Environmental Review Document

Mulga Downs Iron Ore Mine

Environmental Protection Act 1986
Assessment Number 2326

Hancock Prospecting Pty Ltd
ABN 69 008 676 417

10 April 2025

Revision Register

REV	DATE	AUTHOR	REVIEWER	APPROVED FOR ISSUE	DESCRIPTION OF CHANGES
0	15/06/2023	JBS&G	L.TAYLOR V,CAMPAGNA	S.BLAKE	FIRST DRAFT
1	28/03/2024	JBS&G	V.CAMPAGNA S.GOLDSWORTHY	K.FREHILL	Updated assessment report following s43A and agency RFI from first draft ERD
2	20/12/2024	JBS&G	B. McGuire	J. Huang	Updated in response to EPA RFI dated 4 July 2024 and s43A approval dated 4 October 2024
3	2/04/2025	JBS&G	B. McGuire		Updated in response to EPA RFI dated 20 March 2025
4	10/04/2025	JBS&G	B. McGuire	J. Huang	Finalised for publication.

Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on the environmental review for this Proposal.

Hancock Prospecting Pty Ltd proposes to develop the Mulga Downs Iron Ore Mine located 210 km south of Port Hedland and 180 km north west of Newman in the Pilbara Region of Western Australia. This Environmental Review Document (ERD) has been prepared in accordance with the EPA's ***Procedures Manual.*** The ERD is the report by the proponent on their environmental review which describes this Proposal and its likely effects on the environment.

The ERD is available for a public review period of **6** weeks from **17 April 2025**, closing on **3 June 2025**.

Information on the Proposal from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the Proposal to the Minister for the Environment.

Why write a submission?

The EPA seeks information that will inform its consideration of the likely effect of the Proposal, if implemented, on the environment. This may include relevant new information that is not in the ERD, such as alternative courses of action or approaches.

In preparing its assessment report for the Minister for the Environment, the EPA will consider the information in submissions, the proponent's responses, and other relevant information.

Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*.

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people) please indicate the names of each participant. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on information in the ERD.

When making comments on specific elements in the ERD:

- clearly state your point of view and give reasons for your conclusions
- reference the source of your information, where applicable
- suggest alternatives to improve environmental outcomes.

What to include in your submission

Include the following in your submission to make it easier for the EPA to consider your submission:

- Your name and address
- Date of your submission
- Whether you want your contact details to be confidential
- A summary of your submission, if it is long
- A list of points so that issues raised are clear, preferably by environmental factor
- Refer each point to the page, section and if possible, paragraph of the ERD
- Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for public submissions is: **3 June 2025.**

The EPA prefers submissions to be made electronically via the EPA's Consultation Hub at https://consultation.epa.wa.gov.au.

Alternatively, submissions can be:

posted to: Chairman, Environmental Protection Authority, Locked Bag 10, Joondalup DC WA 6919, or

delivered to: Environmental Protection Authority, Prime House, 8 Davidson Terrace, Joondalup 6027.

If you have any questions on how to make a submission, please contact EPA Services at the Department of Water and Environmental Regulation on 6364 7000.

TABLE OF CONTENTS

Executive Summary 17
1 Introduction 45
1.1 The Proponent 45
1.2 Purpose and Scope 46
2 Proposal 48
2.1 Background 48
2.2 Proposal Content 49
2.2.1 General Proposal Description 49
2.2.2 Proposal Elements 50
2.2.3 Detailed Description of Proposal Elements 56
2.2.4 Timeframes 63
2.2.5 Exclusions 63
2.3 Proposal Alternatives 65
2.3.1 Proposal Justification and Benefits 65
2.3.2 Feasible Alternatives 65
2.3.3 Changes to the Proposal during Assessment 71
3 Local and Regional Context 73
3.1 Interim Biogeographic Regionalisation of Australia 73
3.2 Land Systems 76
3.3 Vegetation Associations 78
3.4 Climate 80
3.5 Temperature 80
3.6 Rainfall 80
3.7 Wind 83
3.8 Evaporation 85
3.9 Geology 86
3.10 Soils 87
3.11 Hydrology and Hydrogeology 87
3.11.1 Surface Water 87
3.11.2 Claypans 92
3.11.3 Groundwater 92
3.12 Land Use and Heritage 96
3.12.1 Conservation Reserves and Wetlands 96
3.12.2 Fortescue Valley 99
3.13 Local Development 99
3.13.1 Pastoralism 100
3.13.2 Tourism 100
3.13.3 Communities, Traditional Ownership and Cultural Heritage 100
3.13.4 Wittenoom Asbestos Management Area 100
3.13.5 Other Nearby Projects 101
4 Legislative Context 103
4.1 Environmental Impact Assessment Process 103
4.2 Environmental Protection Act 1986 (Part IV) 103
4.3 Environment Protection and Biodiversity Conservation Act 1999 104
4.4 Native Title Act 1993 105

4.5 Land Tenure 106
4.6 Other Approvals and Regulation 108
5 Stakeholder Engagement 117
5.1 Consultation Strategy 117
5.2 Key Stakeholders 118
5.2.1 Government Agencies 118
5.2.2 Traditional Owners 118
5.2.3 Industry 121
5.2.4 Community 121
5.3 Stakeholder Consultation Outcomes 121
6 Object and Principles of the Environmental Protection Act 1986 136
6.1 Identification of Key Environmental Factors 139
7 Inland Waters 140
7.1 EPA Objective 140
7.2 Policy and Guidance 140
7.3 Receiving Environment 141
7.3.1 Relevant Studies 141
7.3.2 Geomorphology and Hydrology 142
7.3.3 Surface Water Quality 148
7.3.4 Claypans 152
7.3.5 Geology 157
7.3.6 Hydrogeology 165
7.3.7 Potential Environmental Receptors 193
7.3.8 Other Potential Users 195
7.4 Proposed Water Management Strategy 198
7.4.1 Dewatering 198
7.4.2 Construction and Operational Water Demand 202
7.4.3 Excess Water Disposal 202
7.4.4 Surface Water 203
7.5 Potential Environmental Impacts 203
7.5.1 Direct impacts 204
7.5.2 Indirect impacts 214
7.5.3 Cumulative Impacts 215
7.6 Mitigation 215
7.7 Assessment and Significance of Residual Impacts 219
7.7.1 Direct Impacts 219
7.7.2 Indirect Impacts 223
7.8 Significant Residual Impact 226
7.9 Environmental Outcomes 227
8 Subterranean Fauna 228
8.1 EPA Objective 228
8.2 Policy and Guidance 228
8.3 Receiving environment 229
8.3.1 Relevant Studies 229
8.3.2 Subterranean Fauna (Data) 231
8.3.3 Subterranean Fauna Habitat 243
8.3.4 Subterranean Fauna Assemblages 257

8.4 Potential Impacts 278
8.4.1 Direct impacts to Troglofauna 278
8.4.2 Indirect Impacts to Troglofauna 283
8.4.3 Direct Impacts to Stygofauna 283
8.4.4 Indirect Impacts to Stygofauna 288
8.4.5 Cumulative Impacts 288
8.5 Mitigation 289
8.6 Assessment and Significance of Residual Impacts 296
8.6.1 Direct Impacts - Troglofauna 296
8.6.2 Indirect Impacts – Troglofauna 296
8.6.3 Direct Impacts - Stygofauna 298
8.6.4 Indirect Impacts – Stygofauna 300
8.7 Significant Residual Impact 300
8.8 Environmental Outcome 301
9 Flora and Vegetation 302
9.1 EPA Objective 302
9.2 Policy and Guidance 302
9.3 Receiving Environment 302
9.3.1 Relevant Studies 302
9.3.2 Pre-European Vegetation Associations 308
9.3.3 Vegetation Types 308
9.3.4 Vegetation Condition 312
9.3.5 Significant Vegetation 314
9.3.6 Flora 323
9.3.7 Introduced Flora 331
9.4 Potential Impacts 334
9.4.1 Direct Impacts 334
9.4.2 Indirect Impacts 341
9.4.3 Cumulative Impacts 344
9.5 Mitigation 344
9.6 Assessment and Significance of Residual Impacts 352
9.6.1 Direct Impacts 352
9.6.2 Indirect Impacts 360
9.7 Significant Residual Impact 367
9.8 Environmental Outcome 367
10 Terrestrial Fauna 369
10.1 EPA Objective 369
10.2 Policy and Guidance 369
10.3 Receiving Environment 370
10.3.1 Relevant Studies 370
10.3.2 Vertebrate Fauna 393
10.3.3 Conservation Significant Fauna 396
10.3.4 Vertebrate Fauna Habitat 456
10.3.5 Short Range Endemic Invertebrate Fauna 469
10.3.6 Aquatic Invertebrates 477
10.4 Potential Impacts 478
10.4.1 Direct Impacts 478
10.4.2 Indirect Impacts 484
10.4.3 Cumulative Impacts 487

10.5 Mitigation 487
10.5.1 Exclusion Areas 487
10.6 Assessment and Significance of Residual Impacts 493
10.6.1 Direct Impacts 493
10.6.2 Indirect Impacts 506
10.7 Significant Residual Impact 517
10.8 Environmental Outcome 518
11 Terrestrial Environmental Quality 520
11.1 EPA Objective 520
11.2 Policy and Guidance 520
11.3 Receiving Environment 520
11.3.1 Relevant Studies 521
11.3.2 Soil and Landforms 523
11.3.3 Acid Sulfate Soils 524
11.3.4 Characterisation of Waste Rock Material 529
11.3.5 Asbestiform Minerals and Asbestos Containing Materials 533
11.4 Potential Impacts 541
11.4.1 Indirect Impacts 541
11.4.2 Cumulative Impact 543
11.5 Mitigation 543
11.6 Assessment and Significance of Residual Impacts 546
11.6.1 Indirect Impacts 546
11.7 Significant Residual Impact 548
11.8 Environmental Outcome 548
12 Greenhouse Gas Emissions 550
12.1 EPA Objective 550
12.2 Policy and Guidance 550
12.3 Safeguard Mechanism Confirmation 551
12.3.1 Application of Mitigation Hierarchy 552
12.4 Estimate of Emissions 558
12.4.1 Scope 1 (as defined by the EPA) 558
12.4.2 Scope 2 563
12.4.3 Scope 3 563
13 Air Quality 568
13.1 EPA Objective 568
13.2 Policy and Guidance 568
13.3 Receiving Environment 569
13.3.1 Relevant Studies 569
13.3.2 Climate 570
13.3.3 Ambient Air Quality (Particulates) 571
13.3.4 Soils 574
13.3.5 Geology 574
13.3.6 Hydrology 575
13.3.7 Historic Anthropogenic Activities 575
13.3.8 Receptors 575
13.4 Potential Impacts 575
13.4.1 Direct Impacts 576

13.4.2 Indirect Impacts....577
13.4.3 Cumulative Impacts....577
13.5 Mitigation Measures....577
13.6 Assessment and Significance of Residual Impact....580
13.6.1 Direct Impacts....580
13.6.2 Indirect impacts....581
13.7 Significant Residual Impact....581
13.8 Environmental Outcome....582
14 Social Surroundings....583
14.1 EPA Objective....583
14.2 Policy and Guidance....583
14.2.1 Native Title Act 1993....584
14.2.2 Aboriginal Heritage Act 1972....585
14.3 Receiving Environment....587
14.3.1 Relevant Studies....587
14.3.2 Location and Land Use....592
14.3.3 Social Surroundings Consultation....595
14.3.4 Aboriginal Heritage Values and Cultural Associations....600
14.3.5 Other Historic Heritage....619
14.3.6 Social Surroundings Values....619
14.4 Potential Impacts....620
14.4.1 Proposal Design Considerations....620
14.4.2 Direct Impacts....623
14.4.3 Indirect Impacts....625
14.4.4 Cumulative Impacts....630
14.5 Mitigation....630
14.6 Assessment and Significance of Residual Impact....639
14.6.1 Direct Impacts....639
14.6.2 Indirect Impacts....640
14.7 Significant Residual Impact....644
14.8 Environmental Outcome....644
15 Other Factors....646
16 Offsets....649
16.1 Objective....649
16.2 State Policy and Guidance....649
16.2.1 Consistency with State Offset Principles....650
16.3 Assessment of Significant Residual Impact....651
16.4 Proposed Offsets....657
16.5 Impact Reconciliation....658
17 Cumulative Impact Assessment....659
17.1 Inland Waters....664
17.1.1 Surface Water....664
17.1.2 Groundwater....665
17.2 Vegetation and Flora....667
17.2.1 Land Systems....667
17.2.2 Broad-scale mapping....671

17.2.3 Local Vegetation Types 675
17.2.4 Flora 677
17.2.5 Surface Water Dependent Communities 679
17.2.6 Priority Ecological Communities 679
17.2.7 Flora and Vegetation Cumulative Impacts 680
17.3 Terrestrial Fauna 683
17.4 Subterranean Fauna 685
17.5 Air Quality 685
17.5.1 Dust 685
17.5.2 Airbourne Asbestos 686
17.6 Terrestrial Environmental Quality 686
17.6.1 Contamination 687
17.6.2 Asbestos Mobilisation 687
17.7 Greenhouse Gas Emissions 687
17.8 Social Surroundings 688
17.8.1 Noise and Vibration 691
17.8.2 Air Quality and Dust 691
18 Holistic Impact Assessment 693
Abbreviations 725
References 728
Appendices 740

