newlands Mine site, situated approximately 20 km east of chainage 202 km, and contained artefact scatters from three source sites and 'camp' sites comprising a large number of artefacts. The majority of the finds were located in proximity to Cerito Creek, which is located within the study area to the east and south east of the NGBR Project realignment between chainage 179 km and chainage 188 km at a distance of between approximately one kilometre and 4.6 km.

Identified Indigenous heritage values

A search of the Indigenous cultural heritage databases was undertaken in February 2014 for the NGBR Project realignment footprint (refer Appendix F). The search returned the following Indigenous heritage values:

- 57 artefact scatters
- Two landscape features
- Five artifact scatters with hearth ovens
- One artifact scatter with cultural site
- Two artifact scatters with resource sites
- One artifact scatter with landscape feature
- One scarred/carved tree
- One scarred/carved tree with artefact scatter
- 17 isolated finds
- Four resource areas
- Two artefact scatters, resource area
- One scarred/carved tree, resource area
- One artefact scatter, contact site
- One cultural site.

Further detail on the above values is provided in Table 12-1. The locations of the identified Indigenous heritage values are depicted in Figure 12-2.

Table 12-1 Indigenous cultural heritage database search results

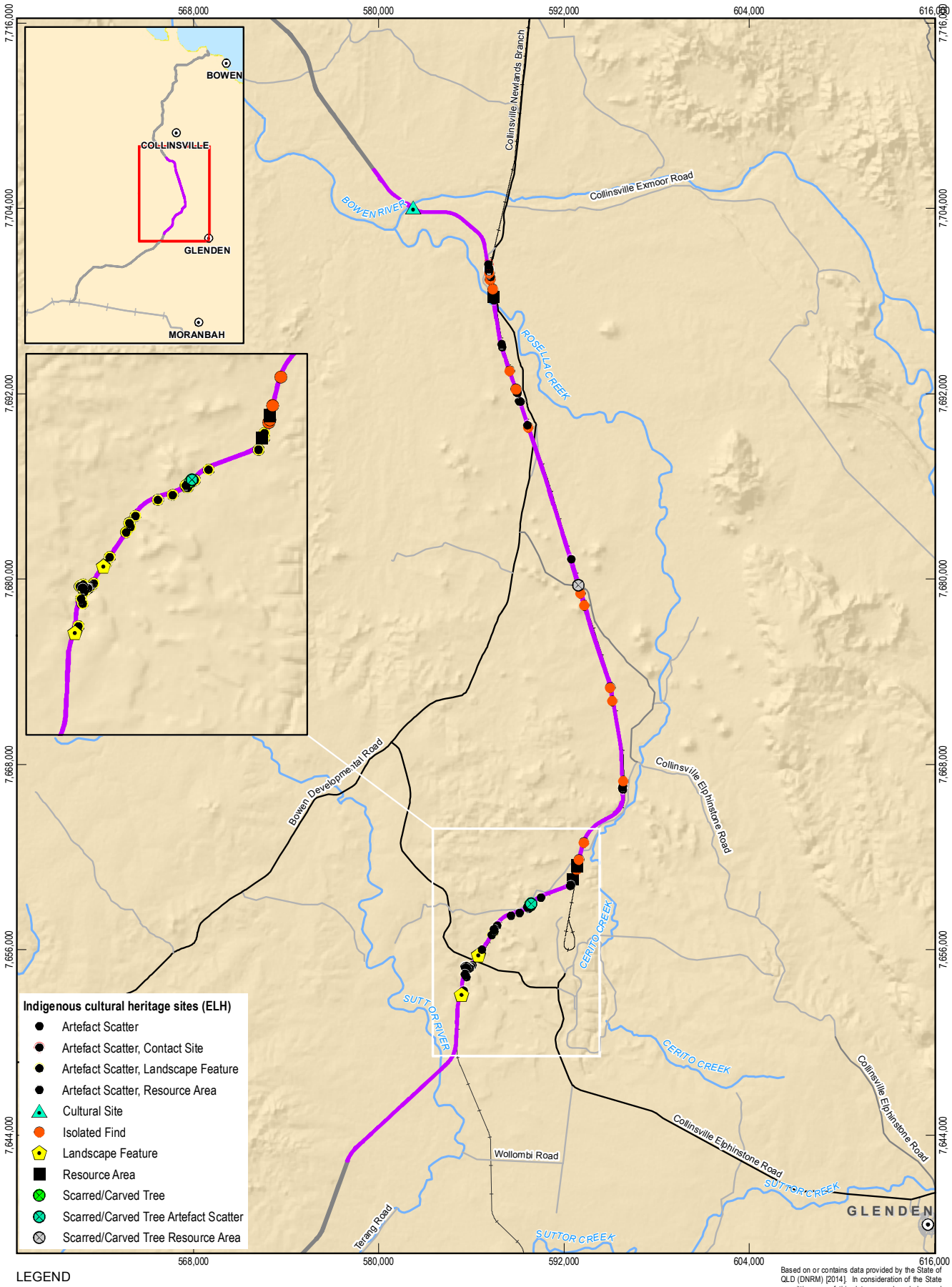
Site Id	Attribute	Aboriginal Party
GH:J98	Artefact Scatter	Jangga Operations Pty Ltd
GH:J99	Landscape Feature	Jangga Operations Pty Ltd
GH:K00	Artefact Scatter	Jangga Operations Pty Ltd
GH:K00	Artefact Scatter	Jangga Operations Pty Ltd
GH:K00	Artefact Scatter	Jangga Operations Pty Ltd
GH:K00	Artefact Scatter	Jangga Operations Pty Ltd
GH:K00	Artefact Scatter	Jangga Operations Pty Ltd

Site Id	Attribute	Aboriginal Party
GH:K00	Artefact Scatter	Jangga Operations Pty Ltd
GH:K00	Artefact Scatter	Jangga Operations Pty Ltd
GH:K01	Artefact Scatter	Jangga Operations Pty Ltd
GH:K03	Artefact Scatter	Jangga Operations Pty Ltd
GH:K07	Artefact Scatter	Jangga Operations Pty Ltd
GH:K08	Landscape Feature	Jangga Operations Pty Ltd
GH:K60	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
GH:K60	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
GH:K60	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
GH:K60	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
GH:K60	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
GH:K61	Artefact Scatter	Jangga Operations Pty Ltd
GH:K62	Artefact Scatter	Jangga Operations Pty Ltd
GH:J97	Artefact Scatter, Cultural Site	Jangga Operations Pty Ltd
GH:L23	Artefact Scatter	Birriah
GH:L24	Artefact Scatter	Birriah
GH:L24	Artefact Scatter	Birriah
GH:L25	Resource Area	Birriah
GH:L26	Artefact Scatter, Resource Area	Birriah
GH:L26	Artefact Scatter, Resource Area	Birriah
GH:L29	Artefact Scatter	Birriah
GH:L32	Artefact Scatter	Birriah
GH:L33	Artefact Scatter	Birriah
GH:L33	Artefact Scatter	Birriah
GH:L33	Artefact Scatter	Birriah
GH:L34	Artefact Scatter	Birriah
GH:L34	Artefact Scatter	Birriah
GH:L35	Artefact Scatter	Birriah

Site Id	Attribute	Aboriginal Party
GH:L36	Artefact Scatter	Birriah
GH:L37	Artefact Scatter, Landscape Feature	Birriah
GH00000036	Scarred/Carved Tree	Birriah
GH00000035	Artefact Scatter	Birriah
GH00000035	Artefact Scatter	Birriah
GH00000033	Artefact Scatter	Birriah
GH00000037	Scarred/Carved Tree, Artefact Scatter	Birriah
GH00000038	Isolated Find	Birriah
GH00000039	Isolated Find	Birriah
GH00000040	Resource Area	Birriah
GH00000040	Resource Area	Birriah
GH00000041	Isolated Find	Birriah
GH00000042	Isolated Find	Birriah
GH00000043	Artefact Scatter	Birriah
GH00000043	Artefact Scatter	Birriah
GH00000043	Artefact Scatter	Birriah
GH00000043	Artefact Scatter	Birriah
GH00000044	Isolated Find	Birriah
GH00000045	Isolated Find	Birriah
GH00000046	Isolated Find	Birriah
GJ00000013	Isolated Find	Birriah
GJ:F60	Artefact Scatter	Birriah
GJ:F61	Artefact Scatter	Birriah
GJ:F61	Artefact Scatter	Birriah
GJ:F62	Artefact Scatter	Birriah
GJ:F62	Artefact Scatter	Birriah

Site Id	Attribute	Aboriginal Party
GJ00000014	Isolated Find	Birriah
GJ00000015	Scarred/Carved Tree, Resource Area	Birriah
GJ00000016	Artefact Scatter	Birriah
GJ00000017	Isolated Find	Birriah
GJ00000018	Artefact Scatter	Birriah
GJ00000019	Artefact Scatter	Birriah
GJ00000019	Artefact Scatter	Birriah
GJ00000020	Isolated Find	Birriah
GJ00000021	Isolated Find	Birriah
GJ00000022	Isolated Find	Birriah
GJ00000023	Artefact Scatter	Birriah
GJ00000025	Artefact Scatter	Birriah
GJ00000027	Artefact Scatter	Birriah
GJ00000027	Artefact Scatter	Birriah
GJ00000027	Artefact Scatter	Birriah
GJ00000028	Resource Area	Birriah
GJ00000030	Isolated Find	Birriah
GJ00000031	Isolated Find	Birriah
GJ00000032	Isolated Find	Birriah
GJ00000033	Artefact Scatter	Birriah
GJ00000034	Artefact Scatter	Birriah
GJ00000035	Isolated Find	Birriah
GJ00000036	Artefact Scatter	Birriah
GJ00000036	Artefact Scatter	Birriah
GJ00000036	Artefact Scatter	Birriah
GJ00000036	Artefact Scatter	Birriah
GJ00000036	Artefact Scatter	Birriah

Site Id	Attribute	Aboriginal Party
GJ00000036	Artefact Scatter	Birriah
GJ00000036	Artefact Scatter	Birriah
GJ00000036	Artefact Scatter	Birriah
GJ00000036	Artefact Scatter	Birriah
GJ00000037	Artefact Scatter, Contact Site	Birriah
GJ00000038	Cultural Site	Birriah



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourse (Major)
- NGBR Project final rail corridor
- NGBR Project realignment

Based on or contains data provided by the State of QLD (DNRM) [2014]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

Indigenous cultural heritage database search results

Figure 12-2

G:\41\26457\06 GIS\Maps\MXD\1500_Cultural_Heritage\41_26457_1508_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, DATSIMA and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Population centres, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), DNRM: Physical Road Network (2010) ELH: CH Search Locations (2014). Created by:MS

12.3.3 Non-Indigenous cultural heritage

Non-Indigenous historical land use within the study area

Non-Indigenous historical land use within the region of the study area is detailed in the NGBR Project EIS. As indicated, the ground surface of the study area has been subject to a range of pastoral and mining activities including vegetation clearing coal extraction and grazing. This reduces the potential for historical archaeology to exist in the study area.

Identified non-Indigenous heritage values

Searches of the National Heritage List and Commonwealth Heritage List, and the Queensland Heritage Register were undertaken. Consistent with the NGBR Project EIS, no non-Indigenous heritage places relevant to the study area were identified.

Non-Indigenous sites in the wider region were identified from the Queensland Heritage Register, These were used to characterise or consider the kinds of heritage places typical to the wider area. Five of the 10 non-Indigenous heritage sites detailed in the NGBR Project EIS were relevant to the NGBR Project realignment. These were:

- Bowen River Hotel (former)
- Strathmore Homestead
- Collinsville Cemetery
- Bowen Consolidated Colliery (No. 1 underground mine)
- Mount Coolon Gold Mine's (Barclay's Battery).

The majority of these sites are associated with early mining or pastoral activities with low-density human settlements in the northern Bowen Basin, predominantly around Collinsville. These activities have produced a range of heritage places including scattered homesteads, informal cemeteries, mine operations and farming infrastructure.

The identified non-Indigenous cultural heritage places, and assessments against the *Queensland Heritage Act 1992* criteria and Australian Historic Themes Framework (Australian Heritage Commission 2001), are detailed in the NGBR Project EIS. The locations of the identified non-Indigenous heritage values are depicted in the NGBR Project EIS Volume 1 Chapter 13 Cultural heritage Figure 13.3.

12.4 Potential impacts and mitigation measures

Potential impacts to cultural heritage during construction and operation predominantly relate to damage to or removal of items of significance. This includes registered and identified items or places, unregistered or unassessed items or places, and unexpected items or places.

12.4.1 Construction

Damage or removal of items of Indigenous cultural heritage significance

Known items or places of Indigenous cultural heritage significance that have been identified within the study area for the NGBR Project realignment include artefact scatters, cultural sites, hearth ovens, landscape features, resource sites, landscape features, a quarry site, scarred/carved trees, isolated finds, and an unknown item (refer Section 12.3.2, Table 12-1, and Figure 12-2). These items are relatively consistent with those previously identified.

Details in relation to mitigation measures for damage to or removal of potential items of Indigenous cultural heritage significance are provided in the NGBR Project EIS.

Adani will continue to engage and consult with the relevant Traditional Owners in relation to the assessment and management of Aboriginal cultural heritage values in the NGBR Project realignment.

As indicated, the implementation of mitigation measures incorporated into CHMPs for the NGBR Project will minimise impacts to identified Indigenous cultural heritage sites. The CHMP will include mitigation measures to be followed where previously unregistered items or places of Indigenous cultural heritage are encountered in accordance with the relevant Traditional Owner group requirements.

Damage or removal of items of non-Indigenous cultural heritage significance

The NGBR Project realignment does not intersect with any identified non-Indigenous cultural heritage sites (refer Section 12.3.3). In addition there is low potential for previously unidentified heritage places to be found. As such, no direct impacts on places of non-Indigenous cultural heritage significance are expected.

As described in the NGBR Project EIS, a non-Indigenous CHMP will be developed as part of the Environmental Management Plan in accordance with duty of care requirements under the *Queensland Heritage Act 1992*. This is considered likely to prevent direct impacts occurring to previously unregistered items or places of non-Indigenous cultural heritage.

12.4.2 Operation

Operational impacts and mitigation are discussed in the NGBR Project EIS (refer to NGBR Project EIS Volume 1 Chapter 15 Cultural heritage). No additional impacts or mitigation measures are required for the NGBR Project realignment.

12.4.3 Summary of mitigation and management measures

Mitigation and management measures to be implemented during construction and operation of the NGBR Project realignment to minimise and avoid impacts of the on cultural heritage are consistent with those provided in the NGBR Project EIS (refer to NGBR Project EIS Volume 1 Chapter 15 Cultural heritage).

12.5 Conclusion

The desktop study indicates that Indigenous cultural heritage places are likely to occur within the study area, however there is a low potential for non-Indigenous cultural heritage to occur.

Adani will minimise impacts to cultural heritage by adhering to mitigation measures outlined in the NGBR Project EIS during the pre-construction, construction and operation phases of the NGBR Project.

The development of CHMPs is the overarching mitigation measure that will assist in the identification of cultural heritage sites, determination of heritage significance, mitigation and management of impacts, and carrying out consultation with Native Title and Traditional Owner stakeholders.

Consistent with the NGBR Project EIS, the only potential residual impact resulting from the NGBR Project realignment in relation to cultural heritage is damage to cultural heritage that is unregistered or unexpected. Surveys will be conducted to attempt to identify these sites prior to construction. The CHMP will direct appropriate measures in the event of damage.

13. Other matters

The purpose of this section is to assess the potential impacts of the NGBR Project realignment on environmental matters that are not assessed in other sections. Only a high level assessment of 'other matters' is provided as the impacts on these environmental aspects, as assessed in the NGBR Project EIS, will not materially change due to the NGBR Project realignment. For the purpose of this section, other matters include:

- Coastal environment
- Social and economic impacts
- Climate and natural hazards
- Hazard, risk, health and safety.

13.1 Coastal environment

For the purpose of this assessment, the coastal environment is considered the coastal zone as defined by the *Coastal Protection and Management Act 1995* (Qld). The NGBR Project realignment is approximately 100 km from the Port of Abbot Point and is not located within the coastal environment. Impacts to the costal environment from the NGBR Project realignment are included in Section 6 or are not considered further where they have not changed from those identified in the NGBR Project EIS (refer NGBR Project EIS Volume 1 Chapter 8 Coastal processes).

13.2 Greenhouse gas

A revised greenhouse gas inventory has been prepared for the NGBR Project, incorporating the NGBR Project realignment, other minor realignments and associated changes (refer to Section 12 of Volume 1). The greenhouse gas inventory does not differ significantly from the inventory provided in NGBR Project EIS Volume 1 Chapter 11 Greenhouse gas. The mitigation and management measures identified in the NGBR Project EIS are considered sufficient to abate greenhouse gas emissions from the NGBR Project as much as practicable.

13.3 Waste

Waste volumes stated in NGBR Project EIS Volume 1 Chapter 13 Waste were indicative only, for the purpose of identifying potential waste streams and appropriate waste management options. The waste assessment undertaken for the NGBR Project EIS is therefore considered to apply equally to the NGBR Project realignment.

13.4 Social and economic impacts

At a regional level, the NGBR Project realignment will not modify the nature or magnitude of social and economic impacts identified in the NGBR Project EIS (refer NGBR Project EIS Volume 1 Chapter 16 Social and economic impacts). This includes the social and economic benefits that will arise through increased employment and business opportunities in the region. The NGBR Project realignment crosses the same local government areas as those identified in the NGBR Project EIS (Whitsunday Regional Council and Isaac Regional Council) and the key urban localities are the same (Bowen, Collinsville, Moranbah and Mackay). Furthermore, the potential sources of labour, equipment and materials as well as the number of construction and operational workforce will not substantially change due to the NGBR Project realignment.

At a local level, the NGBR Project realignment intersects eight properties, five of which are new properties not previously assessed in the NGBR Project EIS. Potential adverse social impacts on the landholders of these properties are discussed in the following sections:

- Section 3 Land use (including land fragmentation)
- Section 4 Scenic amenity and lighting
- Section 9 Air quality
- Section 10 Noise
- Section 11 Transport (including access to properties).

Of the total 77 km length of the NGBR Project realignment, approximately 57 km will run alongside the Newlands line. The majority of properties intersected by the NGBR Project realignment are already crossed by rail infrastructure similar to the NGBR Project. The NGBR Project realignment has sought to minimise potential fragmentation by running adjacent to the established Newlands line. Where the NGBR Project realignment moves away from the existing rail corridor, potential impacts include general property management issues, particularly in relation to the movement of stock and equipment across and between properties. The realignment will include 17 occupational crossings and will incorporate similar associated crossing treatments as those approved as part of the Alpha Coal Project EIS as 57 km of the proposed NGBR Project realignment will be developed in a corridor consistent with the previously approved Alpha Coal Project rail corridor. During detailed design, further consultation will be undertaken with landholders to refine a range of measures, including the provision of appropriate access arrangements and determining optimal locations for stock and occupational crossings.

Whilst the realignment has been developed to avoid and minimise the extent of intrusion into properties, landholders will lose agricultural land due to the realignment footprint. The loss of agricultural land combined with potential access impacts to parts of their properties, has the potential to impact productivity and economic viability of businesses. These impacts will be mitigated and managed through implementation of land access protocols, as well as negotiation and compensation mechanisms outlined in the NGBR Project EIS Volume 1 Chapter 3 Land use and tenure.

13.5 Climate and natural hazards

The NGBR Project realignment is located east of Collinsville and Glenden in an area characterised by a persistently dry, sub-tropical climate. The long-term monthly mean daytime summer temperature ranges between 29 to 38 °C, with night-time winter temperatures ranging between 3 to 16 °C. Temperatures exceeding 35 °C can be expected between 35 to 74 days per year. Long-term rainfall records obtained from BOM indicate annual rainfall decreases with distance inland from the coast and potential for short duration flood events between September and May.

The climatic conditions that may affect operation and management of the NGBR Project realignment are the same climatic conditions and natural hazards identified and assessed in the NGBR Project EIS (refer NGBR Project EIS Volume 1 Chapter 17 Climate and natural hazards).This includes the vulnerability of the NGBR Project realignment to existing and future climatic conditions, including the effects of climate change.

Natural hazards that have the potential to impact the NGBR Project realignment include flooding and bushfires. Flood plains, particularly those associated with the Bowen River, Suttor River

and a number of smaller creeks, are located along the length of the NGBR Project realignment. A review of published information (Bureau of Meteorology, 2013) indicates that flooding has historically been reported in these areas and therefore has the potential to overtop rail formations, submerge access roads and damage rail infrastructure. To minimise the potential impacts of flooding on the NGBR Project realignment, the rail formation will be designed above the one in 50 year flood level and the rail track will be designed above the one in 100 year flood level.

Bushfires have a low to medium risk of occurring along or adjacent to the NGBR Project realignment (QFRS 2008a; QFRS 2008b). The bushfire mitigation and management measures proposed in the NGBR Project EIS (refer NGBR Project EIS Volume 1 Chapter 17 Climate and natural hazards) will be implemented during construction and operation of the NGBR Project realignment to minimise and avoid the potential risk of bushfire impacts.

The Risk Management Plan that will be developed and implemented for the NGBR Project will apply to the NGBR Project realignment and will include preventative and responsive mitigation measures to reduce the overall risk of potential hazards (refer Volume 2 Appendix H Revised environmental management plan framework).

13.6 Hazard, risk, health and safety

Construction, operation and decommissioning of the NGBR Project realignment have the potential to result in hazards to people, property and the surrounding environment. Hazards may include potential accidents, spills, wildlife, traffic collisions and the use of hazardous substances.

A hazard identification and risk assessment has been undertaken for the NGBR Project within the NGBR Project EIS Volume 1 Chapter 18 Hazard, risk, health and safety. The indicative list of hazardous substances that will be used and the likely quantities to be stored on site are unlikely to change due to the NGBR Project realignment. The likelihood and consequence of the risks identified in the hazard and risk assessment are also unlikely to change due to the realignment.

The NGBR Project realignment will not intersect any additional gas or water pipelines, high voltage transmission lines, telecommunication cables or transport infrastructure that has not already been assessed in the NGBR Project EIS. No other new hazards have been identified for the NGBR Project realignment.

The transportation of hazardous substances for the NGBR Project realignment will be via the road network, primarily the two major roads being Bowen Developmental Road and Collinsville Elphinstone Road. A traffic assessment of the NGBR Project realignment impacts on these roads, as well as the three minor roads (Council owned roads) is included within Section 11. For an assessment of the entire road network impacted by the NGBR Project refer NGBR Project EIS Volume 1 Chapter 14 Transport. The large quantities of fuel required to maintain the earthmoving fleet during construction and any other hazardous substances required for construction of the NGBR Project realignment will be stored in bunded storage facilities as outlined in the NGBR Project EIS Volume 1 Chapter 18 Hazard, risk, health and safety. The Risk Management Plan and Emergency Management Plan that will be developed and implemented for the NGBR Project will also apply to the NGBR Project realignment. These plans will include preventative and responsive mitigation measures to reduce the overall risk of potential hazards identified (refer Volume 2 Appendix H Revised environmental management plan framework).

Construction, operation and decommissioning may also result in potential impacts on the community in terms of public health and safety. Human health and public safety impacts can potentially arise from air pollution, odour, lighting, amenity, dust, noise and water quality degradation. Each of these potential impacts is assessed within the following sections:

- Section 4 Scenic amenity and lighting - alterations to lighting or scenic amenity
- Section 8 Water resources - potential impacts on water quality
- Section 9 Air quality - emissions with potential impacts on air quality including potential sources of odour
- Section 10 Noise - noise emissions
- Section 11 Transport - increase likelihood of traffic incidents.

Workplace health and safety issues during construction, operation and decommissioning of the NGBR Project realignment will be assessed and managed through development and implementation of a Work Health and Safety Management System in accordance with statutory processes and relevant health and safety legislation. The health and safety management system will comply with the requirements of the Australian Standard AS/NZS 4801:2001, Occupational health and safety management systems - Specification with guidance for use as well as applicable legislation.

13.7 Cumulative impacts

A revised cumulative impact assessment has been prepared for the NGBR Project, incorporating the NGBR Project realignment, other minor realignments and associated changes (refer to Section 19 of Volume 1 Additional information to the Environmental Impact Statement). The cumulative impact assessment undertaken for the NGBR Project EIS (refer NGBR Project EIS Volume 1 Chapter 19 Cumulative impacts) concluded that residual impacts related to nature conservation and matters of national environmental significance had the greatest potential to result in cumulative impacts. The potential for these cumulative impacts to occur is considered broadly unchanged. Any unavoidable residual impacts will be offset in accordance with Volume 2 Appendix E Revised offsets.

Potential cumulative air quality and noise and vibration impacts may occur due to the proximity of the NGBR Project realignment and the Newlands line. These potential impacts are assessed in Sections 9 and 10 respectively. The extent of cumulative impacts relating to air quality and noise and vibration will be minimised by the adherence of the NGBR Project to the GBCIF.

Other potential cumulative impacts are not considered to be significantly different from those identified within the NGBR Project EIS. The mitigation and management measures identified throughout the NGBR Project EIS and the NGBR Project realignment report are considered to be sufficient to avoid potential cumulative impacts.

14. Legislation and approvals

14.1 Purpose of section

The purpose of this section is to identify and discuss any legislation, planning instruments and polices that apply to the NGBR Project realignment. This includes Commonwealth, State and local government legislation and approvals.

A brief description of each relevant act, planning instrument or policy is provided with a description of the relevant triggers as they relate to the NGBR Project realignment.

Any changes to legislation, planning instruments or policies will be reflected in development applications and NGBR Project environmental management plan, prior to construction.

14.2 Commonwealth legislation and policy

The NGBR Project realignment will not trigger any additional overarching Commonwealth approvals to that identified in Volume 2 Appendix J Revised legislation and approvals.

14.3 State legislation and policy

14.3.1 State Development and Public Works Organisation Act 1971

Proposed Galilee Basin State Development Area

Following publication of the NGBR Project EIS in December 2013 (DSDIP 2014), the Queensland Government released a proposed Galilee Basin State Development Area (GBSDA) Draft Development Scheme which includes indicative mapping for rail infrastructure, including a proposed North to South Rail Corridor Precinct to service the central area of the Galilee Basin. The proposed GBSDA aligns with the State Government's support for a single north-south and multi-user common access rail corridor and is in accordance with the Galilee Basin Coal Infrastructure Framework (Queensland Government 2013a) and the Galilee Basin Development Strategy (Queensland Government 2013b).

The final NGBR Project footprint is contained within the South to North Rail Corridor Precinct boundaries of the proposed GBSDA Draft Development scheme.

The proposed GBSDA does not change the ownership of the land within the area. However, it may assist the Coordinator-General in acquiring land and easements for future projects and will help provide a streamlined approvals process for proponents.

Upon declaration of the GBSDA and finalisation of the associated development scheme, Adani will seek a development approval for a material change of use in accordance with the development scheme, where required. The final GBSDA Development Scheme is expected to remove the need for a material change of use approval for the NGBR Project under the *Bowen Shire Planning Scheme 2006*, *Belyando Shire Planning Scheme 2008* and *Nebo Shire Planning Scheme 2008* in accordance with the *Sustainable Planning Act 2009* once this new scheme is approved.

14.3.2 State planning policy

Since the NGBR Project EIS was submitted, the Queensland Government has developed a single state planning policy that replaces the multiple state planning policies previously in place. The single policy outlines the State's interests in land use planning and development under five

broad themes. The five broad themes are generally consistent with the multiple state planning policies assessed in the NGBR Project EIS, namely:

- SPP 1/92 Development and the Conservation of Agricultural Land
- SPP 1/02 Development in the Vicinity of Certain Airports and Aviation Facilities
- SPP 2/02 Planning and Managing Development Involving Acid Sulfate Soils
- SPP 1/03 Mitigating the Adverse Impacts of Flood, Bushfire and Landslide
- SPP 1/07 Housing and Residential Development including Guideline
- SPP 2/07 Protection of Extractive Resources and Guideline
- SPP 2/10 South East Queensland Koala Conservation
- SPP 3/10 Acceleration of Compliance Assessment
- SPP 4/10 Healthy Waters
- SPP 5/10 Air, Noise and Hazardous Materials
- SPP 4/11 Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments
- SPP 1/12 Protection of Queensland's Strategic Cropping Land
- Temporary SPP 2/12 Planning for Prosperity.

An assessment of the NGBR Project, including the NGBR Project realignment, against the single state planning policy is provided in Volume 2 Appendix J Revised legislation and approvals.

14.4 Local planning instruments

The NGBR Project realignment crosses properties zoned as rural within the Whitsunday Regional Council (chainage 128 km – chainage 192.5 km; chainage 196.9 km – chainage 205 km) and the Isaac Regional Council area (chainage 192.5 km – chainage 196.9 km). Land use activities on these properties are regulated by the *Bowen Shire Planning Scheme 2006* and the *Nebo Shire Planning Scheme 2008* respectively. Volume 2 Appendix J Revised legislation and approvals includes an assessment of the NGBR Project against the *Bowen Shire Planning Scheme 2006* and the *Nebo Shire Planning Scheme 2008*.

15. Conclusion and recommendations

15.1 Rationale for the NGBR Project realignment

Following publication of the NGBR Project EIS in December 2013, further consultation was undertaken with the State government and potentially affected resource companies. As a result, realignment of approximately 70 kilometres of the NGBR Project final rail corridor (as set out in the NGBR Project EIS) is proposed to minimise known/potential sterilisation of coal resources and/or encroachment on existing coal tenements crossed by the NGBR Project.

The approximately 77 km NGBR Project realignment deviates to the east in the vicinity of Bowen River, Newlands and then coincides with the approved Alpha Coal Project for approximately 64 km before re-joining the NGBR Project final rail corridor as described in the NGBR Project EIS, south of the Suttor River near Mt Coolon. Approximately 57 km of the total 77 km length of the NGBR Project realignment runs parallel to Aurizon's Newlands line and Northern Missing Link, at a distance of approximately 50 metres.

The final NGBR Project, including the realignment, will provide significant capital investment of approximately $2.2 billion and will generate approximately 6,150 jobs (1,700 direct and 4,452 indirect) in the region. The NGBR aligns with the Galilee Basin Coal Infrastructure Framework (Queensland Government 2013a), the Galilee Basin Development Strategy (Queensland Government 2013b) and conforms with the south to north rail corridor precinct boundaries of the proposed GBSDA. The NGBR Project is considered to be well aligned with relevant government policy and supports the opening up of the Galilee Basin to mining.

15.2 Realignment impacts

This report provides a desktop assessment of the potential environmental impacts associated with construction and operation of the NGBR Project realignment. The assessment utilises publically available information from previously approved rail infrastructure projects within close proximity to the realignment as well as publically available database information and information created during the development of the NGBR Project EIS.

The assessment identified a number of predominantly localised, adverse impacts to the environment as well as a number of beneficial effects. The beneficial effects of the NGBR Project realignment include:

- Minimising sterilisation of coal resources and encroachment on existing mining tenements
- Coinciding with 64 km section of the approved (but yet to be constructed) Alpha Coal Project rail corridor, 57 km of which is adjacent to the existing Newland line and therefore minimising land disturbance and fragmentation of properties.

The temporary adverse environmental impacts that are likely to occur during construction of the realignment and that will replace a component of the impacts identified in the NGBR Project EIS include:

- Land use change of 224.49 ha of land from predominantly cattle breeding and fattening activities to construction infrastructure (temporary laydown areas, a construction maintenance yard, concrete batching plant and construction camp)
- Short-term increases in traffic volumes on State-controlled roads.

The key permanent adverse environmental impacts that will result due the realignment and will replace a component of the impacts identified in the NGBR Project EIS include:

- Land use change of approximately 581.34 ha of land across eight properties from predominantly cattle breeding and fattening activities to rail infrastructure
- Land fragmentation of approximately 20 km of the NGBR Project realignment (greenfield corridor)
- Sterilisation of approximately 267.2 ha of GQAL and 252.22 ha of potential SCL
- Changes to landscape character and scenic amenity due to cut and fill activities and the rail embankment moderately impacting two homesteads
- Clearing of approximately 806 ha of vegetation, of which approximately 543 ha is mapped remnant vegetation, 26.8 ha is riparian vegetation, and 27 ha is wetland vegetation
- Clearing of approximately 354.2 ha of potential habitat for bluegrass (*Dichanthium setosum*), listed as vulnerable under the EPBC Act
- Clearing of approximately 263.3 ha of potential habitat for king bluegrass (*Dichanthium queenslandicum*) listed as endangered under the EPBC Act
- Clearing of approximately 125.1 ha of potential habitat for black ironbox (*Eucalyptus raveretiana*), listed as vulnerable under the EPBC Act and NC Act
- Direct loss of potential habitat for four EPBC Act-listed threatened fauna species confirmed present or considered likely to occur
- Direct loss of potential habitat for eight NC Act-listed threatened fauna species confirmed present or considered likely to occur
- Habitat fragmentation and restrictions of fauna movement, including aquatic fauna, due to the NGBR Project realignment formation and waterway crossings
- GHG emissions due to vegetation clearing and diesel usage during construction and operation respectively
- Potential noise and vibration impacts at Homestead 16 and Homestead R2
- Damage to or removal of items or places of Indigenous cultural heritage significance during construction.

The potential adverse environmental impacts will be minimised and managed through implementation of the measures outlined in this realignment report. These mitigation and management measures will be incorporated within Volume 2 Appendix H Revised environmental management plan framework.

15.3 Recommendation

With due regard to the outcomes of the assessment of the benefits and potential impacts of the NGBR Project realignment, Adani is seeking approval of the NGBR Project, subject to:

- All necessary approvals and permits being obtained
- Developing, implementing and maintaining management and mitigation measures outlined in the NGBR Project EIS and NGBR Project realignment report
- Developing and implementing detailed environmental management plans consistent with the principles, objectives and performance criteria outlined in Volume 2 Appendix H

Revised environmental management plan framework for the construction and operation phase of the NGBR Project

- Undertaking obligations and commitments consistent with the intent of those outlined in Volume 2 Appendix G Revised commitments
- Further development and implementation of the final offsets package for the NGBR Project, as describe in Volume 2 Appendix E Revised offsets.

16. References

16.1 Project description

State of Queensland 2013a, Galilee Basin Coal Infrastructure Framework – Rail and port, retrieved June 29, 2013, from http://www.dsdip.qld.gov.au/infrastructure-planning-and-reform/galilee-basin-infrastructure-framework-rail-and-ports.html.

State of Queensland 2013b, Galilee Basin Development Strategy, retrieved February 10, 2014, from http://www.dsdip.qld.gov.au/resources/plan/galilee-basin-strategy.pdf.

16.2 Land use and tenure

Department of Environment and Resource Management (DERM) 2010, Topographic maps. Department of Environment and Resource Management.

Department of Natural Resources and Mines (DNRM) 2014, Cadastral maps. Department of Natural Resources and Mines.

Department of Natural Resources and Mines (DNRM) 2014, Mining tenures. Department of Natural Resources and Mines.

Department of Natural Resources and Mines (DNRM) 2014, Title and tenure details of freehold and leasehold properties. Department of Natural Resources and Mines.

Department of Natural Resources and Mines (DNRM) 2013, Guide to Tenure under the *Land Act 1994*, retrieved January 15, 2014, from http://www.dnrm.qld.gov.au/__data/assets/pdf_file/0008/104867/land-tenure-qld.pdf

Department of Natural Resources and Mines (DNRM) 2013, Stock route network maps, Department of Natural Resources and Mines.

Department of Natural Resources and Mines (DNRM) 2010, Location of roads. Physical Road Network, Department of Natural Resources and Mines.

Department of Local Government and Planning (DLGP), 2012, Mackay, Isaac and Whitsunday Regional Plan, retrieved January 15, 2014, from http://www.parliament.qld.gov.au/Documents/TableOffice/ TabledPapers/2012/5312T6545.pdf

Environment Land Heritage (ELH) 2014, Cultural heritage Technical Addendum Report, Northern Galilee Basin Rail Project Additional Environmental Impact Statement, report prepared for Adani Mining Pty Ltd.

Google Earth Professional Imagery 2013, Aerial photography, Google Earth.

Geosciences Australia 2007, Location of gas and water pipelines. Pipelines, Geosciences Australia.

Geosciences Australia (GA) 2007, Location of rail lines. Railway network, Geosciences Australia.

Geosciences Australia (GA) 2007, Maps identifying sensitive receptors, Geosciences Australia.

Hancock Prospecting Pty Ltd 2010, Alpha Coal Project EIS, Volume 3, Railway Corridor. report prepared by GHD Pty Ltd.

Hancock Prospecting Pty Ltd 2011, Alpha Coal Project SEIS (Rail), report prepared by GHD Pty Ltd.

Isaac Regional Council (IRC) 2008, Planning Scheme for Belyando Shire, retrieved January 18, 2014, from http://www.isaac.qld.gov.au/documents/12238/11766856/Belyando%20Shire%20Planning%20Scheme.pdf

Queensland Government 2014 a, Draft Galilee Basin State Development Area Development Scheme, Department of State Development, Infrastructure and Planning 2014

Whitsunday Regional Council (WRC) 2006, Bowen Shire Council Planning Scheme 2006. retrieved January 25, 2014, from http://www.whitsunday.qld.gov.au/c/document_library/get_file?uuid=0e564b25-4dea-452a-824f-aaff3bf63d82&groupId=800153

16.3 Scenic amenity and lighting

Department of Environment and Heritage (DEH) 2005, Interim Biogeographic Regionalisation for Australia (IBRA). Department of Environment and Heritage.

Department of Environment and Resource Management (DERM) 2007, Local Government Area (LGA) boundaries. Department of Natural Resources and Mines.

Department of Environment and Resource Management (DERM) 2007, Rail network maps, Department of Natural Resources and Mines

Department of Environment and Resource Management (DERM) 2010, Topographic maps. Department of Environment and Resource Management.

Department of Environment and Resource Management (DERM) 2010, Road network maps, Department of Natural Resources and Mines

Department of Environment and Resource Management (DERM) 2011, Digital Cadastral Database (DCDB) to delineate protected areas, Department of Natural Resources and Mines.

Department of Environment and Resource Management (DERM) 2012, Cadastral maps, Department of Natural Resources and Mines

Department of Natural Resources and Mine (DNRM) 2013, Burdekin Catchment 25 m Digital Elevation Model (DEM). Department of Natural Resources and Mine

Environmental Systems Research Institute (ESRI) 2011, Hillshade (Shuttle Radar Topography Mission Shaded Relief), Environmental Systems Research Institute.

Forest Practice Board Tasmania, 2006 A Manual for Forest Landscape Management, retrieved 10 February 2014, http://www.fpa.tas.gov.au/__data/assets/pdf_file/0007/58588/Section_1_landscape_manual.pdf

Geosciences Australia (GA) 2007, Homestead locations. Geosciences Australia

Geosciences Australia (GA) 2007, Watercourse maps. Geosciences Australia.

Google Earth Professional Imagery 2013, Aerial photography, Google Earth.

Hancock Prospecting Pty Ltd 2010, Alpha Coal Project EIS, Volume 3, Railway Corridor. report prepared by GHD Pty Ltd.

Landscape Institute and Institute for Environmental Management and Assessment, 2002. Guidance for Landscape and Visual Impact Assessment. Spon Press 2nd Edition.

Western Australian Planning Commission, 2007. Visual Landscape Planning in Western Australia – a manual for evaluation, assessment, siting and design, retrieved 10 February 2014, http://www.planning.wa.gov.au/dop_pub_pdf/Landscape_Web_Pt1.pdf.

16.4 Topography, geology, soils and land contamination

4DGeotechnics Pty Ltd (2014) Adani NGBR O9R1 Draft Realignment Preliminary Geotechnical Desktop Report. Unpublished report for Adani Mining Pty Ltd.

Hancock Prospecting Pty Ltd (2010) Alpha Coal Project Environmental Impact Statement, Volume 3, Railway Corridor. Unpublished report for Hancock Prospecting Pty Ltd.

Hazelton, P and Murphy, B (2007) Interpreting soil test results: what do all the numbers mean? CSIRO Publishing, Victoria.

National Committee on Soil and Terrain 2009, Australian soil and land survey field handbook, 3rd edn, CSIRO Publishing, Collingwood.

Natural Resources Conservation Service 1993, Soil Survey Manual. retrieved 10 February 2014, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/planners/?cid=nrcs142p2_054262

16.5 Nature conservation

Algers, B, Ekesbo, I, and Strömberg, S 1978, The impact of continuous noise on animal health, Acta Veterinaria Scandinavica (Supplementum) vol 67 pp 1-26.

Allen, GR, Midgley, SH and Allen, M 2002, Field Guide to the Freshwater Fishes of Australia, Western Australian Museum

Allendorf, FW 1983. Isolation, gene flow, and genetic differentiation among populations. In 'Genetics and conservation: A reference for managing wild animal and plant populations'. (Eds CM Schonewald-Cox, SM Chambers, B MacBryde, WL Thomas) pp 51-65. (Benjamin Cummings: Menlo Park).

Andren, H 1994, 'Effects of habitat fragmentation on birds and mammals in landscapes with different proportions of suitable habitat: A review', Oikos, pp 355 – 366

Bean, AR 2010, Personal communication cited in: Department of Environment (SEWPaC) 2014. *Eucalyptus raveretiana,* in: Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra, retrieved June 20, 2013, from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=16344.

Bogan, MT and Boersma, KS 2012, Aerial dispersal of aquatic invertebrates along and away from arid-land streams, Freshwater Science, vol. 31, pp 1131-1144.

Butler, DW, 2007, Recovery plan for the "Brigalow (*Acacia harpophylla* dominant and co-dominant) endangered ecological community (draft of 1 May 2007). Report to the Department of the Environment and Water Resources, Canberra. Queensland National Parks and Wildlife Service, Brisbane.

Calvert, G, Lokkers, C and Cumming, R 2005, Rare and Threatened Plants of the Townsville Thuringowa Region, Costal Dry Tropics Landcare Inc, Townsville.

Carter, J and Tait, J 2008, Freshwater Fish of the Burdekin Dry Tropics NRM Region, Burdekin Dry Tropics NRM

CDM Smith 2012, 'Abbot Point Coal Terminal 0 Draft Environmental Impact Statement', prepared for Adani Mining Pty Ltd.

Churchill, S 2008, Australian Bats,. Second Edition, New Holland Publishers Pty Ltd, Sydney.

Clayton, PD, Fielder, DP, Howell, S and Hill, CJ 2006, Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment, Environmental Protection Agency, Brisbane.

Cogger, HG, Cameron, EE, Sadlier, RA and Eggler, P, 1993, The Action Plan for Australian Reptiles. [Online]. Canberra, ACT: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/biodiversity/threatened/action/reptiles/index.html.

Connell Hatch 2008, Final Report: Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains on the Goonyella, Blackwater and Moura Coal Rail Systems, Prepared for Queensland Rail Limited.

Council of Heads of Australasian Herbaria, 2013, Australia's Virtual Herbarium, retrieved June 20, 2013, from http://avh.chah.org.au/.

Department of Employment, Economic Development and Innovation (DEEDI) 2010, Feral pigs in Queensland Fact Sheet.

Department of Employment, Economics Development and Innovation (DEEDI), 2013, Noxious fish, retrieved August 27, 2013, from http://www.daff.qld.gov.au/fisheries/pest-fish/noxious-fish.

Department of Environment and Heritage Protection (DEHP) 2013a, Common death adder profile, retrieved February 13, 2014, from https://www.ehp.qld.gov.au/wildlife/animals-az/common_death_adder.html

Department of Environment and Heritage Protection (DEHP) 2013b, Wetland Info Burdekin drainage basin, retrieved June 06, 2013, from http://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/basin-burdekin/.

Department of Environment and Heritage Protection (DEHP) 2014a, Regional ecosystem details for 11.3.25, retrieved February 20, 2014, from http://www.ehp.qld.gov.au/ecosystems/biodiversity/regional-ecosystems/details.php?reid=11.3.25

Department of Environment and Heritage Protection (DEHP) 2014b, Regional ecosystem details for 11.3.27, retrieved February 20, 2014, from http://www.ehp.qld.gov.au/ecosystems/biodiversity/regional-ecosystems/details.php?reid=11.3.27

Department of Environment and Resource Management (DERM) 2010, Burdekin Natural Resource Management Region Back on Track Actions for Biodiversity, Department of Environment and Resource Management, Brisbane.

Department of Environment and Resource Management (DERM) 2012, National recovery plan for the red goshawk *Erythrotriorchis radiatus*, retrieved February 13, 2014, from http://www.environment.gov.au/system/files/resources/115185bc-74f7-40e4-a0af-f46aaa482dc7/files/erythrotriorchis-radiatus.pdf

Department of Environment and Resource Management (DERM), 2011, Wetland System Definitions, retrieved June 24, 2013, from http://wetlandinfo.ehp.qld.gov.au/wetlands/what-are-wetlands/definitions-classification/system-definitions.html.

Department of the Environment (DotE) 2014a, *Tyto novaehollandiae* kimberli in Species Profile and Threats Database, retrieved February 13, 2014, from:http://www.environment.gov.au/sprat

Department of the Environment (DotE) 2014b, *Denisonia maculata* in Species Profile and Threats Database, retrieved February 13, 2014, from:http://www.environment.gov.au/sprat.

Department of the Environment (DotE) 2014c, *Crocodylus porosus* in Species Profile and Threats Database, retrieved February 13, 2014, from http://www.environment.gov.au/sprat.

Department of the Environment (DotE) 2014d, *Egernia rugosa* in Species Profile and Threats Database, retrieved February 13, 2014, from http://www.environment.gov.au/sprat.

Department of the Environment (DotE) 2014e, Koala (Phascolarctos cinereus) Listing: Habitat for protection listing, retrieved February 13 2014, from http://www.environment.gov.au/node/16419.

Department of the Environment (DotE) 2014f, *Paradelma orientalis* in Species Profile and Threats Database, retrieved February 13, 2014, from:http://www.environment.gov.au/sprat.

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2009a, Significant impact guidelines 1.1, Matters of National Environmental Significance. Department of the Environment, retrieved February 14 2014, from http://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf.

Dight, I 2009, Burdekin Water Quality Improvement Plan, North Queensland Dry Tropics, Townsville.

Dunlop, J, McGregor, G, and Horrigan N, 2005, Potential impacts of salinity and turbidity in riverine ecosystems. Queensland Department of Natural Resources and Mines.

E3 Consulting 2010, China First Project – Aquatic Ecology: Galilee Coal Project – Environmental Impact Statement, Prepared for Waratah Coal.

Environment Institute of Australia and New Zealand (EIANZ) 2010, Ecological Impact Assessment Guidelines, EIANZ Ecology

Environmental Protection Agency (EPA) 2008, Brigalow Belt North Landscape Expert Panel Report, Environmental Protection Agency, Brisbane

Environment Protection Agency (EPA) 2005, Wetland data springs – Queensland – digital data for download, retrieved August 27, 2013, from http://www.ehp.qld.gov.au/services/index.php?item_id=33188.

Fairfull, S and Witheridge G. 2003. Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla.

Fletcher, JL and Busnel, RG 1978, Effects of noise on wildlife, New York Academic Press.

Forster, PI 1992, *Cerbera dumicola,* in Orchard, AE (ed.) 1996 Flora of Australia, vol. 28, pp. 142-143, CSIRO Publishing, Melbourne.

GHD 2010a, Alpha Coal Project (Rail) – Freshwater Aquatic Flora and Fauna, prepared for Hancock Prospecting Pty Ltd.

GHD 2010b, Alpha Coal Project (Rail) EIS Terrestrial Ecology Report, report prepared by GHD Pty Ltd.

GHD 2012a, Drake Coal Project EIS Ecological Assessment Technical Report, report prepared by GHD Pty Ltd.

Gibbons, P and Lindenmayer, DB 2002, Tree hollows and wildlife conservation in Australia, CSIRO Publishing

Gilpin, ME and Soule, ME 1986, Minimum viable populations, Processes of species extinctions, In Soule, ME Conservation Biology: The science of scarcity and diversity, Sinauer Associates, Sunderland, MA.

Goosem, M 2007, 'Fragmentation impacts caused by roads through rainforests', Current Science, vol 93, pp 1587–1595.

Greiner, R and Hall, H, 2006, Social, economic, cultural and environmental values of streams and wetlands in the Burdekin Dry Tropics region, prepared for the Burdekin Dry Tropics NRM and the Coastal Catchments Initiative.

Higgins, PJ, Peter, JM and Cowling, SJ 2006, Handbook of Australian, New Zealand and Antarctic Birds, Volume 7, Boatbill to Larks, Oxford University Press, Melbourne.

Higgins, PJ, Peter, JM and Steele, WK (eds.) 2001, Handbook of Australian, New Zealand and Antarctic Birds Volume 5: Tyrant-flycatchers to Chats, Oxford University Press, Melbourne.

Hill, B and Ward, S 2010, National Recovery Plan for the Northern Quoll *Dasyurus hallucatus,* Department of Natural Resources, Environment, The Arts and Sport, Darwin.

Hughes, JM 2007, Constraints on recovery: using molecular methods to study connectivity of aquatic biota in rivers and streams, Freshwater Biology, vol 52, pp 616-631.

Inglis, SN and Howell, S 2009a, Aquatic Conservation Assessments (ACA), using AquaBAMM, for the Riverine Wetlands of the Great Barrier Reef Catchment, Department of Environment and Resource Management, Brisbane.

Inglis, SN and Howell, S 2009b, Aquatic Conservation Assessments (ACA), using AquaBAMM, for the Non-riverine Wetlands of the Great Barrier Reef Catchment, Department of Environment and Resource Management, Brisbane.

Larkin, R 1996, Effects of Military Noise on Wildlife: A Literature Review, USA CERL Technical Report.

Larned, ST, Datry, T and Robinson CT 2007, Invertebrate and microbial responses to inundation in an ephemeral river reach in New Zealand: effects of preceding dry periods, Aquatic Sciences, vol. 69, pp 554-567.

Lockwood, JL, and McKinney, ML 1999, Biotic Homogenization Kluwer Academic/Plenum Publishers

Marchant S and Higgins PJ (eds.) 1990, Handbook of Australian, New Zealand and Antarctic Birds Volume 1: Ratites to Ducks, Oxford University Press, Melbourne.

Marchant S and Higgins PJ (eds.) 1993, Handbook of Australian, New Zealand and Antarctic Birds Volume 2: Raptors to Lapwings, Oxford University Press, Melbourne.

Marsden, T and Power, T 2007. Proposal for raising Eden Bann Weir and construction of Rookwood Weir – An assessment of the potential requirements for fish passage, Commercial-in-confidence report prepared for the Department of Natural Resources and Water, Queensland.

Marsh, DM, and Trenham, PC 2001, Metapopulation dynamics and amphibian conservation, Conservation Biology vol 15, pp 40–49.

McDonald, WJF, 1996, *Spatial and temporal patterns in the dry season subtropcial rainforests of eastern Australia, with particular reference to the vine thickets of central and southern Queensland*. PhD thesis, Botany Department, University of New England, Armidale.

McDonald, WJF, 2007, *National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community*. Draft prepared by the Queensland Parks and Wildlife Service for the Department of the Environment, Water, Heritage and the Arts, Canberra.

Melzer, A, Carrick, F, Menkhorst, P, Lunney D and John, BS 2000, '*Overview, critical assessment, and conservation implications of koala distribution and abundance*', Conservation Biology, vol 14, pp 619-628.

National Water Commission (NWC) 2013, Burdekin Basin, retrieved June 04, 2013, from http://archive.nwc.gov.au/library/topic/planning/report-card/queensland/planning-areas/water-resource-burdekin-basin-plan.

Patterson, R 1996, The distribution of the koala in Queensland 1986-1989, In Gordon, G, (ed) Koalas, Research for Management: Proceedings of the Brisbane Koala Symposium, World Koala Research Inc., Corinda pp. 75-81.

Pizzey, G and Knight, F 2007, The Field Guide to the Birds of Australia, 8th edn, Harper Collins, Sydney

Pusey, B, Kennard, M and Arthington, A 2004, Freshwater fishes of north-eastern Australia, CSIRO Publishing, Melbourne, Australia

Queensland Herbarium 2002, Environment Protection and Biodiversity Conservation Act Threatened ecological communities 1997 remnant, Unpublished map, Queensland Herbarium, Brisbane.

Queensland Herbarium 2013, Regional Ecosystem Description Database (REDD), Version 8 (February 2013), Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane.

Rich, C and Longcore, T 2006, Ecological consequences of artificial night lighting, Island Press, Washington, D.C

Sattler, PS and Williams, RD (eds.) 1999, The Conservation Status of Queensland's Bioregional Ecosystems, Environmental Protection Agency, Brisbane.

Shine, R 1983, Food habits and reproductive biology of the Australian elapid snakes of the genus *Denisonia*, Journal of Herpetology, vol 17, pp171-175.

Simon, BK 1982, New Species of Gramineae from south-eastern Queensland, Austrobaileya, vol. 1, issue 5, pp 455-467.

Strahan, R 1995, Complete Book of Australian Mammals, Reed Books, Chatswood.

Swer, S and Singh, OP 2003 Coal mining impacting water quality and aquatic biodiversity in Jaiñtia Hills District of Meghalaya, Himalayan Ecology, vol 11 p 29.

Therriault, TW and Kolasa, J 2000, Patterns of community variability depend on habitat variability and habitat generalists in natural aquatic microcosms, Community Ecology, vol 1, issue 2, pp 195-203.

Thompson, B, Schulz, M, Clague, C, Ellis, M and Young, A 2011, The Action Plan for Australian Bats – Recovery outlines and taxon summaries (continued) – Taxon summary: Little Pied Bat. Department of Sustainability, Environment, Water, Population and Communities. Canberra, retrieved February 13, 2014, from http://www.environment.gov.au/resource/action-plan-australian-bats

Threatened Species Scientific Committee (TSSC) 2001o, Commonwealth Conservation Advice on http://www.environment.gov.au/biodiversity/threatened/communities/pubs/99-listing-advice.pdfSemi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions, retrieved February 17, 2014, from http://www.environment.gov.au/node/14552

Threatened Species Scientific Committee (TSSC) 2005s, Commonwealth Listing Advice on Black-throated Finch (*Poephila cincta cincta*), retrieved February 13, 2014, from http://www.environment.gov.au/node/16484

Threatened Species Scientific Committee (TSSC) 2005x, Commonwealth Listing Advice on Northern Quoll (*Dasyurus hallucatus*), retrieved February 13, 2014, from http://www.environment.gov.au/node/16356

Threatened Species Scientific Committee (TSSC) 2008adq, Commonwealth Conservation Advice on Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin, retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/communities/pubs/99-listing-advice.pdf

Threatened Species Scientific Committee (TSSC) 2008agn, Commonwealth Conservation Advice on *Dichanthium setosum*, retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/14159-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) 2008agp, Commonwealth Conservation Advice on *Geophaps scripta scripta* (Squatter Pigeon (southern)), retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/64440-conservation-advice.pdf.

Threatened Species Scientific Committee (TSSC) 2008cu, Commonwealth Listing Advice on *Neochmia ruficauda ruficauda* (Star Finch (eastern)), retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/26027-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) 2008dt, Commonwealth Listing Advice on *Lerista vittata* (Mount Cooper striped Lerista), retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/1308-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) 2008ek, Commonwealth Listing Advice on *Digitaria porrecta* (Finger panic grass), retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/12768-listing-advice.pdf

Threatened Species Scientific Committee (TSSC) 2012au, Commonwealth Listing Advice on *Eucalyptus raveretiana*, retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/16344-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) 2013as, Commonwealth Listing Advice on *Rostratula australis* (Australian Painted Snipe) retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-listing-advice.pdf

Threatened Species Scientific Committee (TSSC) 2013n Commonwealth Listing Advice on *Dichanthium queenslandicum* (king blue grass) retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/5481-conservation-advice.pdf

Webb, LJ and Tracey, JG, 1994, The rainforests of northern Australia. Chapter 4 in RH Groves (ed.), *Australian Vegetation*, second edition, Cambridge University Press.

Wilson, S 2005, A Field Guide to the Reptiles of Queensland, New Holland Publishers Australia Pty Ltd, Sydney.

16.6 Matters of national environmental significance

Calvert, G, Lokkers, C and Cumming, R 2005, Rare and Threatened Plants of the Townsville Thuringowa Region, Costal Dry Tropics Landcare Inc, Townsville.

Carter, J and Tait, J 2008, Freshwater Fish of the Burdekin Dry Tropics NRM Region, Burdekin Dry Tropics NRM

Clayton, PD, Fielder, DP, Howell, S and Hill, CJ 2006, Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment. Environmental Protection Agency, Brisbane.

Council of Heads of Australasian Herbaria, 2013, Australia's Virtual Herbarium, retrieved June 20, 2013, from http://avh.chah.org.au/.

Department of Environment and Heritage Protection (DEHP) 2013, Wetland mapping. Department of Environment and Heritage Protection.

Department of Environment and Resource Management (DERM) 2012, National recovery plan for the red goshawk *Erythrotriorchis radiatus*, retrieved February 13, 2014, from http://www.environment.gov.au/system/files/resources/115185bc-74f7-40e4-a0af-f46aaa482dc7/files/erythrotriorchis-radiatus.pdf

Department of Natural Resources and Mines (DNRM) 2011, Regional Ecosystem Mapping v 6.1. Department of Natural Resources and Mines.

Department of Natural Resources and Mines (DNRM) 2013, Essential Habitat Mapping, Department of Natural Resources and Mines.

Department of the Environment (DotE) 2014a, *Tyto novaehollandiae* kimberli in Species Profile and Threats Database, retrieved February 13, 2014, from:http://www.environment.gov.au/sprat

Department of the Environment (DotE) 2014b, *Denisonia maculata* in Species Profile and Threats Database, retrieved February 13, 2014, from:http://www.environment.gov.au/sprat.

Department of the Environment (DotE) 2014c, *Crocodylus porosus* in Species Profile and Threats Database, retrieved February 13, 2014, from http://www.environment.gov.au/sprat.

Department of the Environment (DotE) 2014d, *Egernia rugosa* in Species Profile and Threats Database, retrieved February 13, 2014, from http://www.environment.gov.au/sprat.

Department of the Environment (DotE) 2014e, Koala (Phascolarctos cinereus) Listing: Habitat for protection listing, retrieved February 13 2014, from http://www.environment.gov.au/node/16419.

Department of the Environment (DotE) 2014f, *Myiagra cyanoleuca* in Species Profile and Threats Database, retrieved February 13, 2014, from http://www.environment.gov.au/sprat.

Department of State Development, Infrastructure and Planning (DSDIP) 2013, Galilee Basin Development Strategy, November 2013

Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC) 2011, Directory of Important wetlands. Department of the Environment.

Drake Coal Pty Ltd 2012, Drake Coal Project EIS. report prepared by GHD Pty Ltd.

Hancock Prospecting Pty Ltd 2010, Alpha Coal Project EIS, Volume 3, Railway Corridor. report prepared by GHD Pty Ltd.

Hill, B and Ward, S 2010, National Recovery Plan for the Northern Quoll *Dasyurus hallucatus,* Department of Natural Resources, Environment, The Arts and Sport, Darwin.

Inglis, SN and Howell, S 2009a, Aquatic Conservation Assessments (ACA), using AquaBAMM, for the Riverine Wetlands of the Great Barrier Reef Catchment, Department of Environment and Resource Management, Brisbane.

Inglis, SN and Howell, S 2009b, Aquatic Conservation Assessments (ACA), using AquaBAMM, for the Non-riverine Wetlands of the Great Barrier Reef Catchment, Department of Environment and Resource Management, Brisbane.

Marchant S and Higgins PJ (eds.) 1993, Handbook of Australian, New Zealand and Antarctic Birds Volume 2: Raptors to Lapwings, Oxford University Press, Melbourne.

Melzer, A, Carrick, F, Menkhorst, P, Lunney D and John, BS 2000, '*Overview, critical assessment, and conservation implications of koala distribution and abundance*', Conservation Biology, vol 14, pp 619-628.

Patterson, R 1996, The distribution of the koala in Queensland 1986-1989, In Gordon, G, (ed) Koalas, Research for Management: Proceedings of the Brisbane Koala Symposium, World Koala Research Inc., Corinda pp. 75-81.

Pizzey, G and Knight, F 2007, The Field Guide to the Birds of Australia, 8th edn, Harper Collins, Sydney

Pusey, B, Kennard, M and Arthington, A 2004, Freshwater fishes of north-eastern Australia, CSIRO Publishing, Melbourne, Australia

Queensland Museum (QM) 2013, Queensland Museum Data Search, retrieved February 11, 2014, from www.qm.qld.gov.au

Simon, BK 1982, New Species of Gramineae from south-eastern Queensland, Austrobaileya, vol. 1, issue 5, pp 455-467.

Strahan, R 1995, Complete Book of Australian Mammals, Reed Books, Chatswood.

Threatened Species Scientific Committee (TSSC) 2005s, Commonwealth Listing Advice on Black-throated Finch (*Poephila cincta cincta*), retrieved February 13, 2014, from http://www.environment.gov.au/node/16484

Threatened Species Scientific Committee (TSSC) 2005x, Commonwealth Listing Advice on Northern Quoll (*Dasyurus hallucatus*), retrieved February 13, 2014, from http://www.environment.gov.au/node/16356

Threatened Species Scientific Committee (TSSC) 2008adq, Commonwealth Conservation Advice on Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin, retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/communities/pubs/99-listing-advice.pdf

Threatened Species Scientific Committee (TSSC) 2008agn, Commonwealth Conservation Advice on *Dichanthium setosum*, retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/14159-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) 2008agp, Commonwealth Conservation Advice on *Geophaps scripta scripta* (Squatter Pigeon (southern)), retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/64440-conservation-advice.pdf.

Threatened Species Scientific Committee (TSSC) 2008cu, Commonwealth Listing Advice on *Neochmia ruficauda ruficauda* (Star Finch (eastern)), retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/26027-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) 2008dt, Commonwealth Listing Advice on *Lerista vittata* (Mount Cooper striped Lerista), retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/1308-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) 2013as, Commonwealth Listing Advice on *Rostratula australis* (Australian Painted Snipe) retrieved February 13, 2014, from http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-listing-advice.pdf

Wilson, S 2005, A Field Guide to the Reptiles of Queensland, New Holland Publishers Australia Pty Ltd, Sydney.

Vallee, L, Hogbin, T, Monks, L, Makinson, B, Matthes, M & Rossetto, M 2004, Guidelines for the Translocation of Threatened Plants in Australia - Second Edition, Australian Network for Plant Conservation, Canberra.

16.7 Water resources

ANZECC/ARMCANZ 2000, Australian and New Zealand guidelines for fresh and marine water quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Brierley G and Fryirs K, 2005, Geomorphology and River Management: Applications of the River Styles Framework, Blackwell Publishing, Oxford, UK, pp 398.

Bureau of Meteorology (BOM) 2013a, Climate Data Online, retrieval June 20, 2013, from http://www.bom.gov.au/climate/data/index.shtml

Bureau of Meteorology (BOM) 2013b, Flood Warning System for the Burdekin River, retrieval June 20, 2013, from http://www.bom.gov.au/qld/flood/brochures/burdekin/burdekin.shtml

Department of Natural Resources and Mines (DNRM) 2013, Water Monitoring Portal, available at: http://watermonitoring.derm.qld.gov.au/host.htm.

Department of Environment and Resource Management (DERM) 2009, Monitoring and Sampling Manual.

Department of Natural Resources and Mines (DNRM) 2013, Groundwater bore database. Department of Natural Resources and Mines.

E3 Consulting 2011, China First Project Waratah Coal Galilee Coal Project – Environmental Impact Statement, Prepared for Waratah Coal.

Geoscience Australia (GA) 2007, Topographic mapping.

Hancock Prospecting Pty Ltd 2010, Alpha Coal Project EIS, Volume 3, Railway Corridor. report prepared by GHD Pty Ltd.

Hancock Prospecting Pty Ltd 2011, Alpha Coal Project SEIS (Rail), report prepared by GHD Pty Ltd.

Kellogg Brown and Root 2012, Xstrata Coal Newlands Coal Extension Project – Environment Impact Statement.

Queensland Reconstruction Authority (QRA) 2011, Queensland Interim Floodplain Overlay, available at: http://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/get-mapping-help/metadata/floodplain-assessment-overlay/.

State of Queensland 2012, Coordinator-General's Evaluation Report on the environmental impact statement, retrieved February 13 2014, from http://www.dlg.qld.gov.au/resources/project/alpha-coal-project/alpha-coal-cg-report-final-sig.pdf.

16.8 Air quality

Aarvee Associates 2013, North Galilee Basin Rail Concept Design Report. Prepared for Adani Mining Pty Ltd.

Aurizon 2013, 2013 Network Development Plan, retrieved February 20, 2014, from http://www.aurizon.com.au/Downloads/Aurizon%20Network%20Development%20Plan%202013.pdf.

Bureau of Meteorology (BOM) (2014), Climate statistics for Australian locations, Summary statistics COLLINSVILLE POST OFFICE, retrieved February 14, 2014, from http://www.bom.gov.au/climate/averages/tables/cw_033013.shtml.

Countess Environmental, 2006. WRAP Fugitive Dust Handbook, Prepared for Western Governors' Association by Countess Environmental, retrieved February 14 2014, from http://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf

Department of the Environment and Conservation (DEC) 2005, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, Department of Environment and Conservation, Sydney.

Department of Environment and Heritage Protection (DEHP), 2013, Guideline, Environmental Protection Act 1994, Application requirements for activities with impacts to air.

Hancock Prospecting Pty Ltd 2010, Alpha Coal Project EIS, Volume 3, Railway Corridor. report prepared by GHD Pty Ltd.

Pasquill, F. (1961). The estimation of the dispersion of windborne material, The Meteorological Magazine, vol 90, No. 1063, pp 33-49.

State of Queensland 2012, Coordinator-General's Evaluation Report on the environmental impact statement, retrieved February 13 2014, from http://www.dlg.qld.gov.au/resources/project/alpha-coal-project/alpha-coal-cg-report-final-sig.pdf.

16.9 Greenhouse gas

Aarvee Associates 2013, North Galilee Basin Rail Concept Design Report. Prepared for Adani Mining Pty Ltd.

Australian Greenhouse Office 2005, National Carbon Accounting System. Commonwealth of Australia, Canberra.

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCRTE) 2013, Australian National Greenhouse Accounts, National Greenhouse Accounts

Facotrs July 2013, retrieved February 20, 2014, from http://www.climatechange.gov.au/sites/climatechange/files/documents/07_2013/national-greenhouse-accounts-factors-july-2013.pdf.

16.10 Noise and vibration

Aarvee Associates 2013, North Galilee Basin Rail Concept Design Report. Prepared for Adani Mining Pty Ltd.

Aurizon 2013, Network Development Plan, retrieved February 10, 2014, from https://www.aurizon.com.au/Downloads/Aurizon%20Network%20Development%20Plan%202013.pdf

Department of Environment and Climate Change 2009, Interim Construction Noise Guideline. retrieved February 10, 2014, from http://www.environment.nsw.gov.au/resources/noise/09265cng.pdf

Department of Environment and Resource Management (DERM) 2004, Planning for Noise Control Guideline.

Department of Environment and Resource Management (DERM) 2010, Topographic maps with 10 m contours, Department of Natural Resources and Mines.

Environmental Protection Agency (EPA Qld) 2006, Noise and vibration from blasting. retrieved February 10, 2014, from http://mines.industry.qld.gov.au/assets/explosives-pdf/noise-vibration-blasting.pdf

Environmental Protection Authority (NSW EPA) 2013, Rail Infrastructure Noise Guideline. retrieved February 10, 2014, from http://www.epa.nsw.gov.au/resources/noise/20130018eparing.pdf

Geosciences Australia 2007, Homestead locations. Geosciences Australia.

Google Earth Professional Imagery 2013, Aerial photography, Google Earth.

Hancock Prospecting Pty Ltd 2010, Alpha Coal Project EIS, Volume 3, Railway Corridor. report prepared by GHD Pty Ltd.

Hunter8 Alliance (2010), Maitland to Minimbah Third Track Noise and Vibration Impact Assessment, report to Australian Rail Track Corporation.

Queensland Rail 2006, Northern Missing Link (North Goonyella to Newlands) Environmental Impact Statement, prepared by GHD Pty Ltd.

Queensland Rail 2007, Code of Practice – Railway Noise Management Version 2. retrieved February 10, 2014, from http://www.queenslandrail.com.au/AboutUs/ReleaseOfInformation/Documents/EMS-STD-46-004.pdf

Roads and Traffic Authority (RTA) 2001, Environmental Noise Management Manual. retrieved February 10, 2014, from http://www.rms.nsw.gov.au/environment/downloads/environmental_noise_management_manual_v2.pdf

16.11 Transport

Aarvee Associates 2013, North Galilee Basin Rail Concept Design Report. Prepared for Adani Mining Pty Ltd.

Department of Natural Resources and Mines (DNRM) 2010, Physical Road Network, Department of Natural Resources and Mines

Department of Transport and Main Roads (DTMR) 2010, Crash data from Queensland roads, Queensland Government. Retrieved February 13 2014, from https://data.qld.gov.au/dataset/crash-data-from-queensland-roads

Department of Transport and Main Roads 2012 (DTMR), Traffic census data, Queensland Government. Retrieved February 13 2014, from https://data.qld.gov.au/dataset/traffic-census-for-the-queensland-state-declared-road-network

Transportation Research Board 1985, Highway Capacity Manual. National Research Council, 2nd Edition. Washington DC.

16.12 Cultural heritage

Environment Land Heritage (ELH) 2014, North Galilee Basin Rail Project Additional Environmental Impact Statement Cultural Heritage Technical Addendum Report, report prepared for Adani Mining Pty Ltd.

Hill, IW 1978, An archaeological report on Newlands Coal Project, Unpublished report prepared for MIM Holding Ltd.

L'Oste-Brown, S, Godwin, L and Porter, C 1998, Towards an Indigenous Social and Cultural Landscape of the Bowen Basin: Bowen Basin Aboriginal Cultural Heritage Project, Cultural Heritage Monograph Series 2, Department of Environment, Brisbane.

16.13 Cumulative impacts

Department of State Development, Infrastructure and Planning (DSDIP) 2014, North Galilee Basin Rail Project, retrieved February 26, 2014, from http://www.dsdip.qld.gov.au/assessments-and-approvals/north-galilee-basin-rail-project.html.

State of Queensland 2013a, Galilee Basin Coal Infrastructure Framework – Rail and port, retrieved June 29, 2013, from http://www.dsdip.qld.gov.au/infrastructure-planning-and-reform/galilee-basin-infrastructure-framework-rail-and-ports.html.

State of Queensland 2013b, Galilee Basin Development Strategy, retrieved February 10, 2014, from http://www.dsdip.qld.gov.au/resources/plan/galilee-basin-strategy.pdf.

16.14 Other matters

Bureau of Meteorology (BOM) 2013, History of Floods, retrieved May, 2013, from http://www.bom.gov.au/qld/flood/fld_history/index.shtml.

Queensland Fire and Rescue Services (QFRS) 2008a, Bushfire Risk Analysis for Whitsunday Regional Council, retrieved May, 2013, from http://www.ruralfire.qld.gov.au/Bushfire%20Planning/.

Queensland Fire and Rescue Services (QFRS) 2008b, Bushfire Risk Analysis for Isaac Regional Council, retrieved May, 2013, from http://www.ruralfire.qld.gov.au/Bushfire%20Planning/.

16.15 Conclusions and recommendations

State of Queensland 2013a, Galilee Basin Coal Infrastructure Framework – Rail and port, retrieved June 29, 2013, from http://www.dsdip.qld.gov.au/infrastructure-planning-and-reform/galilee-basin-infrastructure-framework-rail-and-ports.html.

State of Queensland 2013b, Galilee Basin Development Strategy, retrieved February 10, 2014, from http://www.dsdip.qld.gov.au/resources/plan/galilee-basin-strategy.pdf.