TABLES

Table 1-1: Proponent Details 45
Table 2-1: General Proposal Description 49
Table 2-2: Proposal Content Elements 50
Table 2-3: Expected Timeframes 63
Table 2-4: Consideration of Alternatives 68
Table 3-1: The IBRA Bioregion and Subregions within the Development Envelope (IBRA7) 73
Table 3-2: Land Systems within the Development Envelope 76
Table 3-3: Vegetation Associations within the Development Envelope 78
Table 3-4: Average Rainfall, Mulga Downs BoM Station 1898 – 2018 (AQ2, 2024a) 81
Table 3-5: Wittenoom Mean Pan Evaporation (BoM) (AQ2, 2024a) 85
Table 3-6: Managed Lands within proximity to the Development Envelope 96
Table 4-1: EPA Procedures and Guidance for EIA 103
Table 4-2: Tenement Holder Details 106
Table 4-3: Other relevant approvals (Decision making authorities) 109
Table 5-1: Proposed ongoing communication and / or consultation schedule with Banjima Traditional Owners and Communities 120
Table 5-2: Consultation and Communication undertaken to date with Key Stakeholder Groups 122
Table 6-1: Principles of Environmental Protection 136
Table 7-1: Inland Waters Policy and Guidance 140
Table 7-2: Completed Baseline Inland Water Surveys and Studies 141
Table 7-3: Baseline Surface Water Catchment Summary 143
Table 7-4: Summary of Key Baseline Surface Water Quality Results (mg/L) 149

Table 7-5: Regional Stratigraphic Sequence within the Development Envelope (Source AQ2 2025, Mine Earth 2020).....160
Table 7-6: Generalised Hydrostratigraphy across the Development Envelope 165
Table 7-7: Summary of Aquifer Parameters (AQ2 2025).....168
Table 7-8: Summary of Baseline Groundwater Quality Results Compared to Livestock Drinking Water Guidelines (ANZECC & ARMCANZ 2000) 189
Table 7-9: Salinity threshold categories (Australian Government, 2004; DoW 2009) 191
Table 7-10: Proposal Catchment Area Changes (AQ2 2024a) 205
Table 7-11: Mitigation Measures for Inland waters 216
Table 7-12: Environmental Outcomes for Inland Waters.....227
Table 8-1: Subterranean Fauna Policy and Guidance.....228
Table 8-2: Subterranean fauna studies undertaken to inform the Proposal 229
Table 8-3: Survey Effort Subterranean Fauna 2009-2014 232
Table 8-4: Subterranean Fauna Survey Effort -Detailed and Targeted Surveys (2019-2024) 233
Table 8-5: Lithological Groupings with respect to Potential Subterranean Fauna Habitats (from AQ2 2024b).247
Table 8-6: Troglofauna identified as having linear ranges only within the area impact ("restricted") at MDIOM. 259
Table 8-7: Stygofauna identified as having linear ranges only within the area impact (restricted) at MDIOM. Risk Ranking identified. 271
Table 8-8: Potential Troglofauna Habitat (volumetric) which will be impacted from excavation and/or mounding (MAR) 279
Table 8-9: Predicted Percentage of Habitat Lost within the Area of Impact (excavation and mounding) 280
Table 8-10: Troglofauna identified as most at risk from implementation of.....281
Table 8-11: Potential Stygofauna Habitat Loss During Mining (dewatering).....284
Table 8-12: Predicted Percentage of Habitat Lost Within the Area of Impact.....285
Table 8-13: Stygofauna identified as most at risk from implementation of Proposal 287
Table 8-14: Mitigation Measures for Subterranean Fauna 291
Table 8-15: Environmental Outcomes of Subterranean Fauna.....301
Table 9-1: Flora and Vegetation Policy and Guidance.....302
Table 9-2: Flora and Vegetation Surveys.....304
Table 9-3: Vegetation Types within the Development Envelope.....308
Table 9-4: Vegetation Condition within the Development Envelope (Maia, 2022). 312
Table 9-5: Four plant assemblages of the Wona Land System PEC.....315
Table 9-6: Key attributes of locally significant vegetation within the Development Envelope (Maia, 2022).....317
Table 9-7: Potential Sheet Flow Vegetation 317
Table 9-8: Mapped Vegetation Types in the Development Envelope and their Ecohydrological Characteristics (AQ2 2024a).....321
Table 9-9: Conservation Significant Flora Recorded in the Development Envelope.....327
Table 9-10: Loss of Pre-European Vegetation Associations 334
Table 9-11: Impacts to Vegetation Types (shaded cells represent locally significant vegetation types).....336
Table 9-12: The extent of proposed vegetation clearing per IBRA subregion within the Development Envelope and Indicative Footprint 337
Table 9-13: Loss of Conservation Significant Vegetation within the Development Envelope 337
Table 9-14: Impacts to Conservation Significant Species and their Habitat (coloured cells = taxa in Indicative Footprint).....339
Table 9-15: Mitigation Measures for Flora and Vegetation 346
Table 9-16: Loss of habitat for *Hibiscus* sp. Mulga Downs (Priority 1).....354
Table 9-17: Loss of habitat for *Triodia veniciae* (Priority 1) 356
Table 9-18: Loss of habitat for *Dolichocarpa sp*. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3) 357
Table 9-19: Flora and Vegetation Environmental Outcomes.....367

Table 10-1: Terrestrial Fauna Policy and Guidance 369
Table 10-2: Terrestrial Fauna Surveys and Studies 371
Table 10-3: Likelihood of Occurrence....393
Table 10-4: Conservation Significant Species Identified from Desktop and Literature Assessments....394
Table 10-5: Conservation Significant Fauna within the Development Envelope (recorded and likely to occur)396
Table 10-6: Mapped Vertebrate Fauna habitat within the Development Envelope 457
Table 10-7: Land Systems and Related Fauna Habitat 461
Table 10-8: Category 4 Caves Surveyed for Pilbara Leaf-nosed and Ghost Bats (X = cave found to be suitable) 466
Table 10-9: SRE categorization 469
Table 10-10: SRE Invertebrate Taxa (Confirmed and Potential SRE Status) Identified in Desktop Assessments. 470
Table 10-11: SREs (confirmed and potential) located within the within the Development Envelope. Data is a consolidation of all SRE records following DNA Barcoding. Taxa are presented as OTUs (operational taxonomic units)....473
Table 10-12: Loss of Terrestrial Fauna Habitat....480
Table 10-13: Mitigation Measures for Terrestrial Fauna 489
Table 10-14: Fauna Habitat – Assessment of Impacts....495
Table 10-15: Impacts to Conservation Significant Fauna 497
Table 10-16: Terrestrial Fauna Environmental Outcomes 518
Table 11-1:Policy and Guidance 520
Table 11-2: Completed Baseline TEQ Surveys and Studies 521
Table 11-3 Soil and Landform Associations across the Development Envelope.....523
Table 11-4: Distribution of sulfur percentage for entire assay database....529
Table 11-5: Stratigraphy of waste per pit (Mt)....532
Table 11-6: Acid potential classification of waste by acid-base by pit (Mt)....532
Table 11-7: DWER Online Contaminated Sites Database Search 535
Table 11-8: Mitigation Measures for Terrestrial Environmental Quality....544
Table 11-9: Terrestrial Environmental Quality Environmental Outcomes....548
Table 12-1: Greenhouse gas policy and guidance....550
Table 12-2: Summary of Mitigation Measures for Greenhouse Gas Emissions....556
Table 12-3: Parameters for calculation of carbon sequestration loss due to biomass disturbance....560
Table 12-4: Description and Boundaries of Scope 3 Categories 563
Table 12-5: List of likely countries that would import the product....567
Table 13-1: Relevant Policy and Guidance 568
Table 13-2: Air Quality Studies....570
Table 13-3: Mitigation Measures 578
Table 13-4: Air Emissions Environmental Outcomes....582
Table 14-1: Social Surroundings Policy and Guidance....583
Table 14-2: Other Policy and Guidance 584
Table 14-3: Social Surroundings Surveys and Studies 588
Table 14-4: Extent of on-ground heritage surveys completed to date for Banjima Traditional Owners....600
Table 14-5: Summary of Aboriginal heritage surveys undertaken for the Proposal....600
Table 14-6: Sites of heritage value identified to date within the Development Envelope and Indicative Footprint 601
Table 14-7: Culturally significant flora identified within the Development Envelope (ACHM, 2024)....609
Table 14-8: Summary of consultation outcomes with Banjima Traditional Owners on Proposal design and avoidance and minimisation measures already implemented. 620
Table 14-9: Assigned Noise Limits Summary (LGA, 2024) 627
Table 14-10: All Scenario's Assessment, L10 dB(A) (LGA, 2024) 628

Table 14-11: Aircraft Noise Assessment, dB LAmax (LGA, 2024) 628
Table 14-12: Summary of consultation outcomes with Banjima Traditional Owners and proposed mitigation631
Table 14-13: Mitigation Measures for Social Surroundings 634
Table 14-14: Environmental Outcomes.....645
Table 15-1: Assessment of Other Environmental Factors 647
Table 16-1: Consideration of State Offset Principles.....650
Table 16-2: Residual Impact Significance Model (RISM) 653
Table 16-3: Environmental Offsets Table 655
Table 16-4: PEOF Offset Values 658
Table 17-1: Projects within the Local Assessment Boundary.....660
Table 17-2: Cumulative Impacts within the Local Assessment Area 662
Table 17-3: Cumulative Impacts to Land Systems.....667
Table 17-4: Cumulative Impacts Pre-European Vegetation 671
Table 17-5: Cumulative Impacts - Local Vegetation Types.....675
Table 17-6 Cumulative Impacts to Conservation Significant Flora.....678
Table 17-7: Cumulative Impacts - Sheet Flow Dependent Mulga 679
Table 17-8: Local Cumulative Impacts to Fauna Habitat.....684
Table 17-9: Cumulative Impacts – Banjima Native Title Determination Area.....689
Table 17-10: Cumulative Predicted Noise Levels, L_{10} dB(A) (LGA 2024) 691
Table 18-1: Connections and interactions between key environmental factors and predicted outcomes.....695

FIGURES

Figure 2-1: Regional Location of the Proposal.....53
Figure 2-2: Proposal Location, Development Envelope and Indicative Footprint.....54
Figure 2-3: Proposed Pits within the Proposal 55
Figure 3-1: Pilbara IBRA Subregions 75
Figure 3-2: Land Systems within the Development Envelope.....77
Figure 3-3: Beard Vegetation Associations within the Development Envelope.....79
Figure 3-4: Annual Rainfall – Mulga Downs (AQ2 2024a) 81
Figure 3-5: Time series of rainfall and temperature at Mulga East (AQ2, 2024a) 82
Figure 3-6. Wind data from Karijini North (Station 05098) (Source SLR 2021a) 83
Figure 3-7: Karijini North Wind Speed Frequencies June 2019 to February 2021. (Source: SLR 2021a) 84
Figure 3-8: Annual Average Pan Evaporation Rate (Source: BoM, 2023) 85
Figure 3-9: Simplified Pilbara Geology (Source Pepper et al 2013).....86
Figure 3-10: Fortescue Valley including Goodiadarrie Swamp (SourceAQ2 2024a) *(Development Envelope no longer falls in E47/135)*.....89
Figure 3-11: Surface water flows including claypans of the Fortescue River Valley 90
Figure 3-12: Geomorphology influencing claypans (Source AQ2 2024a).....91
Figure 3-13: Hydrogeological Cross Sections in Mulga East (AQ2 2024a).....94
Figure 3-14: Groundwater Level Contours (AQ2 2024a).....95
Figure 3-15: Conservation Reserves and Wetlands.....98
Figure 3-16: Land Use within/adjacent to the Proposal.....102
Figure 4-1: Tenement Boundaries 107
Figure 7-1: Pre-development Catchment Areas.....145
Figure 7-2: Geomorphology Overview (AQ2 2025).....146
Figure 7-3: Regional Hydrology 147
Figure 7-4: Surface Water Monitoring Locations (AQ2 2025).....150
Figure 7-5: Claypan Hydrological Conceptualisation (AQ2 2025) 154