Appendices

Appendix A - Desktop assessment results

Flora

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Acanthaceae	*Brunoniella australis*	blue trumpet	C					✓	✓	D
Acanthaceae	*Hypoestes floribunda*		C					✓	✓	
Acanthaceae	*Pseuderanthemum variabile*	pastel flower	C					✓	✓	
Acanthaceae	*Rostellularia*		C					✓	✓	
Acanthaceae	*Rostellularia adscendens*		C					✓	✓	
Acanthaceae	*Rostellularia adscendens subsp. adscendens*		C					✓	✓	
Acanthaceae	*Rostellularia adscendens var. adscendens*		C					✓	✓	
Acanthaceae	*Rostellularia adscendens var. hispida*	pink tongues	C							D
Aizoaceae	*Trainthema portulacastrum*	giant pigweed	I							D
Aizoaceae	*Trianthema triquetra*	red spinach	C					✓	✓	
Aizoaceae	*Zaleya galericulata subsp. galericulata*		C					✓	✓	
Amaranthaceae	*Achyranthes aspera*		C					✓	✓	D
Amaranthaceae	*Aerva javanica*		I					✓	✓	
Amaranthaceae	*Alternanthera ficoidea*		I					✓	✓	D
Amaranthaceae	*Alternanthera nodiflora*	joyweed	C					✓		D
Amaranthaceae	*Amaranthus cochleitepalus*		C					✓	✓	
Amaranthaceae	*Gomphrena celosioides*		I							D
Amaranthaceae	*Kelita uncinella*		C					✓	✓	
Amaranthaceae	*Nyssanthes erecta*		C					✓	✓	
Amaryllidaceae	*Crinum sp.*		C							D
Anacardiaceae	*Pleiogynium timorense*	Burdekin plum	C							D
Annonaceae	*Melodorum crassipetalum*		C					✓	✓	
Apiaceae	*Centella asiatica*		C					✓	✓	
Apocynaceae	*Alstonia constricta*	bitterbark	C					✓	✓	
Apocynaceae	*Alstonia scholaris*	white cheesewood	C					✓		
Apocynaceae	*Carissa ovata*	currantbush	C						✓	D
Apocynaceae	*Cerbera dumicola*		NT					✓	✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Apocynaceae	*Cryptostegia grandiflora*	rubber vine	I		WONS	Class 2	✓			D
Apocynaceae	*Hoya australis subsp. australis*		C					✓	✓	
Apocynaceae	*Marsdenia cymulosa*		C					✓		
Apocynaceae	*Marsdenia microlepis*		C					✓	✓	
Apocynaceae	*Marsdenia viridiflora subsp. tropica*		C					✓	✓	
Apocynaceae	*Marsdenia viridiflora subsp. viridiflora*		C					✓	✓	
Apocynaceae	*Parsonsia lanceolata*	northern silkpod	C					✓	✓	D
Apocynaceae	*Parsonsia plaesiophylla*		C					✓	✓	
Apocynaceae	*Tylophora erecta*		C					✓	✓	
Apocynaceae	*Wrightia versicolor*		C					✓	✓	
Asteraceae	*Ageratum conyzoides subsp. conyzoides*		I					✓	✓	
Asteraceae	*Bidens pilosa*	cobbler's pegs	I							D
Asteraceae	*Blumea saxatilis*		C					✓	✓	
Asteraceae	*Camptacra barbata*		C					✓	✓	
Asteraceae	*Camptacra gracilis*		C					✓	✓	
Asteraceae	*Cyanthillium cinereum*		C					✓		
Asteraceae	*Emilia sonchifolia var. javanica*		I					✓	✓	
Asteraceae	*Epaltes australis*	spreading nutheads	C						✓	
Asteraceae	*Parthenium hysterophorus*	parthenium weed	I		WONS	Class 2	✓	✓	✓	D
Asteraceae	*Peripleura hispidula var. setosa*		C					✓	✓	
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey cudweed	C					✓		
Asteraceae	*Pterocaulon serrulatum var. serrulatum*	fruit salad plant	C					✓	✓	
Asteraceae	*Pterocauoln redolens*		C							D
Asteraceae	*Tridax procumbens*	tridax daisy	I							D
Asteraceae	*Vernonia cinerea*	daisy	C							D
Asteraceae	*Wedelia spilanthoides*									D
Asteraceae	*Xanthium pungens*	noogoora burr	I							D
Boraginaceae	*Ehretia grahamii*		C					✓	✓	
Boraginaceae	*Ehretia grahamii x E.membranifolia*		C					✓	✓	
Boraginaceae	*Ehretia grahamii x E.saligna*		C					✓	✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Boraginaceae	*Ehretia membranifolia*	weeping koda	C					✓	✓	
Boraginaceae	*Heliotropium geocharis*		C					✓	✓	
Boraginaceae	*Heliotropium tenuifolium*		C					✓	✓	
Boraginaceae	*Trichodesma zeylanicum*	rough bluebell								D
Byttneriaceae	*Melochia pyramidata*	pyramid flower	I							D
Byttneriaceae	*Waltheria indica*		C					✓	✓	
Cactaceae	*Harrisia martini*	harrisia cactus	I							D
Cactaceae	*Opuntia stricta*	prickly pear	I							D
Caesalpineaceae	*Cassia brewsteri*	Leichhardt bean	C							D
Caesalpiniaceae	*Chamaecrista concinna*		C					✓	✓	
Caesalpiniaceae	*Lysiphyllum carronii*	red bauhinia	C							D
Caesalpiniaceae	*Lysiphyllum hookeri*	white bauhinia	C							D
Caesalpiniaceae	*Parkinsonia aculeata*	Jerusalem thorn	I		WONS	Class 2	✓	✓	✓	
Caesalpiniaceae	*Petalostylis labicheoides*		C					✓	✓	
Caesalpiniaceae	*Senna barclayana*	pepper-leaf senna								D
Caesalpiniaceae	*Senna coronilloides*		C					✓	✓	
Caesalpiniaceae	*Senna gaudichaudii*		C					✓	✓	
Caesalpiniaceae	*Senna notabilis*		C					✓	✓	
Caesalpiniaceae	*Senna occidentalis*		I							D
Caesalpiniaceae	*Senna planitiicola*		C					✓	✓	
Capparaceae	*Apophyllum anomalum*	warrior bush	C							D
Capparaceae	*Capparis lasiantha*	nipan	C					✓	✓	D
Capparaceae	*Capparis mitchellii*		C					✓	✓	
Capparaceae	*Capparis sepiaria*		C					✓	✓	
Capparaceae	*Capparis shanesiana*		C					✓	✓	
Capparaceae	*Cleome viscosa*									D
Caryophyllaceae	*Polycarpaea corymbosa var. minor*		C					✓	✓	
Casuarinaceae	*Casuarina cunninghamiana*	river oak	C							D
Celastraceae	*Denhamia oleaster*		C							D

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Celastraceae	*Denhamia sp. (Junee Tableland T.J.McDonald 553)*		C					✓	✓	
Celastraceae	*Maytenus cunninghamii*									D
Ceratophyllaceae	*Ceratophyllum demersum*	hornwort	C					✓	✓	
Chenopodiaceae	*Atriplex lindleyi*		C					✓	✓	
Chenopodiaceae	*Atriplex muelleri*	lagoon saltbush	C					✓	✓	D
Chenopodiaceae	*Atriplex semibaccata*	creeping saltbush	C					✓	✓	
Chenopodiaceae	*Dysphania carinata*		C					✓	✓	
Chenopodiaceae	*Dysphania kalpari*		C					✓	✓	
Chenopodiaceae	*Dysphania melanocarpa forma melanocarpa*		C					✓	✓	
Chenopodiaceae	*Einadia nutans*	climbing saltbush	C							D
Chenopodiaceae	*Enchylaena tomentosa*	ruby saltbush	C					✓	✓	D
Chenopodiaceae	*Maireana microphylla*		C					✓	✓	
Chenopodiaceae	*Marsenia sp.*		C							D
Chenopodiaceae	*Salsola kali*	roly-poly bush	C							D
Chenopodiaceae	*Salsola tragus*		I					✓	✓	
Chenopodiaceae	*Scerolaena calcarata*	red burr	C							D
Chenopodiaceae	*Sclerolaena muricata*		C						✓	
Chenopodiaceae	*Sclerolaena tetracuspis*	brigalow burr	C					✓	✓	
Cleomaceae	*Cleome viscosa*	tick-weed	C					✓	✓	
Clusiaceae	*Hypericum gramineum*		C					✓	✓	
Combretaceae	*Terminalia oblongata subsp. oblongata*	yellow wood	C					✓	✓	D
Commelinaceae	*Commelina ensifolia*	scurvy grass	C							D
Commelinaceae	*Commelina lanceolata*		C					✓	✓	
Convolvulaceae	*Bonamia media var. media*	common bonamia	C					✓	✓	D
Convolvulaceae	*Convolvulus arvensis*	bindweed	I							D
Convolvulaceae	*Evolvulus alsinoides*	tropical speedwell	C							D
Convolvulaceae	*Ipomoea calobra*		C					✓	✓	
Convolvulaceae	*Ipomoea lonchophylla*		C							D
Convolvulaceae	*Jacquemontia browniana*	snake stem	C							D

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Convolvulaceae	*Jacquemontia paniculata var. tomentosa*		C					✓	✓	
Convolvulaceae	*Operculina aequisepala*		C						✓	
Convolvulaceae	*Polymeria marginata*		C					✓	✓	
Convolvulaceae	*Polymeria pusilla*		C					✓	✓	D
Cucurbitaceae	*Diplocyclos palmatus*		C					✓	✓	
Cucurbitaceae	*Diplocyclos palmatus subsp. palmatus*		C					✓	✓	
Cucurbitaceae	*Momordica charantia*	balsam pear	I					✓	✓	
Cycadaceae	*Cycas media subsp. media*		C					✓		
Cycadaceae	*Cycas ophiolitica*		E	E			✓			
Cyperaceae	*Cyperus alopecuroides*		C					✓	✓	
Cyperaceae	*Cyperus conicus*		C					✓	✓	
Cyperaceae	*Cyperus conicus var. conicus*		C					✓		
Cyperaceae	*Cyperus difformis*	rice sedge	C					✓	✓	D
Cyperaceae	*Cyperus exapltus*	giant sedge	C							D
Cyperaceae	*Cyperus fulvus*		C					✓	✓	
Cyperaceae	*Cyperus gilesii*		C					✓	✓	
Cyperaceae	*Cyperus gracilis*		C						✓	
Cyperaceae	*Cyperus leiocaulon*		C					✓	✓	
Cyperaceae	*Cyperus polystachyos*		C					✓	✓	
Cyperaceae	*Cyperus rotundus*	nutgrass	I					✓	✓	
Cyperaceae	*Cyperus tuberosus*		I					✓	✓	D
Cyperaceae	*Eleocharis acuta*		C					✓	✓	
Cyperaceae	*Eleocharis geniculata*		C					✓		
Cyperaceae	*Fimbristylis bisumbellata*		C					✓	✓	
Dioscoreaceae	*Dioscorea transversa*	native yam	C					✓	✓	
Ebenaceae	*Diospyros humilis*	small-leaved ebony	C					✓	✓	
Erythroxylaceae	*Erythroxylum australe*	cocaine tree	C					✓	✓	D
Euphorbiaceae	*Acalypha eremorum*	soft acalypha	C					✓	✓	
Euphorbiaceae	*Croton arnhemicus*		C					✓	✓	
Euphorbiaceae	*Croton insularis*	Queensland cascarilla	C					✓	✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Euphorbiaceae	*Croton magneticus*		V					✓	✓	
Euphorbiaceae	*Croton phebalioides*	narrow-leaved croton	C					✓	✓	
Euphorbiaceae	*Euphorbia coghlanii*		C					✓	✓	
Euphorbiaceae	*Euphorbia dallachyana*		C						✓	
Euphorbiaceae	*Euphorbia tannensis*		C					✓		
Euphorbiaceae	*Ricinocarpos ledifolius*	scrub wedding bush	C					✓	✓	
Euphorbiaceae	*Ricinus communis*	castor oil bush	I					✓	✓	
Fabaceae	*Aeschynomene indica*	budda pea	C							D
Fabaceae	*Albizia*		C					✓	✓	
Fabaceae	*Albizia canescens*		C					✓		D
Fabaceae	*Alysicarpus rugosa*	chain pea	C							D
Fabaceae	*Clitoria ternatea*	butterfly pea	I							D
Fabaceae	*Crotalaria incana*		I							D
Fabaceae	*Crotalaria juncea*		I							D
Fabaceae	*Crotalaria laburnifolia*		I					✓	✓	
Fabaceae	*Crotalaria medicaginea var. neglecta*		C					✓	✓	D
Fabaceae	*Crotalaria mitchellii subsp. mitchellii*		C					✓	✓	
Fabaceae	*Crotalaria pallida var. obovata*		I					✓	✓	
Fabaceae	*Erythrina verspertilio*	bat wing coral tree	C							D
Fabaceae	*Glycine tomentella*	woolly glycine	C					✓	✓	
Fabaceae	*Hardenbergia violacea*	native sarsaparilla	C							D
Fabaceae	*Indigofera australis*		C							D
Fabaceae	*Indigofera colutea*	sticky indigo	C					✓	✓	
Fabaceae	*Indigofera glandulosa*		C					✓	✓	
Fabaceae	*Indigofera hirsuta*	hairy indigo	C					✓	✓	D
Fabaceae	*Indigofera linifolia*		C					✓	✓	D
Fabaceae	*Indigofera tinctoria*		I							D
Fabaceae	*Macroptilium atropurpureum*	siratro	I					✓	✓	D
Fabaceae	*Macroptilium lathyroides*		I							D
Fabaceae	*Rhynchosia minima*	rhynchosia	C							D

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Fabaceae	*Sesbania cannabina var. cannabina*		C							D
Fabaceae	*Stylosanthes hamata*	stylo	I							D
Fabaceae	*Stylosanthes scabra*	stylo	I							D
Fabaceae	*Tephrosia barbatala*		C					✓		
Fabaceae	*Tephrosia filipes subsp. filipes*		C					✓	✓	D
Fabaceae	*Tephrosia filipes var. (Mt Blackjack A.R.Bean+ 7332)*		C					✓	✓	
Fabaceae	*Tephrosia leptoclada*		C					✓	✓	
Fabaceae	*Tephrosia macrostachya*		C					✓	✓	
Fabaceae	*Vigna lanceolata var. lanceolata*		C					✓	✓	
Fabaceae	*Zornia muelleriana subsp. muelleriana*		C					✓	✓	
Goodeniaceae	*Goodenia glabra*		C					✓	✓	
Goodeniaceae	*Goodenia hirsuta*		C					✓	✓	
Haloragaceae	*Haloragis stricta*		C					✓	✓	
Hemerocallidaceae	*Geitonoplesium cymosum*	scrambling lily	C					✓	✓	
Hernandiaceae	*Gyrocarpus americanus*		C					✓	✓	
Hydrocharitaceae	*Vallisneria annua*		C					✓		
Juncaceae	*Juncus polyanthemus*		C					✓	✓	
Lamiaceae	*Clerodendrum floribundum*	lolly bush	C							D
Lamiaceae	*Clerodendrum tomentosum*		C						✓	
Lamiaceae	*Glossocarya hemiderma*		C					✓	✓	
Lamiaceae	*Leucas lavandulifolia*		I					✓	✓	
Lamiaceae	*Ocimum tenuiflorum*		C						✓	
Lamiaceae	*Spartothamnella juncea*	native broom	C					✓	✓	
Laxmanniaceae	*Eustrephus latifolius*	wombat berry	C							D
Laxmanniaceae	*Lomandra longifolia*		C						✓	
Lecythidaceae	*Planchonia careya*	cockatoo apple	C					✓	✓	D
Loranthaceae	*Amyema congener subsp. rotundifolia*		C					✓	✓	
Loranthaceae	*Amyema conspicua subsp. conspicua*		C					✓	✓	
Loranthaceae	*Amyema quandang var. bancroftii*	broad-leaved grey mistletoe	C						✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Loranthaceae	*Dendrophthoe glabrescens*		C					✓		D
Malvaceae	*Abelmoschus ficulneus*	native rosella	C					✓	✓	
Malvaceae	*Abutilon auritum*		C							D
Malvaceae	*Abutilon guineense*		I					✓		
Malvaceae	*Abutilon leucopetalum*		C					✓	✓	
Malvaceae	*Abutilon micropetalum*		C					✓	✓	
Malvaceae	*Abutilon oxycarpum var. oxycarpum*		C					✓	✓	
Malvaceae	*Gossypium australe*		C					✓	✓	
Malvaceae	*Hibiscus burtonii*		C					✓	✓	
Malvaceae	*Hibiscus sp.*		C					✓	✓	
Malvaceae	*Hibiscus sp. (Emerald S.L.Everist 2124)*		C					✓	✓	
Malvaceae	*Malvastrum americanum var. stellatum*		C					✓		D
Malvaceae	*Sida atherophora*		C					✓	✓	
Malvaceae	*Sida cordifolia*		I					✓	✓	D
Malvaceae	*Sida pleiantha*		C					✓	✓	
Malvaceae	*Sida rhombifolia*		I					✓	✓	D
Malvaceae	*Sida rohlenae subsp. rohlenae*		C					✓		
Malvaceae	*Sida sp. (Charters Towers E.J.THompson+ CHA456)*		C					✓	✓	
Malvaceae	*Sida sp. (Musselbrook M.B.Thomas+ MRS437)*		C					✓	✓	
Malvaceae	*Sida spinosa*	spiny sida	I					✓	✓	D
Malvaceae	*Sida trichopoda*		C					✓	✓	D
Meliaceae	*Owenia acidula*	emu apple	C							D
Menispermaceae	*Pleogyne australis*	wiry grape	C					✓	✓	
Mimosaceae	*Acacia bancroftiorum*		C					✓	✓	
Mimosaceae	*Acacia catenulata*	bendee	C						✓	
Mimosaceae	*Acacia colei*		C					✓	✓	
Mimosaceae	*Acacia complanata*	flatstem wattle	C					✓	✓	
Mimosaceae	*Acacia excelsa subsp. excelsa*	ironwood	C							D
Mimosaceae	*Acacia flavescens*	toothed wattle	C					✓	✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Mimosaceae	*Acacia harpophylla*	brigalow	C							D
Mimosaceae	*Acacia holocericea*		C							D
Mimosaceae	*Acacia julifera subsp. julifera*		C					✓	✓	
Mimosaceae	*Acacia nilotica subsp. indica*	Prickly Acacia	I		WONS	Class 2	✓			D
Mimosaceae	*Acacia oswaldii*	nelia	C							D
Mimosaceae	*Acacia salicina*	Sally's wattle	C							D
Mimosaceae	*Acacia shirleyi*	lancewood	C					✓	✓	
Mimosaceae	*Acacia triptera*		C						✓	
Mimosaceae	*Neptunia gracilis forma gracilis*		C					✓	✓	
Mimosaceae	*Vachellia bidwillii*	corkwood wattle	C							D
Mimosaceae	*Vachellia farnesiana*	mimosa bush	I					✓		D
Moraceae	*Ficus opposita*	sandpaper fig	C							D
Myoporaceae	*Eremophila debilis*	winter apple	C					✓	✓	
Myoporaceae	*Eremophila mitchellii*	false sandalwood	C							D
Myoporaceae	*Myoporum acuminatum*	coastal boobialla	C					✓		D
Myrtaceae	*Corymbia clarksoniana*		C					✓	✓	
Myrtaceae	*Corymbia dallachiana*	ghost gum	C							D
Myrtaceae	*Corymbia erythrophloia*	red bloodwood	C							D
Myrtaceae	*Corymbia intermedia*		C							D
Myrtaceae	*Corymbia tessellaris*	Moreton Bay ash	C							D
Myrtaceae	*Eucalyptus brownii*	Reid River box	C					✓	✓	D
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark	C							D
Myrtaceae	*Eucalyptus melanophloia*	silver-leaved ironbark	C							D
Myrtaceae	*Eucalyptus orgadophila*	mountain coolibah	C					✓	✓	D
Myrtaceae	*Eucalyptus persistens*		C					✓	✓	
Myrtaceae	*Eucalyptus platyphylla*	white gum								D
Myrtaceae	*Eucalyptus raveretiana*	black ironbox	V	V			✓		✓	
Myrtaceae	*Eucalyptus tereticornis subsp. tereticornis*	forest red gum	C					✓	✓	D
Myrtaceae	*Gossia bidwillii*		C					✓	✓	
Myrtaceae	*Lophostemon suaveolens*	swamp box	C							D

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Myrtaceae	*Melaleuca bracteata*	black teatree	C							D
Myrtaceae	*Melaleuca fluviatilis*		C					✓	✓	
Myrtaceae	*Melaleuca leucadendra*	weeping teatree	C							D
Myrtaceae	*Melaleuca viminalis*	weeping bottlebrush	C							D
Myrtaceae	*Micromyrtus capricornia*		C					✓	✓	
Nyctaginaceae	*Boerhavia dominii*		C					✓	✓	D
Nyctaginaceae	*Boerhavia pubescens*		C					✓	✓	
Nyctaginaceae	*Boerhavia sp. (St George A.Hill AQ399299)*		C					✓	✓	
Olacaceae	*Ximenia americana*		C					✓	✓	
Oleaceae	*Jasminum didymum subsp. racemosum*		C					✓	✓	D
Oleaceae	*Notelaea microcarpa*		C					✓	✓	
Orchidaceae	*Cymbidium canaliculatum*	black wattle	C							D
Papaveraceae	*Argemone ochroleuca subsp. ochroleuca*	Mexican poppy	I					✓	✓	D
Parmeliaceae	*Parmotrema rimulosum*		C					✓		
Pentapetaceae	*Melhania oblongifolia*		C					✓	✓	
Phyllanthaceae	*Bridelia leichhardtii*		C					✓	✓	
Phyllanthaceae	*Flueggea leucopyrus*		C						✓	
Phyllanthaceae	*Phyllanthus amarus*		I					✓	✓	
Phyllanthaceae	*Phyllanthus carpentariae*		C					✓	✓	
Phyllanthaceae	*Phyllanthus gunnii*		C					✓	✓	
Phyllanthaceae	*Phyllanthus maderaspatensis*		C					✓	✓	D
Phyllanthaceae	*Phyllanthus virgatus*		C					✓	✓	
Physciaceae	*Physcia crispa*		C					✓		
Physciaceae	*Pyxine rugulosa*		C					✓		
Picrodendraceae	*Petalostigma banksii*		C						✓	
Picrodendraceae	*Petalostigma pubescens*	quinine tree	C						✓	D
Pittosporaceae	*Bursaria incana*		C					✓	✓	D
Pittosporaceae	*Bursaria spinosa subsp. spinosa*		C					✓	✓	D
Pittosporaceae	*Pittosporum spinescens*		C					✓	✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Poaceae	*Alloteropsis cimicina*		C					✓	✓	
Poaceae	*Ancistrachne uncinulata*	hooky grass	C					✓	✓	
Poaceae	*Aristida acuta*		C					✓	✓	
Poaceae	*Aristida calycina var. calycina*	dark wiregrass	C							D
Poaceae	*Aristida calycina var. praealta*		C					✓	✓	
Poaceae	*Aristida caput-medusae*		C					✓	✓	
Poaceae	*Aristida holathera var. holathera*		C					✓	✓	
Poaceae	*Aristida jerichoensis var. subspinulifera*		C					✓	✓	D
Poaceae	*Aristida lappacea*		C							D
Poaceae	*Aristida personata*	purple wiregrass	C							D
Poaceae	*Arundinella nepalensis*	reedgrass	C					✓	✓	
Poaceae	*Astrebla lappacea*	curly mitchell grass	C					✓	✓	
Poaceae	*Astrebla squarrosa*		C							D
Poaceae	*Bothriochloa decipiens var. decipiens*		C					✓	✓	D
Poaceae	*Bothriochloa ewartiana*	desert bluegrass	C					✓	✓	D
Poaceae	*Bothriochloa pertusa*		I					✓	✓	D
Poaceae	*Brachyachne convergens*		C							D
Poaceae	*Brachyachne tenella*		C					✓	✓	
Poaceae	*Calyptochloa gracillima subsp. gracillima*		C					✓	✓	
Poaceae	*Cenchrus ciliaris*	buffel grass	I							D
Poaceae	*Chloris divaricata*	slender chloris	C							D
Poaceae	*Chloris gayana*	rhodes grass	I							D
Poaceae	*Chrysopogon fallax*	golden beard	C							D
Poaceae	*Cymbopogon bombycinus*	silky oilgrass	C						✓	
Poaceae	*Cymbopogon obtectus*		C					✓	✓	
Poaceae	*Cymbopogon refractus*	barbed-wire grass	C						✓	
Poaceae	*Cynodon dactylon var. dactylon*		I					✓	✓	D
Poaceae	*Dactyloctenium radulans*	button grass	C							D
Poaceae	*Dichanthium annulatum*	sheda grass	I					✓	✓	D
Poaceae	*Dichanthium aristatum*	angleton grass	I					✓	✓	D

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Poaceae	*Dichanthium fecundum*	curly bluegrass	C						✓	
Poaceae	*Dichanthium queenslandicum*	King Blue-grass	V	E			✓	✓	✓	
Poaceae	*Dichanthium sericeum subsp. sericeum*	Queensland bluegrass	C					✓	✓	D
Poaceae	*Dichanthium setosum*	bluegrass	C	V						D
Poaceae	*Digitaria hystrichoides*	umbrella grass	C					✓	✓	
Poaceae	*Digitaria longiflora*		C					✓	✓	
Poaceae	*Digitaria porrecta*	Finger Panic Grass	NT	E			✓			
Poaceae	*Dinebra decipiens var. decipiens*		C					✓	✓	
Poaceae	*Echinochloa colona*	awnless barnyard grass	I							D
Poaceae	*Elionurus citreus*	lemon-scented grass	C					✓	✓	
Poaceae	*Enneapogon gracilis*	slender nineawn	C					✓	✓	D
Poaceae	*Enneapogon lindleyanus*		C					✓	✓	
Poaceae	*Eragrostis cilianensis*		I					✓	✓	D
Poaceae	*Eragrostis leptocarpa*	drooping lovegrass	C					✓	✓	
Poaceae	*Eragrostis leptostachya*		C					✓	✓	
Poaceae	*Eragrostis pubescens*		C					✓	✓	
Poaceae	*Eragrostis sororia*		C					✓	✓	D
Poaceae	*Eragrostis tenellula*	delicate lovegrass	C					✓	✓	
Poaceae	*Eriochloa meyeriana*		I					✓	✓	
Poaceae	*Eriochloa procera*		C							D
Poaceae	*Eriochloa pseudoacrotricha*		C					✓	✓	
Poaceae	*Eulalia aurea*	silky browntops	C							D
Poaceae	*Heteropogon contortus*	black spear grass	C							D
Poaceae	*Hymenachne amplexicaulis*	hymenachne	I		WONS	Class 2	✓			
Poaceae	*Iseilema vaginiflorum*	red flinders grass	C					✓	✓	D
Poaceae	*Leptochloa digitata*		C					✓	✓	
Poaceae	*Megaththyrsus maximus var. pubilumis*	guinea grass	I							D
Poaceae	*Melinis repens*	red natal grass	I							D
Poaceae	*Mnesithea rottboellioides*		C					✓	✓	
Poaceae	*Panicum decompositum*	windmill grass	C							D

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Poaceae	*Panicum effusum*		C					✓	✓	D
Poaceae	*Panicum laevinode*	pepper grass	C					✓	✓	
Poaceae	*Panicum larcomanium*		C							D
Poaceae	*Paspalidium aversum*		C							D
Poaceae	*Paspalidium distans*	shotgrass	C					✓	✓	
Poaceae	*Paspalidium globoideum*	sago grass	C					✓	✓	D
Poaceae	*Paspalum plicatulum*		I							D
Poaceae	*Paspalum scrobiculatum*	ditch millet	C					✓	✓	
Poaceae	*Perotis rara*	comet grass	C							D
Poaceae	*Setaria australiensis*	scrub pigeon grass	C					✓	✓	
Poaceae	*Sorghum halepense*		I							D
Poaceae	*Sporobolus contiguus*		C					✓	✓	
Poaceae	*Sporobolus coromandelianus*		I					✓	✓	D
Poaceae	*Sporobolus scabridus*		C					✓	✓	D
Poaceae	*Thellungia advena*		C							D
Poaceae	*Themeda avenacea*		C					✓	✓	D
Poaceae	*Themeda triandra*	kangaroo grass	C							
Poaceae	*Thyridolepis xerophila*		C						✓	
Poaceae	*Triodia bitextura*		C					✓	✓	
Poaceae	*Urochloa mosambicensis*		I							D
Poaceae	*Urochloa mutica*	para grass	I							D
Poaceae	*Urochloa piligera*		C					✓	✓	
Polygonaceae	*Persicarea dicipiens*	slender knotweed	C							D
Portulacaceae	*Portulaca*		C					✓	✓	
Portulacaceae	*Portulaca bicolor*		C					✓	✓	
Portulacaceae	*Portulaca filifolia*		C					✓	✓	
Potamogetonaceae	*Potamogeton tricarinatus*	floating pondweed	C					✓	✓	
Proteaceae	*Grevillea helmsiae*		C					✓	✓	
Proteaceae	*Grevillea parallela*		C					✓	✓	
Proteaceae	*Grevillea sessilis*		C					✓	✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Proteaceae	*Grevillea striata*	beefwood	C							D
Proteaceae	*Hakea lorea*	gnarled corkbark	C							D
Putranjivaceae	*Drypetes deplanchei*	grey boxwood	C					✓	✓	
Ramalinaceae	*Ramalina inflata*		C					✓	✓	
Rhamnaceae	*Alphitonia excelsa*	soap tree	C					✓	✓	
Rhamnaceae	*Ventilago viminalis*	vine tree	C							D
Rhamnaceae	*Ziziphus mauritiana*	chinee apple	I			Class 2				D
Rubiaceae	*Antirhea putaminosa*		C					✓	✓	
Rubiaceae	*Everistia vacciniifolia forma vacciniifolia*		C					✓	✓	
Rubiaceae	*Oldenlandia mitrasacmoides subsp. trachymenoides*		C					✓	✓	
Rubiaceae	*Psydrax johnsonii*		C					✓	✓	
Rubiaceae	*Psydrax oleifolia*	myrtle tree	C							D
Rubiaceae	*Richardia brasiliensis*	white eye	I					✓	✓	
Rubiaceae	*Triflorensia ixoroides*		C					✓	✓	
Rutaceae	*Flindersia australis*	crow's ash	C					✓	✓	
Rutaceae	*Geijera salicifolia*	brush wilga	C					✓	✓	D
Rutaceae	*Micromelum minutum*	clusterberry	C					✓		
Rutaceae	*Murraya ovatifoliolata*		C					✓	✓	D
Santalaceae	*Exocarpos latifolius*		C					✓	✓	
Santalaceae	*Santalum lanceolatum*	sandalwood	C							D
Sapindaceae	*Alectryon connatus*	grey birds-eye	C					✓	✓	
Sapindaceae	*Alectryon diversifolius*	scrub boonaree	C					✓	✓	D
Sapindaceae	*Alectryon oleifolius subsp. elongatus*		C					✓	✓	D
Sapindaceae	*Atalaya calcicola*		C					✓	✓	
Sapindaceae	*Atalaya hemiglauca*		C						✓	D
Sapindaceae	*Atalaya salicifolia*									D
Sapindaceae	*Cardiospermum halicacabum var. halicacabum*		I					✓	✓	
Sapindaceae	*Dodonaea lanceolata var. subsessilifolia*		C					✓		
Sapindaceae	*Dodonaea stenophylla*		C					✓	✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data
Sapindaceae	*Dodonaea triangularis*		C					✓	✓	
Sapotaceae	*Amorphospermum antilogum*		C					✓	✓	
Sapotaceae	*Planchonella myrsinoides*		C					✓	✓	
Scrophulariaceae	*Mecardonia procumbens*		I					✓		
Scrophulariaceae	*Scoparia dulcis*	Scoparia	I					✓	✓	
Scrophulariaceae	*Stemodia sp.*		C					✓		
Solanaceae	*Capsicum frutescens*		I					✓	✓	
Solanaceae	*Datura inoxia*		I					✓	✓	
Solanaceae	*Nicotiana forsteri*		C					✓	✓	
Solanaceae	*Solanum furfuraceum*		C					✓	✓	
Solanaceae	*Solanum galbinum*		C					✓	✓	
Solanaceae	*Solanum nigrum subsp. nigrum*		I					✓	✓	
Solanaceae	*Solanum parvifolium subsp. parvifolium*		C					✓	✓	
Solanaceae	*Solanum seaforthianum*	Brazilian nightshade	I					✓	✓	
Solanaceae	*Solanum torvum*	devil's fig	I					✓	✓	
Sparrmanniaceae	*Corchorus trilocularis*		C					✓	✓	D
Sparrmanniaceae	*Grewia latifolia*	dogs balls	C							D
Sparrmanniaceae	*Grewia retusifolia*		C					✓	✓	
Sparrmanniaceae	*Grewia scabrella*		C					✓	✓	
Sparrmanniaceae	*Triumfetta rhomboidea*	chinese burr	I					✓	✓	
Sterculiaceae	*Brachychiton australis*	broad-leaved bottle tree	C					✓	✓	D
Stylidiaceae	*Stylidium adenophorum*		C					✓	✓	
Thymelaeaceae	*Pimelea haematostachya*		C					✓	✓	
Ulmaceae	*Trema tomentosa var. aspera*		C					✓	✓	
Verbenaceae	*Lantana camara*	lantana	I		WONS	Class 3	✓	✓	✓	
Verbenaceae	*Lantana montevidensis*	creeping lantana	C							D
Violaceae	*Hybanthus enneaspermus*		C					✓	✓	
Vitaceae	*Clematicissus opaca*									D
Zygophyllaceae	*Tribulopis angustifolia*		C					✓	✓	
Zygophyllaceae	*Tribulus micrococcus*	yellow vine	C					✓	✓	

Family	Scientific Name	Common Name	NC Act	EPBC Act	WONS	LP Act	PMST	WO	Herbrecs	Previous EIS data

V = Vulnerable, E = Endangered, NT = Near Threatened, C = Common, I = Introduced, D = Drake Coal Mine EIS.

Note: Where species were not identified to species level during previous EIS surveys, these species have been omitted from the list

Fauna

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Amphibians									
Rhinella marina (Bufo marinus)	cane toad	Y			✓	✓		✓	D
Cyclorana alboguttata	greenstripe frog		C			✓		✓	
Cyclorana cultripes	grassland collared frog		C			✓			
Cyclorana novaehollandiae	eastern snapping frog		C			✓		✓	
Litoria caerulea	common green treefrog		C			✓		✓	D
Litoria gracilenta	graceful treefrog		C			✓			
Litoria inermis	bumpy rocketfrog		C			✓		✓	D
Litoria latopalmata	broad palmed rocketfrog		C			✓		✓	D
Litoria rothii	northern laughing treefrog		C			✓		✓	D
Litoria rubella	ruddy treefrog		C			✓		✓	D
Limnodynastes salmini	salmon-striped Frog		C					✓	
Limnodynastes tasmaniensis	spotted grassfrog		C			✓		✓	A
Platyplectrum ornatum	ornate burrowing frog		C			✓		✓	D
Uperoleia sp.						✓			
Uperoleia littlejohni	little John's toad		C					✓	
Uperoleia lithomoda / mimula	gungan		C						D
Birds									
Struthidea cinerea	apostlebird		C			✓	✓		D
Anhinga novaehollandiae	Australasian darter		C			✓	✓		
Sphecotheres vieilloti	Australasian figbird		C			✓	✓		D
Tachybaptus novaehollandiae	Australasian grebe		C			✓	✓		D
Anthus novaeseelandiae	Australasian pipit		C			✓	✓		D
Alectura lathami	Australian brush-turkey		C			✓	✓		
Ardeotis australis	Australian bustard		C			✓	✓		D
Falco longipennis	Australian hobby		C			✓	✓		

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Cracticus tibicen	Australian magpie		C			✓	✓		A, D
Aegotheles cristatus	Australian owlet-nightjar		C			✓	✓		D
Rostratula australis	Australian painted snipe		V	E; Mi; Ma	✓		✓		
Pelecanus conspicillatus	Australian pelican		C			✓			
Corvus coronoides	Australian raven		C				✓		D
Acrocephalus australis	Australian reed-warbler		C			✓			
Chenonetta jubata	Australian wood duck		C			✓	✓		D
Ninox connivens	barking owl		C				✓		D
Hirundo rustica	barn swallow		C	Mi; Ma	✓				
Geopelia humeralis	bar-shouldered dove		C			✓			
Falco subniger	black falcon		C			✓	✓		
Milvus migrans	black kite		C			✓	✓		A, D
Cygnus atratus	black swan		C			✓	✓		
Melithreptus gularis	black-chinned honeyeater		NT			✓	✓		
Coracina novaehollandiae	black-faced cuckoo-shrike		C	Ma		✓	✓		D
Monarcha melanopsis	black-faced monarch		C	Mi; Ma	✓		✓		
Artamus cinereus	black-faced woodswallow		C			✓			D
Elseyornis melanops	black-fronted dotterel		C			✓	✓		
Ephippiorhynchus asiaticus	black-necked stork		NT			✓	✓		
Elanus axillaris	black-shouldered kite		C			✓	✓		
Poephila cincta cincta	black-throated finch		E	E	✓		✓		
Himantopus himantopus	black-winged stilt		C			✓	✓		
Entomyzon cyanotis	blue-faced honeyeater		C			✓	✓		A, D
Dacelo leachii	blue-winged kookaburra		C			✓	✓		A, D
Falco berigora	brown falcon		C			✓	✓		D
Accipiter fasciatus	brown goshawk		C			✓	✓		
Lichmera indistincta	brown honeyeater		C			✓	✓		

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Coturnix ypsilophora	brown quail		C			✓	✓		D
Phaps elegans	brush bronzewing		C			✓	✓		
Cacomantis variolosus	brush cuckoo		C			✓			
Melopsittacus undulatus	budgerigar		C			✓	✓		
Acanthiza reguloides	buff-rumped thornbill		C			✓	✓		D
Hydroprogne caspia	Caspian tern		C			✓	✓		
Ardea ibis	cattle egret		C	Mi; Ma	✓		✓		
Scythrops novaehollandiae	channel-billed cuckoo		C			✓			D
Lonchura castaneothorax	chestnut-breasted mannikin		C			✓	✓		
Nymphicus hollandicus	cockatiel		C			✓	✓		D
Phaps chalcoptera	common bronzewing		C			✓	✓		
Nettapus coromandelianus	cotton pygmy-goose		NT			✓	✓		
Ocyphaps lophotes	crested pigeon		C			✓	✓		A
Corvus sp.	crow		C			✓	✓		
Geopelia cuneata	diamond dove		C			✓	✓		
Eurystomus orientalis	dollarbird		C	Ma		✓	✓		D
Taeniopygia bichenovii	double-barred finch		C			✓	✓		D
Gallinula tenebrosa	dusky moorhen		C			✓	✓		D
Tyto javanica	eastern barn owl		C			✓	✓		D
Ardea modesta	eastern great egret		C	Mi; Ma	✓	✓	✓		
Eudynamys orientalis	eastern koel		C				✓		D
Pandion cristatus	eastern osprey		C	Mi; Ma	✓				
Dromaius novaehollandiae	emu		C			✓			
Fulica atra	Eurasian coot		C			✓	✓		
Gerygone palpebrosa	fairy gerygone		C			✓	✓		
Petrochelidon ariel	fairy martin		C			✓	✓		D
Cacomantis flabelliformis	fan-tailed cuckoo		C			✓	✓		

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Todiramphus macleayii	forest kingfisher		C			✓	✓		D
Apus pacificus	fork-tailed swift		C	Mi; Ma	✓	✓	✓		
Eolophus roseicapillus	galah		C			✓	✓		A
Cisticola exilis	golden-headed cisticola		C			✓	✓		D
Ptilonorhynchus nuchalis	great bowerbird		C			✓	✓		D
Phalacrocorax carbo	great cormorant		C			✓	✓		
Podiceps cristatus	great crested grebe		C			✓	✓		
Cracticus torquatus	grey butcherbird		C			✓	✓		D
Rhipidura albiscapa	grey fantail		C			✓	✓		D
Colluricincla harmonica	grey shrike-thrush		C			✓	✓		
Anas gracilis	grey teal		C			✓	✓		
Pomatostomus temporalis	grey-crowned babbler		C			✓	✓		D
Coracina maxima	ground cuckoo-shrike		C			✓	✓		
Aythya australis	hardhead		C			✓	✓		
Philemon buceroides	helmeted friarbird		C			✓	✓		
Poliocephalus poliocephalus	hoary-headed grebe		C			✓	✓		
Chalcites basalis	Horsfield's bronze-cuckoo		C			✓	✓		D
Mirafra javanica	Horsfield's bushlark		C			✓	✓		
Passer domesticus	house sparrow	Y			✓		✓		
Ardea intermedia	intermediate egret		C			✓			
Gallinago hardwickii	Latham's snipe		C	Mi; Ma	✓		✓		
Dacelo novaeguineae	laughing kookaburra		C			✓			D
Myiagra rubecula	leaden flycatcher		C				✓		D
Microeca flavigaster	lemon-bellied flycatcher		C			✓	✓		
Phalacrocorax sulcirostris	little black cormorant		C			✓	✓		D
Egretta garzetta	little egret		C			✓	✓		
Philemon citreogularis	little friarbird		C			✓	✓		D

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Microcarbo melanoleucos	little pied cormorant		C			✓	✓		
Colluricincla megarhyncha	little shrike-thrush		C			✓	✓		
Anseranas semipalmata	magpie goose		C	Ma	✓		✓		
Grallina cyanoleuca	magpie-lark		C			✓			A, D
Vanellus miles	masked lapwing		C			✓	✓		D
Tyto novaehollandiae kimberli	masked owl (northern subspecies)		V	V	✓		✓		
Dicaeum hirundinaceum	mistletoebird		C			✓			D
Falco cenchroides	nankeen kestrel		C			✓	✓		D
Philemon corniculatus	noisy friarbird		C			✓	✓		D
Manorina melanocephala	noisy miner		C				✓		A, D
Lonchura punctulata	nutmeg mannikin	Y			✓		✓		
Oriolus sagittatus	olive-backed oriole		C						D
Cuculus optatus	oriental cuckoo		C			✓	✓		
Aviceda subcristata	Pacific baza		C			✓	✓		
Anas superciliosa	Pacific black duck		C			✓	✓		
Platycercus adscitus	pale-headed rosella		C			✓	✓		A, D
Cacomantis pallidus	pallid cuckoo		C			✓	✓		D
Geopelia striata	peaceful dove		C			✓	✓		
Falco peregrinus	peregrine falcon		C				✓		D
Centropus phasianinus	pheasant coucal		C			✓			D
Cracticus nigrogularis	pied butcherbird		C			✓	✓		A, D
Strepera graculina	pied currawong		C			✓	✓		
Neochmia modesta	plum-headed finch		C			✓	✓		
Porphyrio porphyrio	purple swamphen		C			✓	✓		
Merops ornatus	rainbow bee-eater		C	Mi; Ma	✓	✓	✓		A, D
Trichoglossus haematodus moluccanus	rainbow lorikeet		C			✓	✓		A, D

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Erythrotriorchis radiatus	red goshawk		E	V	✓		✓		
Turnix maculosus	red-backed button-quail		C				✓		D
Malurus melanocephalus	red-backed fairy-wren		C			✓			D
Todiramphus pyrrhopygius	red-backed kingfisher		C			✓			
Pardalotus rubricatus	red-browed pardalote		C			✓	✓		
Charadrius ruficapillus	red-capped plover		C	Mi; Ma			✓		D
Calyptorhynchus banksii	red-tailed black-cockatoo		C			✓	✓		
Aprosmictus erythropterus	red-winged parrot		C			✓			D
Myiagra inquieta	restless flycatcher		C			✓	✓		
Cincloramphus mathewsi	rufous songlark		C			✓	✓		
Pachycephala rufiventris	rufous whistler		C			✓	✓		D
Todiramphus sanctus	sacred kingfisher		C				✓		D
Myiagra cyanoleuca	satin flycatcher		C	Mi; Ma	✓	✓	✓		
Trichoglossus chlorolepidotus	scaly-breasted lorikeet		C			✓	✓		
Myzomela sanguinolenta	scarlet honeyeater		C			✓	✓		
Chalcites minutillus	shining bronze-cuckoo		C				✓		D
Gavicalis virescens	singing honeyeater		C			✓	✓		
Ninox boobook	southern boobook		C			✓			D
Dicrurus bracteatus	spangled drongo		C			✓	✓		D
Ptilonorhynchus maculatus	spotted bowerbird		C			✓	✓		
Streptopelia chinensis	spotted dove	Y			✓		✓		
Circus assimilis	spotted harrier		C			✓	✓		
Eurostopodus argus	spotted nightjar		C			✓			
Pardalotus punctatus	spotted pardalote		C			✓	✓		
Geophaps scripta scripta	squatter pigeon (southern subspecies)		V	V	✓	✓	✓		A
Neochmia ruficauda	star finch		E	E	✓		✓		
Threskiornis spinicollis	straw-necked ibis		C			✓	✓		

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Pardalotus striatus	striated pardalote		C			✓			A, D
Plectorhyncha lanceolata	striped honeyeater		C			✓	✓		
Cacatua galerita	sulphur-crested cockatoo		C			✓	✓		D
Podargus strigoides	tawny frogmouth		C			✓	✓		D
Corvus orru	Torresian crow		C			✓	✓		A, D
Petrochelidon nigricans	tree martin		C			✓	✓		
Lalage leucomela	varied triller		C			✓	✓		
Aquila audax	wedge-tailed eagle		C			✓	✓		D
Smicrornis brevirostris	weebill		C			✓	✓		D
Hirundo neoxena	welcome swallow		C			✓	✓		D
Gerygone fusca	western gerygone		C				✓		D
Haliastur sphenurus	whistling kite		C	Ma		✓	✓		D
Coracina papuensis	white-bellied cuckoo-shrike		C			✓	✓		
Haliaeetus leucogaster	white-bellied sea-eagle		C	Mi; Ma	✓	✓	✓		
Artamus leucorynchus	white-breasted woodswallow		C			✓			
Artamus superciliosus	white-browed woodswallow		C			✓	✓		
Egretta novaehollandiae	white-faced heron		C			✓	✓		D
Ardea pacifica	white-necked heron		C			✓	✓		
Gerygone albogularis	white-throated gerygone		C			✓	✓		
Melithreptus albogularis	white-throated honeyeater		C			✓	✓		D
Corcorax melanorhamphos	white-winged chough		C			✓	✓		
Lalage sueurii	white-winged triller		C			✓	✓		D
Rhipidura leucophrys	willie wagtail		C			✓	✓		D
Stomiopera flavus	yellow honeyeater		C			✓	✓		D
Acanthiza nana	yellow thornbill		C			✓	✓		
Platalea flavipes	yellow-billed spoonbill		C			✓			
Calyptorhynchus funereus	yellow-tailed black cockatoo		C				✓		D

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Manorina flavigula	yellow-throated miner		C			✓	✓		
Taeniopygia guttata	zebra finch		C			✓	✓		
Fish							✓		
Ambassis agassizii	Agassiz's glassfish							✓	
Ambassis agrammus	sailfin glassfish					✓	✓		
Anguilla reinhardtii	longfin eel					✓	✓		
Neoarius graeffei	blue catfish					✓			
Craterocephalus stercusmuscarum	flyspecked hardyhead					✓			
Strongylura kreffti	freshwater longtom							✓	A
Lates calcarifer	barramundi					✓			
Nematalosa erebi	bony bream					✓		✓	A
Oxyeleotris lineolata	sleepy cod					✓		✓	A
Melanotaenia splendida splendida	eastern rainbowfish					✓		✓	A
Neosilurus ater	black catfish					✓			
Neosilurus hyrtlii	Hyrtl's catfish					✓			
Neosilurus mollespiculum	soft-spined catfish							✓	A
Amniataba percoides	barred grunter					✓		✓	A
Hephaestus fuliginosus	sooty grunter					✓			
Leiopotherapon unicolor	spangled perch					✓		✓	A
Notesthes robusta	bullrout							✓	A
Mammals									
Canis lupus dingo	dingo	Y				✓			D
Canis lupus familiaris	dog	Y			✓				
Vulpes vulpes	red fox	Y			✓				
Dasyurus hallucatus	northern quoll		C	E	✓				
Planigale ingrami	long-tailed planigale		C			✓			
Planigale maculata	common planigale		C			✓			

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Sminthopsis macroura	stripe-faced dunnart		C			✓			
Saccolaimus flaviventris	yellow-bellied sheathtail bat		C						A, D
Taphozous troughtoni	Troughton's sheathtail bat		C						D
Equus caballus	horse	Y			✓				
Felis catus	cat	Y			✓				
Lepus europaeus	European brown hare	Y			✓				
Oryctolagus cuniculus	rabbit	Y			✓	✓			D
Lagorchestes conspicillatus	spectacled hare-wallaby		C						D
Macropus agilis	agile wallaby		C			✓			
Macropus giganteus	eastern grey kangaroo		C			✓			A, D
Macropus parryi	whiptail wallaby		C			✓			
Macropus robustus	common wallaroo		C			✓			
Macropus rufogriseus	red-necked wallaby		C			✓			
Petrogale assimilis	allied rock-wallaby		C			✓			
Petrogale inornata	unadorned rock-wallaby		C			✓			
Miniopterus australis	little bentwing bat		C						D
Miniopterus orianae oceansis	eastern bentwing bat		C						D
Austronomus australis	white-striped freetail		C						D
Chaerephon jobensis	bat		C						A, D
Mormopterus beccarii	Beccari's freetail bat		C						A, D
Mormopterus ridei	eastern freetail bat		C						D
Mus musculus	house mouse	Y			✓	✓			
Pseudomys delicatulus	delicate mouse		C			✓			
Pseudomys gracilicaudatus	eastern chestnut mouse		C			✓			
Rattus tunneyi	pale field-rat		C			✓			
Isoodon macrourus	northern brown bandicoot		C						D
Trichosurus vulpecula	common brushtail possum		C						D

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Phascolarctos cinereus	koala		C	V	✓				
Aepyprymnus rufescens	rufous bettong		C			✓			
Sus scrofa	pig	Y			✓	✓			D
Tachyglossus aculeatus	short-beaked echidna		C			✓			
Scotorepens balstoni	inland broad-nosed bat		C			✓			
Chalinolobus gouldii	Gould's wattled bat		C						A, D
Chalinolobus morio	chocolate wattled bat		C						A, D
Chalinolobus nigrogriseus	hoary wattled bat		C						D
Nyctophilus sp.	long-eared bat		C						A, D
Scotorepens balstoni	inland broad-nosed bat		C						A, D
Scotorepens greyii/sanborni	little broad-nosed bat/northern broad-nosed bat		C						A, D
Vespadelus baverstocki	inland forest bat		C						A
Vespadelus troughtoni	eastern cave bat		C						A, D
Reptiles									
Diporiphora australis	Tommy roundhead		C			✓		✓	D
Pogona barbata	bearded dragon		C			✓			D
Antaresia maculosa	spotted python		C			✓			D
Aspidites melanocephalus	black-headed python		C			✓			D
Liasis mackloti	water python		C						D
Nephrurus asper	spiny knob-tailed gecko		C			✓		✓	
Chelodina canni	Cann's longneck turtle		C					✓	
Boiga irregularis	brown tree snake		C			✓			
Dendrelaphis punctulata	common tree snake		C						D
Tropidonophis mairii	freshwater snake		C			✓			D
Crocodylus porosus	estuarine crocodile		V	Mi	✓				
Diplodactylus conspicillatus	fat-tailed diplodactylus		C			✓		✓	
Diplodactylus vittatus	wood gecko		C			✓		✓	

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Lucasium steindachneri	Steindachner's gecko		C			✓		✓	
Oedura castelnaui	northern velvet gecko		C						D
Oedura marmorata	marbled velvet gecko		C			✓			
Oedura monilis			C			✓			
Oedura ocellata	Ocellated velvet gecko		C					✓	
Oedura rhombifer	zig-zag gecko		C						D
Strophurus williamsi	soft-spined gecko		C			✓		✓	
Acanthophis antarcticus	common death adder		NT			✓			
Brachyurophis australis	coral snake		C			✓			D
Cryptophis boschmai	Carpentaria whip snake		C			✓		✓	
Cryptophis nigrostriatus	black-striped snake		C			✓			
Demansia psammophis	yellow-faced whip snake		C			✓		✓	
Demansia torquata	collared whip snake		C					✓	
Demansia vestigiata	black whip snake		C			✓		✓	D
Denisonia maculata	ornamental snake		V	V	✓	✓		✓	D
Furina diadema	red-naped snake		C			✓			
Furina ornata	orange-naped snake		C			✓			
Parasuta dwyeri	Dwyer's snake		C					✓	
Pseudechis australis	king brown snake		C			✓			
Pseudonaja textilis	eastern brown snake		C			✓		✓	
Suta suta	myall snake		C			✓			
Vermicella annulata	bandy-bandy		C			✓		✓	
Gehyra catenata			C					✓	
Gehyra dubia			C			✓		✓	D
Gehyra variegata	tree dtella		C			✓			D
Heteronotia binoei	Bynoe's gecko		C			✓		✓	D
Delma tincta			C					✓	

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Lialis burtonis	Burton's legless lizard		C			✓		✓	
Pygopus schraderi	eastern hooded scaly-foot		C			✓		✓	
Anomalopus brevicollis			C			✓		✓	
Anomalopus gowi	speckled worm-skink		C					✓	
Carlia munda			C			✓		✓	D
Carlia pectoralis sensu lato			C			✓		✓	
Carlia rubigo	orange-flanked rainbow skink							✓	
Carlia schmeltzii			C			✓		✓	D
Carlia vivax			C			✓			D
Cryptoblepharus adamsi	Adam's snake-eyed skink		C						D
Cryptoblepharus metallicus	metallic snake-eyed skink		C						D
Cryptoblepharus pannosus	ragged snake-eyed skink		C			✓			
Cryptoblepharus plagiocephalus sensu lato			C			✓			
Cryptoblepharus virgatus sensu lato			C			✓			
Ctenotus allotropis			C			✓		✓	
Ctenotus robustus			C			✓		✓	
Ctenotus strauchii			C			✓		✓	
Ctenotus taeniolatus	copper-tailed skink		C			✓		✓	D
Egernia rugosa	Yakka Skink		V	V	✓				
Glaphyromorphus punctulatus	fine-spotted mulch-skink		C					✓	
Lampropholis delicata	garden skink		C						D
Lerista allanae	Allan's Lerista		E	E	✓				
Lerista fragilis			C			✓		✓	D
Lerista vittata	Mount Cooper Striped Lerista		V	V	✓				
Lygisaurus foliorum			C			✓		✓	
Menetia greyii			C			✓		✓	

Scientific Name	Common Name	Introduced	NC Act	EPBC Act	PMST	WO	BA	QM	Previous EIS Data
Menetia timlowi			C			✓		✓	
Morethia boulengeri			C			✓		✓	
Morethia taeniopleura	fire-tailed skink		C			✓		✓	D
Tiliqua scincoides	eastern blue-tongued lizard		C						D
Ramphotyphlops affinis	small-headed blind snake		C					✓	
Ramphotyphlops grypus			C			✓			
Ramphotyphlops ligatus			C			✓		✓	
Ramphotyphlops sp.			C			✓		✓	
Ramphotyphlops unguirostris			C			✓			
Varanus tristis	black-tailed monitor		C			✓		✓	

Ma = Marine, Mi = Migratory, V = Vulnerable, E = Endangered, NT = Near Threatened, C = Common, A = Alpha Coal Project EIS, D = Drake Coal Mine EIS.

Appendix B - Likelihood of occurrence assessment

Flora

Species	EPBC Act/ NC Act status	Predicted to occur by PMST	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
Cerbera dumicola	Not listed/ near threatened	-	WO, Herbrecs	x	*Cerbera dumicola* is a shrub or a small tree that is widespread in central Queensland. It grows in vine thickets and lancewood (*Acacia shirleyi*) thickets (Forster 1992). Within the desktop search extent, it has been recorded from the site of the Collinsville mine and from lancewood scrub beside the Cerito-Elphinstone Road, on Byerwen Station (near Figtree and Cerito Stations) (Council of Heads of Australasian Herbaria 2013).	**May occur** Previously recorded in the desktop search extent AND potential suitable SEVT habitat is mapped within the NGBR Project realignment footprint.
Croton magneticus	Not listed/ vulnerable	✓	WO, herbrecs	x	*Croton magneticus* is a shrub found in vine thickets on skeletal granite, limestone or sandstone soils, including rocky seashores (Calvert *et al* 2005). Common vine thicket species that it is known to grow in association with include Croton arnhemicus and Croton phebalioides. It may be deciduous during the dry season (Calvert *et al* 2005). This species was recorded from vine thicket mixed with brigalow on Havilah Station in 1994, within 2 km of the preliminary investigation corridor described in the NGBR Project EIS (Council of Heads of Australasian Herbaria 2013).	**May occur** Previously recorded in the desktop search extent AND potential suitable SEVT habitat mapped within the NGBR Project realignment footprint.

Species	EPBC Act/ NC Act status	Predicted to occur by PMST	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
King bluegrass ***Dichanthium queenslandicum***	Endangered/ vulnerable	x	WO, Herbrecs	✓	King bluegrass can be found throughout central Queensland on black cracking clay soils derived from basalt, in association with other *Dichanthium* and *Bothriochloa* spp. within native grasslands and some open woodlands (Simon 1982). It has been recorded approximately 15km from the NGBR Project realignment footprint in the desktop search extent (Council of Heads of Australasian Herbaria 2013).	**Likely to occur** Previously recorded in the desktop search extent AND potential suitable habitat (natural grassland) likely to occur within the NGBR Project realignment footprint.
Dichanthium setosum	Vulnerable/ not listed	x	x	x	In Queensland, *Dichanthium setosum* has been reported from the Leichhardt, Morton, North Kennedy and Port Curtis regions. This species occurs in the Mistake Range, in Main range National Park, and possibly in Glen Rock Regional Park, adjacent to the Main Range National Park (SEWPaC 2013b).	**Confirmed present** Recorded for the Drake Coal Project EIS within one kilometre of the NGBR Project realignment footprint AND potential habitat (natural grassland) may occur within the NGBR Project realignment footprint
Finger panic ***Digitaria porrecta***	Not listed/ near threatened	x	WO	✓	Finger panic occurs within disjunct areas of Queensland, including in the Nebo district (one record), south-west of Mackay; the Central Highlands between Springsure and Rolleston; and from Jandowae south to Warwick (Council of Heads	**May occur** Previously recorded in the desktop search extent AND the species appears to be at its northern-most distribution and rare in

Species	EPBC Act/ NC Act status	Predicted to occur by PMST	Previously recorded*	Recorded within 1 km of the NGBR Project realignment	Habitat preferences and known distributions	Likelihood of occurrence
					of Australasian Herbaria, 2013). It occurs in grassland and open woodlands communities on undulating plains, often road reserves, with an underlying basaltic geology (TSSC 2008mi). A single record for this species is located in the desktop search extent, more than 45 km from the corridor (Council of Heads of Australasian Herbaria 2013).	this area AND suitable habitat is present.
Eucalyptus raveretiana	Vulnerable/ vulnerable	✓	WO	✓	Black ironbox occurs in riparian woodlands on alluvial flats along creek and river banks on sandy or alluvial soils. It is commonly associated with *Melaleuca* spp., *Casuarina cunninghamiana* and *Eucalyptus tereticornis* in the canopy layer. (Calvert *et al* 2005). It has been recorded from within the corridor in the Elliot, Bogie and Bowen Rivers, and from Pelican and Sandy Creek. It was recorded during the surveys undertaken for the NGBR Project EIS in Strathmore and Crush Creeks, where it was co-dominant in the canopy with other eucalypts.	**Likely to occur** Previously recorded in the desktop search extent AND known to occur in the region, specifically along Bowen River AND suitable habitat is present within the NGBR Project realignment footprint

* Note that these desktop results are based on historical records (from across all seasons ranging from 1870 through to 2012) from Herbrecs or from historical records from Wildlife Online (where record dates are not specified).

Fauna

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Birds – likely to occur				
Black-chinned honeyeater ***Melithreptus gularis***	Not listed/ near threatened	Predicted to occur by PMST# - no Previously recorded* - WO Recorded from field surveys^ - no	The black-chinned honeyeater occurs through much of eastern, northern and central Australia. It inhabits eucalypt woodlands and open forests, especially where box and ironbark species are present (Higgins *et al.* 2001). In arid and semi-arid areas the black-chinned honeyeater is often associated with riparian and littoral areas (Higgins *et al.* 2001).	**Likely to occur** Historically recorded in the desktop search extent. The NGBR Project realignment occurs within the distribution of this species (Pizzey and Knight 2007).Potentially suitable habitat occurs within the NGBR Project realignment in areas of remnant vegetation, particularly in eucalypt woodland and fringing riparian vegetation habitats.
Black-throated finch ***Poephila cincta cincta***	Endangered/ endangered	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	This subspecies is now known from three general areas, namely Townsville, Ingham and scattered sites in central Queensland. The sub-species typically occurs in native grasslands and woodlands along creeks and riverbanks. Mosaics of habitat types that provide sufficient foraging resources (i.e. seed) through the wet season are thought to be required by this species (TSSC 2005s).	**Likely to occur** Predicted to occur, but not recorded in the desktop search extent. However, a black-throated finch (southern) record from the Birds Australia database, dated April 2012, is located on the Bowen Developmental Road approximately 12 km from the NGBR Project realignment. The NGBR Project realignment occurs within the distribution of this species (Pizzey and Knight 2007). Suitable habitat occurs in open woodland habitat featuring an understorey of native grasses, where water is locally available.

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Black-necked stork ***Ephippiorhynchus asiaticus***	Not listed/ near threatened	Predicted to occur by PMST# - no Previously recorded* - WO Recorded from field surveys^ - no	The black necked-stork occurs throughout eastern and central Queensland, and across much of northern Australia. It favours habitats featuring wetlands, swamps and riverine areas (Marchant and Higgins 1990). It occasionally occurs in woodland and grassland habitats. (Marchant & Higgins 1990). Nesting usually occurs at the top of tall trees (Marchant & Higgins 1990).	**Likely to occur** Historically recorded in the desktop search extent. The NGBR Project realignment occurs within the distribution of this species (Pizzey and Knight 2007). Potentially suitable habitat occurs at the within the NGBR Project realignment in larger water courses, wetlands as well as natural and artificial waterbodies. This species was recorded during original EIS surveys for the NGBR Project.
Cotton pygmy-goose ***Nettapus coromandelianus***	Not listed/ near threatened	Predicted to occur by PMST# - no Previously recorded* - WO Recorded from field surveys^ - no	The cotton pygmy-goose occurs in eastern and central Queensland. It is an almost entirely aquatic species, with a preference for deep, permanent fresh waterbodies (Marchant & Higgins 1990). Habitats featuring floating and submerged vegetation interspersed with open water are favoured (Marchant & Higgins 1990).	**Likely to occur** Historically recorded in the desktop search extent. The NGBR Project realignment occurs within the distribution of this species (Pizzey and Knight 2007). Potentially suitable habitat occurs within the NGBR Project realignment in natural and artificial waterbodies including farm dams. This species was recorded during surveys for the NGBR Project EIS.

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Squatter pigeon ***Geophaps scripta scripta***	Vulnerable/ vulnerable	Predicted to occur by PMST# - yes Previously recorded* - WO Recorded from field surveys^ - yes	The squatter pigeon (southern) is locally abundant within the northern part of its range (i.e. Brigalow Belt (North) and Desert Uplands Bioregions) (TSSC 2008agp). It is considered to be common in grazing country north of the Tropic of Capricorn (TSSC 2008agp). The species occurs in a wide range of habitats wherever there is a grassy understorey. It is often found within close proximity of water bodies (TSSC 2008agp). The squatter pigeon (southern) has been historically recorded within 10 km of the NGBR Project realignment (Wildlife Online).	**Confirmed present** Historically recorded in the desktop search extent. Suitable habitat occurs in parts of NGBR Project realignment. This species was recorded during field surveys for the NGBR Project, Alpha Coal Project EIS (GHD 2010b) and the Drake Coal Project EIS (GHD 2012).
Birds – may occur				
Australian painted snipe ***Rostratula australis***	Endangered, migratory, marine/ vulnerable	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The Australian painted snipe has a scattered distribution across eastern and northern Australia (TSSC 2013as). Shallow freshwater wetlands are the main habitat for the species (Marchant and Higgins 1993). Such wetlands may include lakes, swamps, claypans, inundated / waterlogged grassland, dams, irrigated crop land and sewage ponds (Marchant and Higgings 1993). Preferred wetland habitats boast emergent vegetation (including tussocks, grasses, sedges, rushes, reeds, canegrass and/or Melaleuca) (Marchant and Higgins 1993). Nesting occurs amongst vegetation in or adjacent to wetlands (TSSC 2013as).	**May occur** Not recorded in the desktop search extent. The NGBR Project realignment occurs within the distribution of this species (Pizzey and Knight 2007). Potentially suitable habitat occurs within the NGBR project realignment where wetlands are present.

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Freckled duck ***Stictonetta naevosa***	Not listed/ near threatened	Predicted to occur by PMST# - no Previously recorded* - no Recorded from field surveys^ - no	This species inhabits larger fresh waterbodies including lakes and vegetated swamps (Pizzey & Knight 2007). The freckled duck is a rare visitor to northern Queensland.	**May occur** Not recorded in the desktop extent. Potentially suitable habitat occurs in and near large freshwater bodies. This species generally occurs in southern Australia and is a vagrant visitor to northern Queensland. Freckled duck was recorded during surveys for the NGBR Project EIS.
Masked owl (northern subspecies) ***Tyto novaehollandiae kimberli***	Vulnerable/ vulnerable	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The masked owl (northern) occurs across northern Australia and is a conventionally accepted subspecies of the masked owl. In Queensland, the northern subspecies occurs across Cape York Peninsula, to a southern distribution limit along the central Queensland coast, with records from Mackay and near Duaringa, west of Rockhampton (DotE 2014a). Habitat for the subspecies includes riparian forest, rainforest, open forest Melaleuca swamps, edges of mangroves and the margins of sugar cane fields (DotE 2014a). This species is territorial, occupies a large home range and requires large old growth trees with large hollows for nesting (DotE 2014a).	**May occur** Predicted to occur, but not recorded in the desktop search extent. The NGBR Project realignment is within the species known distribution. Potentially suitable habitat occurs in NGBR Project realignment, particularly where tall riparian vegetation occurs along larger watercourses.

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Red goshawk ***Erythrotriorchis radiatus***	Vulnerable/ endangered	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The red goshawk prefers landscapes containing a mosaic of habitats including coastal and sub-coastal tall open forest, woodland and rainforest edges (Marchant and Higgins 1993). Forests of intermediate density are particularly favoured, as are ecotones between variably dense habitats (i.e. ecotone between rainforest and sclerophyll forest) (DERM 2012). Large bird populations (the primary prey of this species) are also an important determinant of red goshawk habitat utilisation (DERM 2012). It generally avoids open habitats, and is only rarely encountered over agricultural land (Marchant and Higgins 1993). Nesting occurs in tall trees within one kilometre of permanent water, generally in open, biologically rich forest or woodland (Marchant and Higgins 1993). The species is sparsely dispersed across approximately 15 per cent of coastal and sub-coastal Australia. The species occurs at low densities occupying home ranges estimated between 50 – 220 km^2 (DERM 2012).	**May occur** Predicted to occur, but not recorded in the desktop search extent. The NGBR Project realignment is within the species known distribution. Potentially suitable habitat occurs in NGBR Project realignment, particularly where tall riparian vegetation occurs along larger watercourses (possible nesting habitat).

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Birds – unlikely to occur				
Star finch **(eastern sub species)** ***Neochima ruficauda ruficauda***	Endangered/ endangered	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The distribution of the subspecies of the star finch is poorly known, however it is restricted to eastern Queensland (and distribution is likely to be severely fragmented (TSSC 2008cu). Areas of permanently occupied habitat or permanent populations have not been identified (TSSC 2008cu). An estimate puts the extant wild population of the subspecies at 50 birds (TSSC 2008cu). Habitat preferences include grasslands and grassy woodlands near water, sedgelands, swamps and wetlands (Higgins *et al.* 2006; TSSC 2008cu). The subspecies is also known from disturbed habitats including farmland (Higgins *et al.* 2006; TSSC 2008cu).	**Unlikely to occur** Predicted to occur, but not previously recorded in the desktop search extent. This subspecies has disappeared from much of its former eastern and central Queensland range, with a lack of recent records (Higgins *et al.* 2006).
Reptiles – likely to occur				
Common death adder ***Acanthophis antarcticus***	Not listed/ near threatened	Predicted to occur by PMST# - no Previously recorded* - WO Recorded from field surveys^ - no	The common death adder occurs throughout central and eastern Queensland, the Northern Territory and New South Wales (DEHP 2013a). The species prefers habitat associated with a deep leaf litter layer, such as those found in forests, woodlands and grasslands (DEHP 2013a).	**Likely to occur** Historically recorded in the desktop search extent Potentially suitable habitat occurs in areas featuring dense remnant vegetation with leaf litter present. These habitat requirements limit potential habitat within the NGBR Project realignment to areas of remnant woodland vegetation where suitable microhabitat features are present.

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Ornamental snake ***Denisonia maculata***	Vulnerable/ vulnerable	Predicted to occur by PMST# - yes Previously recorded* - WO Recorded from field surveys^ - no	The ornamental snake's distribution is confined to the Brigalow Belt North bioregion and parts of the Brigalow Belt South bioregion (DotE 2014b). This species is typically found in areas of brigalow, riverside woodland and open forest on natural levees (DotE 2014). Habitats featuring cracking clay and sandy substrates are known to be utilised by the species.	**Confirmed present** Predicted to occur and historically recorded in the desktop search extent. The NGBR Project realignment is within the DotE modelled 'known/likely to occur' distribution for this species. Suitable habitat is likely to exist within the NGBR Project realignment, particularly in remnant vegetation north and south of the Bowen River. Ornamental snake was recorded during field surveys of the Drake Coal Project EIS.
Reptiles – may occur				
Brigalow scaly-foot ***Paradelma orientalis***	Not listed/ vulnerable	Predicted to occur by PMST# -no Previously recorded* - no Recorded from field surveys^ - no	The brigalow scaly-foot inhabits a variety of open forest habitats in central and south-east Queensland. Acacia and eucalypt woodlands are known habitat for this species. The species has been recorded from habitats featuring substrates including cracking clays and sandy alluvium (DotE 2014f).	**May occur** Not historically recorded in the desktop search extent. The NGBR Project realignment is within the SEWPaC modelled 'may occur' distribution for this species. Potentially suitable habitat associated with eucalypt woodland and acacia dominated woodland/ shrubland occurs within and near the NGBR Project realignment.