Figure 7-6: Effective Catchment Areas for the Major Claypans (Mulga East) (AQ2 2025).....155
Figure 7-7: Groundwater and Surface Water Hydrographs for the Koodjeepindarranna Claypans and Gnalka Gnoona (AQ2 2025).....156
Figure 7-8: Regional Geology and Geomorphology (Lascelles, 2002).....158
Figure 7-9: Regional Geology (Kitzig et al 2018).....159
Figure 7-10: Surface Geology within the Mulga Downs Iron Ore Mine 164
Figure 7-11: Examples of possible inferred geological features from magnetics data (AQ2, 2025). Mine Pits are shown in orange. 167
Figure 7-12: Location of Hydrogeological Sections – Mulga East (AQ2 2025) 169
Figure 7-13: Hydrogeological Cross Section A – Mulga East (AQ2 2025).....170
Figure 7-14: Hydrogeological Cross Section B – Mulga East (AQ2 2025).....171
Figure 7-15: Hydrogeological Cross Section C – Mulga East (AQ2 2025).....172
Figure 7-16: Hydrogeological Cross Section D – Mulga East (AQ2 2025).....173
Figure 7-17: Hydrogeological cross section highlighting recharge and discharge from claypans in Mulga East (SourceAQ2 2025).....176
Figure 7-18: Groundwater Level Contours (AQ2 2025).....177
Figure 7-19: Groundwater Level Contours (AQ2 2025).....178
Figure 7-20: Hydrographs for Hydrogeological Cross Section B (AQ2 2025) 180
Figure 7-21: Hydrographs for Hydrogeological Cross Section C (AQ2 2025).....181
Figure 7-22: Hydrographs for Hydrogeological Cross Section D (AQ2 2025) 182
Figure 7-23: Hydrographs near the Koodjeepindarranna Claypan (AQ2 2025) 183
Figure 7-24: Hydrographs near Gnalka Gnalka Claypan (AQ2 2025).....184
Figure 7-25: Bore Locations for Long-Term Hydrographs (AQ2 2025).....186
Figure 7-26: Long-Term Groundwater Level Hydrographs (AQ2 2025) 187
Figure 7-27: Groundwater Salinity Contours at Water Table (AQ2 2025) 192
Figure 7-28: Conceptual Ecohydrological Model of the *E. victrix* woodland communities (AQ2 2024a) 196
Figure 7-29: Location of Potential Environmental Receptors and other Potential Users 197
Figure 7-30: Simulated pits in the groundwater model (Mulga Downs) (AQ2 2025) 199
Figure 7-31: Predicted dewatering Schedule (AQ2 2025).....200
Figure 7-32: Simulated Dewatering Bores (AQ2 2025). 201
Figure 7-33: Conceptual cross section showing potential impact of mining (AQ2 2025) 206
Figure 7-34: Proposed Surface Water Diversions (AQ2 2024a) 207
Figure 7-35: Predicted drawdown and mounding for January 2032 and July 2034 (AQ2 2024a) 210
Figure 7-36: Predicted drawdown and mounding for July 2035 and July 2038 (AQ2 2024a).....211
Figure 7-37: Predicted groundwater drawdown and mounding for July 2041 and July 2042 (AQ2 2024a).....212
Figure 7-38: Maximum extent of predicted drawdown and mounding throughout LOM (AQ2 2024a) 213
Figure 8-1: Troglofauna survey extent - 2019-2024 239
Figure 8-2: Stygofauna survey extent 2019-2024 240
Figure 8-3: Troglofauna sampling effort with respect to mine pits and mounding) (2019-2024) 241
Figure 8-4: Stygofauna sampling effort with respect to extent of drawdown and mounding (2019-2024).....242
Figure 8-5: Predicted Areal Extent of Impact to Troglofauna Habitat.....248
Figure 8-6: Geological cross section of modelled troglofauna habitat (Section 1) 249
Figure 8-7: Geological cross section of modelled troglofauna habitat (Section 2) 250
Figure 8-8: Geological cross section of modelled troglofauna habitat (Section 3) 251
Figure 8-9: Predicted Areal Extent of Impact to Potential Stygofauna Habitat 252
Figure 8-10: Geological cross section of modelled stygofauna habitat (cross section 1) 253
Figure 8-11: Geological cross section of modelled stygofauna habitat (cross section 2) 254
Figure 8-12: Geological cross section of modelled stygofauna habitat (cross section 3) 255
Figure 8-13: Geological cross section of modelled stygofauna habitat (cross section 4) 256

Figure 8-14: Distribution of troglofauna identified as restricted (Class Chilopoda, Diplopoda, Entognatha and Symphyla) 265
Figure 8-15: Distribution of troglofauna identified as restricted (Class Arachnida). 266
Figure 8-16: Distribution of troglofauna identified as restricted (Class Insecta). 267
Figure 8-17: Distribution of troglofauna identified as restricted (Class Malacostraca). 268
Figure 8-18: Linear extent of "restricted" troglofauna across suitable subterranean habitat. Congeneric taxa are included. 269
Figure 8-19: Distribution of stygofauna considered restricted (Class Malacostraca). 275
Figure 8-20: Distribution of stygofauna identified as restricted (Class Maxillopoda and Ostracoda). 276
Figure 8-21: Linear extent of “restricted” stygofauna across suitable subterranean habitat. Congeneric taxa are included. 277
Figure 9-1: Flora and Vegetation Surveys Effort 307
Figure 9-2: Mapped Vegetation Types within the Development Envelope 311
Figure 9-3: Vegetation Condition Mapped within the Development Envelope (Maia, 2022) 313
Figure 9-4: Conservation Significant Ecological Communities based on DBCA designated buffers....316
Figure 9-5: Potential Sheetflow Dependent Vegetation within the Development Envelope (Maia, 2022)....319
Figure 9-6: Conservation Significant Flora in relation to the Proposal....332
Figure 9-7: Mapped Riparian vegetation Types within the Development Envelope 333
Figure 9-8: Records of *Hibiscus* sp. Mulga Downs....355
Figure 9-9: Records of *Triodia veniciae* 358
Figure 9-10: Records of *Dolichocarpa sp*. Hamersley Station (A.A. Mitchell PRP 1479) 359
Figure 10-1: Terrestrial Survey Extent....387
Figure 10-2: Terrestrial Fauna Survey area for the Proposal 388
Figure 10-3: Terrestrial Fauna Survey Area for the Proposal (Acoustic, Avifauna and Nocturnal Survey Sites).389
Figure 10-4: Terrestrial Fauna Survey area for the Proposal (UAV Survey Sites)....390
Figure 10-5: Terrestrial Fauna Survey Effort (Habitat assessment, Cave assessment, Systematic Trapping and Targeted Survey) 391
Figure 10-6: Short Range Endemic Survey Effort for the Proposal 392
Figure 10-7: Conservation Significant Fauna Recorded in Relation to the Proposal....398
Figure 10-8: Pilbara Leaf-nosed Bat records and Category 4 nocturnal refuges....410
Figure 10-9: Ghost Bat records and Category 4 Nocturnal Refuges....411
Figure 10-10: Northern Quoll records and Habitat 417
Figure 10-11: Bilby Survey Effort 422
Figure 10-12: Pilbara Olive Python record 426
Figure 10-13: Night Parrot Survey Effort....432
Figure 10-14: Night Parrot Survey Effort from Spectrum 2024a....433
Figure 10-15: Grey Falcon records and potential nesting trees....439
Figure 10-16: Peregrine Falcon and Grey Falcon Records and Habita 440
Figure 10-17: Gane’s Blind Snake records and Habitat 443
Figure 10-18: Western Pebble-mound Mouse records and Habitat 452
Figure 10-19: Migratory Species Records....455
Figure 10-20: Mapped Vertebrate Fauna Habitat....465
Figure 10-21: Location of confirmed and potential SRE taxa 475
Figure 10-22: Maximum extent of groundwater drawdown across mapped fauna habitat extent 511
Figure 11-1: Soil-landform Mapping across the Development Envelope 526
Figure 11-2: ASS Risk Mapping (DWER) (Source: Mine Earth, 2023). 527
Figure 11-3: ASS occurrence Probability Mapping (CSIRO) (Source: Mine Earth, 2023)....528
Figure 11-4: Distribution of all sampled drillholes across the Proposal....531
Figure 11-5: Location of Site with Asbestos in relation to the Proposal 537
Figure 11-6: Anthropogenic Sample Locations (JBSG 2024 – Asbestos Management Plan)....540

Figure 12-1: Scope 1 emissions profile for the Proposal 562
Figure 13-1: Air Quality Monitoring Locations 573
Figure 14-1: Traditional Owner Native Title Determination Area 586
Figure 14-2: Land use and sensitive receptors 594
Figure 14-3: Heritage Sites (DPLH) 603
Figure 14-4: Heritage Survey and Social Surroundings Coverage 604
Figure 14-5: Heritage Sites Identified During Heritage Surveys 605
Figure 14-6: Overview of where the ethnobotanical Survey Team travelled (ACHM 2024) 608
Figure 14-7: Development Envelope Changes 622
Figure 17-1: Projects in the Local and Regional Assessment Areas 663
Figure 17-2: Maximum drawdown modelled (source AQ2) 666
Figure 17-3: Cumulative Impact Assessment – Land Systems 669
Figure 17-4: Cumulative Impact Assessment – Pilbara IBRA Land Systems 670
Figure 17-5: Cumulative Impact Assessment – Pre-European Vegetation 673
Figure 17-6: Cumulative Impact Assessment – IBRA Pre-European Vegetation 674
Figure 17-7: Cumulative impacts - Local Vegetation Types 676
Figure 17-8: Cumulative impacts – TEC and PEC 681
Figure 17-9: Cumulative impacts –Pilbara IBRA TEC and PEC 682
Figure 17-10: Cumulative Assessment – Banjima Native Title Determination Area 690
Figure 18-1: Relationships between environmental factors 694

Executive Summary

Hancock Prospecting Pty Ltd (HPPL, the Proponent) is proposing to develop the Mulga Downs Iron Ore Mine (MDIOM, the Proposal), located approximately 210 kilometres (km) south of Port Hedland and 180 km north-west of Newman in the Pilbara Region of Western Australia. The Proposal will produce up to 12 million tonnes per annum (Mtpa) of iron ore and have an operational life of approximately 18 years. The Proposal is a new asset that will contribute to maintaining the supply of iron ore product for HPPL customers through port facilities located at Port Hedland.

The Proposal is being assessed under Part IV of the *Envirnmental Protection Act 1986* (EP Act). The Proposal has also been separately referred for assessment under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) (EPBC 2021/09255). The assessment process by the Commonwealth is not an accredited assessment. This ERD has been prepared for assessment under Part IV of the EP Act and provides an assessment of key environmental factors which fall under the EP Act. MNES are being assessed separately by the Commonwealth under the EPBC Act.

A Development Envelope approach has been proposed for this Proposal, which allows for flexibility in respect to the Proposal footprint. The Proposal footprint is considered indicative and is referred to as the Indicative Footprint for the purpose of the impact assessment. As the planning and design of the mine progresses and studies that inform the assessment are completed, changes may occur to the Indicative Footprint to apply the mitigation hierarchy and further reduce and prevent potential environmental impacts.

The Proposal extent is a Development Envelope of 16,848.53 hectares (ha) within which up to 4,339.16 ha of vegetation will be cleared.

The Proposal description and Proposal Content Elements are outlined below in **Table ES 1** and **Table ES 2.**

Table ES 1: General Proposal Description

Proposal title	Mulga Downs Iron Ore Mine (Proposal)
Proponent name	Hancock Prospecting Pty Ltd (HPPL)

Short description	The Proposal is for the development of the MDIOM located approximately 210 km south of Port Hedland and 180 km north west of Newman in the Pilbara Region of Western Australia (refer to **Figure 2-1**). The Proposal includes and is not limited to the following: • The development of a series of above and below water table mine pits; • Dry ore crushing and screening plant(s); • Groundwater abstraction for water supply (for the mine and all associated infrastructure) and for the dewatering to facilitate the recovery of ore below water table in the mine pits; • Surplus water management via managed aquifer recharge (MAR) and/or in pit infiltration; • Waste rock dumps (WRD); • Infrastructure to manage surface water (diversion of creeks and surface water flows); • Linear infrastructure (haul roads, powerlines, pipelines and conveyor corridors); • Mine associated infrastructure and support facilities (including, but not limited to accommodation camp, energy supply infrastructure, airstrip; wastewater treatment plant; landfill, offices, workshops, laydown areas, etc.); and • Transport of the ore via the Great Northern Highway to Port Hedland or via road to a siding along the existing Roy Hill railway and then via that railway to Port Hedland for export. Future transport options (e.g. rail) will be subject to a separate referral. • The Proposal is located within a 16,848.53 ha Development Envelope and will require the clearing of up to 4,339.16 ha of native vegetation.

Table ES 2: Proposal Content Elements

Proposal Element	Location / Description	Maximum Extent, Capacity or Range
Physical Elements		
Mine elements, including: • Series of open pits (above and below water table); • WRDs; • Topsoil stockpiles; and • Dewatering.	Within the Development Envelope	Clearing of up to 4,339.16 ha of native vegetation within the 16,848.53 ha Development Envelope.
Processing elements, including: • Ore stockpiles; • Crushing and screening plant(s); • Dry crushing and screening plant; • Transfer water dams/ponds.		
Infrastructure elements, including: • Accommodation camp; • Energy supply infrastructure; • Road haulage of ore from the mine to Port or Rail Siding; • Conveyors for the transportation of ore; • Bore fields/water reinjection infrastructure; • Mine workshops & infrastructure; • Pipelines; • Haul and light vehicle roads; • Ancillary buildings (e.g. workshops, telecommunications, offices); • WWTPs; • Landfill; • Hydrocarbon storage; • Explosive mixing and storage facility; • Laydown areas; • Evaporative ponds; • Water diversion channels and catchment ponds; and • Above ground water storage dams to manage supply or disposal of clean or mine water.		
Operational elements		
Groundwater abstraction for water supply and mine dewatering	Within the Development Envelope	Over the life of the mine, it is anticipated that the water extraction requirements may reach up to 12 gigalitres per annum (GL/a), due to

Proposal Element	Location / Description	Maximum Extent, Capacity or Range
		mine dewatering and water supply requirements. Consideration may be given to the use of a water treatment facility (i.e., reverse osmosis desalination) should it be required to provide the necessary water quality.
Management of surplus water	Within the Development Envelope	Up to 11 GL/a to be disposed of through MAR and/or infiltration within the Development Envelope. Temporary water storage may be required to assist in the management of water quality for supply or prior to discharge.
Evaporation ponds	Within the Development Envelope	May be required to assist in the management of surplus water and discharge. These will preferentially be located in disturbed areas such as pit voids, however some ex-pit structures may be required within the WRDs.
Crushing and screening plant(s)	Within the Development Envelope	Dry processing of ore to produce up to 12 Mtpa of iron ore product.
WRD	Within the Development Envelope	Approximately 160 Mt of waste rock will be mined throughout the life of the Proposal. WRDs will be designed to integrate into the surrounding landforms where possible, with a maximum height defined by waste rock characterisation studies.
Proposal elements with greenhouse gas emissions		
Construction elements- Peak annual average		
Scope 1	65,852.26 tonnes of carbon dioxide equivalents (t CO_2-e)	
Scope 2	0 t CO_2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).	
Construction elements- Over period of construction		
Scope 1	263,409.02 t CO_2-e over ~ 4 years	
Scope 2	0 t CO_2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).	
Operation elements- Peak annual average		
Scope 1	100,000 t CO_2-e	
Scope 2	0 t CO_2-e	
Operation elements- Annual average life of mine		
Scope 1	100,000 t CO_2-e	
Commissioning		
Commissioning of the processing facility will be undertaken subject to the operational limits above.		
Rehabilitation		

Proposal Element	Location / Description	Maximum Extent, Capacity or Range
Where practicable, progressive rehabilitation will be undertaken over the LoM. Areas disturbed through the implementation of the Proposal will be designed to be safe and non-polluting and will be constructed so the final shape, size, stability, are comparable with the natural landforms in the area.		
Other elements which affect extent of effects on the environment		
Proposal duration	Maximum Proposal life	18 years

The EPA identified the preliminary key environmental factors for the Proposal as:

- Inland waters (**Section 7**);
- Subterranean fauna (**Section 8**);
- Flora and vegetation (**Section 9**);
- Terrestrial fauna (**Section 10**);
- Terrestrial environmental quality (**Section 11**);
- Greenhouse gas emissions **(Section 12**);
- Air Quality (**Section 13**), and
- Social surroundings (including Aboriginal heritage) (**Section 14**).