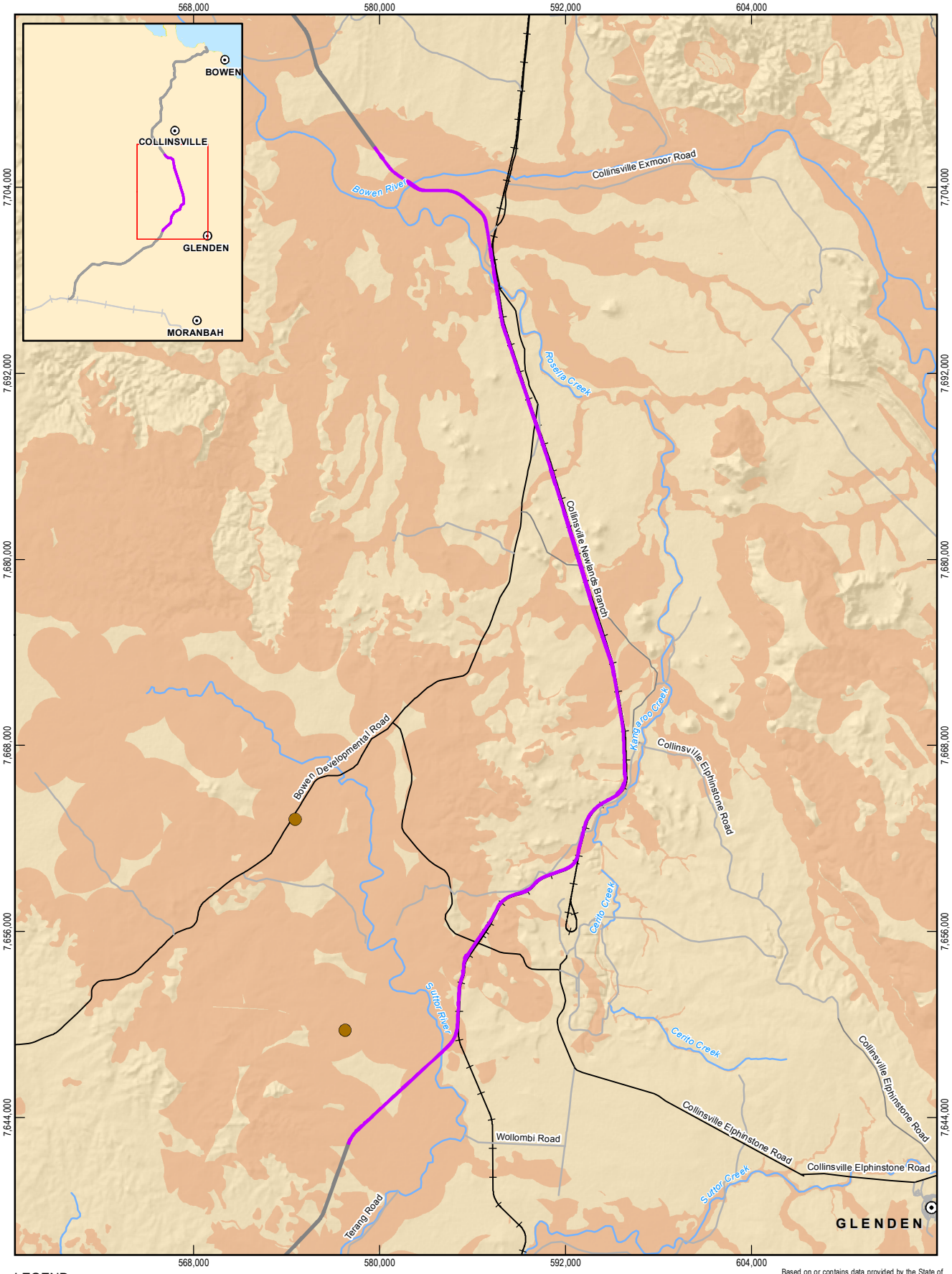
Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Estuarine crocodile ***Crocodylus porosus***	Migratory (Bonn); Marine/ vulnerable	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The estuarine crocodile is the largest species of crocodile in the world, with an average male crocodile 5 m long and weighing 450 kg. This species occurs from Rockhampton in Queensland, throughout coastal areas of the Northern Territory to near Broome in Western Australia and inhabits coastal waters, estuaries, freshwater sections of lakes, inland swamps and marshes. This species has been recorded from the Burdekin River Basin (DotE 2014c).	**May occur** Predicted to occur, but not previously recorded in the desktop search extent. Potentially suitable habitat may occur where large permanent pools of water are present within the major rivers of the Burdekin Basin, including the Bowen River.
Yakka skink ***Egernia rugosa***	Vulnerable/ vulnerable	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The yakka skink is endemic to dry open forests, woodlands and rocky areas of central and eastern Queensland. Yakka skinks live in communal borrow complexes, and often take refuge among low vegetation or under heaped dead timber, logs, rocks and in deep rock crevices (Wilson 2005; DotE 2014d). The species occurs in a wide variety of vegetation types including poplar box (*Eucalyptus populnea*), ironbark (*Eucalyptus spp*.), brigalow (*Acacia harpophylla*), white cypress pine (*Callitris spp*.), mulga (*Acacia aneura*), bendee (*Acacia catenulata*) and lancewood (*Acacia shirleyi*) woodland and open forest (DotE 2014d).	**May occur** Predicted to occur, but not recorded in the desktop search extent. The NGBR Project realignment is within the DotE modelled 'may occur' distribution for this species. Suitable habitat may occur within the NGBR Project realignment in eucalypt woodland with suitable timber microhabitats are present.

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Reptiles – unlikely to occur				
Retro slider ***Lerista allanae***	Endangered/ endangered	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The retro slider has only been recorded from three locations at Clermont, Logan Downs Station and Retro Station. The most recent specimen was collected in 1960. Despite extensive searches, the species has not been found and may be extinct (Wilson 2005).The original habitats of this species have been substantially altered by agriculture. The original habitat preferences of the species are therefore unclear (Wilson 2005).	**Unlikely to occur** This species is predicted to occur in PMST. However, the species has only been recorded from three locations. The closest record is located approximately 100 km south of the southern end of the NGBR Project realignment. The species may be extinct and is considered unlikely to occur.
Mount Cooper striped Lerista ***Lerista vittata***	Vulnerable/ vulnerable	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	The Mount Cooper striped lerista is found in Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions, which is not predicted to occur in the investigation corridor (TSSC 2008dt).	**Unlikely to occur** Predicted to occur, but not recorded in the desktop search extent. Limited suitable habitat is available within NGBR Project realignment.

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Mammals – likely to occur				
Little pied bat ***Chalinolobus picatus***	Not listed/ near threatened	Predicted to occur by PMST# - no Previously recorded* - Alpha Coal Project EIS unconfirmed record (Anabat) Drake Coal Project EIS Recorded from field surveys^ - no	The little pied bat is located through central Queensland and into north-west New South Wales (Thompson *et al.* 2011). In central western Queensland, this species reaches its greatest relative abundance in riverine open forest communities (Churchill 2008). A variety of woodland and open forest habitats are utilised by this species (Churchill 2008). Roosting habitat includes tree hollows, caves and abandoned buildings and mines (Churchill 2008).	**Likely to occur** Not historically recorded in the desktop search extent. This species' echolocation calls were positively identified on anabat devices during surveys for the NGBR Project. In addition, little pied bat was recorded during surveys for the Alpha Coal Project EIS (Hancock Prospecting Pty Ltd 2010) and an unconfirmed echolocation call was recorded on Anabat during field surveys for the Drake Coal Project EIS. Potentially suitable habitat occurs in areas featuring remnant vegetation with tree hollows – particularly eucalypt woodlands; acacia dominated woodland/ shrubland and fringing riparian vegetation. Foraging habitat is also present at natural and artificial waterbodies.
Koala ***Phascolarctos cinereus***	Vulnerable/ special least concern	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	In Queensland, the species contains scattered populations throughout moist forests along the coastline, subhumid woodlands in central and southern regions and within Eucalypt woodlands along watercourses within semi-arid areas further west (Melzer *et al.* 2000). The greatest density of koalas occur through central and eastern areas including the Brigalow Belt, Mitchell Grass Downs, Mulga lands and the Desert Uplands (Patterson 1996).	**Confirmed present** Predicted to occur, but not historically recorded in the desktop search extent. Koala was recorded during field surveys of the NGBR Project EIS. Additionally, the NGBR Project realignment is mapped within the DotE modelled 'likely to occur to known to occur' distribution for this species (DotE 2014e). Suitable habitat occurs within the NGBR Project realignment within eucalypt woodland and fringing riparian vegetation, based on species known habitat requirements.

Species	EPBC Act/ NC Act status	Prediction of occurrence and previous records*	Habitat preferences and known distributions	Likelihood of occurrence
Mammals – may occur				
Northern quoll ***Dasyurus hallucatus***	Endangered /not listed	Predicted to occur by PMST# - yes Previously recorded* - no Recorded from field surveys^ - no	Species distribution covers much of north eastern Australia, although the current range has contracted considerably such that it is now restricted to six discrete areas across northern Australia (Strahan 1995). The species has no highly specific habitat requirements, though rocky areas associated with open woodland and open forest are considered optimal habitat (Hill and Ward 2010). The preference for rocky habitat may be related to reduced exposure to threatening processes (i.e. vegetation clearing, fire, cane toads, reduced competition with cats) and the diversity of micro-habitats available (Hill and Ward 2010). The modelled distribution of the species, as presented in the Referral Guidelines for the Northern Quoll *Dasyurus hallucatus* (TSSC 2005x), indicates that the NGBR Project realignment coincides with the modelled 'may occur' distribution area for the species.	**May occur** Not previously recorded in the desktop search extent. The NGBR Project realignment is within the DotE modelled 'may occur' distribution for this species. Suitable habitat may occur within the NGBR Project realignment where areas of rocky eucalypt woodland are present.

Appendix C - Threatened species habitat mapping



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Railway
- Carmichael Project (Rail)
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Squatter pigeon (southern)
- Potential squatter pigeon (southern) habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Squatter pigeon (southern) potential habitat mapping

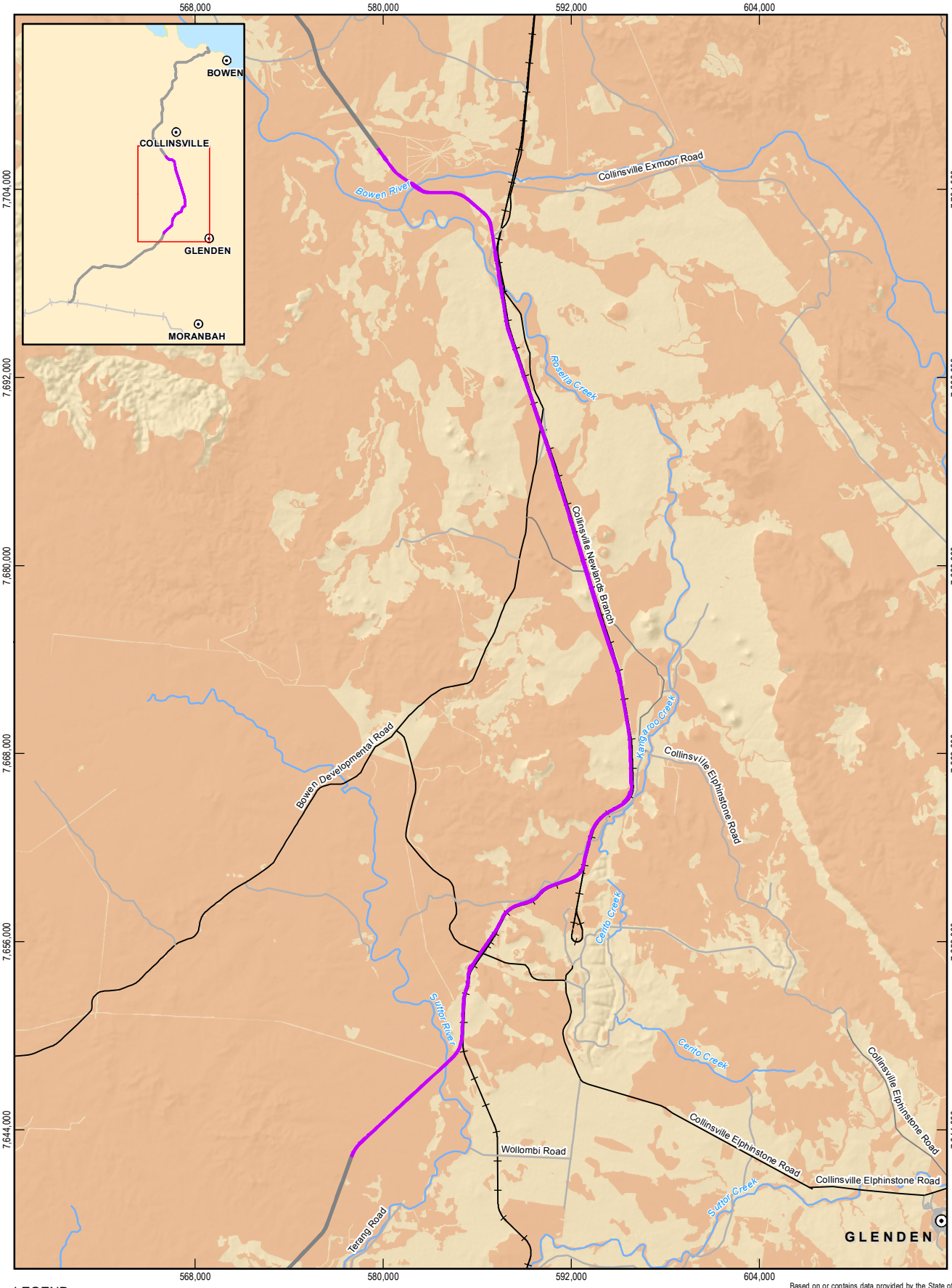
Figure C-1

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1173_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011); GHD: Threatened Species Sightings (2013). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential common death adder habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Common death adder potential habitat mapping

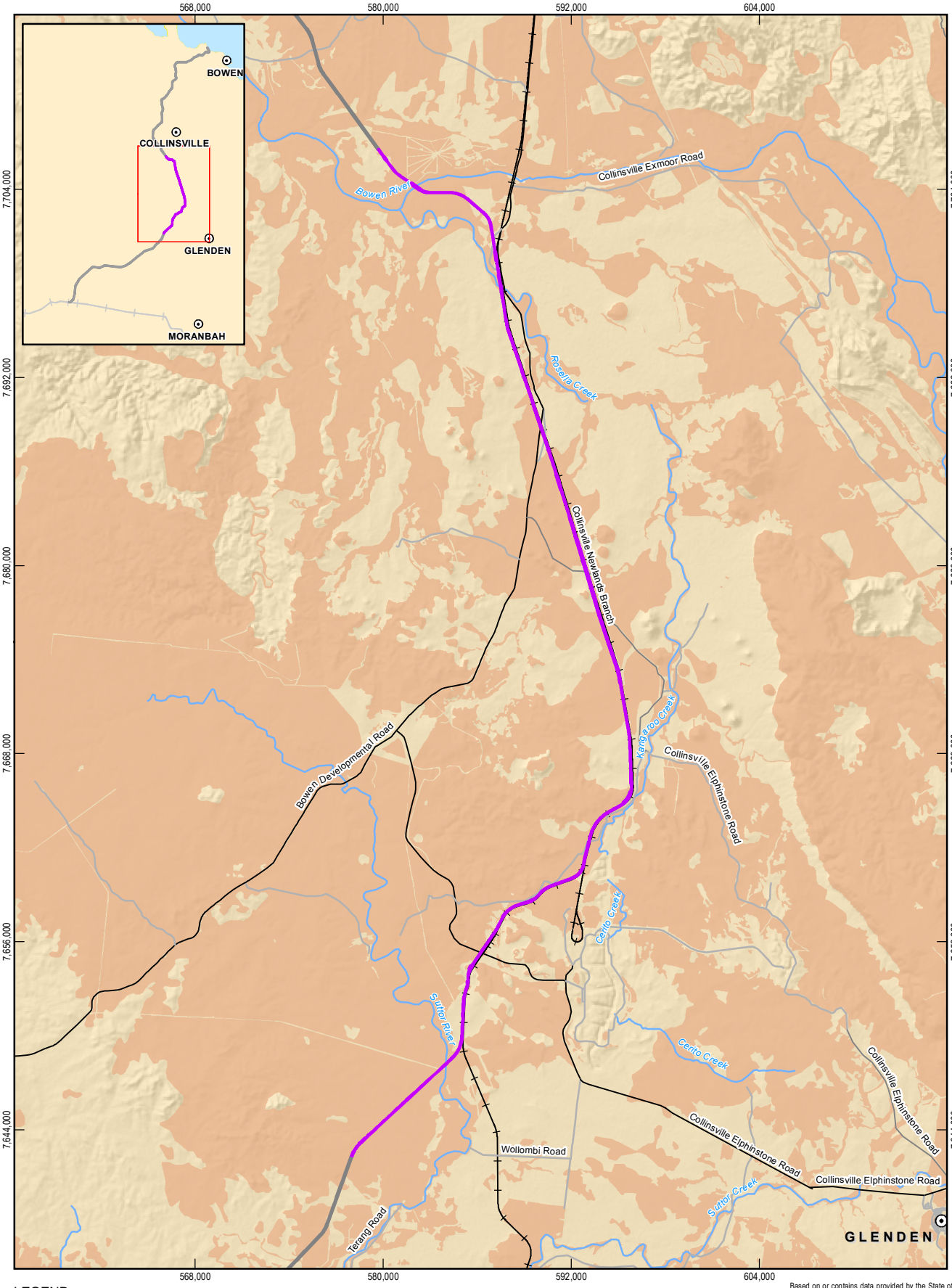
Figure C-2

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1174_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential brigalow scaly-foot habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Brigalow scaly-foot potential habitat mapping

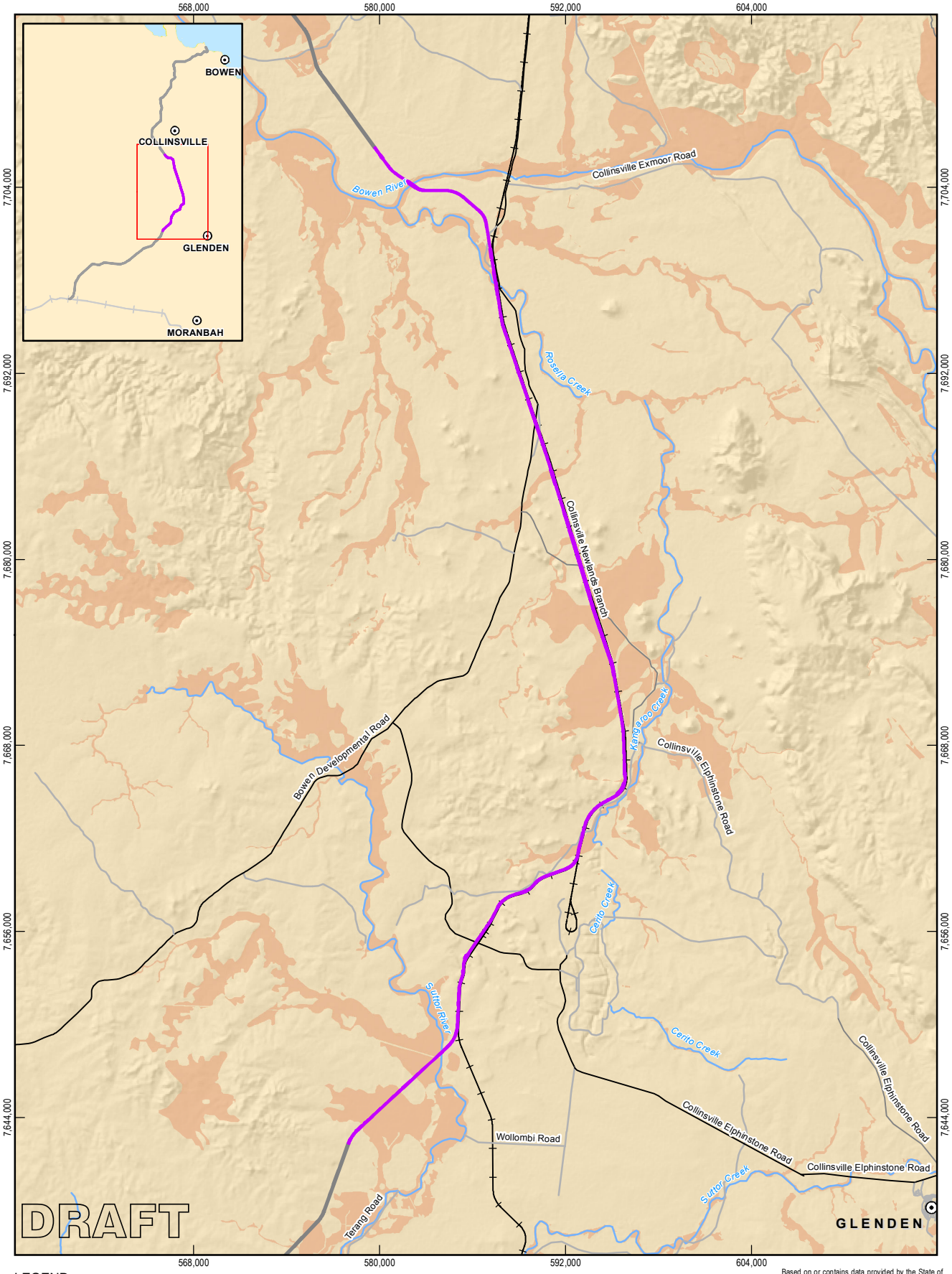
Figure C-3

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1175_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential black-necked stork habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Black-necked stork potential habitat mapping

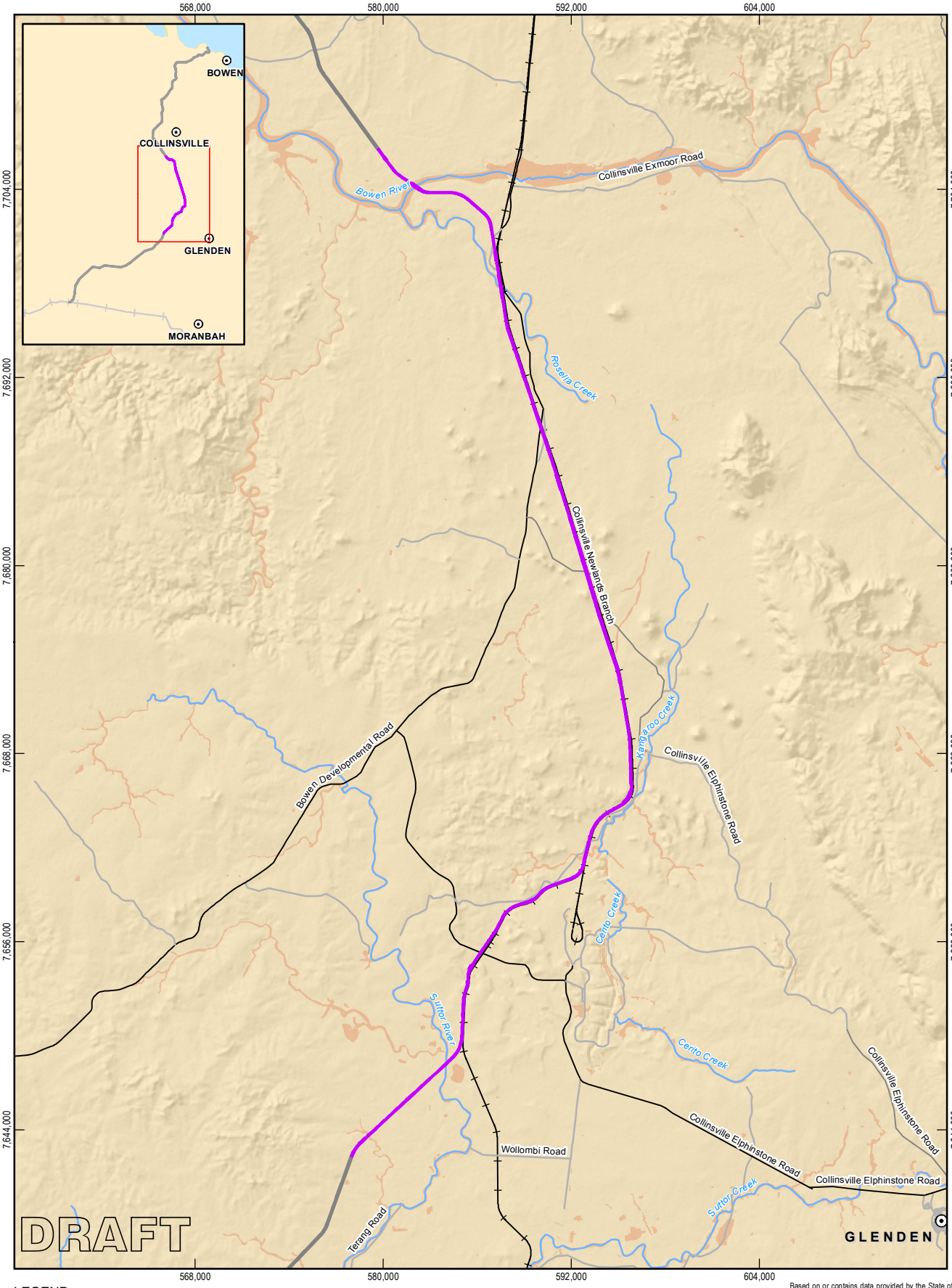
Figure C-4

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1176_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential cotton-pygmy goose and freckled duck habitat - based on wetland classification mapping

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Cotton pygmy-goose and freckled duck potential habitat mapping

Job Number	41-26457
Revision	A
Date	27 Feb 2014

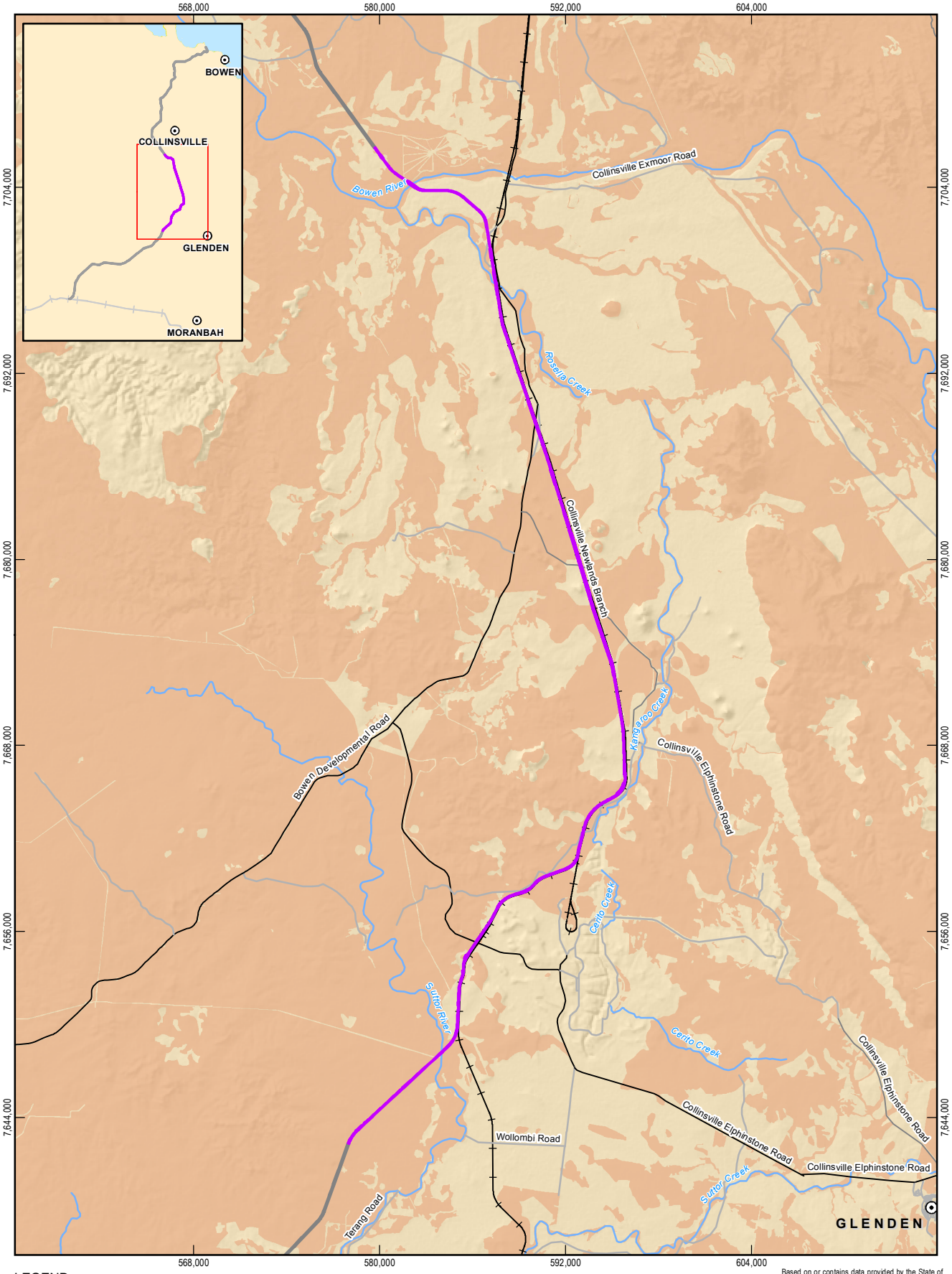
Figure C-5

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1177_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential black-throated finch habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12 Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Black-throated finch potential habitat mapping

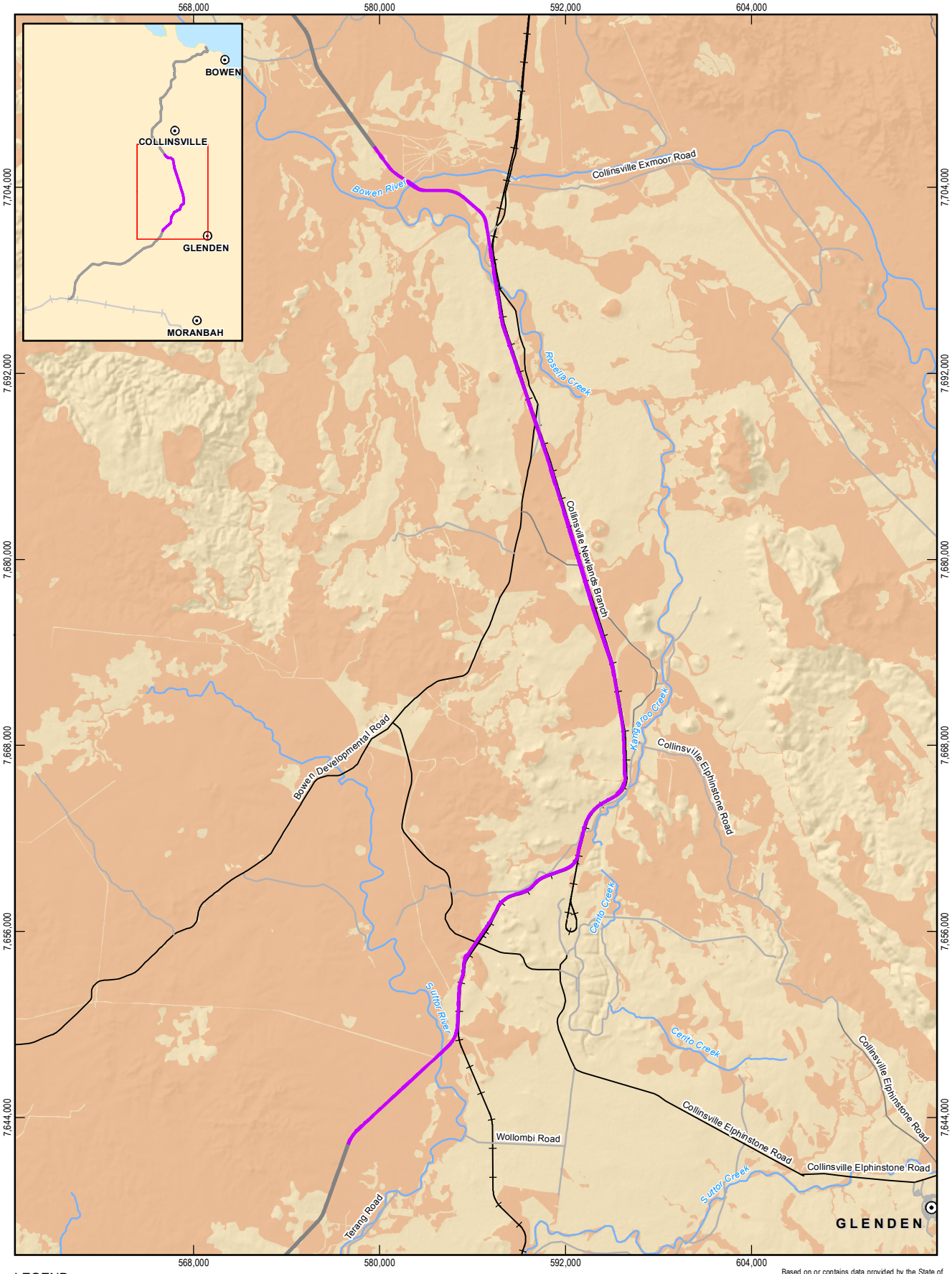
Figure C-6

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1178_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential black-chinned honeyeater habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Black-chinned honeyeater potential habitat mapping

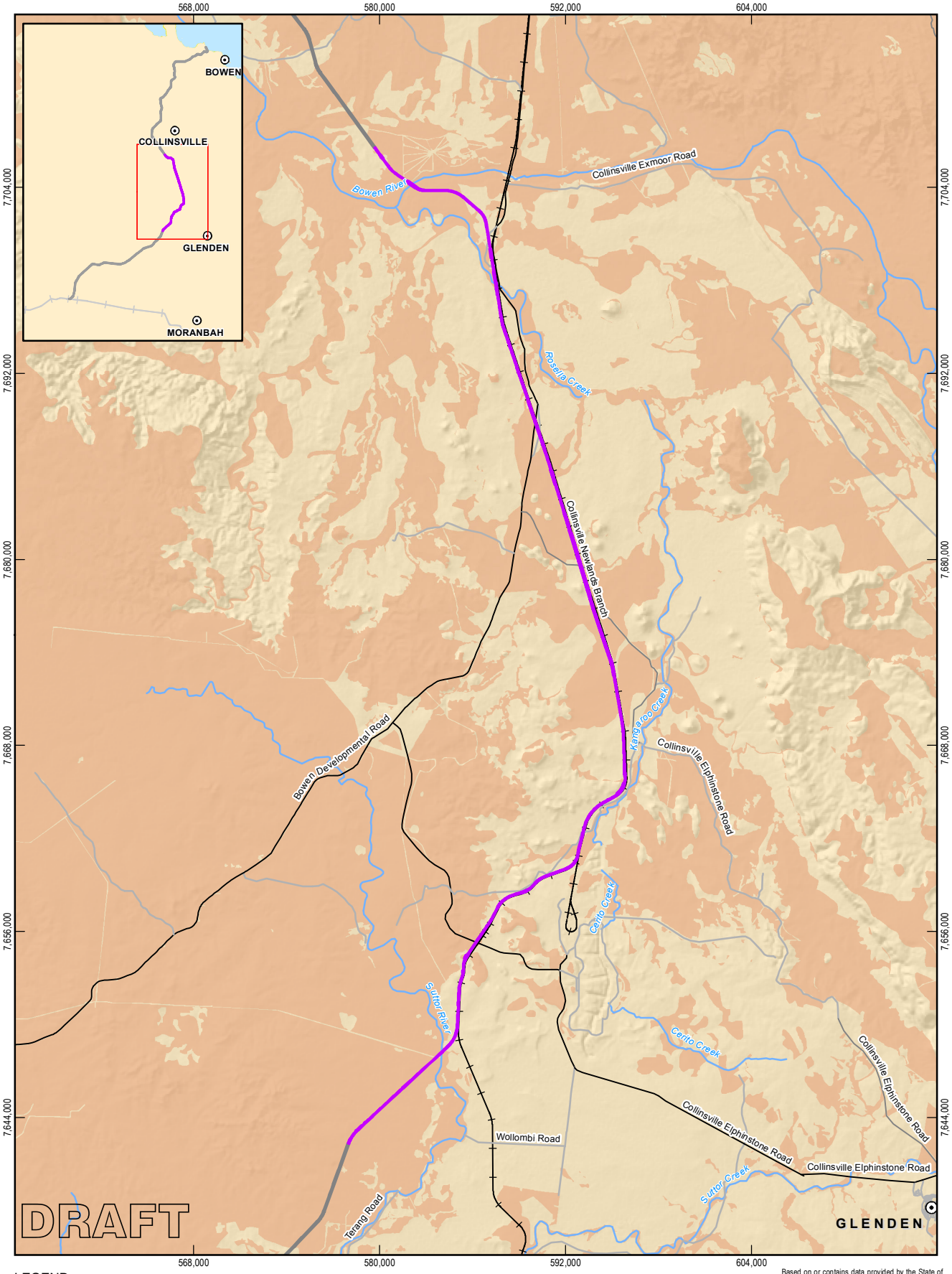
Figure C-7

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1179_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Square-tailed kite habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Square-tailed kite potential habitat mapping