A summary of the potential impacts identified for each key environmental factor are summarised in **Table ES-3**, along with details of the proposed mitigation and management measures.

Table ES 3: Summary of Potential Impacts, Proposed Mitigation Measures and Outcomes

Inland Waters	
EPA Objective	"To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected"
Potential Impacts	**Direct Impacts: Surface Water** The identification of potential impacts from the Proposal on the hydrological environment was completed by comparing the proposed infrastructure layout to the existing catchments and baseline floor modelling results. Direct impacts to the hydrological environment fall into the following categories (AQ2 2024b) • Modification of the existing hydrological regime, by increasing or reducing water availability within the downstream environment. This can have impacts both immediately downstream of the disturbance area footprints and surface water diversions, and further downstream as an accumulation of impacts from multiple disturbance areas. The receptors which may potentially be impacted by the Project are local vegetation and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools. • Modification of the physical water quality (i.e. suspended sediments) in the downstream environment, which may be due to erosion of disturbed areas relating to construction, stockpiles, laydowns and waste rock dumps (among others). The environmental impacts from this would be increased sediment loads to the Fortescue Valley (including claypans and pools). • Modification of the chemical water quality (for example hydrocarbon pollution) resulting in contamination of local waterways and the Fortescue Valley. **Direct Impacts: Surface Water** Potential indirect impacts to surface water include changes to physical and chemical water quality through: • Leaks and spills from mine operations including vehicles, stored fuels, chemicals and hydrocarbons; • Acid mine drainage (AMD) leachate seepage from the WRD and to a lesser extent the run of the mine (RoM); and • Saline water runoff (dust suppression), saline pipeline leaks/failure. Modification of the chemical water quality (for example hydrocarbon pollution, seepage from WRDs) may result in contamination of local waterways and the Fortescue Valley. Site drainage infrastructure will be designed to minimise or eliminate surface water runoff into areas where hydrocarbon contamination may occur. Use of saline water for the suppression of dust during construction and operations of the mine can result in increased surface water salinity entering onto the receiving environment (creeklines, claypans, pools and floodplains). There is also the potential for pipeline failure resulting in release of saline water into the receiving environment, including vegetation. **Direct Impacts** • Changes in groundwater levels (groundwater drawdown and groundwater mounding). • Changes to groundwater salinity. **Indirect Impacts: Groundwater** Potential **indirect impacts to groundwater include:** • Contamination through: o Spills and accidental discharged of stores materials (oils, fuels etc); o Leaching contaminants or acid mine drainage from WRDs or RoM and/or onsite landfill.

<table>
<tr><td></td><td>

- Impacts on other groundwater users through reduction in quantity or quality of groundwater available.

Cumulative Impacts:

- The Proposal and other projects in the region may have a cumulative impact on inland waters at a regional scale through:
  - Changes in surface hydrological regimes.
  - Change in groundwater regimes (associated with drawdown from abstraction and mounding from MAR).

</td></tr>
<tr><td>Mitigation Hierarchy</td><td>

Avoid

- Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal
- Diver surface water flows away from mining areas to avoid the potential for contamination.

Minimise

- The Water Management Plan will be implemented.
- The surface water management during construction, mining and closure will be designed to minimise adverse impacts on the natural function and environmental value of watercourses water quality and sheet flow downstream of the mine area
- Adherence to permit requirements under the *Rights in Water and Irrigation Act 1914* (Riwi Act).

Rehabilitate/ Monitor

- Implement the monitoring as outlined in the Water Management Plan.
- Implement the approved Mine Closure Plan (MCP).
- Temporary infrastructure will be removed and natural flow paths, and catchments, reestablished in these areas.

</td></tr>
<tr><td>Significant Residual Impact</td><td>The residual impacts of the Proposal to Inland Waters are not considered significant. HPPL therefore considers the Proposal can be managed to meet the EPA's objective to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.</td></tr>
<tr><td>Proposed Environmental Outcomes</td><td>
<table>
<tr><td colspan="2">Direct Impacts</td></tr>
<tr><td>Modifications to hydrological processes</td><td>

- Water depth increases of up to 0.3 m are predicted in some areas of valley floor ponding. Water depth reductions of up to 0.2 m are predicted in some areas of valley floor ponding.
- No significant impacts to key environmental assets (including the claypans) are predicted.
- No impacts to terrestrial groundwater dependent ecosystems.
- Groundwater drawdown and catchment area modifications are not predicted to materially impact on the key ecohydrological receptors.
- The potential indirect impacts on claypans within the vicinity of the Development Envelope are not considered significant.

</td></tr>
</table>
</td></tr>
</table>

	Changes to surface water quality	• The residual risks to the physical quality of surface water have been rated Low. • Potential changes to surface water quality will be managed in accordance with the Water Management Plan.
	Change to groundwater levels	• Potential changes to groundwater levels will be managed to ensure that mounding is maintained beneath root zones of vegetation. • Managed in accordance with the Water Management Plan.
	Changes to groundwater salinity	• Changes (and extent of changes) to groundwater salinity resulting from dewatering and MAR are predicted to be minor with respect to beneficial use and stygofauna habitat
	Indirect Impacts	
	Contamination of Surface Water	• Potential contamination of surface water will be managed in accordance with the MCP and Water Management Plan.
	Contamination of groundwater	• Potential contamination of groundwater will be managed in accordance with the MCP and Water Management Plan.
Assessment of Offsets (if relevant)	Not applicable.	
Subterranean Fauna		
EPA Objective	"To protect subterranean fauna so that biological diversity and ecological integrity are maintained" (EPA 2016a).	
Potential Impacts	**Direct Impacts: Troglofauna** The direct impacts to trologfauna from implementation of the Proposal are from the excavation of the mine pits (including some proposed borrow pit areas) and MAR leading to moundaing. These impacts have the potential to result in: • Loss of troglofauna habitat; and • Loss of troglofauna species. **Indirect Impacts: Troglofauna** Indirect impacts to trologfauna have been identified as: • Clearing of vegetation and construction of infrastructure (i.e., WRD, RoM pads) – resulting in the loss of energy transfer to the subterranean environment); • Contamination of subterranean environment from mine activities – such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste dumps, and use of saline mine water for dust suppression in mine area; and • Changes to groundwater affecting humidity in vadose zone. **Direct Impacts: Stygofauna** The indirect impact which has the potential to effect stygofauna as a result of the Proposal is the contamination of subterranean environment from mine activities such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste rock.	

	There is the potential for contaminants to seep into the subterranean environment and be transported across the aquifer. There is the risk of contamination from hydrocarbon spills and leaching from the waste rock. The use of saline water within the mine area to suppress dust has the potential to increase salinity levels of surface water which move through into subterranean fauna habitat. These potential impacts may reduce the suitability of subterranean habitat. **Cumulative Impacts** The proposal and other projects in the region may have a cumulative impact on inland waters at a regional scale through: • Changes in surface hydrological regimes. • Change in groundwater regimes (associated with drawdown from abstraction and mounding from MAR). • Clearing, construction and operation of the Proposal.
Mitigation Hierarchy	**Avoid** • Complete avoidance is not possible for this Proposal; however, the Proposal has been designed so that excavation is contained to seven designate mine pits as per mining schedule. • Excavation of troglofaunal habitat is contained in seven mine pits. • The number of pits has been reduced and mining output has been reduced from20 Mtpa to 12 Mtpa avoiding troglofaunal habitat. **Minimise** • Excavate no more than 66,731.74 m^3 of Tertiary/Detritals identified as likely troglofauna habitat. • Limit the reduction of habitat to 274,648,900 m^3 of troglofauna habitat primarily in the CID/Pisolite. • Undertake pit construction in stages to manage dewatering and MAR requirements – optimise the West to East mining scenario as outlined in Water Management Plan. • Maintain the current beneficial use of groundwater as per the Water Management Plan, to limit the extent of groundwater extraction (and associated drawdown and MAR). • Maintain groundwater levels such that there is no surface expression of groundwater (as a result of MAR) limiting troglofauna habitat. • Implement management actions as defined in the Water Management Plan. • Implement the management actions as defined in the SFMMP. • Apply the developed habitat assessment model to updated species list. • Loss of no more than 370,648,900 m3 of stygofauna habitat from extraction of mine pits for LoM • Implement mine schedule of staged pit excavation (optimise West to East mining scenario as per Water Management Plan). • Limit dewatering profile to that which is necessary for mining. • Limit MAR profile to that which is necessary for mining. • Backfilling of pits to reduce ex-pit WRDs. • Minimise the clearing of vegetation required where possible. • Design of potential contaminating facilities (landfill, WRD, TSF) to prevent seepage to surface water and/or groundwater. • Adhere to works approval and licence conditions under Part V of the EP Act.

	• Storage of contaminating materials in Australian Standard compliant locations with bunding, spill controls and leak prevention. • Saline water (> 5000 mg/L TDS) shall not be used for dust suppression unless approved by the Environmental Manager and where approved, dribble bars shall be used to control overspray onto adjacent vegetation. • WRD to be designed in accordance with the MCP. • Design and construction of WRD with appropriate seepage and leachate control structures. • Management of chemical and hydrocarbons, appropriate types and quantities of spill response equipment will be maintained. • Manage any spills including any contaminated material, in accordance with the internal procedures; and investigate and report incidents in accordance with internal procedures, to prevent the recurrence of incidents of the same or similar nature. • Limit mounding to that which is necessary for mining. **Rehabilitate/ Monitor** • Develop and implement a MCP as approved by DEMIRS (as per the requirements of the Mining Act and DEMIRS Guidelines for Preparing Mine Closure Plan, March 2020). • Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act. • Monitoring program targeting troglofauna which have the highest level of endemism. • Implement monitoring as detailed in the Water Management Plan and SFMP. • Backfilling of pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process. • Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. • Conduct periodic inspections of chemical and hydrocarbon storage areas to confirm compliance with Licence conditions and applicable Australian Standards. • Ongoing groundwater monitoring and modelling will be undertaken for the mine and borefields throughout the mine in accordance with the Water Management Plan.
Significant Residual Impact	The significant residual impact of the Proposal to Subterranean Fauna, after the application of the mitigation hierarchy, is: • The loss of up to 96,048,900 m^3 of troglofauna habitat from the excavation of pits. • A reduction of up to 274,648,900 m^3 of troglofauna habitat as a result of changes to the groundwater levels from MAR reinjection. • Loss of up to 370,648,900 m^3 of stygofauna habitat from dewatering of mine pits for LoM. • The loss of stygofauna habitat as a result of changes to groundwater salinity from MAR and dewatering drawdown. • There is potential to impact up to six species of troglofauna which have not been found outside the mine pit and mounding areas. • No stygofauna taxa will be lost. The data shows dispersal is possible from areas of impact to areas outside any impact from the Proposal. Up to 14 have been found to be restricted, however there is no evidence of isolated or fragmentated habitat where these taxa were found. Surveys for both stygofauna and troglofauna for this Proposal have been extensive and the area has been characterised in respect to significance as subterranean habitat. The likely habitat for

<table>
<tr><td></td><td colspan="2">stygofauna and troglofaunal has been assessed and found to be extensive and continuous, dispersal has been displayed by the subterranean fauna at MDIOM.</td></tr>
<tr><td rowspan="8">Proposed Environmental Outcomes</td><td>Potential Impact</td><td>Environmental Outcome</td></tr>
<tr><td colspan="2">Direct Impacts</td></tr>
<tr><td>Loss of subterranean fauna habitat</td><td>• Loss of no more than 66,731,740 m^3 of likely troglofauna habitat (mostly Mineralised Marra Mamba).
• A reduction of up to 128,396,700 m^3 of troglofauna habitat altered as a result of changes in groundwater levels (mounding) from MAR during the LoM
• A reduction of no greater than 16% Upper Calcrete stygofauna habitat from dewatering;
• A reduction of no greater than 4% Channel Iron Deposits (CID)/Pisolite habitat which can support stygofauna.
• A reduction of no more than 6% of undifferentiated tertiary habitat which can support stygofauna.
• Loss of stygofauna habitat from changes in groundwater salinity as a result of MAR of up to 4,200 mg/L TDS above baseline</td></tr>
<tr><td>Impact on species</td><td>Impact on up to six troglofaunal taxa from excavation of mine pits:
• No impact to stygofauna from changes in groundwater levels or salinity.</td></tr>
<tr><td colspan="2">Indirect Impacts</td></tr>
<tr><td>Contamination of GW/subsurface habitat from mining activities</td><td>Not considered significant as will be controlled under EP Act Part V and the Mining Act approvals</td></tr>
<tr><td>Reduction in energy input (removal of vegetation)</td><td>Not considered significant because of limit transfer of energy across epigean (surface) to hypogean (below surface) environments</td></tr>
<tr><td>Reduction in humidity in vadose zone (altered hydrology)</td><td>Not considered significant</td></tr>
<tr><td>Assessment of Offsets (if relevant)</td><td colspan="2">Not applicable</td></tr>
<tr><td colspan="3">Flora and Vegetation</td></tr>
<tr><td>EPA Objective</td><td colspan="2">“To protect flora and vegetation so that biological diversity and ecological integrity are maintained” (EPA 2016a; EPA 2021d).</td></tr>
<tr><td>Potential Impacts</td><td colspan="2">Direct Impacts
The direct impact to flora and vegetation from the Proposal will be from clearing. The impacts include:
• Loss of native vegetation;
• Loss of conservation significant vegetation communities, and
• Loss of conservation significant flora.
Indirect Impacts</td></tr>
</table>

	Indirect impacts which will result in the decline of vegetation health are: • Altered fire regimes and increased risk of fire; • Dust deposition and management with saline or decant water; • Introduction and spread of weed species; • Altered hydrological regimes, and • Fragmentation and/or isolation of populations/occurrences. **Cumulative Impacts** The Proposal and other projects in the region including the Mulga Downs Hub and Rail Spur and Murray's Hill, will have a cumulative impact on flora and vegetation at a regional scale through: • The loss and fragmentation of native vegetation from clearing; and • The loss of conservation significant species and communities as a result of clearing.
Mitigation Hierarchy	**Avoid** • Establishment of a Fauna Habitat Exclusion Zone (FHEZ) which avoids impact to 1,320.82 ha of native vegetation and a FHEZ corridor which avoids impacts within an additional 991.45 ha area, both of which includes drainage lines to avoid fragmentation in that area of the Development Envelope. • Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 Priority Ecological Community (PEC) are avoided. **Minimise** • The Development Envelope and Indicative Footprint has been revised and reduced through iterative mine planning to reduce the extent of clearing required where possible resulting in a 5,288.84 ha reduction in impacts to native vegetation. • Utilise areas of existing disturbance before clearing of new ground where possible. • Proposal elements have been located to minimise impacts on environmental factors. • Phase the works to enable progressive clearing and where possible progressive rehabilitation. • Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • Ensure clearing only occurs in approved ground disturbance areas (in accordance with an internal Ground Disturbance Permit (GDP). • Located Proposal elements to minimise impacts to Priority flora species and locally significant vegetation communities. • Implement induction and education of the workforce with respect to flora and vegetation protection and management. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with an internal GDP. • An emergency management plan shall be developed and implemented and shall include methods for managing major environmental incidents, including but not limited to fire. • Ensure compliance with the *Bushfire Act 1954*. • Compliance with internal Hot Works Procedures. • Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous material storage areas, hot works job sites, service trucks. • An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment.

	• Dust management measures will be utilised to minimise dust emissions and subsequent deposition on retained native vegetation in proximity to disturbance. • Dust control measures will be implemented throughout the life of the Proposal and may include: • Saline water (> 5000 mg/L Total Dissolved Solids [TDS]) shall not be used for dust suppression unless approved by the Environmental Manager and where approved, dribble bars shall be used to control overspray onto adjacent vegetation; • Dust suppression techniques (e.g. water trucks) shall be used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; • Vehicle speeds on haul roads, work and camp sites shall be reduced where necessary to minimise dust emissions; • Vegetation clearing and earthworks during high winds (>50 km/hr) shall be avoided; and • Zones for saline water use will be in place. This includes, for instance, using saline water on heavy vehicle roads that do not cross a drainage line or creek crossing, whilst not allowing saline water to be used on roads that cross drainage lines without an appropriately sized windrow, not using saline water on topsoil stockpiles etc **Rehabilitate/ Monitor** • Construction areas no longer required for operations will be rehabilitated upon completion of construction. • Progressive rehabilitation of operational areas no longer required, throughout life of mine (LoM). • Decommissioning and rehabilitation of disturbed areas at the end of LoM. • Topsoil will be collected in windrows and stored for rehabilitation of temporary construction areas. • Topsoil will be recovered and stockpiled to a maximum height of 2 m to preserve the soil physical/chemical properties and seed bank for use over temporary construction areas or for future rehabilitation. • Topsoil will be progressively re-spread over temporary construction areas or utilised for future rehabilitation. • Rehabilitation will occur with vegetation comprised of native species of local provenance in accordance with a DEMIRS approved MCP. • Consultation with Banjima to determine which species are ideal for seed collection. • Decommissioning and rehabilitating of Development Envelope at end of LoM. Topsoil will be recovered and stockpiled to a maximum height of 2 m to preserve the soil physical/chemical properties and seed bank for use over temporary construction areas or for future rehabilitation. • Consultation with Banjima to determine which species are ideal for seed collection. • Progressive rehabilitation will be undertaken as areas become available. • Ongoing monitoring and management of weeds within the Development Envelope. • The MCP will detail specific weed management measures in rehabilitation areas. • Impacts to vegetation as a result of altered hydrological regimes will be managed through the implementation of the Water Management Plan. • Conduct rehabilitation in accordance with the MCP. • Weed monitoring.
Significant Residual Impact	The significant residual impact of the Proposal to Flora and Vegetation, after the application of the mitigation hierarchy, is:

<table>
<tr><td></td><td colspan="2">

- Clearing of up to 4,296.93 ha of native vegetation in Good to Excellent condition;
- Loss of up to 2,973.51 ha of sheet flow dependent vegetation;
- Loss of 4.31 ha of riparian vegetation, and
- Loss of 70.31 ha of 'Four Plant Assemblages of the Wona Land System' P1 PEC.

</td></tr>
<tr><td rowspan="8">Proposed Environmental Outcomes</td><td>Potential Impact</td><td>Environmental Outcome</td></tr>
<tr><td colspan="2">Direct Impacts</td></tr>
<tr><td>Loss of native vegetation</td><td>

- Loss of no more than 4,296.93 ha of native vegetation in Good to Excellent condition of which:
  - 243.12 ha occurs within the Chichester Interim Biogeographic Regionalisation for Australia (IBRA) subregion.
  - 4,053.80 ha occurs within the Fortescue IBRA subregion.
- Loss of native vegetation across 15 vegetation types, including five locally significant vegetation types.

</td></tr>
<tr><td>Loss of Conservation Significant Vegetation</td><td>

- Loss of up to 2,973.51 ha of potential sheet flow dependent vegetation.
- Loss of up to 70.31 ha of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC.
- Loss of up to 4.31 ha of Riparian vegetation

</td></tr>
<tr><td>Loss of Conservation Significant Flora</td><td>

- No impact to Threatened Flora listed under the *Biodiversity Conservation Act 2016* (BC Act).
- Clearing of three Department of Biodiversity Conservation and Attractions (DBCA) listed Priority flora species (based on the Indicative Footprint):
- Up to 1,263 known *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638) (Priority 1 [P1]) individuals of the 2,890 recorded in the Development Envelope. 3,543 individuals were recorded in total during the survey effort for the Proposal.
- Up to 130 known *Triodia veniciae* (P1) individuals, of the 1,648 recorded in the Development Envelope. 6,864 individuals were recorded in total during the survey effort for the Proposal.
- Up to 7 known *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3 [P3]) individuals of the 57 recorded in the Development Envelope. 180,305 individuals were recorded in total during the survey effort for the Proposal.

</td></tr>
<tr><td colspan="2">Indirect Impacts</td></tr>
<tr><td>Altered fire regimes and increased fire risk</td><td>No significant damage to vegetation and flora s a result of fires caused by the Proposal</td></tr>
<tr><td>Dust and use of saline water for dust suppression</td><td>No significant decline in vegetation and flora health as a result of dust deposition and the use of saline water for dust suppression required for the Proposal.</td></tr>
</table>

	Introduced weeds	No introduction of new environmental weed species within the Development Envelope as a result of Proposal activities.
	Altered hydrological regime	No significant decline in health of potential sheet flow dependant vegetation or Freshwater claypans of the Fortescue Valley P1 Priority Ecological Community (Fortescue claypans) PEC as a result of altered hydrological regimes resulting from Proposal activities as determined through monitoring and adaptive management in accordance with the Water Management Plan.
Assessment of Offsets (if relevant)	Environmental offsets are proposed to mitigate the significant residual impacts of the Proposal.	
Terrestrial Fauna		
EPA Objective	"To protect terrestrial fauna so that biological diversity and ecological integrity are maintained" (EPA 2016b).	
Potential Impacts	**Direct Impacts** Potential direct impacts as a result of the Proposal include: • Loss of fauna individuals (collision and entrapment) resulting from ground disturbance, vehicle strike (including heavy haulage vehicles), machinery, infrastructure and mining operations. • Loss of fauna habitat resulting from clearing for ore extraction, construction and operation (mining infrastructure) – this includes clearing of vegetation and removal of landforms (caves, ridges). **Indirect Impacts** Potential indirect impacts to terrestrial fauna as a result of the Proposal may include: • A decline or change in health/composition of fauna habitat arising from: o Deposition of dust during construction and operation of the mine and use of saline water for dust suppression. o Altered hydrological and hydrogeological regimes. o Impacts (i.e. cave collapse) from blasting/vibrations; o Introduction and spread of weeds. o Altered fire regimes. • Disruption of natural foraging and breeding patterns of terrestrial fauna due to: o Fragmentation; o Noise, light, vibration and vehicle movements; and o Increased feral animals. **Cumulative Impacts** The Proposal and other projects in the region including the Mulga Downs Hub and Rail and Murray's Hill, will have a cumulative impact on terrestrial fauna at a regional scale through: • The loss and fragmentation of terrestrial fauna habitats, including that of SREs, from clearing; and • The fauna individuals as a result of the clearing activities.	
Mitigation Hierarchy	**Avoid** • Establishment of a FHEZ which avoids impact to 1,320.82 ha of habitat (including native vegetation). • Establishment of FHEZ Corridor which both avoids and minimises impact within 991.45 ha of habitat (including native vegetation).	

	• Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided which provide important habitat for migratory species. • Avoidance of 36 Category 4 caves within the FHEZ. • Avoidance of six Category 4 caves within the FHEZ Corridor. • Freshwater Claypans of the Fortescue Valley P1 PEC is outside the Development Envelope. This is habitat for Migratory species when inundated and foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat, Northern Quolls and potentially the Night Parrot. • Establishment of the FHEZ and FHEZ Corridor protecting breeding and foraging for conservation significant fauna and allowing dispersal across high value Rocky Hills Habitat. **Minimise** • Implementation of the Conservation Significant Fauna Management Plan (CSFMP). • Utilise areas of existing disturbance before clearing of new ground where possible. • Where possible Proposal elements have been located to avoid and minimise impacts on environmental factors. • Removal of Mulga West Borefield from the Development Envelope which reduces the extent of clearing and associated impacts. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with a GDP). • No more than 4,339.16 ha of clearing within a Development Envelope of 16,848.53 ha. • Phase the works to enable progressive clearing and rehabilitation. • Manage construction and operational works through an Environmental Management System (EMS). • Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • No permanent mining activities will be undertaken within the FHEZ corridor, however supporting activities may be required such as access tracks and a provision for a future conveyor and ancillary service corridor. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal. • Implement the Water Management Plan. • Appropriate permits will be obtained under the RiWI Act. • Blasting requirements will be designed to meet vibration thresholds of susceptible caves. • All machinery and vehicles shall be cleaned down of all soil and vegetation material prior to arriving or entering on site. Any soil and vegetation removed from machinery or vehicles during clean down upon arrival, but prior to entry on site shall be collected and disposed of offsite. • All vehicles and machinery mobilised to site shall be inspected prior to entry to site and issued with a Weed & Soil Hygiene Certificates. • Imported fill or other potential weed mediums to be certified by the supplier as being free from weed free sources prior to arrival on site. • Areas of known weed-infestation will be identified and managed separately to weed free areas. • Where areas of weed-infestation are to be disturbed or cleared, material will be stockpiled/placed in windrows separately from weed-free material. • Targeted control of infestations.

<table>
<tr><td></td><td colspan="2">

- An emergency management plan shall be developed and implemented and shall include methods for managing major environmental incidents, including but not limited to fire.
- Ensure compliance with the *Bushfire Act 1954*.
- Compliance with internal Hot Works Procedures.
- Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous material storage areas, hot works job sites, service trucks.
- An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment.