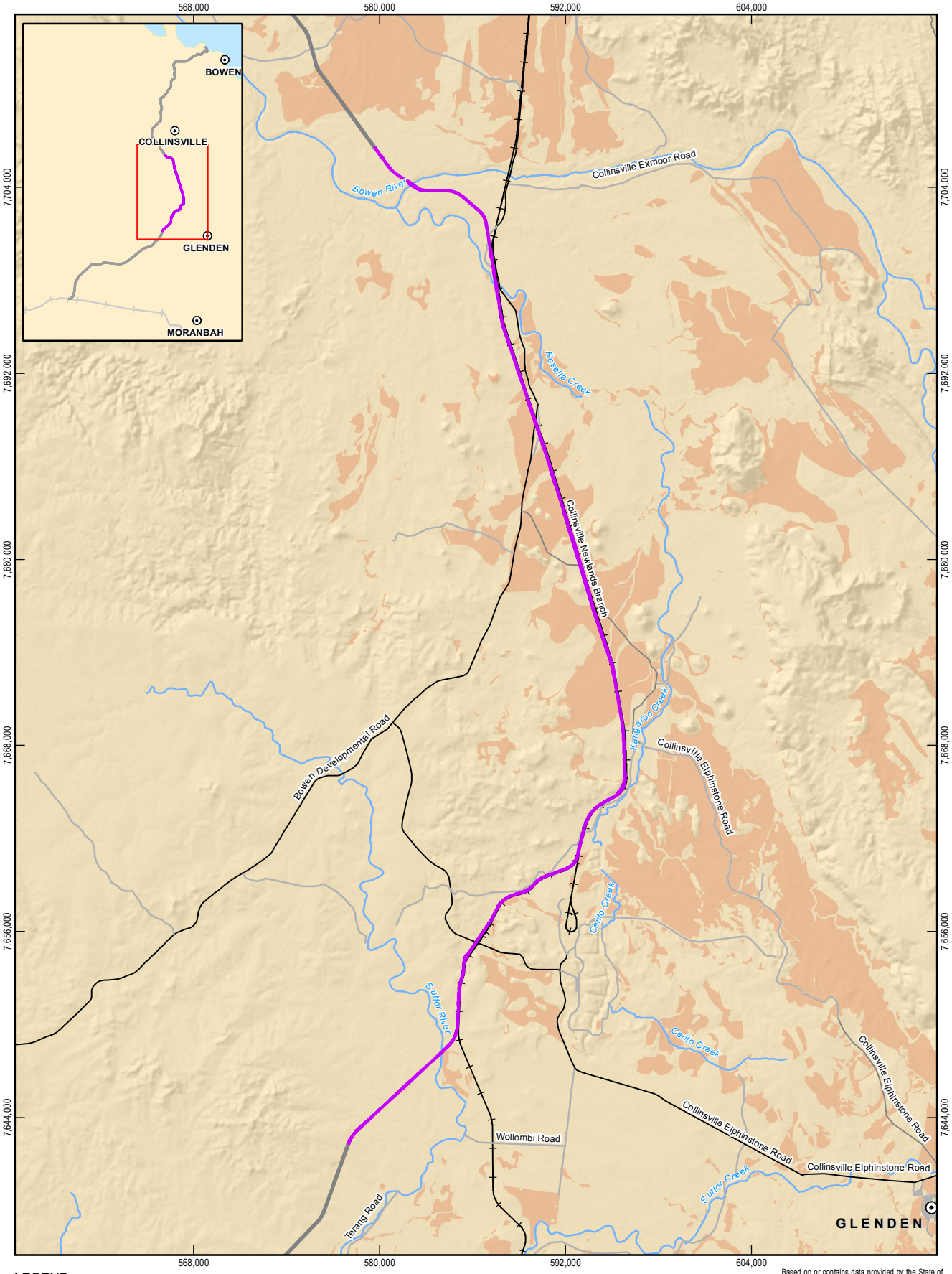
Figure C-8

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1180_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential ornamental snake habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Ornamental snake potential habitat mapping

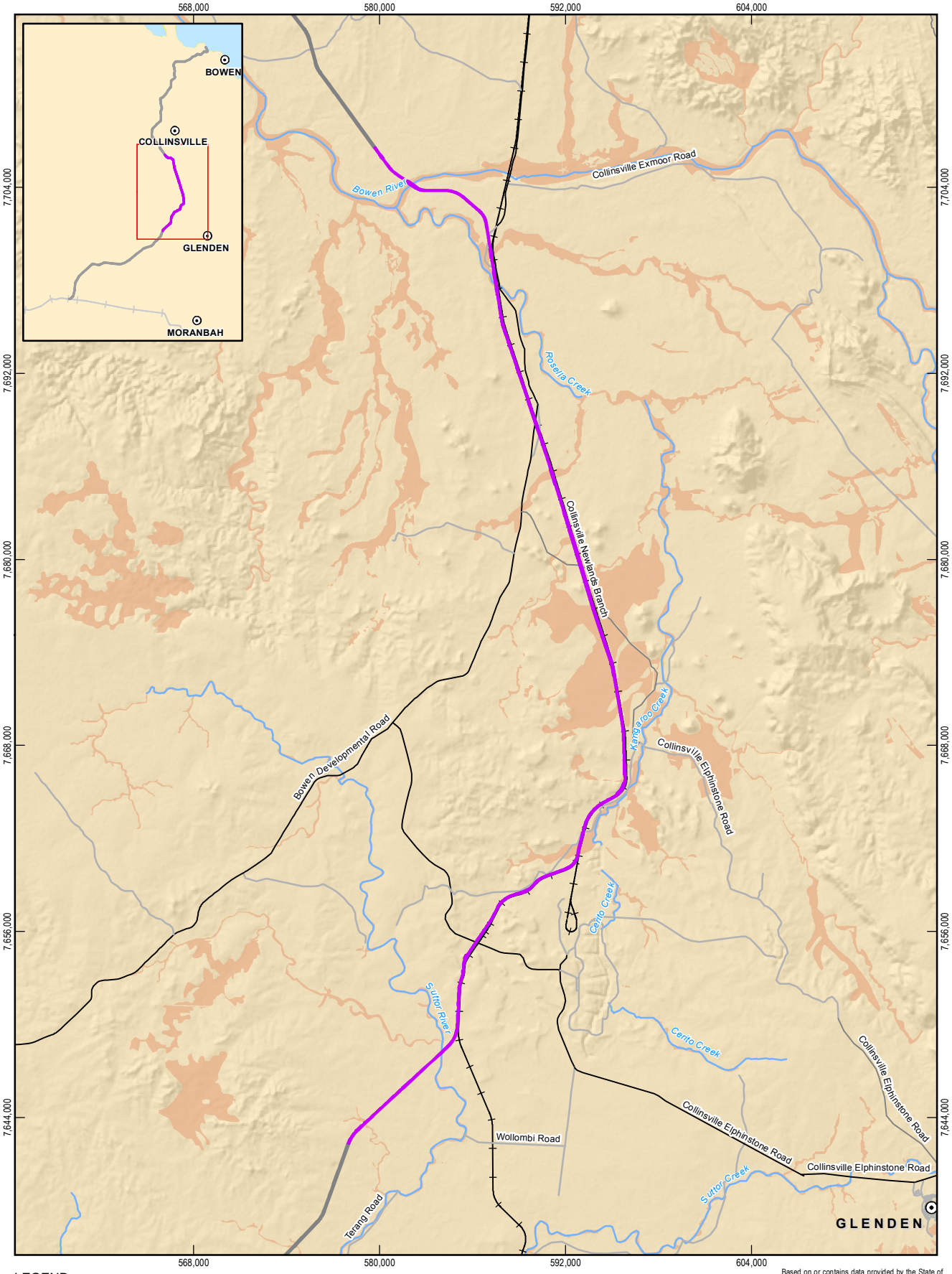
Figure C-9

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1181_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential estuarine crocodile habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12 Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Estuarine crocodile potential habitat mapping

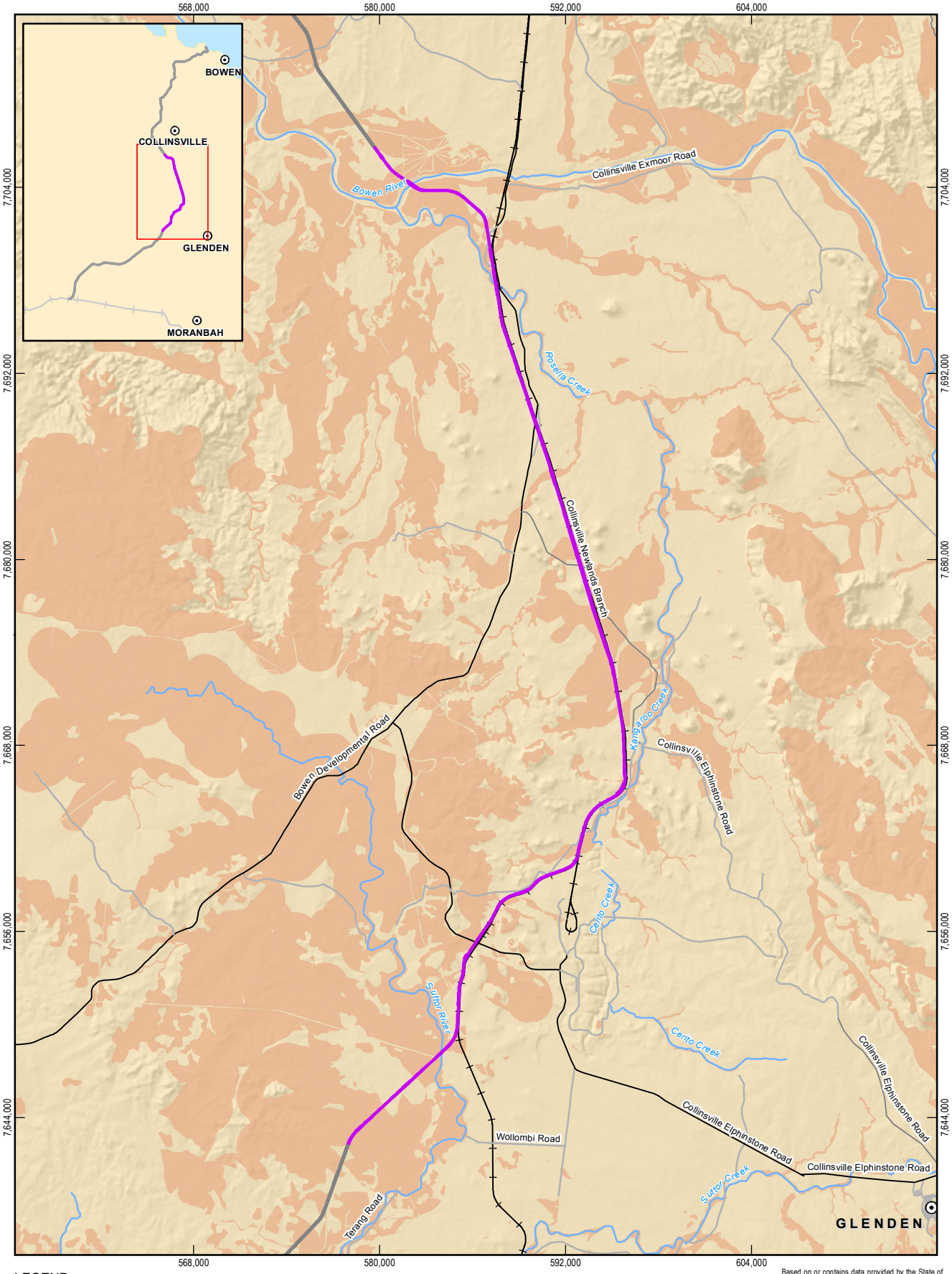
Figure C-10

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1182_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential koala habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Koala potential habitat mapping

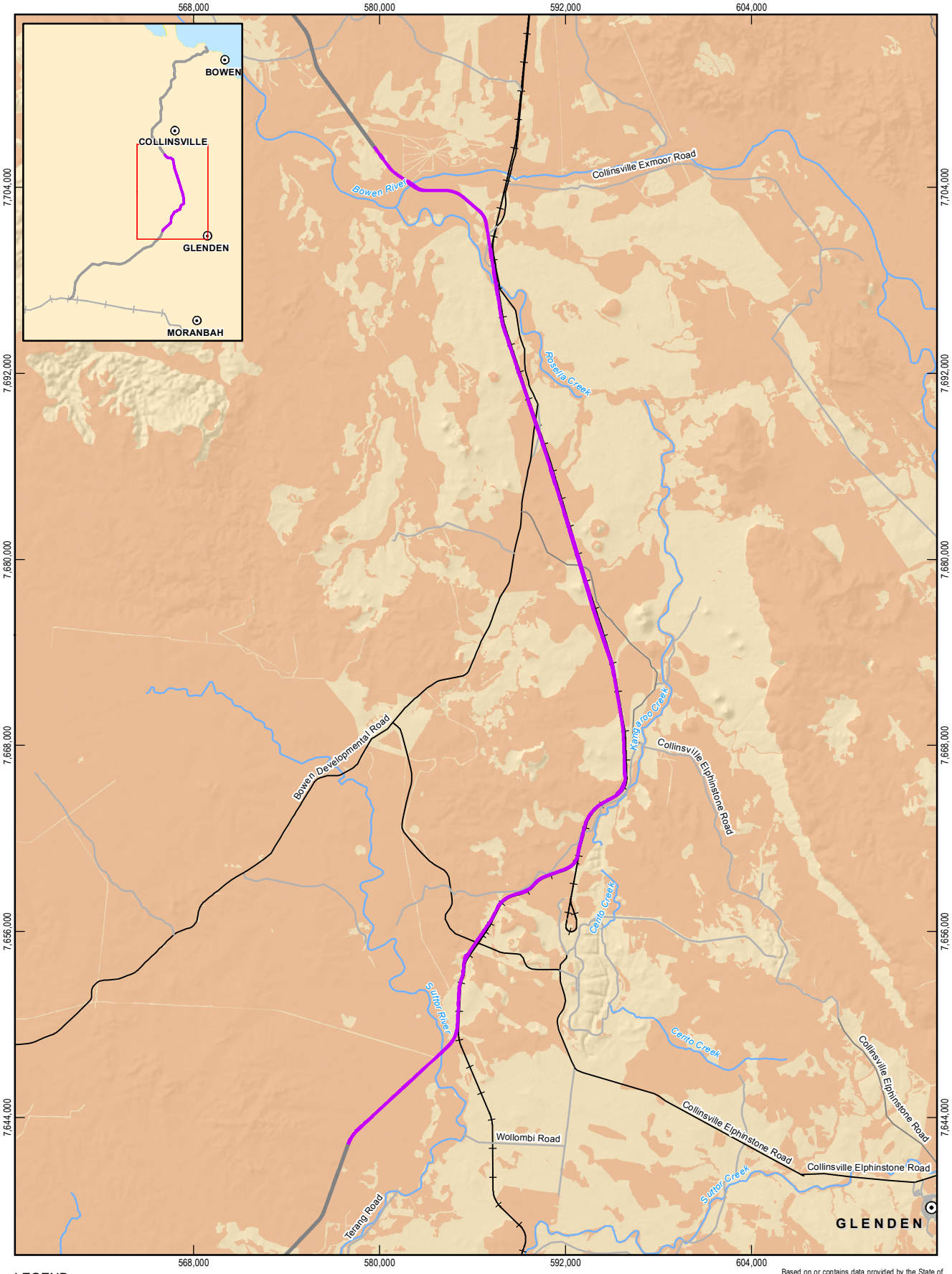
Figure C-11

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1183_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Railway
- Main road
- Watercourses (Major)
- Secondary road
- Local road
- Potential little pied bat habitat - based on DNRM certified regional ecosystems version 6.1
- NGBR Project final rail corridor
- NGBR Project realignment

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Little pied bat potential habitat mapping

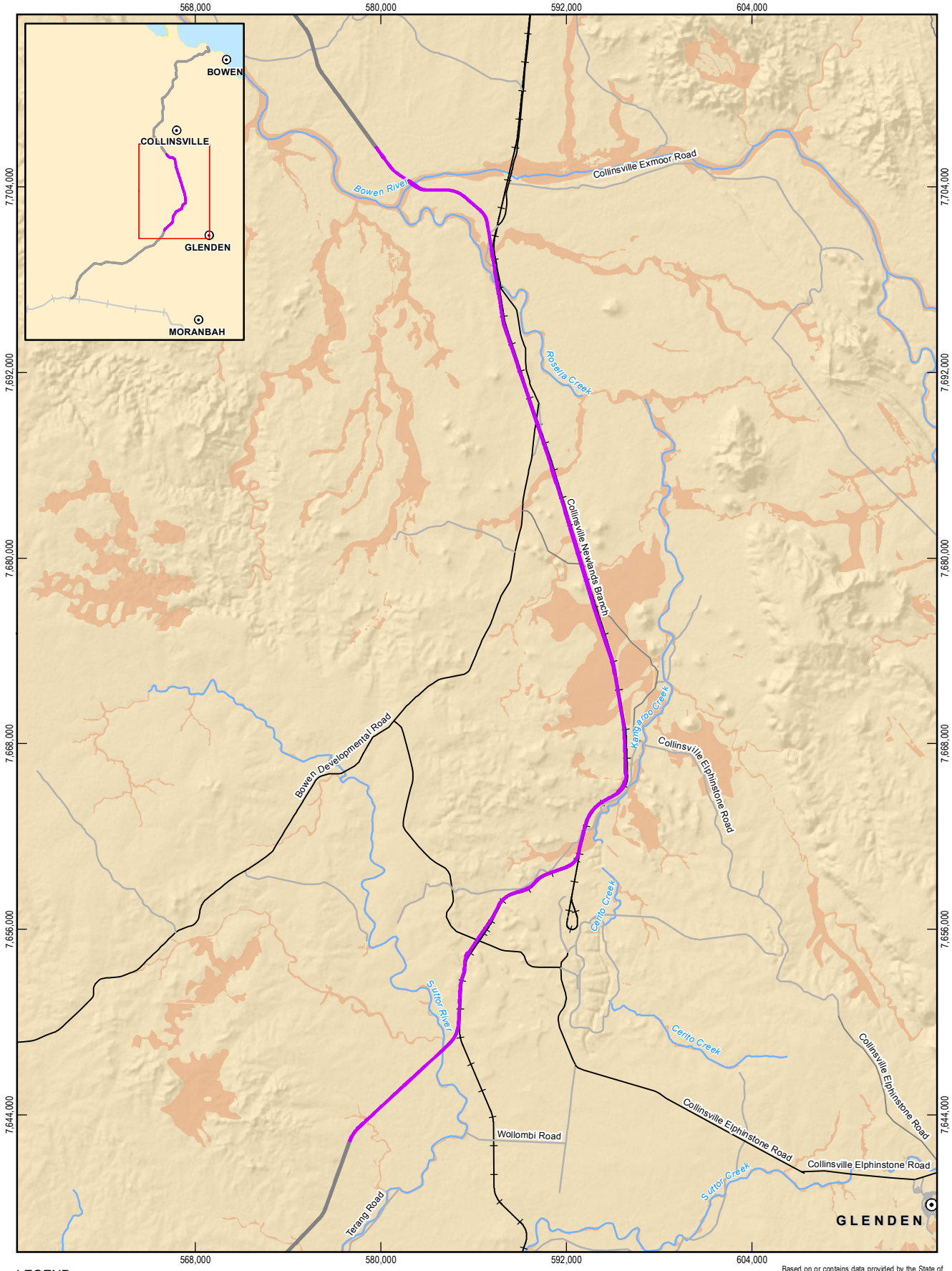
Figure C-12

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1184_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014); DNRM: Physical Road Network (2010), Regional Ecosystems (2013). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential black ironbox habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd
North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Black ironbox potential habitat mapping

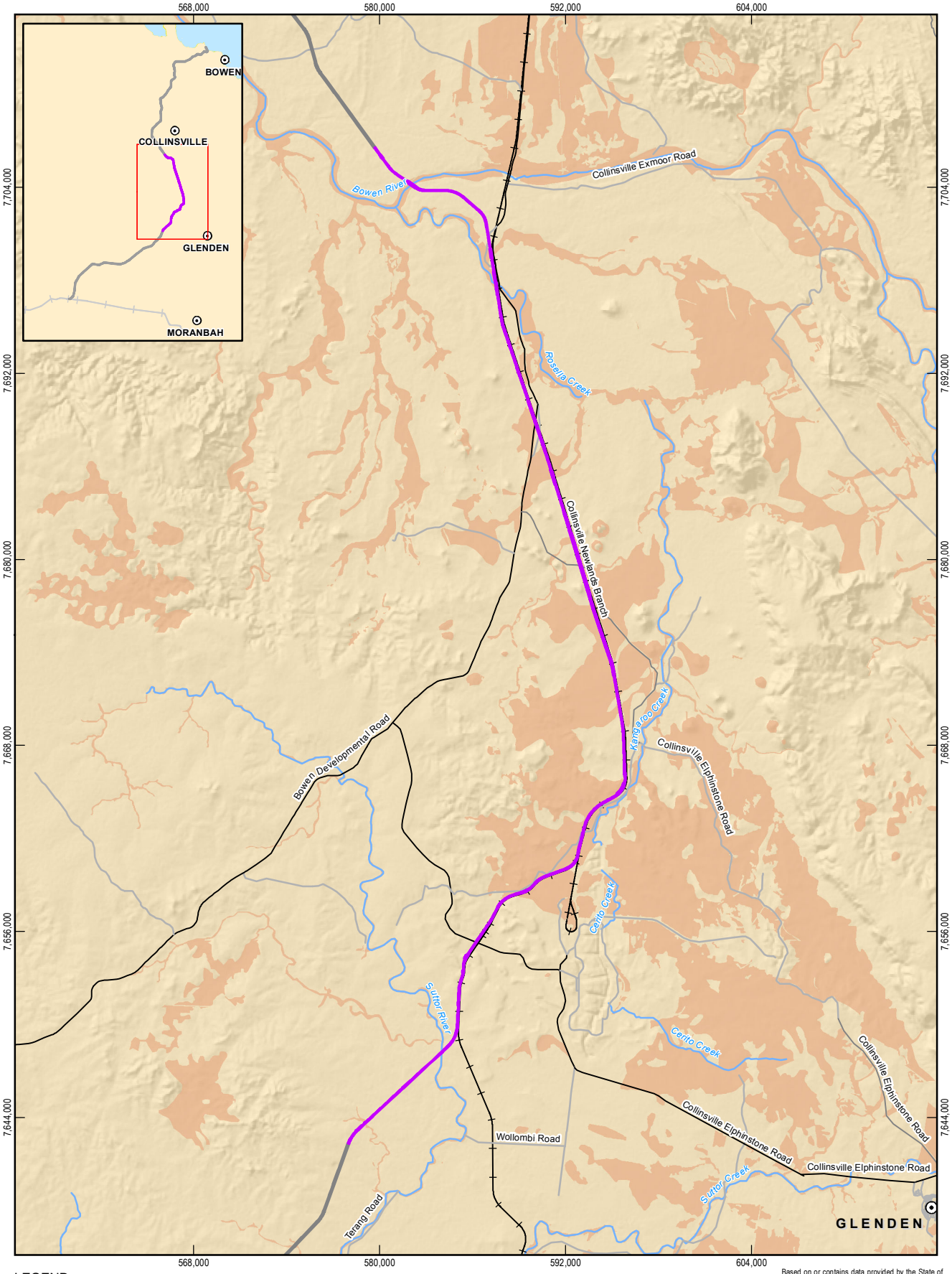
Figure C-13

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1185_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential bluegrass habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	27 Feb 2014

Bluegrass potential habitat mapping

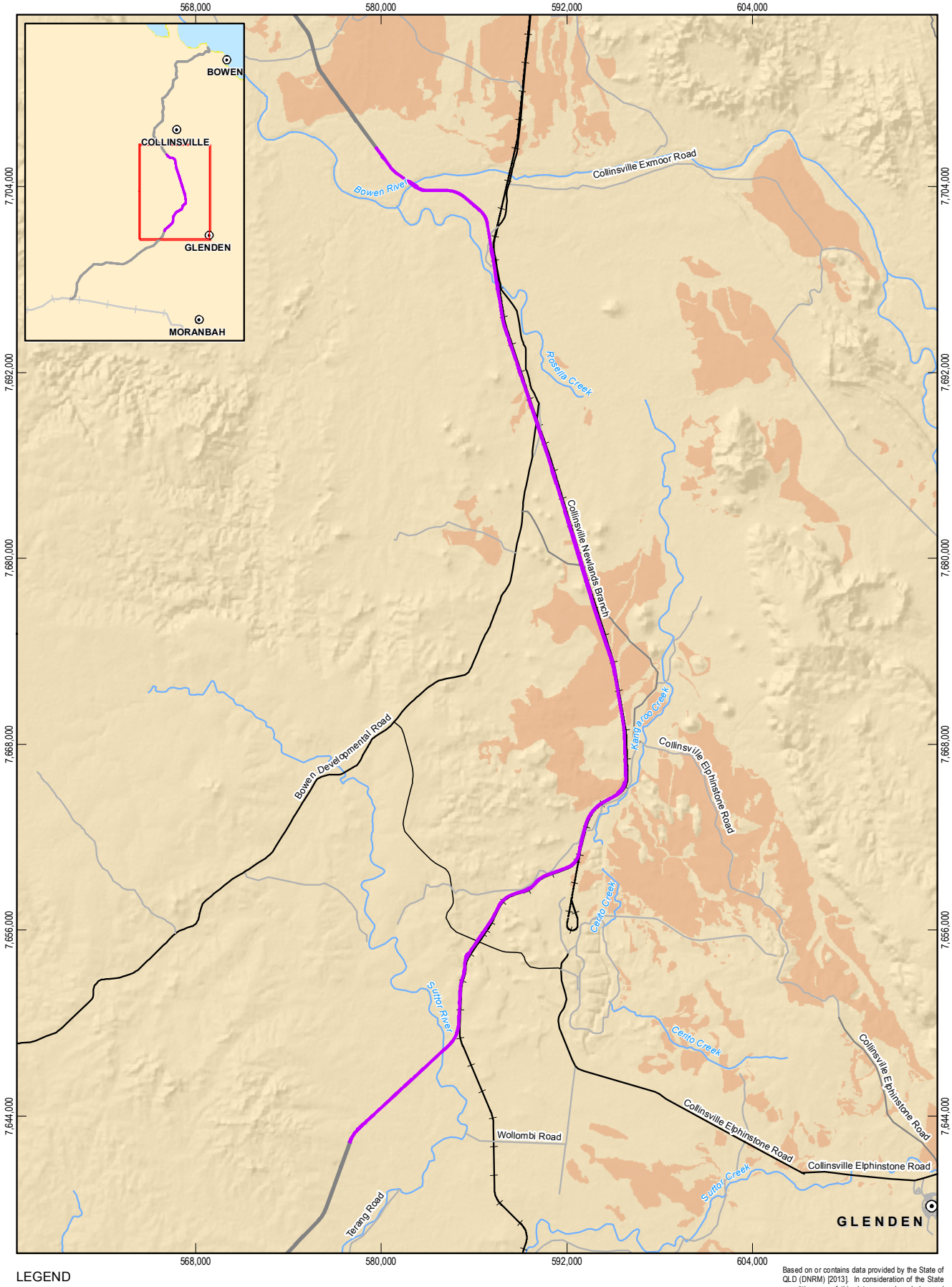
Figure C-14

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1224_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse/2007; Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ



LEGEND

- Population centres
- Main road
- Secondary road
- Local road
- Carmichael Project (Rail)
- Railway
- Watercourses (Major)
- NGBR Project final rail corridor (EIS)
- NGBR Project final rail corridor
- Potential king bluegrass habitat - based on DNRM certified regional ecosystems version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:350,000 Paper Size A4

0 3 6 12

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project AEIS

Job Number	41-26457
Revision	A
Date	28 Feb 2014

King bluegrass potential habitat

Figure C-15

G:\41\26457\06 GIS\Maps\MXD\1100_Ecology\41_26457_1223_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

© 2014. Whilst every care has been taken to prepare this map, GHD, GA, Adani and DNRM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: GA: Populated Places, Railway, Watercourse(2007); Adani: AEIS Option 9 Rev1 final rail corridor (2014), Carmichael Project Rail (2012); DNRM: Physical Road Network (2010), Potential Habitat (2011). Created by: AJ

Appendix D - Potential fish community within the Suttor and Bowen River catchments

Species	Habitat preferences	Movement behaviour	Environmental tolerance
Catadromous			
marbled eel (*Anguilla reinhardtii*)	Occurs predominantly within fast flows in riffles and runs. Can occupy lakes, swamps, floodplains and impoundments. Adults occur *c.* 100 km upstream of the river mouth, with juveniles found towards the river mouth. Utilises oceanic waters are required for breeding.	Adults are catadromous and migrate to sea during late summer – autumn for spawning. Movement between freshwater and saltwater habitats an obligatory component of species' life history. Juveniles (elvers) – migrate back to coastal rivers during spring – summer.	Tolerant to a wide range of environmental conditions. Possess significant hypo-osmoregulatory ability. Tolerance to hypoxic conditions. Seasonal cues in rising flows and increasing water temperature possible cues for movement.
barramundi[#] (*Lates calcarifer*)	Occurs in a variety of freshwater, brackish and coastal habitats. Prefers areas with submerged snags, logs and rock ledges. Requires access to river mouths and estuaries for breeding. Floodplain habitats are highly important for larvae.	Adults migrate from the freshwater or brackish estuaries to the sea to spawn. Requires passage between freshwater and saltwater habitats to complete its life cycle Juveniles move upstream from estuarine nursery habitats.	Require elevated salinity and temperature for breeding. Can tolerant a range of turbidity and pH (4.0 to 7.2). Seasonal rising flows and increasing water temperature suspected as cues for movement.
bullrout (*Notesthes robusta*)	Occurs in a wide range of habitats but prefers riffle/runs. Often associated with underwater snags, vegetation and logs. Estuarine habitats may be required for breeding. Associated with downstream habitats and restricted to elevations of <60 metres above sea level.	Largely sedentary but possibly catadromous as passage between freshwater and estuarine habitats thought to be necessary to complete life cycle. Peak upstream movement in this species in the nearby Fitzroy River recorded between July and November. Seasonal low flows and cooler temperatures are suspected as cues for movement.	Tolerance to a range of salinities and temperatures. Typically occurs in low turbidity environments.
Potamodromous			
Agassiz's glassfish (*Ambassis agassizii*)	Occurs in low flow, well-vegetated areas of rivers, creeks, swamps and ponds; Macrophytes and submerged marginal vegetation preferred for spawning.	Adult fish move upstream during late autumn and spring. Remains in freshwater for entire life cycle.	Likely to be able to tolerate a wide range of physicochemical conditions (temperature, DO, pH and salinity).

Species	Habitat preferences	Movement behaviour	Environmental tolerance
sailfin glassfish# (*Ambassis agrammus*)	Found in a range of freshwater environments, but common in lentic waters with abundant macrophyte cover.	A mass migrator. Passive downstream dispersal is undergone by juveniles, with subsequent upstream migrations by adults. Some evidence that adults also undergo wet season downstream migrations.	Well-adapted to high temperatures up to 40 °C. Intolerant of hypoxic conditions, but capable of adapting to changes in pH (ranging between 3.8 and 8.4). Noted as being sensitive to reductions in water quality.
blue catfish (*Arius graeffei*)	Common in freshwater and estuarine habitats, but suspected to utilise marine waters. Known to inhabit impoundments and-channel floodplains.	Males migrate to deeper water when incubating offspring. Upstream movement occurs year round.	Can tolerate a range in water clarity but prefer clear waters. Tolerant of temperatures between 11 °C to 38 °C. Moves onto the floodplain during times of inundation.
fly-specked hardyhead# (*Craterocephalus stercusmuscarum*)	Occurs in a variety of habitats including flood plains, billabongs, brackish estuaries and impoundments. Prefers slow-flowing areas dominated by aquatic vegetation and gravel substrates.	Migration upstream occurs mainly in November with smaller numbers migrating in July and December. Entire life-cycle occurs in freshwater.	Tolerant of a wide range of environmental conditions including temperatures in excess of 30 °C.
sooty grunter# (*Hephaestus fuliginosus*)	Occurs in large flowing waterways, particularly the upstream reaches of rivers. Prefers habitats with woody debris on a sandy or rocky substrate.	Potamodromous with varying patterns of migration across its distribution. Migration to riffle areas occurs during the breeding season.	Found over a wide range of water acidities. Preference for moderately to well-oxygenated water. Can tolerant some turbidity. Turbidity may reduce feeding efficiency (visual predator).
empire gudgeon (*Hypseleotris compressa*)	Occurs in lower reaches of rivers, occasionally estuarine waters. Prefers still or slow flowing waters with underwater structures. Juveniles school in estuarine reaches. Oviposition likely to occur on aquatic macrophytes, rocks and woody debris. Likely to be found in riverine habitats of the NGBR Project.	A predominantly freshwater species. Access to estuarine or marine environments is not an essential to complete life cycle. Upstream migrations for spawning and juvenile dispersal occur in late spring and early summer. Higher flows suspected as cues for movement.	Species collected over a relatively wide range of physicochemical conditions.

Species	Habitat preferences	Movement behaviour	Environmental tolerance
western carp gudgeon (*Hypseleotris klunzingeri*)	Native, but possible translocated to the Burdekin basin. Occurs in areas of low flow with aquatic vegetation in rivers and streams. Prefers still water bodies such as lakes and impoundments. Aquatic macrophytes, submerged marginal vegetation and woody debris may be important for oviposition.	Possibly potamodromous – move upstream during the wet season.	Tolerant of a wide range of physicochemical conditions.
Midgley's carp gudgeon (*Hypseleotris species* 1)	Common in wetlands and swamps. Found in a variety of habitats, including coastal streams, rivers, floodplains and impoundments. Benthic species that is often in direct contact with the substrate. Hard surfaces near the substrate are preferred for oviposition.	Large aggregations move upstream during the summer months.	Can tolerate poor water quality and degraded habitats. Present in inland desert drainages suggesting tolerance of high temperatures and turbid environments. Increased water temperature and day length are suspected as cues for movement.
spangled perch[#] (*Leiopotherapon unicolor*)	Occurs in most permanent and temporary freshwater habitats including billabongs, bores, impoundments, rivers and streams. Non-flowing, shallow habitats with soft substrate are preferred for spawning.	Moves upstream or downstream within the freshwater environment to spawn. Spawning migrations coincide with the wet season (October – April). This species may also undertake substantial movements away from dry season habitats as they recede. Adept at colonising newly inundated habitat.	Highly tolerance of environmental variability. Can tolerant saline conditions but rarely encountered in estuarine areas. Despite being a visual predator can survive in turbid inland drainages.
yellowbelly (*Macquaria ambigua oriens*)	*Macquaria ambigua oriens* has been translocated to the Burdekin River. Endemic to the Fitzroy River. Inhabits billabongs, lakes, rivers and creeks – prefers deep, shaded, slow-flowing water with woody debris.	Moves large distances (up to 1000 km) for upstream spawning.	Information lacking, but thought to tolerate a broad range of temperatures and oxygen levels, and is tolerant of saline (and hypersaline) conditions. Prefers turbid waters.