Rehabilitate / Monitor

- Implementation of the CSFMP.
- Construction areas no longer required for operations will be rehabilitated upon completion of construction.
- Progressive rehabilitation of operational areas no longer required, throughout LoM.
- Decommissioning and rehabilitation of disturbed areas at the end of LoM.
- Consultation with Banjima to determine which species are ideal for seed collection, as informed by the ethnobotanical surveys.
- Implement the Water Management Plan.
- Rehabilitation of areas of land utilised for construction purposes will occur upon completion of construction.
- Progressive rehabilitation of temporary disturbance areas will be undertaken (such as borrow pits and temporary construction areas).
</td></tr>
<tr><td>Significant Residual Impact</td><td colspan="2">The significant residual impact of the Proposal to Terrestrial Fauna, after the application of the mitigation hierarchy, is:

- Loss of up to 1,406.03 ha of high value habitat for conservation significant fauna species, comprising Rocky Hills; Stony Spinifex Plains and Slopes; and Drainage Lines / Floodplain.
</td></tr>
<tr><td>Proposed Environmental Outcomes</td><td>Potential Impact</td><td>Environmental Outcome</td></tr>
<tr><td></td><td colspan="2">Direct Impacts</td></tr>
<tr><td></td><td>Loss of conservation significant fauna</td><td>Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.</td></tr>
<tr><td></td><td>Loss of fauna habitat</td><td>

- Clearing of up to 4,339.16 ha of fauna habitat within two Pilbara IBRA bio-subregions and across nine fauna habitat types, including:
  - Clearing of up to 4,095.65 ha of Fortescue Valley subregion;
  - Clearing of up to 243.51 ha of Chichester subregions;
- Loss of up to:
  - 520.80 ha of Rocky Hills habitat;
  - Loss of up to 2,824.74 ha of Mulga Woodland habitat;
  - Loss of up to 813.97 ha of Stony Spinifex Plains and Hillslopes habitat;
</td></tr>
</table>

		○ Loss of up to 71.26 ha of Drainage Line/Floodplain habitat; ○ Loss of up to 15.27 ha of Chenopod/Cracking Clay Floodplain habitat; ○ Loss of up to 56.69 ha of Gibber Cracking Clay habitat ○ Loss of up to 28.10 ha of Cracking Clay habitat; and ○ Loss of up to 8.04 ha of Snakewood habitat. ○ Loss of up to 520.80 ha of Rocky Hills habitat which is the habitat where four possible SREs taxa were only recorded.
		Potential impacts to the conservation significant fauna recorded from within the Development Envelope include the loss of up to: • 1,462.72 ha of Ghost Bat (*Macroderma gigas*) (Vulnerable BC Act) foraging habitat; • 1,406.03 ha of Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) (Vulnerable BC Act) foraging habitat; • 1,406.03 ha of Northern Quoll (*Dasyurus hallucatus*) (Endangered BC Act) habitat of which 520.80 ha is potential denning habitat; • 1,406.03 ha of Pilbara Olive Python (*Liasis olivaceus*) (Vulnerable BC Act) foraging habitat; • 813.97 ha of Western Pebble-mound Mouse (*Pseudomys chapmani*) (Priority 4, DBCA) foraging and breeding habitat. • 2,896.00 ha Gane's Blind Snake (*Anilios ganei*) (Priority 1, DBCA) habitat; • 921.37 ha of Grey Falcon (*Falco hypoleaucos*) (Vulnerable, BC Act) habitat; • 648.75 ha of Peregrine Falcon (*Falco peregrinus*) (OS, specially protected BC Act); • 900.95 ha of potential habitat for Night Parrot (*Pezoporus occidentalis);* • 2,911.72 ha of potential habitat for Greater Bilby *(Macrotis lagotis);* • There will be no loss of Category 1, 2 or 3 roosts for Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) or Ghost Bat (Macroderma gigas). Up to 8 Category 4 roosts will be removed. • Up to 31 possible SREs and one confirmed SRE (*Buddelundia* 56) were recorded within various habitats in the Development Envelope, primarily Rocky Hills, Drainage Line/Floodplain, and Stony Spinifex Plains and Hillslopes habitats.
	Indirect Impacts	

	A decline or change in health/composition of fauna habitat	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.
	Disruption of natural foraging and breeding patterns of terrestrial fauna	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.
Assessment of Offsets (if relevant)	Environmental offsets are proposed for the clearing of high value fauna habitat.	
Terrestrial Environmental Quality		
EPA Objective	"To maintain the quality of land and soils so that environmental values are protected" For the purposes of EIA, the EPA defines terrestrial environmental quality as "*the chemical, physical, biological and aesthetic characteristics of soils*"	
Potential Impacts	**Direct Impacts:** • Not applicable **Indirect Impacts:** The potential indirect impacts to Terrestrial Environmental Quality from implementation of the Proposal, prior to mitigation, include: • Contamination of soils, surface water and groundwater. • Redistribution of Asbestos Containing Material (ACM) that is present from historical anthropogenic activities. • Contamination of Soils, Surface Water and Groundwater. **Cumulative Impacts:** The Proposal and other projects in the region including the Mulga Downs Hub and Rail and Murray's Hill, may have a cumulative impact on Terrestrial Environmental Quality through: • Contamination of soils, surface water and groundwater. • Redistribution of asbestos containing material (ACM) that is present from historical anthropogenic activities.	
Mitigation Hierarchy	**Avoid** • As a result of the Acid Mine Drainage (AMD) risk posed by elevated sulfur material at depth, HPPL purposely designed the pits to exclude basal Nammuldi Member subunits and Jeerinah Formation (Roy Hill Shale). • The Development Envelope avoids the Wittenoom Asbestos Management Area (WAMA). • The Mulga Homestead, which is a registered contaminated site, is excluded from the Development Envelope and has been fenced off with appropriate signage provided to prevent unauthorised access. **Minimise** • The Proposal has been designed to avoid direct impacts to areas prone to Acid Sulfate Soils (ASS), such as wetlands. • Surface water diversions have been designed to ensure surface water flows avoid contact with WRDs.	

	• Storage of contaminating materials in Australian Standard (AS) compliant locations with bunding, spill controls and leak prevention. • Appropriate siting of landfill facilities to avoid interaction with surface drainage. • If Potential Acid Forming (PAF) material is encountered during mining, PAF material will be managed according to the Waste Management Plan to ensure final landform is non-acid forming. • Ongoing waste characterisation studies. • Waste rock material will be used as pit backfill to minimise the need for surface waste rock landforms. • Low stability or material the Uncertain or PAF classification waste rock material will not be placed on waste rock landform surfaces. • Competent waste rock material will be used to armour waste rock dump surfaces. • WRD design, including heights, slope lengths, batter angles and surface water control structures account for physical and chemical properties of waste rock. • Design landforms and infrastructure to contain sedimentation where possible. Toe bunds and sediment basins will direct and contain sediment runoff to prevent excessive scour and increased sediment volumes to the downstream environment. • Adherence to Dangerous Goods licence conditions and Australian Standards • Adherence to EP Act Part V licence conditions with respect to bulk chemical storage and landfill management. • Disposal of waste to landfill will be a last resort. Materials will be repurposed or recycled where practicable. • Adherence to the Asbestos Management Plan. • The Proposal has been designed to avoid impacts to areas where ACM has been confirmed or is suspected, where practicable. **Rehabilitate / Monitor** • If unexpected Potential ASS (PASS) is encountered, disturbed soils or low pH waters will be neutralised prior to discharge. • Excavation or dewatering will cease until suitable management measures are employed. • If ASS has been disturbed or dewatered, monitoring of surface and groundwater quality in accordance with a Water Management Plan will continue until water return to below 'trigger' criteria. • Monitoring of surface and groundwater quality in accordance with a Water Management Plan to detect any adverse changes in water quality between the mine and sensitive receptors, with 'early response' criteria, 'trigger' criteria and 'threshold' criteria. • Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act. • Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. • Pipelines, water storage dams and landfills will be appropriately decommissioned and disturbed areas rehabilitated, unless there is a specific agreement in place with a third party to take ownership and responsibility of the infrastructure post mining. The requirements will be regulated as per a MCP to be assessed and approved by DEMIRS, in accordance with the Mining Act. • All chemical and hydrocarbon storage areas will be appropriately decommissioned and closed as per DEMIRS requirements of the MCP, in accordance with the Mining Act.

<table>
<tr><td></td><td colspan="2">• ACM-contaminated areas will be rehabilitated where appropriate, and asbestos management will be subject to monitoring through the Asbestos Management Plan (AMP).</td></tr>
<tr><td>Significant Residual Impact</td><td colspan="2">The residual impacts of the Proposal to Terrestrial Environmental Quality are not considered significant. Based on the studies and investigations undertaken to date, the outcomes of the assessment of potential impacts and proposed mitigation measures to protect environmental values associated with Terrestrial Environmental Quality meet the EPA's objective for this factor.</td></tr>
<tr><td rowspan="4">Proposed Environmental Outcomes</td><td>Potential Impact</td><td>Environmental Outcome</td></tr>
<tr><td colspan="2">Indirect Impacts</td></tr>
<tr><td>Contamination of soils, surface water and groundwater</td><td>• The risk of contamination of soils, surface water and groundwater from AMD is significantly reduced from HPPL's strategy of purposely designing pits not to intersect basal Nammuldi and Roy Hill Shale/ Member of the Jerrinah Formation stratigraphic units, as these have been shown to have the highest sulfur levels and are most likely to lead to generation of AMD.
• SRK (2024) confirms that the AMD potential is, in general, low.
• The potential for leaching is expected to be limited given the neutral pH conditions expected for the majority of waste rock.
• Other regulatory processes such as DEMIRS' Mining Proposal and MCP will ensure waste structures such as waste rock dumps are designed, operated, decommissioned and closed to meet the EPA's objectives for Terrestrial Environmental Quality.
• Any contamination of soils, surface water and/or groundwater arising from failure, leaks or seepage from saline water pipelines, or water storage dams is likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts.
• Similarly, impacts associated with spillage of chemicals and hydrocarbons and landfill leachate or also are likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts.</td></tr>
<tr><td>Redistribution of asbestos containing material (ACM) that is present from historical anthropogenic activities</td><td>• It is considered unlikely that significant risk will be posed to Terrestrial Environmental Quality from clearing, earthworks, construction and/or mining activities redistributing historical, anthropogenic ACM.
• The implementation of, and adherence to, an AMP, including procedures for the safe decommissioning and removal of ACM structures and an unexpected finds procedure can adequately manage ACM risks to Terrestrial Environmental Quality to ensure the EPA's objective for this environmental factor can be met.</td></tr>
</table>

<table>
<tr><td>Assessment of Offsets (if relevant)</td><td colspan="2">Not applicable.</td></tr>
<tr><td colspan="3">Greenhouse Gas Emissions</td></tr>
<tr><td>EPA Objective</td><td colspan="2">“To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable.”</td></tr>
<tr><td>Potential Impacts</td><td colspan="2">Scope 1 emissions associated with the Proposal construction phase will occur from/are associated with:
Combustion of fuel during the construction phase; and
Combustion of fuel during the operation phase.
Estimated emissions, following application of the mitigation hierarchy, are summarised below:
<table>
<tr><th>Construction phase</th><th>Estimated emissions</th></tr>
<tr><td>Scope 1</td><td>Approximately 263,409.02t CO_2-e over 4 years derived from diesel usage for electricity generation, vehicles and equipment associated with construction activities and loss of bio-sequestration due to vegetation clearing.</td></tr>
<tr><td>Scope 2</td><td>0 t CO_2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).</td></tr>
<tr><td colspan="2">Operational phase</td></tr>
<tr><td>Scope 1</td><td>Peak annual average 100,000 t CO_2-e.
Average Scope 1 emissions over the life of mine of 100,000 t CO_2-e /annum.</td></tr>
<tr><td>Scope 2</td><td>0 t CO_2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).</td></tr>
<tr><td>Scope 3</td><td>Estimated Scope 3 emissions of ~14.38 Mt CO_2-e per annum from transport, shipping and steel making.</td></tr>
</table></td></tr>
<tr><td>Mitigation Hierarchy</td><td colspan="2">Avoid – avoid emissions through best-practice design;
Reduce – reduce emissions over the project life; and
Offset – offset some or all residual emissions.</td></tr>
<tr><td>Significant Residual Impact</td><td colspan="2">After application of the mitigation hierarchy, HPPL considers that the Proposal can be managed to meet the EPA’s objective.</td></tr>
<tr><td>Proposed Environmental Outcomes</td><td colspan="2">The peak annual Scope 1 emissions will contribute approximately 0.23% to the State’s total emissions, 0.04% to national emissions, and 0.0004% to global emissions.</td></tr>
<tr><td>Assessment of Offsets (if relevant)</td><td colspan="2">Carbon offsets will be considered as a last resort and will, as far as practicable, be limited to residual emissions that cannot be avoided or to account for emissions that exceed emission reduction commitments and targets.
Where carbon offsets are to be implemented, they will meet offset integrity principles and be based on clear, enforceable and accountable methods.
HPPL will report GHG emissions in accordance with the National Greenhouse and Energy Reporting (NGER) Scheme, in accordance with scoping definitions.</td></tr>
<tr><td colspan="3">Air Quality</td></tr>
<tr><td>EPA Objective</td><td colspan="2">The EPA’s objective for the environmental factor of Air Quality is "to maintain air quality and minimise emissions so that environmental values are protected" (EPA 2023a).
For this assessment, air quality is defined as "the chemical, physical, biological and aesthetic characteristics of air" (EPA 2020d).</td></tr>
<tr><td>Potential Impacts</td><td colspan="2">Direct Impacts</td></tr>
</table>

	• Volatile emissions and airborne particulates (dust). • Activities which may disturb asbestiform minerals and Asbestos Containing Material (ACM). **Indirect Impacts** • Changes in air quality due to dust emissions have the potential to indirectly impact flora and vegetation, terrestrial fauna, terrestrial environmental quality and social surroundings. **Cumulative Impacts** • Cumulative impacts to air quality may occur from projects in the immediate vicinity of the Proposal (Mulga Downs Hub and Rail Spur and Murray's Hill), as a result of dust emissions and potential asbestiform fibres.
Mitigation Hierarchy	**Avoid** • Complete avoidance of volatile emissions and dust is not possible. • Asbestos contaminated areas will be clearly demarcated and access restricted. • Known asbestos contaminated area (abandoned infrastructure area) has been excised from the Development Envelope, and access to site structure containing ACM will be restricted. **Minimise** • Standard dust management measures will be utilised to minimise dust emissions, including: o Dust suppression techniques (e.g., water trucks) used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; o Vehicle speeds on haul roads, work and campsites shall be reduced where necessary to minimise dust emission; o No vegetation clearing and earthworks during wind speed greater than 50 km/hr; and o Clearing activities will be staged to minimise areas of exposed surfaces • Induction and education of the workforce and contractors with respect to dust minimisation. • Adherence to the AMP. **Rehabilitate/ monitor** • Progressive rehabilitation as areas become available. • Dust monitoring at the Wirrilimarra and Youngaleena Communities. • Any dust complaints received will be reported to HPPL and entered into the incident management system. • If ACM is found onsite during construction and operation, it will be remediated as per AMP. • Asbestos management will be subject to monitoring through the AMP.
Significant Residual Impact	Overall, the assessment of potential air emissions impacts indicates that the EPA's objective for Air Quality can be met and that there will be no significant residual adverse impacts from the Proposal. In addition, consideration of other statutory decision-making processes determined that Department of Water and Environmental Regulation (DWER) can manage the potential air quality impacts of the Proposal under Part V of the EP Act and the *Contaminated Sites Act 2003* (CS Act) to ensure that the environmental outcomes are achieved.
Proposed Environmental Outcomes	Potential Impact | Environmental Outcome