Species	Habitat preferences	Movement behaviour	Environmental tolerance
eastern rainbowfish# (*Melanotaenia splendida splendida*)	Occurs in a wide range of still and slow-flowing freshwater habitats, such as creeks, swamps, wetlands, rivers and impoundments. Aquatic vegetation and root masses preferred for oviposition.	Does not require access to estuarine or marine environment during life cycle. Upstream movement by low numbers of individuals has been recorded year round. Undertakes lateral migration onto inundated floodplains.	Tolerant of a large range of water quality conditions and habitat disturbances such as reductions in riparian canopy. Will not survive abrupt changes in salinity. Seasonal rising flows cues for movement.
bony bream (*Nematalosa erebi*)	Occurs in a wide range of habitats, including salt lakes, rivers, billabongs, impoundments and streams. Shallow, still habitats required for spawning.	Adults and juveniles move upstream for dispersal. Does not require access to estuarine or marine environment during life cycle.	Can tolerate of a range of environmental conditions including high turbidity. However, is highly sensitive to reductions in dissolved oxygen.
black catfish (*Neosilurus ater*)	A benthic species that prefers still/slow flowing waters in streams and rivers. Occupies wetlands, pools, and slow-flowing tributaries and side-channels of rivers. Spawning occurs in riffles.	Migrations upstream thought to coincide with spawning at the outset of the wet season (January to February). Downstream migration of adults and juveniles post-spawning poorly understood.	Prefers higher temperatures of between 21 °C and 34 °C. Tolerates a wide range in dissolved oxygen, pH and turbidity, but is sensitive to saline conditions.
Hyrtl's tandan (*Neosilurus hyrtlii*)	Occurs in most freshwater habitats above estuarine reaches Benthic species associated with the substrate. Tributary streams and gravel substrates may be important for spawning.	Potamodromous in some areas, although not thought to undertake significant dispersal.	Can tolerate elevated turbidity and low light conditions. Prefers warm waters and is able to withstand hypoxic conditions.
leathery grunter (*Scortum hillii*)	Possibly native to the Burdekin River. Occurs in flowing streams and pools. Also found in brackish estuaries.	Potamodromous with adults undertaking upstream migrations for spawning.	Tolerates a broad range of temperatures.
tilapia* (*Oreochromis mossambicus*)	Tidal and freshwater habitats including creeks, rivers, lakes, and swamps. Particular preference for standing water bodies.	Potamodromous – adults actively move to inundated floodplains during the wet season.	Highly tolerant of a range of salinities and oxygen levels – qualities that have led to its successful establishment in Australian waterways.
three spot gourami* (*Trichogaster trichopterus*)	Inhabits shallow sluggish or standing-water lowlands. Prefers habitat with aquatic vegetation.	Potamodromous with specific information lacking.	Very tolerant of wide ranges of environmental conditions including pH, temperature and dissolved oxygen levels. The species possesses a labyrinth apparatus, which allows it to breathe air in hypoxic conditions.

Species	Habitat preferences	Movement behaviour	Environmental tolerance
Sedentary			
barred grunter (*Amniataba percoides*)	Benthic species that occurs in slow and fast flowing freshwater habitats. Collected in areas with a dominant substrate of sand. Not as associated with bank-side structure as other terapontids.	Sedentary with some upstream movement recorded.	Tolerant of wide range of temperatures and pH. Can tolerate turbidity, but prefers clearer waters. Preference for fast-flowing riffle/run habitat suggests need for well oxygenated water.
Marjorie's hardyhead (*Craterocephalus marjoriae*)	Translocated to the Burdekin River, but unknown success of establishment. Occurs in shallow, running waters with finer substrates. Often associated with root masses and aquatic macrophytes.	Adept at recolonising intermittently accessible waterways. No particular patterns of migration or dispersal are known.	Able to tolerate a wide range of environmental conditions, but is sensitive to poor water quality and turbidity.
mouth almighty (*Glossamia aprion*)	Occurs in a wide range of habitat, with a preference for well vegetated margins and submerged cover (leaf litter, root masses, aquatic macrophytes) in low flow environments. Uses structure as cover to launch ambush on prey. Most common at low elevations, and shallow depths.	A relatively sedentary species with no particular movement/migration patterns.	Is tolerant of a variety of environmental conditions. Freshwater only.
purple-spotted gudgeon (*Mogurnda adspersa*)	Occurs in pools in slack or slow waters of rivers, streams and billabongs. Prefers abundant cover (including riparian cover), particularly root masses, undercut banks and submerged vegetation.	Undertakes small-scale movements, but is not considered potamodromous. Possibly able to swim up hard, wet surfaces around waterfalls.	Tolerant of a wide range of physicochemical conditions, but prefers lower turbidity.
freshwater longtom (*Strongylura krefftii*)	Occurs in a variety of freshwater habitats including rivers, creeks and lagoons. Occurs in still and slow flowing water. Occurs in the water column and often ambushes prey on the surface. Aquatic macrophytes thought to be important spawning site.	No known migratory behaviour. Movement to off-channel habitats occurs in some areas.	Collected from areas with low conductivity and generally high water clarity.

Species	Habitat preferences	Movement behaviour	Environmental tolerance
mosquitofish* (*Gambusia holbrooki*)	Occurs in shallow, warm waters with little or no flow. Generally occurs along margins of stream bank.	Not known to undertake specific patterns of migration or dispersal.	Introduced species that can survive in degraded habitats and can tolerate a wide range of environmental conditions. Facultative air-breather.
sleepy cod (*Oxyeleotris lineolata*)	Occurs in slow-flowing water amongst submerged structures (vegetation, timber) in rivers, creeks, lagoons and billabongs. Found in both river and upper floodplain environment. Large woody debris is a key requirement for nests and general cover.	A relatively sedentary species that does not undergo any specific migration or dispersal events.	Tolerant of turbid conditions and a wide range of temperatures. Tolerant of hypoxia in still pools, although eggs are sensitive to oxygen depletion. Intolerant of saline conditions or pH values that deviate widely from neutral.
Pacific blue-eye# (*Pseudomugil signifer*)	Occurs in both marine to freshwater environments. Usually inhabits areas with submerged structure, but may also occur in pools and clear streams. Shallow, flowing water is favoured by this species. Breeding can occur in freshwater and saltwater habitats.	Can rapidly recolonise previously dry river banks, although is not considered potamodromous.	Collected over a wide range of physicochemical conditions; but is generally considered to be intolerant of poor water quality. Increased erosion and sediment may threaten spawning habitat and food resources.
freshwater catfish (*Tandanus tandanus*)	Has been translocated to the Burdekin River. Occurs in slow flowing streams, also lakes and impoundments. A benthic species that generally favours sandy or gravel substrates. Gravel substrate required for spawning.	A relatively sedentary species with a limited home range. Possibly territorial.	Tolerant to slightly brackish waters.
Rendahl's catfish (*Porochilus rendahli*)	Occurs in muddy river reaches. Benthic associated. Prefers low flow environments with aquatic vegetation.	Dispersal patterns are not well understood for this species, although spawning migration to muddy lagoons has been recorded.	Can tolerate highly turbid water. Well-developed tolerance to hypoxia. Intolerant of cooler waters.

Species	Habitat preferences	Movement behaviour	Environmental tolerance
Movement biology unknown			
southern saratoga (*Scleropages leichardti*)	Has been translocated to the Burdekin River. Occurs in deep waters of billabongs, large pools, impoundments and slow-flowing rivers and streams. Submerged structures and turbid waters are favoured by this species. Endemic to the Fitzroy River catchment.	Dispersal patterns are not understood for this species.	Tolerant of high levels of turbidity and temperature (7 °C to 40 °C).
snakehead gudgeon (*Giurus margaritacea*)	Lowland freshwater streams with abundant instream cover and an intact riparian zone.	Dispersal patterns are not understood for this species.	Environmental tolerances poorly understood for this species
soft-spined catfish (*Neosilurus mollespiculum*)	Endemic to the Burdekin River drainage. Occurs throughout the Burdekin River both upstream and downstream of the Burdekin Falls. It is a benthic species observed in close association with the substrate.	Movement biology is unknown for this species. However, may be similar to closely related *N. ater* and *N. hyrtlii*.	Occurs in warm, relatively well oxygenated, fresh waters of near neutral acidity. Tolerance range of environmental variables is unknown.
small-headed grunter (*Scortum parviceps*)	Endemic to the Burdekin River drainage. Occurs predominantly in riverine reaches and rarely in tributaries. Substrate types include sand, fine gravel and occasional outcrops of bedrock.	No information is available. Possibly undertakes upstream migrations prior to spawning.	Quantitative data is unavailable. Possibly limited to warm, freshwaters. Found in clear and turbid waters.
seven-spot archerfish[#] (*Toxotes chatareus*)	Associated with intact riparian zones as much of its diet is sourced from terrestrial insects. Generally found in deeper, slow-flowing waterways.	Quantitative data is lacking, however the species is likely sedentary.	Susceptible to poor water quality. Tolerant of higher salinities. Can survive in turbid waters.

*Introduced fish species

[#] species observed during previous field surveys of the NGBR Project EIS preliminary investigation corridor

Habitat preference information sourced from Allen *et al.* (2002) and Pusey *et al.* (2004).

Appendix E - AUSROADS output file for the Homestead 16 simulation

NGBRR Train Dust Unit Emissions: Homestead 16

VARIABLES AND OPTIONS SELECTED FOR THIS RUN

Emission rate units:	g/v-km
Concentration units:	micrograms/m3
Aerodynamic roughness:	0.20 (M)
Aerodynamic roughness at wind vane site:	0.30 (M)
Anemometer height:	10.0 (M)
Read sigma theta values from the met file?	No
Use Pasquill Gifford for horizontal dispersion?	Yes
Sigma theta averaging periods:	60 (min.)
Wind profile exponents set to:	Irwin Rural
Use hourly varying background concentrations?	No
Use constant background concentrations?	Yes
Constant background concentrations set to:	0.00E+00 micrograms/m3
External file for emission rates and traffic volumes?	No

LINK GEOMETRY

LINK NAME	TYPE	LINK COORDINATES (M) X1	Y1	X2	Y2	HEIGHT (M)	MIXING ZONE WIDTH (M)
NGBRR	AG	-69.6	495.1	69.6	-495.1	0.0	12.0

LINK ACTIVITY

NOTE: TF = TRAFFIC VOLUMES; EF = EMISSION FACTORS

NGBRR HOUR	TF WEEK DAY	EM WEEK DAY	TF SATURDAY	EM SATURDAY	TF SUNDAY	EM SUNDAY
1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
2	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
3	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
4	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
5	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
6	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
7	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
8	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
9	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
11	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
12	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
13	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
14	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
15	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
16	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
17	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
18	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
19	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
20	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
21	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
22	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
23	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
24	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

RECEPTOR LOCATIONS

NAME	No.	COORDINATES (M) X	Y	Z	NAME	No.	COORDINATES (M) X	Y	Z
RCP1	1	-495.1	-69.6	0.0	RCP2	2	-297.1	-41.8	0.0
RCP3	3	-198.1	-27.8	0.0	RCP4	4	-99.0	-13.9	0.0
RCP5	5	-49.5	-7.0	0.0	RCP6	6	-24.8	-3.5	0.0
RCP7	7	-9.9	-1.4	0.0	RCP8	8	-7.4	-1.0	0.0
RCP9	9	-5.0	-0.7	0.0	RCP10	10	-3.0	-0.4	0.0
RCP11	11	-2.0	-0.3	0.0	RCP12	12	328.8	46.2	0.0
RCP13	13	329.8	46.3	0.0	RCP14	14	331.7	46.6	0.0
RCP15	15	334.2	47.0	0.0	RCP16	16	336.7	47.3	0.0
RCP17	17	351.5	49.4	0.0	RCP18	18	376.3	52.9	0.0
RCP19	19	425.8	59.8	0.0	RCP20	20	524.8	73.8	0.0
RCP21	21	623.9	87.7	0.0	RCP22	22	821.9	115.5	0.0

METEOROLOGICAL DATA

Meteorolofical data entered via the input file:
C:\jobs\NGBRRModelling\Homestead16\NGBRR H16 2008.met

Title of the meteorological data file is:
Adani NGBR Project Realignment: H16 TAPM-Derived AUSPLUME METFILE 586787mE 7700870mN

AVERAGE OVER ALL HOURS AND FOR ALL SOURCES
in micrograms/m3

Concentrations at the discrete receptors (No. : Value):

1:1.83E-03 2:3.48E-03 3:5.75E-03 4:1.17E-02 5:2.00E-02 6:3.19E-02 7:5.90E-02 8:7.30E-02
9:8.55E-02 10:8.16E-02 11:7.77E-02 12:1.91E-04 13:1.90E-04 14:1.88E-04 15:1.85E-04 16:1.83E-04
17:1.69E-04 18:1.48E-04 19:1.16E-04 20:7.57E-05 21:5.39E-05 22:3.23E-05

HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
AVERAGING TIME = 1 HOUR

At the discrete receptors:

1: 1.41E-02 @Hr22,21/02/08
2: 1.92E-02 @Hr24,10/05/08
3: 2.71E-02 @Hr02,26/08/08
4: 4.66E-02 @Hr04,27/08/08
5: 7.45E-02 @Hr06,04/09/08
6: 1.21E-01 @Hr05,24/11/08
7: 2.26E-01 @Hr02,08/02/08
8: 2.97E-01 @Hr02,08/02/08
9: 3.90E-01 @Hr20,19/02/08
10: 4.28E-01 @Hr05,02/08/08
11: 4.35E-01 @Hr02,25/11/08
12: 1.63E-02 @Hr05,21/07/08

```
 13: 1.63E-02 @Hr05,21/07/08
 14: 1.62E-02 @Hr05,21/07/08
 15: 1.62E-02 @Hr05,21/07/08
 16: 1.61E-02 @Hr05,21/07/08
 17: 1.57E-02 @Hr05,21/07/08
 18: 1.50E-02 @Hr05,21/07/08
 19: 1.36E-02 @Hr01,06/08/08
 20: 1.16E-02 @Hr02,02/08/08
 21: 1.04E-02 @Hr01,02/08/08
 22: 8.56E-03 @Hr13,14/02/08
```

```
      HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
      AVERAGING TIME =  8 HOURS


At the discrete receptors:

  1: 9.28E-03 @Hr08,19/09/08
  2: 1.39E-02 @Hr08,18/09/08
  3: 1.90E-02 @Hr08,16/09/08
  4: 3.41E-02 @Hr08,16/09/08
  5: 5.27E-02 @Hr08,16/09/08
  6: 8.37E-02 @Hr08,07/08/08
  7: 1.50E-01 @Hr08,07/08/08
  8: 1.89E-01 @Hr08,07/08/08
  9: 2.64E-01 @Hr08,19/05/08
 10: 2.93E-01 @Hr08,19/05/08
 11: 2.97E-01 @Hr08,19/05/08
 12: 9.38E-03 @Hr08,09/11/08
 13: 9.35E-03 @Hr08,09/11/08
 14: 9.29E-03 @Hr08,09/11/08
 15: 9.22E-03 @Hr08,09/11/08
 16: 9.15E-03 @Hr08,09/11/08
 17: 8.76E-03 @Hr24,27/07/08
 18: 8.15E-03 @Hr24,27/07/08
 19: 7.08E-03 @Hr24,27/07/08
 20: 5.53E-03 @Hr24,27/07/08
 21: 4.56E-03 @Hr24,27/07/08
 22: 3.32E-03 @Hr24,27/07/08
```

```
      HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
      AVERAGING TIME = 24 HOURS


At the discrete receptors:

  1: 5.47E-03 @Hr24,09/02/08
  2: 8.10E-03 @Hr24,21/02/08
  3: 1.16E-02 @Hr24,08/06/08
  4: 2.06E-02 @Hr24,04/09/08
  5: 3.42E-02 @Hr24,04/09/08
  6: 5.35E-02 @Hr24,22/02/08
  7: 1.01E-01 @Hr24,22/02/08
  8: 1.24E-01 @Hr24,22/02/08
  9: 1.59E-01 @Hr24,30/12/08
 10: 1.74E-01 @Hr24,30/12/08
 11: 1.76E-01 @Hr24,30/12/08
 12: 5.03E-03 @Hr24,21/07/08
 13: 5.01E-03 @Hr24,21/07/08
 14: 4.98E-03 @Hr24,21/07/08
 15: 4.93E-03 @Hr24,21/07/08
 16: 4.88E-03 @Hr24,21/07/08
 17: 4.60E-03 @Hr24,21/07/08
 18: 4.15E-03 @Hr24,21/07/08
 19: 3.33E-03 @Hr24,21/07/08
 20: 2.37E-03 @Hr24,14/12/08
```

```
 21: 1.89E-03 @Hr24,27/07/08
 22: 1.33E-03 @Hr24,27/07/08
```

```
      SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
      AVERAGING TIME =  1 HOUR


At the discrete receptors:
```

```
      SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
      AVERAGING TIME =  8 HOURS


At the discrete receptors:
```

```
      SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
      AVERAGING TIME = 24 HOURS


At the discrete receptors:
```

```
      Peak values for the  100 worst cases - in micrograms/m3
      AVERAGING TIME =  1 HOUR
```

Rank	Value	Time Recorded hour,date	Coordinates		
1	4.35E-01	@Hr02,25/11/08	(-2.0,	-0.3,	0.0)
2	4.29E-01	@Hr05,02/08/08	(-2.0,	-0.3,	0.0)
3	4.24E-01	@Hr03,08/02/08	(-3.0,	-0.4,	0.0)
4	4.22E-01	@Hr22,15/08/08	(-2.0,	-0.3,	0.0)
5	4.22E-01	@Hr20,19/02/08	(-2.0,	-0.3,	0.0)
6	4.18E-01	@Hr05,20/07/08	(-3.0,	-0.4,	0.0)
7	4.12E-01	@Hr02,08/02/08	(-3.0,	-0.4,	0.0)
8	4.12E-01	@Hr23,05/08/08	(-3.0,	-0.4,	0.0)
9	4.05E-01	@Hr06,25/11/08	(-2.0,	-0.3,	0.0)
10	3.93E-01	@Hr22,05/08/08	(-2.0,	-0.3,	0.0)
11	3.89E-01	@Hr11,19/01/08	(-2.0,	-0.3,	0.0)
12	3.88E-01	@Hr05,31/12/08	(-2.0,	-0.3,	0.0)
13	3.82E-01	@Hr05,30/12/08	(-2.0,	-0.3,	0.0)
14	3.78E-01	@Hr03,19/05/08	(-2.0,	-0.3,	0.0)
15	3.78E-01	@Hr02,24/11/08	(-2.0,	-0.3,	0.0)
16	3.75E-01	@Hr03,24/11/08	(-3.0,	-0.4,	0.0)
17	3.68E-01	@Hr04,19/05/08	(-3.0,	-0.4,	0.0)
18	3.65E-01	@Hr07,05/02/08	(-3.0,	-0.4,	0.0)
19	3.59E-01	@Hr04,10/06/08	(-2.0,	-0.3,	0.0)
20	3.58E-01	@Hr03,10/06/08	(-2.0,	-0.3,	0.0)
21	3.53E-01	@Hr07,28/04/08	(-2.0,	-0.3,	0.0)
22	3.50E-01	@Hr01,28/04/08	(-2.0,	-0.3,	0.0)
23	3.42E-01	@Hr02,19/05/08	(-2.0,	-0.3,	0.0)
24	3.42E-01	@Hr21,10/08/08	(-2.0,	-0.3,	0.0)
25	3.41E-01	@Hr21,11/08/08	(-2.0,	-0.3,	0.0)
26	3.40E-01	@Hr04,19/07/08	(-2.0,	-0.3,	0.0)
27	3.40E-01	@Hr04,30/12/08	(-2.0,	-0.3,	0.0)
28	3.39E-01	@Hr01,30/09/08	(-3.0,	-0.4,	0.0)
29	3.38E-01	@Hr22,06/08/08	(-3.0,	-0.4,	0.0)
30	3.38E-01	@Hr05,24/11/08	(-5.0,	-0.7,	0.0)
31	3.38E-01	@Hr05,19/05/08	(-5.0,	-0.7,	0.0)
32	3.38E-01	@Hr06,19/05/08	(-5.0,	-0.7,	0.0)
33	3.38E-01	@Hr02,10/06/08	(-5.0,	-0.7,	0.0)
34	3.33E-01	@Hr06,17/08/08	(-3.0,	-0.4,	0.0)

35	3.32E-01	@Hr07,23/02/08	(	-2.0,	-0.3,	0.0)
36	3.29E-01	@Hr05,10/06/08	(	-2.0,	-0.3,	0.0)
37	3.28E-01	@Hr06,26/07/08	(	-2.0,	-0.3,	0.0)
38	3.26E-01	@Hr03,30/12/08	(	-2.0,	-0.3,	0.0)
39	3.25E-01	@Hr07,20/07/08	(	-3.0,	-0.4,	0.0)
40	3.24E-01	@Hr04,07/12/08	(	-2.0,	-0.3,	0.0)
41	3.24E-01	@Hr21,21/07/08	(	-2.0,	-0.3,	0.0)
42	3.21E-01	@Hr05,21/03/08	(	-5.0,	-0.7,	0.0)
43	3.19E-01	@Hr04,24/11/08	(	-5.0,	-0.7,	0.0)
44	3.18E-01	@Hr06,13/08/08	(	-3.0,	-0.4,	0.0)
45	3.18E-01	@Hr07,24/02/08	(	-5.0,	-0.7,	0.0)
46	3.18E-01	@Hr01,25/04/08	(	-5.0,	-0.7,	0.0)
47	3.18E-01	@Hr07,25/11/08	(	-5.0,	-0.7,	0.0)
48	3.18E-01	@Hr01,31/12/08	(	-2.0,	-0.3,	0.0)
49	3.17E-01	@Hr01,24/11/08	(	-2.0,	-0.3,	0.0)
50	3.14E-01	@Hr06,18/07/08	(	-3.0,	-0.4,	0.0)
51	3.12E-01	@Hr21,08/07/08	(	-2.0,	-0.3,	0.0)
52	3.12E-01	@Hr06,16/08/08	(	-2.0,	-0.3,	0.0)
53	3.10E-01	@Hr01,24/02/08	(	-5.0,	-0.7,	0.0)
54	3.10E-01	@Hr24,29/09/08	(	-5.0,	-0.7,	0.0)
55	3.09E-01	@Hr20,07/08/08	(	-2.0,	-0.3,	0.0)
56	3.08E-01	@Hr15,07/02/08	(	-2.0,	-0.3,	0.0)
57	3.07E-01	@Hr05,20/03/08	(	-3.0,	-0.4,	0.0)
58	3.07E-01	@Hr21,05/08/08	(	-3.0,	-0.4,	0.0)
59	3.07E-01	@Hr21,19/02/08	(	-2.0,	-0.3,	0.0)
60	3.05E-01	@Hr22,11/08/08	(	-5.0,	-0.7,	0.0)
61	3.05E-01	@Hr21,07/08/08	(	-5.0,	-0.7,	0.0)
62	3.04E-01	@Hr05,19/12/08	(	-2.0,	-0.3,	0.0)
63	3.04E-01	@Hr04,31/12/08	(	-2.0,	-0.3,	0.0)
64	3.04E-01	@Hr03,17/08/08	(	-3.0,	-0.4,	0.0)
65	3.04E-01	@Hr04,19/12/08	(	-2.0,	-0.3,	0.0)
66	3.03E-01	@Hr05,13/08/08	(	-5.0,	-0.7,	0.0)
67	3.02E-01	@Hr08,17/05/08	(	-5.0,	-0.7,	0.0)
68	3.02E-01	@Hr21,31/05/08	(	-2.0,	-0.3,	0.0)
69	3.00E-01	@Hr02,17/08/08	(	-2.0,	-0.3,	0.0)
70	3.00E-01	@Hr20,29/02/08	(	-5.0,	-0.7,	0.0)
71	2.98E-01	@Hr04,01/12/08	(	-3.0,	-0.4,	0.0)
72	2.97E-01	@Hr09,22/02/08	(	-2.0,	-0.3,	0.0)
73	2.95E-01	@Hr23,20/11/08	(	-2.0,	-0.3,	0.0)
74	2.94E-01	@Hr06,19/04/08	(	-3.0,	-0.4,	0.0)
75	2.92E-01	@Hr20,08/07/08	(	-5.0,	-0.7,	0.0)
76	2.92E-01	@Hr06,14/08/08	(	-5.0,	-0.7,	0.0)
77	2.92E-01	@Hr04,17/08/08	(	-5.0,	-0.7,	0.0)
78	2.92E-01	@Hr05,17/08/08	(	-5.0,	-0.7,	0.0)
79	2.91E-01	@Hr02,21/06/08	(	-3.0,	-0.4,	0.0)
80	2.91E-01	@Hr04,20/03/08	(	-5.0,	-0.7,	0.0)
81	2.91E-01	@Hr02,30/12/08	(	-3.0,	-0.4,	0.0)
82	2.90E-01	@Hr20,21/07/08	(	-3.0,	-0.4,	0.0)
83	2.90E-01	@Hr09,26/04/08	(	-3.0,	-0.4,	0.0)
84	2.89E-01	@Hr04,20/12/08	(	-2.0,	-0.3,	0.0)
85	2.89E-01	@Hr03,20/12/08	(	-2.0,	-0.3,	0.0)
86	2.86E-01	@Hr03,21/06/08	(	-2.0,	-0.3,	0.0)
87	2.86E-01	@Hr21,06/08/08	(	-2.0,	-0.3,	0.0)
88	2.85E-01	@Hr03,31/12/08	(	-2.0,	-0.3,	0.0)
89	2.83E-01	@Hr06,22/02/08	(	-3.0,	-0.4,	0.0)
90	2.82E-01	@Hr06,05/02/08	(	-3.0,	-0.4,	0.0)
91	2.82E-01	@Hr10,01/08/08	(	-2.0,	-0.3,	0.0)
92	2.82E-01	@Hr20,20/11/08	(	-3.0,	-0.4,	0.0)
93	2.81E-01	@Hr03,21/07/08	(	-2.0,	-0.3,	0.0)
94	2.81E-01	@Hr05,25/11/08	(	-2.0,	-0.3,	0.0)
95	2.80E-01	@Hr05,07/06/08	(	-2.0,	-0.3,	0.0)
96	2.80E-01	@Hr05,13/12/08	(	-2.0,	-0.3,	0.0)
97	2.80E-01	@Hr07,03/06/08	(	-2.0,	-0.3,	0.0)
98	2.80E-01	@Hr22,22/11/08	(	-3.0,	-0.4,	0.0)
99	2.79E-01	@Hr04,29/05/08	(	-5.0,	-0.7,	0.0)
100	2.79E-01	@Hr04,16/08/08	(	-5.0,	-0.7,	0.0)

Peak values for the 100 worst cases - in micrograms/m3
AVERAGING TIME = 8 HOURS

Rank	Value	Time Recorded hour,date	Coordinates		
1	2.97E-01	@Hr08,19/05/08	(-2.0,	-0.3,	0.0)
2	2.83E-01	@Hr08,25/11/08	(-2.0,	-0.3,	0.0)
3	2.73E-01	@Hr08,24/11/08	(-2.0,	-0.3,	0.0)
4	2.65E-01	@Hr08,10/06/08	(-3.0,	-0.4,	0.0)
5	2.56E-01	@Hr08,30/12/08	(-3.0,	-0.4,	0.0)
6	2.53E-01	@Hr08,17/08/08	(-2.0,	-0.3,	0.0)
7	2.48E-01	@Hr08,31/12/08	(-2.0,	-0.3,	0.0)
8	2.32E-01	@Hr24,21/07/08	(-2.0,	-0.3,	0.0)
9	2.30E-01	@Hr24,19/02/08	(-3.0,	-0.4,	0.0)
10	2.28E-01	@Hr08,13/08/08	(-5.0,	-0.7,	0.0)
11	2.27E-01	@Hr08,07/08/08	(-5.0,	-0.7,	0.0)
12	2.26E-01	@Hr08,26/07/08	(-2.0,	-0.3,	0.0)
13	2.22E-01	@Hr08,20/12/08	(-2.0,	-0.3,	0.0)
14	2.20E-01	@Hr08,29/05/08	(-5.0,	-0.7,	0.0)
15	2.19E-01	@Hr24,08/07/08	(-2.0,	-0.3,	0.0)
16	2.16E-01	@Hr08,19/04/08	(-5.0,	-0.7,	0.0)
17	2.12E-01	@Hr08,13/06/08	(-5.0,	-0.7,	0.0)
18	2.11E-01	@Hr08,16/08/08	(-3.0,	-0.4,	0.0)
19	2.10E-01	@Hr08,08/02/08	(-5.0,	-0.7,	0.0)
20	2.06E-01	@Hr08,19/12/08	(-2.0,	-0.3,	0.0)
21	2.04E-01	@Hr08,21/03/08	(-3.0,	-0.4,	0.0)
22	2.04E-01	@Hr08,20/03/08	(-5.0,	-0.7,	0.0)
23	2.02E-01	@Hr08,07/12/08	(-2.0,	-0.3,	0.0)
24	2.01E-01	@Hr08,17/05/08	(-5.0,	-0.7,	0.0)
25	2.00E-01	@Hr08,30/09/08	(-5.0,	-0.7,	0.0)
26	2.00E-01	@Hr08,15/08/08	(-5.0,	-0.7,	0.0)
27	1.99E-01	@Hr08,14/02/08	(-2.0,	-0.3,	0.0)
28	1.99E-01	@Hr08,04/06/08	(-5.0,	-0.7,	0.0)
29	1.97E-01	@Hr24,05/08/08	(-2.0,	-0.3,	0.0)
30	1.95E-01	@Hr08,16/09/08	(-5.0,	-0.7,	0.0)
31	1.95E-01	@Hr24,26/07/08	(-3.0,	-0.4,	0.0)
32	1.94E-01	@Hr08,16/07/08	(-5.0,	-0.7,	0.0)
33	1.94E-01	@Hr08,24/02/08	(-5.0,	-0.7,	0.0)
34	1.94E-01	@Hr08,17/03/08	(-5.0,	-0.7,	0.0)
35	1.94E-01	@Hr08,20/07/08	(-2.0,	-0.3,	0.0)
36	1.93E-01	@Hr08,18/07/08	(-3.0,	-0.4,	0.0)
37	1.93E-01	@Hr24,31/05/08	(-2.0,	-0.3,	0.0)
38	1.92E-01	@Hr08,06/06/08	(-3.0,	-0.4,	0.0)
39	1.91E-01	@Hr08,21/08/08	(-3.0,	-0.4,	0.0)
40	1.91E-01	@Hr08,06/02/08	(-2.0,	-0.3,	0.0)
41	1.91E-01	@Hr08,05/11/08	(-3.0,	-0.4,	0.0)
42	1.91E-01	@Hr24,11/08/08	(-2.0,	-0.3,	0.0)
43	1.90E-01	@Hr08,20/02/08	(-5.0,	-0.7,	0.0)
44	1.90E-01	@Hr08,21/06/08	(-3.0,	-0.4,	0.0)
45	1.89E-01	@Hr08,01/12/08	(-5.0,	-0.7,	0.0)
46	1.89E-01	@Hr08,02/01/08	(-3.0,	-0.4,	0.0)
47	1.88E-01	@Hr24,09/07/08	(-5.0,	-0.7,	0.0)
48	1.88E-01	@Hr08,05/02/08	(-5.0,	-0.7,	0.0)
49	1.88E-01	@Hr08,07/06/08	(-3.0,	-0.4,	0.0)
50	1.88E-01	@Hr08,14/08/08	(-5.0,	-0.7,	0.0)
51	1.87E-01	@Hr08,10/04/08	(-5.0,	-0.7,	0.0)
52	1.87E-01	@Hr08,28/03/08	(-3.0,	-0.4,	0.0)
53	1.87E-01	@Hr08,30/05/08	(-2.0,	-0.3,	0.0)
54	1.86E-01	@Hr24,29/02/08	(-3.0,	-0.4,	0.0)
55	1.85E-01	@Hr08,01/06/08	(-5.0,	-0.7,	0.0)
56	1.85E-01	@Hr08,13/07/08	(-2.0,	-0.3,	0.0)
57	1.84E-01	@Hr08,06/09/08	(-5.0,	-0.7,	0.0)
58	1.84E-01	@Hr08,08/03/08	(-5.0,	-0.7,	0.0)
59	1.83E-01	@Hr08,24/06/08	(-5.0,	-0.7,	0.0)
60	1.83E-01	@Hr08,28/05/08	(-2.0,	-0.3,	0.0)
61	1.82E-01	@Hr08,07/04/08	(-5.0,	-0.7,	0.0)
62	1.81E-01	@Hr08,15/04/08	(-5.0,	-0.7,	0.0)

63	1.81E-01	@Hr08,22/02/08	(	-5.0,	-0.7,	0.0)
64	1.81E-01	@Hr08,12/05/08	(	-5.0,	-0.7,	0.0)
65	1.81E-01	@Hr08,29/02/08	(	-3.0,	-0.4,	0.0)
66	1.81E-01	@Hr24,29/05/08	(	-3.0,	-0.4,	0.0)
67	1.80E-01	@Hr08,17/07/08	(	-5.0,	-0.7,	0.0)
68	1.80E-01	@Hr08,08/10/08	(	-5.0,	-0.7,	0.0)
69	1.80E-01	@Hr08,11/04/08	(	-3.0,	-0.4,	0.0)
70	1.80E-01	@Hr08,02/06/08	(	-5.0,	-0.7,	0.0)
71	1.79E-01	@Hr08,25/01/08	(	-5.0,	-0.7,	0.0)
72	1.79E-01	@Hr08,26/03/08	(	-3.0,	-0.4,	0.0)
73	1.78E-01	@Hr08,11/05/08	(	-3.0,	-0.4,	0.0)
74	1.78E-01	@Hr08,13/05/08	(	-5.0,	-0.7,	0.0)
75	1.78E-01	@Hr08,29/04/08	(	-3.0,	-0.4,	0.0)
76	1.77E-01	@Hr08,14/07/08	(	-3.0,	-0.4,	0.0)
77	1.77E-01	@Hr08,25/12/08	(	-5.0,	-0.7,	0.0)
78	1.76E-01	@Hr08,05/04/08	(	-5.0,	-0.7,	0.0)
79	1.76E-01	@Hr08,10/09/08	(	-5.0,	-0.7,	0.0)
80	1.76E-01	@Hr08,19/07/08	(	-3.0,	-0.4,	0.0)
81	1.75E-01	@Hr08,03/05/08	(	-5.0,	-0.7,	0.0)
82	1.75E-01	@Hr08,09/07/08	(	-2.0,	-0.3,	0.0)
83	1.74E-01	@Hr08,26/06/08	(	-5.0,	-0.7,	0.0)
84	1.73E-01	@Hr08,07/07/08	(	-3.0,	-0.4,	0.0)
85	1.73E-01	@Hr24,06/08/08	(	-2.0,	-0.3,	0.0)
86	1.73E-01	@Hr08,08/11/08	(	-3.0,	-0.4,	0.0)
87	1.73E-01	@Hr08,30/03/08	(	-5.0,	-0.7,	0.0)
88	1.73E-01	@Hr08,10/03/08	(	-5.0,	-0.7,	0.0)
89	1.72E-01	@Hr08,23/02/08	(	-5.0,	-0.7,	0.0)
90	1.72E-01	@Hr16,31/07/08	(	-3.0,	-0.4,	0.0)
91	1.71E-01	@Hr08,05/05/08	(	-5.0,	-0.7,	0.0)
92	1.71E-01	@Hr08,13/03/08	(	-5.0,	-0.7,	0.0)
93	1.71E-01	@Hr08,29/08/08	(	-5.0,	-0.7,	0.0)
94	1.70E-01	@Hr08,03/06/08	(	-3.0,	-0.4,	0.0)
95	1.69E-01	@Hr08,24/04/08	(	-5.0,	-0.7,	0.0)
96	1.69E-01	@Hr08,14/05/08	(	-3.0,	-0.4,	0.0)
97	1.69E-01	@Hr08,08/08/08	(	-5.0,	-0.7,	0.0)
98	1.69E-01	@Hr08,07/05/08	(	-5.0,	-0.7,	0.0)
99	1.69E-01	@Hr08,18/04/08	(	-5.0,	-0.7,	0.0)
100	1.68E-01	@Hr08,24/05/08	(	-5.0,	-0.7,	0.0)