	Dust (PM_{10} concentration or dust deposition)	No significant changes to ambient air quality (PM_{10} concentration or dust deposition) at sensitive receptor locations due to the implementation of the Proposal
	Volatile emissions	Negligible
	ACM and asbestiform minerals	Low risk of Proposal interaction causing disturbance to ACM and asbestiform minerals within the Development Envelope and from asbestos dust emissions
Assessment of Offsets (if relevant)	Not applicable	
Social Surroundings		
EPA Objective	"To protect social surroundings from significant harm" Social Surroundings is defined in the EP Act as: 'In the case of humans, the reference to social surroundings in the definition of environment in subsection (1), is a reference to aesthetic, cultural, economic and other social surroundings to the extent to which they directly affect or are affected by physical or biological surroundings'	
Potential Impacts	**Direct** • The potential direct impacts of the Proposal to Social Surroundings within or surrounding the Development Envelope, have been identified as follows: • Disturbance to sites and areas of social, cultural and heritage value; • Restricting access to country and ability to care for country; and • Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure that impacts ability to enjoy. • The Development Envelope excludes the potential for direct impacts to national parks or other recreational or tourism features within the vicinity of the Proposal. **Indirect** • Potential indirect impacts arising from the current Indicative Footprint or activities within the Proposal may cause indirect impacts to Social Surroundings, including heritage sites, social, cultural and environmental values within and/or surrounding the Development Envelope. The potential indirect impacts have been identified as follows: • Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including changes to groundwater depth, water, surface water flows and altered surface and groundwater quality; • Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust, noise and/or vibration; and • Disturbance to broader cultural associations as a result of environmental changes to country. **Cumulative** • The Proposal and other projects in the Pilbara will have a cumulative impact on social surroundings values in the region.	
Mitigation Hierarchy	**Avoid** • Development Envelope excludes the lodged Mungurrdu site. • Heritage sites will be demarcated and identified as no-go areas for site personnel prior to ground disturbing works.	

	• Aboriginal cultural heritage, or suspected Aboriginal cultural heritage, must not be removed from any heritage place under any circumstance, unless authorised under the Aboriginal Heritage Act 1914 (AH Act). • Removal of the Mulga West borefield from the Development Envelope avoids impacts on Yindjibarndi Country. • Indicative Footprint amended to avoid key heritage sites with ongoing refinement of the Mine Plan to maximise site avoidance and avoid access restrictions. • Avoidance buffers of 25 m (individual sites may have additional buffers applied in consultation with Banjima traditional owners) will be established around retained heritage sites within the Development Envelope, in consultation with Traditional Owners. These avoidance buffers will be demarcated and managed in accordance with appropriate site procedures. This will be monitored via the GDP process. • HPPL will consult with the Banjima Traditional Owners regarding asbestos management. The Proposal is located outside of the WAMA. HPPL is not proposing to undertake any mining in proximity to Wittenoom and has no intention to reopen Wittenoom. • Direct impacts to claypans (including Koodjeepindarrnna and Ngarlganoona pools) and Fortescue valley are avoided through Proposal design. **Minimise** • Facilitate Banjima Traditional Owner involvement in monitoring activities where possible. • Minimise clearing areas as far as practicable. • Ongoing consultation with Traditional Owners during the Proposal. • Waste dumps will be designed to blend in with the surrounding landscape. • Noise, dust and vibration mitigation measures to be implemented. • Implement the Cultural Heritage Management Plan (CHMP). • Implement water management measures, including implementation of the Water Management Plan. • Engagement with Traditional Owners to identify sites of cultural significance and avoid impacts to these sites where possible. • Minimise, as far as practicable, interactions with significant water features and impacts to surface water flow, including changes to the hydrological regimes of culturally significant water sources. • Minimise clearing and access restrictions within areas used for cultural purposes or areas that have cultural significance (e.g. at watercourse crossings). • Ensure sediment controls are in place during construction at waterway crossings. • Implement a SCHMP that is co-developed with the Banjima Traditional Owner group. • Implement Waste Rock Management Plan. • The Proponent will implement standard dust management measures to minimise potential airborne dust emissions and associated impacts to amenity. This includes (but is not limited to) use of dust suppression on access roads and open areas, water sprays for ore processing, transport and stockpiles, limiting the number and height of stockpiles, controlling/reducing trip distance and ensuring vehicles are confined to designated routes with speed limits strictly enforced. • Operating noise, vibration and potential mitigation measures (e.g. sound absorption devices) must be considered when selecting equipment. • Equipment must be fitted with appropriate noise reduction devices (where necessary) to comply with Proposal Health, Safety and Environment (HSE) and regulatory requirements.

	• Blasting activities must be undertaken in accordance with Mines Safety Inspection Regulations 1995 and Noise Regulations. • Regularly inspect, maintain and replace mobile equipment so that noise levels are minimised during the equipment life. • Implement HPPL's Drill and Blast near Aboriginal Cultural Heritage (ACH) Procedure. **Rehabilitate / Monitor** • Personnel must not enter an Aboriginal Cultural Heritage site or a Heritage Restriction Zone (HRZ) without prior consent. • Ongoing engagement with Traditional Owners to understand key impacts and avoid where possible. • Appropriate education of the workforce will occur through the implementation of a Cultural Awareness Training program. • Adherence to internal GDP procedures. • Maintenance of Traditional Owner access to culturally significant places where safe and practical. • Implement a CHMP. • Implement HPPL's Heritage Management Framework; a suite of management procedures. • Maintenance of access to culturally significant places where safe and practical. • Impacts to specific sites of cultural and heritage significance, if unavoidable, will be discussed with Traditional Owners and Approvals sought under the AH Act. • Salvage of heritage material will be undertaken, where appropriate, in consultation with Traditional Owners, prior to direct impact. • Repatriation and restitution of salvaged Heritage material will be undertaken in consultation with Traditional Owners. • Post-closure access to sites of cultural significance will be maintained. • Post-closure access restrictions will be limited only to areas immediately adjacent to remaining open pits (due to safety reasons). • Monitoring for dust, noise and visual impacts will be ongoing. • Monitoring surface water quality in accordance with a Water Management Plan. • WRDs at closure will be rehabilitated to ensure they are stable and revegetated. • Closure landforms are designed to minimise long-term impacts to hydrological regimes associated with sites of cultural significance. • Groundwater recovery will be investigated and incorporated into the final MCP, to be submitted to support the Mining Proposal. • Monitor sites of cultural and heritage significance and the avoidance buffer zones. Report new or unauthorised disturbances to culturally sensitive sites and avoidance buffers. • Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners, including incorporation of bushtucker/ medicine species, and habitat for traditional hunting species and the objectives of the MCP, as required under the Mining Act 1914 (Mining Act). • Seed collection prior to/during construction and operations for use in rehabilitation with involvement of Traditional Owners.
Significant Residual Impact	Overall, with the implementation of mitigation actions as formalised and detailed within management plans such as the SCHMP, impacts to Social Surroundings are considered

<table>
<tr><td></td><td colspan="2">manageable and that the EPA's objectives for this factor can be met. This will be managed via ongoing consultation with Banjima Traditional Owners and other stakeholders identified above.</td></tr>
<tr><td rowspan="10">Proposed Environmental Outcomes</td><td>Potential Impact</td><td>Environmental Outcome</td></tr>
<tr><td colspan="2">Direct Impacts</td></tr>
<tr><td>Disturbance to sites and areas of Social, Cultural and Heritage Value</td><td>• The entire Development Envelope will be surveyed for heritage significance, impacts to sites will be managed via the Aboriginal Heritage Act 1972 (AH Act).</td></tr>
<tr><td>Restricting access to Country and ability to Care for Country</td><td>• No disturbance to Aboriginal cultural heritage sites as identified in consultation with the Banjima Traditional Owners, unless consent is granted to disturb that site under the AH Act.</td></tr>
<tr><td>Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure</td><td>• Subject to reasonable health and safety requirements, no interruption of ongoing access to land utilised by the Banjima people</td></tr>
<tr><td colspan="2">Indirect Impacts</td></tr>
<tr><td>Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality</td><td>• Groundwater drawdown and catchment area modifications will not materially impact on the key ecohydrological receptors.
• Potential impacts on claypans (including Koodjeepindarrnna and Ngarlganoona pools) can be managed to ensure they are not significant.
• Water quality and hydrological/hydrogeological regimes will be maintained and monitored through implementation of the Water Management Plan.
• Water quality and hydrological/hydrogeological regimes can be managed to ensure no significant impact to heritage sites or areas of cultural significance.</td></tr>
<tr><td>Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust and noise and vibration</td><td>• No dust plumes originating from the Proposal received at sensitive receptors outside of the Development Envelope.
• Noise and vibration will be managed in accordance with relevant regulations.</td></tr>
<tr><td>Disturbance to broader cultural associations as a result of environmental changes to country</td><td>• No impacts to cultural associations outside of the Development Envelope.</td></tr>
<tr><td>Assessment of offsets (if relevant)</td><td colspan="2">Not applicable.</td></tr>
</table>

Other Factors

Landforms

Mining activity will result in a direct residual direct effect (loss) on a portion of the Chichester Range landform through the excavation of mine pits and construction of waste landforms, over a linear distance of approximately 40 km. In consideration of the broader local extent of such landforms (noting Chichester Ranges extend ~350 km) and the extent of similar landforms across the wider Pilbara region, the effect of the Proposal to the Chichester Ranges landform is not considered to be environmentally significant.

The Fortescue Valley is split by the Goodiadarrie Hills into the Fortescue Marsh to the east, and the Goodiadarrie Swamp to the west. The Proposal is fully contained within the Goodiadarrie Swamp catchment. The Goodiadarrie Swamp comprises a series of variably interconnected ephemeral swamps, claypans, and floodplains that form a wetland mosaic over a distance of 70 km. Collectively, the Goodiadarrie Swamp has an area of approximately 4,140 km^2. The Goodiadarrie Swamp catchment is bounded by the Chichester Range to the north and the Hamersley Range to the south (AQ2 2024a). Discharge of surface water into the Fortescue Valley is from the northern Chichester Ranges and the southern Hamersley Ranges.

The Proposal will be developed to ensure the flow of surface water from the northern Chichester Range to the Lower Fortescue River valley is maintained and sustained. Accordingly, the impact of the Proposal to the Fortescue River Valley landform is not anticipated to be significant.

HPPL propose to manage the potential effect of the Proposal to 'Landforms' through key management measures including:

- Avoidance of Claypan habitat features within the Fortescue River Valley landform;
- Surface water management structures designed to maintain natural patterns of surface water flow; and
- Progressive and post-mining rehabilitation of landforms to restore flora and vegetation values and fauna habitat values.

Based on the predicted impacts of the Proposal to the recorded landform values, subject to the implementation of the identified management measures (above), it is considered EPA objective for the environmental factor of 'Landforms' can be met.

Human Health

For the purposes of EIA, consideration of possible impacts to human health is largely confined to EIA of harmful emissions to air and harmful discharges to soil, inland waters and marine waters, that is through impacts to the physical environment. Because the consideration of the above health hazards are explicitly informed through other EPA guidelines, the assessment of impacts to human health provides the specific framework for considering the possible impacts to human health arising from the emission of radiation.

The Proposal has no potential to cause or emit radiation that could impact on human health.

1 Introduction

Hancock Prospecting Pty Ltd (HPPL, the Proponent) is proposing to develop the Mulga Downs Iron Ore Mine (MDIOM, the Proposal), located approximately 210 kilometres (km) south of Port Hedland and 180 km north-west of Newman in the Pilbara Region of Western Australia. The Proposal will produce up to 12 million tonnes per annum (Mtpa) of iron ore and have an operational life of approximately 18 years. The Proposal is a new asset that will contribute to maintaining the supply of iron ore product for HPPL customers through port facilities located at Port Hedland.

1.1 The Proponent

The nominated Proponent for the Proposal is Hancock Prospecting Pty Ltd (HPPL). HPPL is an independent, privately owned Australian company that has a long history within the Pilbara and iron ore sector.

HPPL holds exploration and miscellaneous tenements located across the HPPL owned Mulga Downs Pastoral Station and adjacent land in the Central Pilbara region of Western Australia. HPPL has been exploring the tenements held across the Mulga Downs and adjacent Mt Florance and Hooley Station Pastoral Leases since the late 2000's.

HPPL is currently in the process of applying to convert the exploration and miscellaneous leases to mining leases.

HPPL has identified approximately 360 million tonnes (Mt) of Measured, Indicated, and Inferred iron ore Resource on these leases with a cut-off grade of 55% iron (Fe). It is this iron ore resource that forms the Proposal.

The contact details for the Proponent are provided in **Table 1-1**.

Table 1-1: Proponent Details

Proponent	Hancock Prospecting Pty Ltd (ABN 69 008 676 417)
Contact Person	Brett McGuire, Manager Environment and Approvals Projects 28-42 Ventnor Avenue, West Perth, WA 6005 E-mail: brett.mcguire@hanroy.com.au

HPPL has not been subject to any convictions or proceedings under Commonwealth, State or Territory law that pertain to the protection of the environment or the conservation and sustainable use of natural resources.