Peak values for the 100 worst cases - in micrograms/m3
AVERAGING TIME = 24 HOURS

Rank	Value	Time Recorded hour,date	Coordinates			
1	1.76E-01	@Hr24,30/12/08	(	-2.0,	-0.3,	0.0)
2	1.66E-01	@Hr24,19/05/08	(	-2.0,	-0.3,	0.0)
3	1.64E-01	@Hr24,26/07/08	(	-2.0,	-0.3,	0.0)
4	1.48E-01	@Hr24,08/07/08	(	-2.0,	-0.3,	0.0)
5	1.46E-01	@Hr24,18/07/08	(	-5.0,	-0.7,	0.0)
6	1.45E-01	@Hr24,29/05/08	(	-5.0,	-0.7,	0.0)
7	1.45E-01	@Hr24,21/07/08	(	-2.0,	-0.3,	0.0)
8	1.44E-01	@Hr24,22/02/08	(	-5.0,	-0.7,	0.0)
9	1.44E-01	@Hr24,07/08/08	(	-3.0,	-0.4,	0.0)
10	1.44E-01	@Hr24,05/08/08	(	-3.0,	-0.4,	0.0)
11	1.43E-01	@Hr24,19/02/08	(	-3.0,	-0.4,	0.0)
12	1.42E-01	@Hr24,06/02/08	(	-2.0,	-0.3,	0.0)
13	1.39E-01	@Hr24,29/02/08	(	-3.0,	-0.4,	0.0)
14	1.39E-01	@Hr24,23/02/08	(	-3.0,	-0.4,	0.0)
15	1.36E-01	@Hr24,20/02/08	(	-3.0,	-0.4,	0.0)
16	1.36E-01	@Hr24,17/08/08	(	-3.0,	-0.4,	0.0)
17	1.36E-01	@Hr24,09/07/08	(	-2.0,	-0.3,	0.0)
18	1.35E-01	@Hr24,08/02/08	(	-5.0,	-0.7,	0.0)
19	1.34E-01	@Hr24,11/08/08	(	-2.0,	-0.3,	0.0)
20	1.33E-01	@Hr24,31/07/08	(	-5.0,	-0.7,	0.0)
21	1.33E-01	@Hr24,07/07/08	(	-5.0,	-0.7,	0.0)
22	1.33E-01	@Hr24,01/06/08	(	-3.0,	-0.4,	0.0)

23	1.33E-01	@Hr24,13/06/08	(	-5.0,	-0.7,	0.0)
24	1.31E-01	@Hr24,20/06/08	(	-5.0,	-0.7,	0.0)
25	1.31E-01	@Hr24,01/08/08	(	-2.0,	-0.3,	0.0)
26	1.31E-01	@Hr24,29/12/08	(	-5.0,	-0.7,	0.0)
27	1.30E-01	@Hr24,27/03/08	(	-5.0,	-0.7,	0.0)
28	1.30E-01	@Hr24,31/12/08	(	-2.0,	-0.3,	0.0)
29	1.27E-01	@Hr24,24/04/08	(	-3.0,	-0.4,	0.0)
30	1.27E-01	@Hr24,10/06/08	(	-5.0,	-0.7,	0.0)
31	1.27E-01	@Hr24,26/04/08	(	-5.0,	-0.7,	0.0)
32	1.26E-01	@Hr24,16/05/08	(	-5.0,	-0.7,	0.0)
33	1.25E-01	@Hr24,25/11/08	(	-2.0,	-0.3,	0.0)
34	1.25E-01	@Hr24,04/09/08	(	-5.0,	-0.7,	0.0)
35	1.24E-01	@Hr24,15/08/08	(	-2.0,	-0.3,	0.0)
36	1.22E-01	@Hr24,03/06/08	(	-2.0,	-0.3,	0.0)
37	1.22E-01	@Hr24,20/07/08	(	-3.0,	-0.4,	0.0)
38	1.21E-01	@Hr24,24/11/08	(	-3.0,	-0.4,	0.0)
39	1.20E-01	@Hr24,07/02/08	(	-2.0,	-0.3,	0.0)
40	1.20E-01	@Hr24,04/06/08	(	-5.0,	-0.7,	0.0)
41	1.19E-01	@Hr24,14/02/08	(	-3.0,	-0.4,	0.0)
42	1.18E-01	@Hr24,19/01/08	(	-5.0,	-0.7,	0.0)
43	1.18E-01	@Hr24,21/06/08	(	-5.0,	-0.7,	0.0)
44	1.17E-01	@Hr24,10/08/08	(	-2.0,	-0.3,	0.0)
45	1.17E-01	@Hr24,13/08/08	(	-5.0,	-0.7,	0.0)
46	1.17E-01	@Hr24,20/11/08	(	-2.0,	-0.3,	0.0)
47	1.15E-01	@Hr24,28/04/08	(	-2.0,	-0.3,	0.0)
48	1.15E-01	@Hr24,21/02/08	(	-5.0,	-0.7,	0.0)
49	1.15E-01	@Hr24,28/03/08	(	-5.0,	-0.7,	0.0)
50	1.15E-01	@Hr24,16/07/08	(	-5.0,	-0.7,	0.0)
51	1.15E-01	@Hr24,06/06/08	(	-5.0,	-0.7,	0.0)
52	1.14E-01	@Hr24,25/04/08	(	-2.0,	-0.3,	0.0)
53	1.13E-01	@Hr24,02/08/08	(	-2.0,	-0.3,	0.0)
54	1.13E-01	@Hr24,30/07/08	(	-3.0,	-0.4,	0.0)
55	1.13E-01	@Hr24,27/01/08	(	-5.0,	-0.7,	0.0)
56	1.12E-01	@Hr24,31/05/08	(	-2.0,	-0.3,	0.0)
57	1.12E-01	@Hr24,29/09/08	(	-5.0,	-0.7,	0.0)
58	1.11E-01	@Hr24,24/02/08	(	-5.0,	-0.7,	0.0)
59	1.09E-01	@Hr24,04/01/08	(	-5.0,	-0.7,	0.0)
60	1.09E-01	@Hr24,02/06/08	(	-5.0,	-0.7,	0.0)
61	1.09E-01	@Hr24,29/11/08	(	-2.0,	-0.3,	0.0)
62	1.09E-01	@Hr24,19/12/08	(	-2.0,	-0.3,	0.0)
63	1.09E-01	@Hr24,14/06/08	(	-5.0,	-0.7,	0.0)
64	1.09E-01	@Hr24,22/06/08	(	-5.0,	-0.7,	0.0)
65	1.08E-01	@Hr24,26/03/08	(	-5.0,	-0.7,	0.0)
66	1.08E-01	@Hr24,29/04/08	(	-5.0,	-0.7,	0.0)
67	1.07E-01	@Hr24,19/06/08	(	-5.0,	-0.7,	0.0)
68	1.07E-01	@Hr24,14/08/08	(	-5.0,	-0.7,	0.0)
69	1.07E-01	@Hr24,21/08/08	(	-5.0,	-0.7,	0.0)
70	1.07E-01	@Hr24,01/07/08	(	-3.0,	-0.4,	0.0)
71	1.07E-01	@Hr24,21/01/08	(	-5.0,	-0.7,	0.0)
72	1.07E-01	@Hr24,06/09/08	(	-3.0,	-0.4,	0.0)
73	1.06E-01	@Hr24,23/06/08	(	-5.0,	-0.7,	0.0)
74	1.06E-01	@Hr24,10/04/08	(	-5.0,	-0.7,	0.0)
75	1.06E-01	@Hr24,18/03/08	(	-5.0,	-0.7,	0.0)
76	1.06E-01	@Hr24,10/07/08	(	-5.0,	-0.7,	0.0)
77	1.06E-01	@Hr24,01/12/08	(	-5.0,	-0.7,	0.0)
78	1.06E-01	@Hr24,13/05/08	(	-5.0,	-0.7,	0.0)
79	1.05E-01	@Hr24,30/09/08	(	-5.0,	-0.7,	0.0)
80	1.05E-01	@Hr24,20/03/08	(	-5.0,	-0.7,	0.0)
81	1.04E-01	@Hr24,02/01/08	(	-3.0,	-0.4,	0.0)
82	1.04E-01	@Hr24,17/07/08	(	-5.0,	-0.7,	0.0)
83	1.04E-01	@Hr24,18/08/08	(	-5.0,	-0.7,	0.0)
84	1.04E-01	@Hr24,03/07/08	(	-5.0,	-0.7,	0.0)
85	1.04E-01	@Hr24,08/11/08	(	-2.0,	-0.3,	0.0)
86	1.04E-01	@Hr24,07/05/08	(	-5.0,	-0.7,	0.0)
87	1.04E-01	@Hr24,16/09/08	(	-5.0,	-0.7,	0.0)
88	1.03E-01	@Hr24,14/07/08	(	-5.0,	-0.7,	0.0)
89	1.03E-01	@Hr24,28/05/08	(	-3.0,	-0.4,	0.0)
90	1.03E-01	@Hr24,19/04/08	(	-5.0,	-0.7,	0.0)

```
 91    1.03E-01  @Hr24,30/05/08  (    -2.0,      -0.3,     0.0)
 92    1.03E-01  @Hr24,02/07/08  (    -3.0,      -0.4,     0.0)
 93    1.03E-01  @Hr24,07/06/08  (    -5.0,      -0.7,     0.0)
 94    1.03E-01  @Hr24,07/12/08  (    -2.0,      -0.3,     0.0)
 95    1.03E-01  @Hr24,13/02/08  (    -2.0,      -0.3,     0.0)
 96    1.02E-01  @Hr24,11/04/08  (    -5.0,      -0.7,     0.0)
 97    1.02E-01  @Hr24,30/03/08  (    -5.0,      -0.7,     0.0)
 98    1.02E-01  @Hr24,16/03/08  (    -5.0,      -0.7,     0.0)
 99    1.02E-01  @Hr24,05/02/08  (    -3.0,      -0.4,     0.0)
100    1.02E-01  @Hr24,21/03/08  (    -5.0,      -0.7,     0.0)
```

```
Simulation started  at 12:46:55 on 12/02/2014
Simulation finished at 12:46:59 on 12/02/2014
```

Appendix F – Cultural heritage technical addendum

ELH
Environment Land Heritage

ADANI MINING

NORTHERN GALILEE BASIN RAIL PROJECT

ADDITIONAL ENVIRONMETAL IMPACT STATEMENT

CULTURAL HERITAGE TECHNICAL ADDENDUM REPORT

CONTENTS

1. INTRODUCTION 3

1.1. PROJECT OVERVIEW 3

1.2. SCOPE OF REPORT 3

2. METHODOLOGY 6

2.1. STUDY AREA 6

2.2. DATA SOURCES 6

2.3. STAKEHOLDER ENGAGEMENT 7

2.4. DESKTOP ASSESSMENT 9

3. KEY FINDINGS 14

3.1. MT ROUNDBACK REALIGNMENT 14

3.2. NEWLANDS REALIGNMENT 14

1. INTRODUCTION

1.1. PROJECT OVERVIEW

Adani Mining Pty Ltd (**Adani**) proposes to develop the North Galilee Basin Rail (**NGBR**) corridor (**Project**).

Adani has commissioned an Environmental Impact Statement (**EIS**) and subsequently preparing additional information for the Environmental Impact Statement (A**EIS**) for the Project.

Since the EIS was released for public comment, it has become necessary to vary the Project alignment in two places (**Realignments**).

The first realignment (~6km in length) is in the vicinity of Mt Roundback (**Mt Roundback Realignment**), situated approximately 40km west of Bowen, and shown on the map at Figure 1.

The second realignment (~76km in length) is in the vicinity of Newlands (**Newlands Realignment**), situated approximately 100km south of Bowen, and shown on the map at Figure 2.

1.2. SCOPE OF REPORT

The objective of this AEIS Aboriginal cultural heritage technical addendum report (**Report**) is provide a technical assessment of the existing Aboriginal cultural heritage values of the proposed Realignment areas.

This Report details:

- The Realignment areas
- Consultation that has taken place with Aboriginal Parties regarding the Realignments
- Actions undertaken and/or underway to identify the Aboriginal cultural heritage values of the Realignment areas
- Actions undertaken and/or underway to manage the Aboriginal cultural heritage values of the Realignment areas.

The Mt Roundback Realignment area is within the boundaries of the Juru People (**Juru**) Registered Native Title Claim (**RNTC**) area (QUD 554/10). This Report details Adani's extensive consultations and engagement currently underway with Juru, as well as the comprehensive Aboriginal cultural heritage investigations that have been undertaken for the Mt Roundback Realignment area and process for determining management of Aboriginal cultural heritage values for that area.

The Newlands Realignment is on the boundary of the Birriah (sometimes referred to as 'Birri') People (**Birriah**) RNTC area (QUD6244/98), and the Jangga People (**Jangga**) Native Title Determination Area (QUD6230/98). This report outlines the consultations underway with each of Birriah and Jangga in relation to the Newlands Realignments, including in relation to Aboriginal cultural heritage investigation and management arrangements for the Newlands Realignments.

Figure 1. Mount Roundback Realignment Area

Adani Mining North Galilee Basin Rail (NGBR)

Mt Roundback Realignment

0 0.35 0.7 1.4 2.1 2.8
Kilometers

N W E S

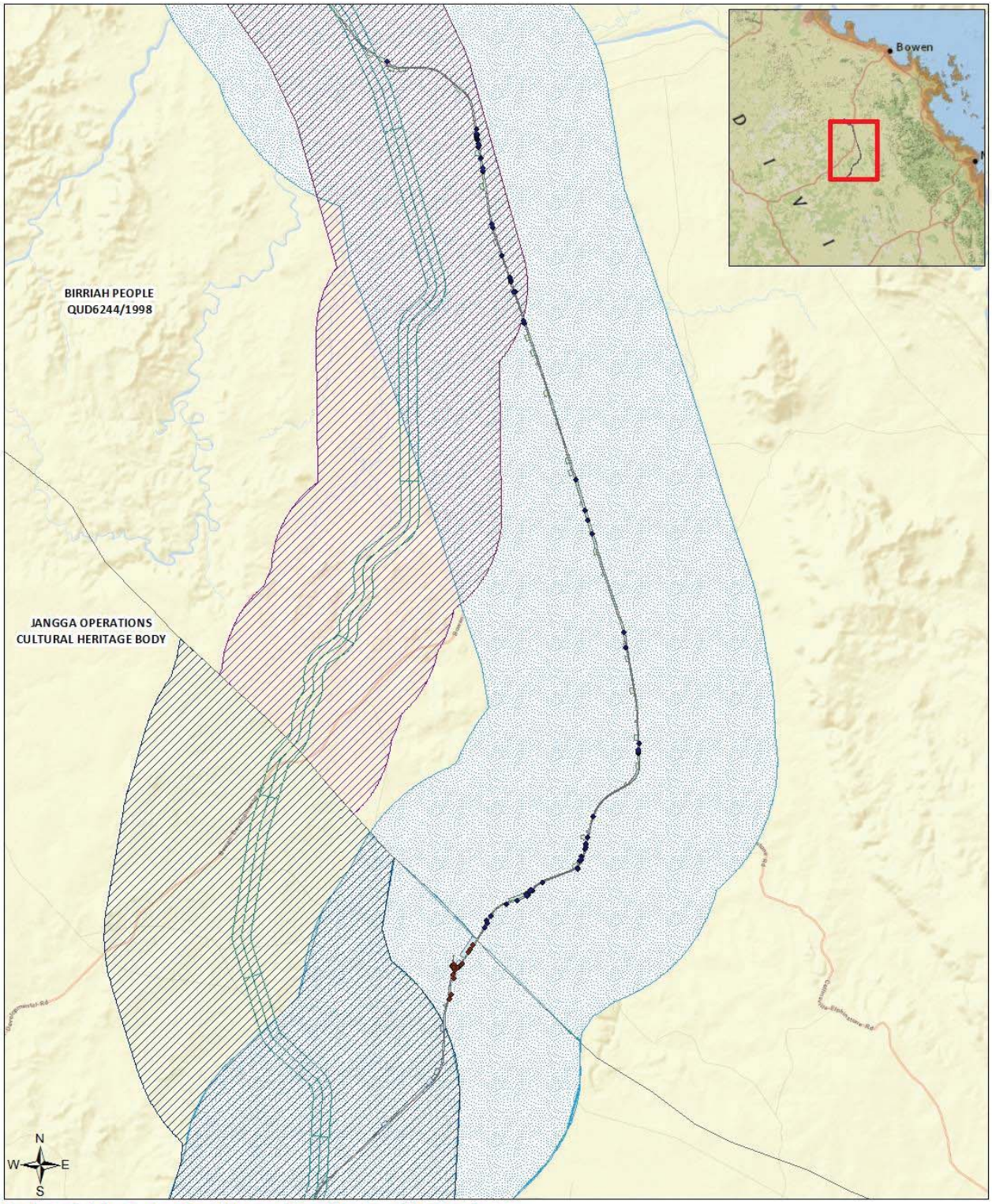
Coordinate System: WGS 1984 Zone 55S
Drawn: Tim Ellis
Date Saved: 14/02/2014

Legend

- Mt Roundback Realignment Route
- Registered Rock Art Site with 300m Buffer
- Original NGBR Alignment

ELH
Environment Land Heritage

Figure 2. Newlands Realignment Area



Adani North Galilee Basin Rail Project
Newlands Realignment

0 1.75 3.5 7 10.5 14
Kilometers

Coordinate System: WGS 1984
Projection: Web Mercator Auxiliary Sphere
Date Saved: 19/12/2013
Drawn: Sarah Annandale
MXD saved: PS/mapping/Client Data/Adani/NGBR rail

Legend

- Original NGBR alignment
- NGBR alignment - Birriah
- Birriah Registered CH sites
- NGBR alignment - Jangga
- Jangga Registered CH sites
- Birriah - Jangga RNTC boundary
- Birriah CHMP Area
- Jangga CHMP Area
- Proposed Additional CHMP Areas

ELH
Environment Land Heritage

2. METHODOLOGY

2.1. STUDY AREA

The study area for this Report consists of two areas:

- An area in the vicinity of Mt Roundback, situated approximately 40km west of Bowen, and shown on the map at Figure 1; and
- An area in the vicinity of Newlands, situated approximately 100km south of Bowen, and shown on the map at Figure 2.

The Mt Roundback Realignment is within the Juru People Registered Native Title Claim area (QUD 554/10).

The Newlands Realignment is partly in the Birriah People Native Title Claim area (QUD6244/98) and partly in the Jangga People Native Title Determination Area (QUD6230/98).

2.2. DATA SOURCES

In developing this Report the following data has been assessed:

- The Department of Aboriginal, Torres Strait Islander and Multicultural Affairs (**DATSIMA**) approved Cultural Heritage Management Plans (**CHMPs**) established between Adani pursuant to Part 7 of the *Aboriginal Cultural Heritage Act 2003* (**ACHA**), including:
    - Juru CHMP dated 6th September 2013
    - Birriah CHMP dated 28th May 2013
    - Jangga CHMP dated 15th May 2013
- Information / findings from the cultural heritage surveys conducted in the NGBR alignment area:
    - Aboriginal cultural heritage survey (**Survey**) – Splitters Creek to Abbot Point – 23 September – 30 September 2013
    - Survey – Mount Roundback Realignment Survey – 12 January to 15 January 2014
    - Survey – Splitters Creek to Southern Boundary of Juru #2 – 21 January 2014 to 30 January 2014
- The Juru cultural heritage survey reports of the Mt Roundback area generally and Roundback Realignment in particular,
    - *Cultural Heritage Progress Report - Adani North Galilee Basin Rail Project Juru Section – Stage 1 of Cultural Heritage Investigation – Splitters Creek to Abbot Point – September 2013*

- *Cultural Heritage Progress Report #2 - Adani North Galilee Basin Rail (NGBR) Project Juru Sector – Stage 2 of Cultural Heritage Investigations, Mount Roundback Sector* – January 2014

- Geospatial information regarding the Realignment areas were provided by Adani.
- This information was used to locate the rail alignment and associated project construction footprints in the field during the surveys, ascertain the proximity of any Aboriginal Cultural Heritage identified during the surveys, and determine alternative alignments where necessary.
- This geospatial information, plus GPS data gathered during the surveys, has been used to create the maps at Figures 1 & 2.
- The results of searches of DATSIMA Aboriginal cultural heritage database and register are detailed in section 2.4.

2.3. STAKEHOLDER ENGAGEMENT

The NGBR alignment area is located within the boundaries of three Aboriginal parties: Juru, Birriah and Jangga people. There are no other known Aboriginal parties for these areas.

Adani has undertaken and continues to undertake extensive consultation with each of these Aboriginal parties in relation to the proposed realignment and in general, has implemented the following processes to mitigate and protect cultural heritage sites:

- Cultural heritage surveys have been conducted within the NGBR existing alignment and the Mt Roundback Realignment area
- Mitigation measures have been identified and presented to the Juru CHMP 'Cultural Heritage Committee' (**CHC**) for consideration
- Consultation has been held with CHC representatives in relation to the impacts of the realignment on identified Aboriginal cultural heritage.

The below provides further detail on the consultation that has been undertaken by Adani with each of the Aboriginal parties.

2.3.1 JURU

Adani executed a CHMP with the Juru for the NGBR project on 6 September 2013.

In accordance with the provisions of the CHMP, a Survey was undertaken from Abbot Point to Splitters Creek, including Mt Roundback, along the corridor edged green in Figure 1.

Following the Survey, Juru provided Adani with the a Survey report entitled *Cultural Heritage Progress Report - Adani North Galilee Basin Rail Project Juru Section – Stage 1 of Cultural Heritage Investigation – Splitters Creek to Abbot Point – September* 2013.

A key recommendation of that report was realignment of the rail corridor away from the DATSIMA registered Aboriginal cultural heritage site (rock art and shelter site) GJ:A31 shown in Figure 1. A minimum 300m buffer around that site was recommended.

Adani accepted this recommendation and then commissioned a further Survey of the Mt Roundback Realignment between the Bruce Highway and Splitters Creek as shown edged red at Figure 1.

A subsequent Survey report for the Mt Roundback Realignment was received by Adani in February 2014, entitled *Cultural Heritage Progress Report #2 - Adani North Galilee Basin Rail (NGBR) Project Juru Sector – Stage 2 of Cultural Heritage Investigations, Mount Roundback Realignment Sector - January 2014*. The results of that report were:

- From a purely archaeological point of view, the results of the cultural heritage survey and assessment of the proposed realignment would indicate that no major, insurmountable or unmanageable archaeological constraints or issues have been identified within the confines of the proposed rail corridor.

- The majority of the Juru Cultural Officers advised that the current proposed realignment should co ntinue to be considered as an option, and that it should remain open to further discussion and negotiation between the parties.

- The Juru Cultural Officers advised that the proposed realignment cannot be considered as an option if Adani do not guarantee that they will provide suitable and safe access point/s across the rail line to the Mount Roundback cultural sites.

- A systematic cultural heritage salvage operation be undertaken by the Juru people for the 4 artefacts identified by the Survey.

- That Adani should make all reasonable efforts to avoid and protect from harm the landscape feature (granitic boulders and native vegetation identified by the Survey.

A CHC meeting will be held to discuss and finalise *the Cultural Heritage Progress Report #2 - Adani North Galilee Basin Rail (NGBR) Project Juru Sector – Stage 2 of Cultural Heritage Investigations, Mount Roundback Realignment Sector - January 2014* report and to agree Aboriginal cultural heritage arrangements for the Mt Roundback Realignment. The CHC is the decision making body under the terms of the CHMP for deciding on Aboriginal cultural heritage management arrangements.

2.3.2 BIRRIAH

Adani executed a CHMP with the Birriah for the Project on 28 May 2013. The CHMP area based upon the original NGBR alignment is shown in Figure 2.

Adani has consulted with Birriah representatives and undertaken to extend the Birriah CHMP to include the Newlands Realignment as shown in Figure 2 and to undertake a Survey of the Newlands Realignment area in accordance with the requirements of the CHMP.

Surveys will be undertaken in order to identify any Aboriginal cultural heritage values in those areas and following consideration of the Survey reports by the Adani and Birriah, any Aboriginal cultural heritage

management arrangements in relation to any Aboriginal cultural heritage issues be identified during the Surveys will be agreed.

A meeting will be held with Birriah representatives to progress negotiations and reach agreement in relation to the proposed Project ILUA and associated ancillary agreement within the Birriah native title claim area.

Adani will continue to negotiate the terms of an ILUA with the Birriah representatives which will cover both the original NGBR alignment and the Newlands Realignment, as well as other Project construction requirements within the Birriah RNTC area.

2.3.3 JANGGA

Adani executed a CHMP with the Bulganunna Aboriginal Corporation (representing Jangga) for the Project on 15 May 2013. The CHMP area was based upon the original NGBR alignment is shown in Figure 2.

Adani has consulted with Jangga representatives and undertaken to extend the Jangga CHMP to include the Newlands Realignment as shown in Figure 2 and to undertake a Survey of the Newlands Realignment area in accordance with the requirements of the CHMP.

Surveys will be undertaken in order to identify any Aboriginal cultural heritage values in those areas and following consideration of the Survey reports by the Adani and Jangga, any Aboriginal cultural heritage management arrangements in relation to any Aboriginal cultural heritage issues be identified during the Surveys will be agreed.

A Project ILUA between Bulganunna Aboriginal Corporation (Jangga) and Adani was executed on 19 December 2013, covering the original NGBR alignment. As part of the abovementioned consultation, Adani has informed Jangga that the existing ILUA will need to be extended to include the Newlands Realignment area.

Adani has commenced action to implement the appropriate amendments to the ILUA to incorporate the Newlands Realignment, and once the amended ILUA is executed, Adani will seek registration of the ILUA by the National Native Title Tribunal to give full effect to it.

2.4. DESKTOP ASSESSMENT

ELH lodged a cultural heritage search request with DATSIMA in September 2013 for the areas covered by the original NGBR alignment in the Juru Aboriginal party areas and Mt Roundback. The result of this search is provided Table 1 below.

In February 2014, ELH lodged a cultural heritage search request for the properties involved in the Newlands Realignment area, which incorporates the Birriah and Jangga areas.

The search results are provided in Table 2 below.

Table 1 - DATSIMA Cultural Heritage Search Results for Original Juru Alignment and Mt Roundback Realignment Area

Area	Site Id	Latitude	Longitude	Record Date	Attribute	Aboriginal Party
24RP804256	No recorded sites					Juru People
3HR1712	No recorded sites					Juru People
3HR1711	No recorded sites					Juru People
2HR1724	GJ:A31	-19.9794	148.0216	6/11/1973	Painting, Shell Midden	Juru People
2HR1724	Part of area without recorded sites					Juru People
1RP705785	No recorded sites					Juru People
3RP748508	No recorded sites					Juru People
3RP748509	No recorded sites					Juru People
80K12450	No recorded sites					Juru People

Table 2 - DATSIMA Cultural Heritage Search Results for the Newlands Realignment Corridor

Area	Site Id	Latitude	Longditude	Record Date	Attribute	Aboriginal Party
14SP225054	GH:J98	-21.197449	147.833873	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:J99	-21.198546	147.833108	30/06/2005 0:00	Landscape Feature	Jangga Operations Pty Ltd
14SP225054	GH:K00	-21.204355	147.829566	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K00	-21.205399	147.828541	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K00	-21.206209	147.827303	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K00	-21.206027	147.827639	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K00	-21.206128	147.827245	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K00	-21.206173	147.827206	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K00	-21.206102	147.827071	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K01	-21.207318	147.826028	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K03	-21.211422	147.825502	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K07	-21.219326	147.823928	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K08	-21.221609	147.822707	30/06/2005 0:00	Landscape Feature	Jangga Operations Pty Ltd
14SP225054	GH:K60	-21.205319	147.8246	30/06/2005 0:00	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd

14SP225054	GH:K60	-21.205301	147.824552	30/06/2005 0:00	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
14SP225054	GH:K60	-21.205301	147.824485	30/06/2005 0:00	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
14SP225054	GH:K60	-21.205518	147.824447	30/06/2005 0:00	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
14SP225054	GH:K60	-21.204899	147.825533	30/06/2005 0:00	Artefact Scatter, Hearth Oven	Jangga Operations Pty Ltd
14SP225054	GH:K61	-21.206192	147.825318	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
14SP225054	GH:K62	-21.209835	147.824732	30/06/2005 0:00	Artefact Scatter	Jangga Operations Pty Ltd
3SP171922	GH:J97	-21.195202	147.835305	30/06/2005 0:00	Artefact Scatter, Cultural Site	Jangga Operations Pty Ltd
3SP171922	GH:L23	-21.151841	147.892543	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L24	-21.153396	147.892293	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L24	-21.153604	147.892188	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L25	-21.153679	147.89163	23/06/2005 0:00	Resource Area	Birriah
3SP171922	GH:L26	-21.157499	147.890304	23/06/2005 0:00	Artefact Scatter, Resource Area	Birriah
3SP171922	GH:L26	-21.15777	147.890248	23/06/2005 0:00	Artefact Scatter, Resource Area	Birriah
3SP171922	GH:L29	-21.164597	147.871863	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L32	-21.168318	147.866809	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L33	-21.170281	147.86448	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L33	-21.170879	147.864195	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L33	-21.171007	147.864032	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L34	-21.173437	147.858719	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L34	-21.175299	147.853124	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L35	-21.180933	147.844814	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L36	-21.184601	147.843024	23/06/2005 0:00	Artefact Scatter	Birriah
3SP171922	GH:L37	-21.186498	147.841426	23/06/2005 0:00	Artefact Scatter, Landscape Feature	Birriah
3SP171922	GH000 00036	-21.168915	147.865083	5/10/2010 0:00	Scarred/Carved Tree	Birriah
3SP171922	GH000 00035	-21.170225	147.863404	5/10/2010 0:00	Artefact Scatter	Birriah
3SP171922	GH000 00035	-21.170125	147.863568	5/10/2010 0:00	Artefact Scatter	Birriah
3SP171922	GH000 00033	-21.183267	147.842528	5/10/2010 0:00	Artefact Scatter	Birriah
3SP171922	GH000 00037	-21.16808	147.865819	6/10/2010 0:00	Scarred/Carved Tree, Artefact Scatter	Birriah
3SP171922	GH000 00038	-21.148093	147.894171	6/10/2010 0:00	Isolated Find	Birriah

3SP171922	GH000 00039	-21.147142	147.894522	6/10/2010 0:00	Isolated Find	Birriah
3SP171922	GH000 00040	-21.145976	147.894553	6/10/2010 0:00	Resource Area	Birriah
3SP171922	GH000 00040	-21.145435	147.89456	6/10/2010 0:00	Resource Area	Birriah
3SP171922	GH000 00041	-21.142258	147.895494	6/10/2010 0:00	Isolated Find	Birriah
3SP171922	GH000 00042	-21.132214	147.898486	6/10/2010 0:00	Isolated Find	Birriah
3SP171922	GH000 00043	-21.100897	147.922549	7/10/2010 0:00	Artefact Scatter	Birriah
3SP171922	GH000 00043	-21.100455	147.922374	7/10/2010 0:00	Artefact Scatter	Birriah
3SP171922	GH000 00043	-21.100393	147.922229	7/10/2010 0:00	Artefact Scatter	Birriah
3SP171922	GH000 00043	-21.099154	147.9225	7/10/2010 0:00	Artefact Scatter	Birriah
3SP171922	GH000 00044	-21.096196	147.923002	7/10/2010 0:00	Isolated Find	Birriah
2CP866147	GH000 00045	-21.049173	147.915792	7/10/2010 0:00	Isolated Find	Birriah
2CP866147	GH000 00046	-21.041609	147.914504	7/10/2010 0:00	Isolated Find	Birriah
1DK230	GJ0000 0013	-20.993371	147.897913	8/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ:F60	-20.874132	147.856654	23/08/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ:F61	-20.874407	147.857588	23/08/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ:F61	-20.874132	147.856654	23/08/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ:F62	-20.869439	147.855512	23/08/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ:F62	-20.868918	147.855058	23/08/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ0000 0014	-20.986436	147.895476	8/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ0000 0015	-20.981644	147.894302	8/10/2010 0:00	Scarred/Carved Tree, Resource Area	Birriah
62SP195387	GJ0000 0016	-20.966663	147.889509	8/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ0000 0017	-20.889553	147.862366	9/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ0000 0018	-20.888372	147.861811	9/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ0000 0019	-20.869277	147.855454	9/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ0000 0019	-20.86907	147.855347	9/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ0000 0020	-20.867472	147.854992	9/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ0000 0021	-20.866959	147.854662	9/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ0000 0022	-20.856634	147.850576	10/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ0000 0023	-20.842699	147.84576	10/10/2010 0:00	Artefact Scatter	Birriah

62SP195387	GJ00000025	-20.840722	147.845335	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000027	-20.815167	147.840619	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000027	-20.815114	147.84059	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000027	-20.814806	147.840675	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000028	-20.813253	147.840358	10/10/2010 0:00	Resource Area	Birriah
62SP195387	GJ00000030	-20.808521	147.839803	10/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ00000031	-20.803118	147.838082	10/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ00000032	-20.802411	147.838405	10/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ00000033	-20.801454	147.838381	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000034	-20.799651	147.837516	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000035	-20.799262	147.837609	10/10/2010 0:00	Isolated Find	Birriah
62SP195387	GJ00000036	-20.798261	147.837383	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000036	-20.797674	147.837323	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000036	-20.797466	147.837341	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000036	-20.79724	147.837368	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000036	-20.797167	147.837425	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000036	-20.796788	147.837433	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000036	-20.796661	147.83748	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000036	-20.796444	147.837441	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000036	-20.796372	147.83744	10/10/2010 0:00	Artefact Scatter	Birriah
62SP195387	GJ00000037	-20.794078	147.837158	10/10/2010 0:00	Artefact Scatter, Contact Site	Birriah
62SP195387	GJ00000038	-20.761006	147.790098	11/10/2010 0:00	Cultural Site	Birriah

3. KEY FINDINGS

3.1. MT ROUNDBACK REALIGNMENT

The Mt Roundback Realignment is proposed as a result of:

- Consultation Adani has undertaken with Juru
- Surveys of the original NGBR alignment and the Mt Roundback Realignment area
- Adani's consideration of the results of the *Cultural Heritage Progress Report - Adani North Galilee Basin Rail Project Juru Section – Stage 1 of Cultural Heritage Investigation – Splitters Creek to Abbot Point – September 2013* and *Cultural Heritage Progress Report #2 - Adani North Galilee Basin Rail (NGBR) Project Juru Sector – Stage 2 of Cultural Heritage Investigations, Mount Roundback Realignment Sector - January 2014* reports
- The implementation of the Adani and Juru CHMP
- The considerations of the Juru CHC.

The proposed Mt Roundback Realignment is a direct result of the strong engagement between Adani and Juru and implementation of the DATSIMA approved Adani and Juru CHMP.

The original NGBR alignment was not supported by Juru. The Mt Roundback Realignment will result in superior Aboriginal cultural heritage management outcomes especially the implementation of an appropriate buffer around the registered Aboriginal cultural heritage site (rock art and shelter site) GJ:A31.

3.2. NEWLANDS REALIGNMENT

The Newlands Realignment is proposed as a result of:

- Consultation Adani has undertaken with stakeholders
- Stakeholder submissions and feedback raised concerns about the potential economic resources that would be sterilised by the original NGBR alignment in the Newlands area.
- Adani's consideration of the stakeholder submissions and feedback

The Newlands Realignment will be subject to Aboriginal cultural heritage investigation and management arrangements in accordance with the DATSIMA approved Adani and Birriah CHMP and Adani and Jangga CHMP.

Adani will continue to engage and consult with Birriah and Jangga Aboriginal party representatives in relation to the assessment and management of Aboriginal cultural heritage values in the Newlands Realignment area.

BIBLIOGRAPHY

Bird, M. (2013) Cultural Heritage Progress Report. Adani North Galilee Basin Rail (NGBR) Project. Juru Sector –
Stage 1 of Cultural Heritage Investigations. Splitters Creek to Abbot Point (Including Mt Roundback and Pinch Point Area). September 2013.

Bird, M. (2014) Cultural Heritage Progress Report #2 - Adani North Galilee Basin Rail (NGBR) Project Juru Sector – Stage 2 of Cultural Heritage Investigations, Mount Roundback Realignment Sector - January 2014

GHD

145 Ann Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com

© GHD 2014

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

G:\41\26457\WP\455692.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	Mike Trebitsch	Philip Bradley	Phil Bradley	Philip Bradley	Phil Bradley	28/02/2014
1	Michael Goodall	Philip Bradley	Phil Bradley	Philip Bradley	Phil Bradley	03/04/2014

www.ghd.com