The registered holder of the mining tenements that is the subject of this Proposal is (or will be shortly, as the transfers are in process) Mulga Downs Iron Ore Pty Ltd (ACN 080 659 150) (MDIO). MDIO is a wholly-owned subsidiary of Mulga Iron Holdings Pty Ltd (ACN 600 967 404) (MIH). Over 94% of the shares in MIH are held by a wholly-owned subsidiary of HPPL. Each of Marubeni Iron Ore Australia Pty Ltd (ACN 156 488 130) (1.71%), POSCO WA Pty Ltd (ACN 145 260 108) (1.43%) and CSC Steel Australia Holdings Pty Ltd (ACN 123 783 282) (0.29%) have small holdings in MIH. Mulga Downs Investments Pty Ltd (ACN 132 484 041) (MDI), which is not a company in the HPPL Group, will shortly hold 1.93% of MIH. While not a member of the HPPL Group, MDI's commitments to the Mulga Downs Project will be funded by HPPL.

HPPL has recently undertaken an internal restructure to consolidate its projects capability in an expert team to deliver project studies, construction and operations readiness - HanRoy Iron Ore Projects Pty Ltd (ACN 657 533

974) (HanRoy) was created as of 1 April 2023. HanRoy will lead the study, design and development of a globally significant pipeline of projects that will provide ongoing supply of critical minerals and energy essential for everyday life, including the Proposal. HanRoy, or its delegate, will manage the delivery of construction and operations of the Proposal, to which contractors will be appointed to fulfill various roles as required, on HanRoy's behalf.

HPPL holds a 70% majority share in Roy Hill Holdings Pty Ltd (Roy Hill). Roy Hill is one of Australia's largest single iron ore mines. Its class-leading operations include dedicated rail and port infrastructure that enables international export of 60 Mtpa, with approvals in place for an increase to 70 Mtpa.

HanRoy's environmental policy is provided **Appendix 2**. To implement this policy, HanRoy will develop an Environmental Management System (EMS) for the Proposal, aligned with that of Roy Hill and to the requirements of ISO 14001. The EMS provides a structured, strategic approach to environmental management, and ensures environmental risks and issues are identified and managed, and regulatory obligations are met in accordance with the HanRoy Environment Policy. Both HanRoy and HPPL are committed to minimising potential harm to the natural environment, local visual amenity and biodiversity, as well as preventing pollution whilst implementing its activities.

1.2 Purpose and Scope

The purpose of this Environmental Review Document (ERD) is to provide a detailed description of the Proposal and the potential effects on the environment resulting from its implementation. The information in this document will allow for the environmental impact assessment (EIA) of the Proposal by the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act).

The Proposal was referred to the EPA in December 2021. On 24 February 2022, the EPA determined the Proposal should be assessed at a Public Environmental Review (PER) level of assessment with a 6-week public review period. A Proponent prepared Environmental Scoping Document (ESD) was submitted and approved by the EPA on the 24 August 2022.

Since referral of the Proposal in 2021, HPPL has continued to refine and develop Proposal design and has undertaken additional environmental studies to support the impact assessment. This refinement has resulted in applications made under Section 43A (s43A) of the EP Act to amend aspects of the Proposal and reduce the overall environmental impact. These applications include:

- s43A application submitted on 15 March 2023 to reduce the overall extent of the Development Envelope and Indicative Footprint. This application was approved on 29 May 2023.
- s43A application submitted in December 2023 to remove the Mulga West Borefield. This application was approved on 23 February 2024.
- s43A application submitted on 12 September 2024, to reduce the scale of the Proposal from a 20 Mtpa mine to an up to 12 Mtpa Direct Shipping Ore (DSO) mine. This application was approved on 4 October 2024.

This ERD revision reflects all approved variation applications in relation to the Proposal that have occurred during the assessment process. Details of the s43A applications submitted are provided in **Section 2.3.3**.

The ERD provides detailed information, using relevant studies specific to the Proposal (provided as Appendices), on each of the key environmental factors which the Proposal may significantly impact, should it be implemented. Eight key environmental factors (**Section 6.1**) were identified by the EPA. The ERD considers all phases of Proposal implementation including construction, commissioning, operation and closure. Cumulative impacts with other projects (**Section 17**) and holistic impacts (**Section 18**) between the EPA key environmental factors are also addressed.

The Proposal has also been separately referred for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2021/09255). The Proposal differs slightly from the Proposed Action being assessed by the Commonwealth Department of Climate Change, Energy, Environment and Water (DCCEEW) under the EPBC Act in that the Proposal being assessed by the EPA does not include the Murray's Hill Project which forms part of the Proposal under assessment by DCCEEW. The ERD therefore does not assess the potential impacts of the Proposal to Matters of National Environmental Significance (MNES). This difference is explained in **Section 2.2.5**.

2 Proposal

2.1 Background

HPPL is proposing to develop a greenfield iron ore mine at Mulga Downs, located in the Fortescue River valley and on the flanks of the adjacent Chichester Range (MDIOM; the Proposal). The Proposal is located within the boundaries of the HPPL owned Mulga Downs Pastoral Station. The Proposal is approximately 210 km south of Port Hedland and 180 km north-west of Newman in the Pilbara Region of Western Australia (**Figure 2-1**).

For the purpose of EIA, the Development Envelope is the maximum area within which the physical Proposal elements will occur (EPA 2021a).

A Development Envelope approach has been proposed for this Proposal, which allows for flexibility in respect to the Proposal footprint. The Proposal footprint is considered indicative and is referred to as the Indicative Footprint in all assessment documents. As the planning and design of the mine progresses and studies that inform the assessment are completed, changes may occur to the Indicative Footprint to apply the mitigation hierarchy and further reduce and prevent potential environmental impacts.

The Proposal extent is a Development Envelope of 16,848.53 hectares (ha) (**Figure 2-2)** within which up to 4,339.16 ha of vegetation will be cleared. This equates to approximately 25.7% of the Development Envelope that will be disturbed to construct and operate the Proposal (**Figure 2-2**).

The Proposal includes above and below the water table mining of iron ore from multiple open cut pits (**Figure 2-3**). The production rate of the mine will be up to 12 Mtpa of ore over an expected Life of Mine (LoM) of 18 years.

The Proposal will be accessed from the existing Great Northern Highway. The maximum extent of the Proposal is detailed in the Proposal Content Document (PCD) (**Appendix 1**) and is further detailed in **Section 2.2.1.**

Subject to approval, construction of the Proposal is planned to commence FY 2026 with operations scheduled to occur from FY 2027 to approximately FY 2044.

2.2 Proposal Content

Key elements and associated activities of the Proposal are described in **Section 2.2.1** and **Section 2.2.2**. The PCD (**Appendix 1)** has been published on the EPA website (www.epa.wa.gov.au).

2.2.1 General Proposal Description

The general Proposal description is summarised in **Table 2-1**.

Table 2-1: General Proposal Description

Proposal title	Mulga Downs Iron Ore Mine
Proponent name	Hancock Prospecting Pty Ltd
Short description	The Proposal is for the development of the Mulga Downs Iron Ore Mine (MDIOM) located approximately 210 km south of Port Hedland and 180 km north west of Newman in the Pilbara Region of Western Australia. The Proposal includes and is not limited to the following: • The development of a series of above and below water table mine pits; • Dry ore crushing and screening plant(s); • Groundwater abstraction for water supply (for the mine and all associated infrastructure) and for the dewatering to facilitate the recovery of ore below water table in the mine pits; • Surplus water management via managed aquifer recharge (MAR) and/or in pit infiltration; • Waste rock dumps (WRD); • Infrastructure to manage surface water (diversion of creeks and surface water flows); • Linear infrastructure (haul roads, powerlines, pipelines and conveyor corridors); • Mine associated infrastructure and support facilities (including, but not limited to accommodation camp, energy supply infrastructure, airstrip; wastewater treatment plant; landfill, offices, workshops, laydown areas, etc.); and • Transport of the ore via the Great Northern Highway to Port Hedland or via road to a siding along the existing Roy Hill railway and then via that railway to Port Hedland for export. Future transport options (e.g. rail) will be subject to a separate referral. • The Proposal is located within a 16,848.53 ha Development Envelope and will require the clearing of up to 4,339.16 ha of native vegetation.

2.2.2 Proposal Elements

Key elements of the Proposal are summarised in **Table 2-2** and discussed below.

Table 2-2: Proposal Content Elements

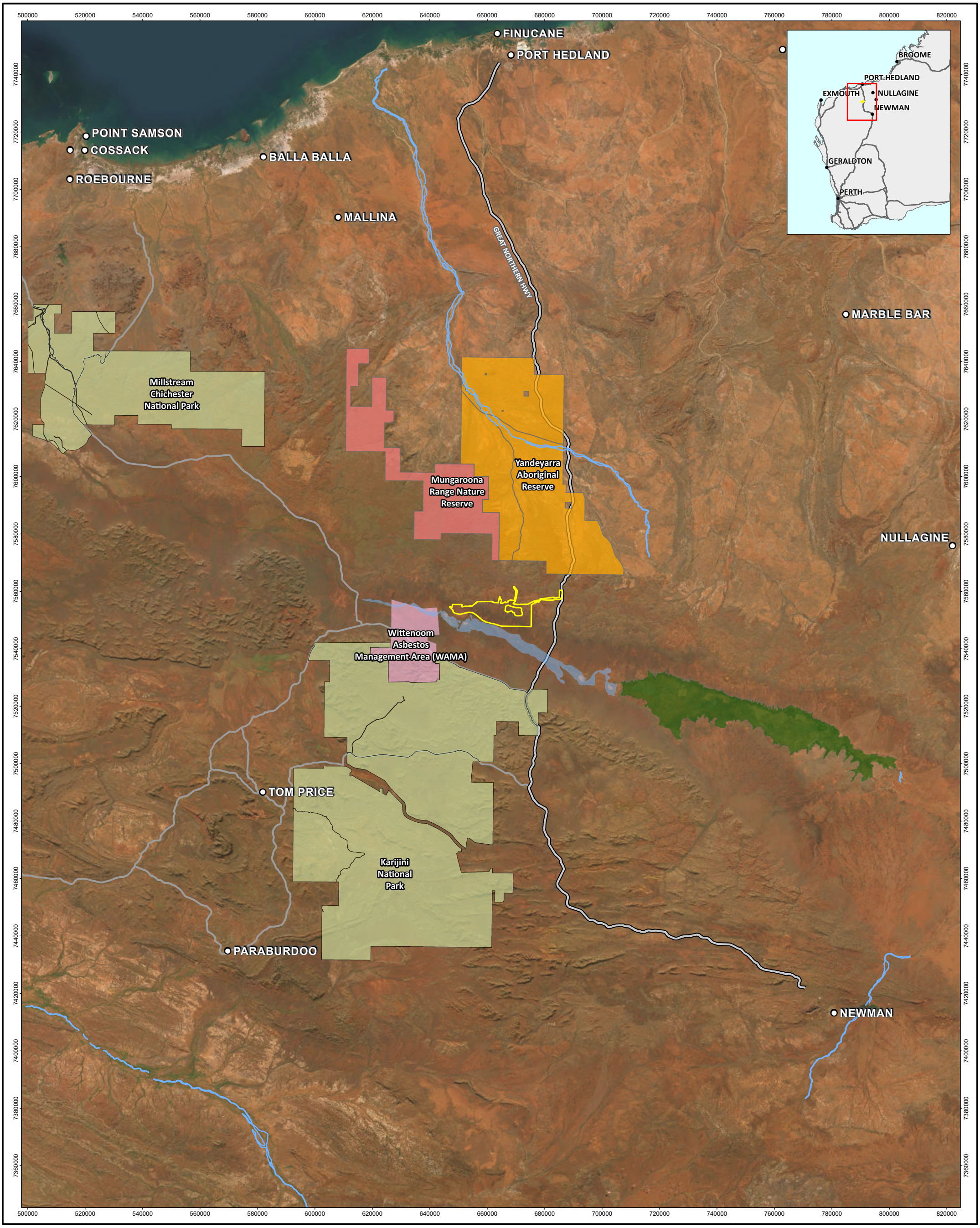
Proposal Element	Location	Maximum Extent or Capacity
Physical Elements		
Mine including: • Series of open pits (above and below water table); • WRD; • Topsoil elements, in stockpiles; and • Dewatering.	Within the Development Envelope (**Figure 2-2** and **Figure 2-3**)	Clearing of up to 4,339.16 ha of native vegetation within the 16,848.53 ha Development Envelope.
Processing elements, including: • Ore stockpiles; • Crushing and screening plant (s); • Dry crushing and screening plant; and • Transfer water dams/ponds.		
Infrastructure elements, including: • Accommodation camp; • Energy supply infrastructure; • Road haulage or ore from the mine to Port or Rail Siding; • Conveyors for the transportation of ore; • Bore fields/water reinjection infrastructure; • Mine workshops & infrastructure; • Pipelines; • Haul and light vehicle roads; • Ancillary buildings (e.g. workshops, telecommunications, offices); • WWTPs; • Landfill; • Hydrocarbon storage; • Explosive mixing and storage facility; • Laydown areas; • Evaporative ponds; • Water diversion channels and catchment ponds; and • Above ground water storage dams to manage supply or disposal of clean or mine water.		

Proposal Element	Location	Maximum Extent or Capacity
Operational elements		
Groundwater abstraction for water supply and mine dewatering	Within the Development Envelope (**Figure 2-2**)	Over the life of the mine it is anticipated the water abstraction requirements may reach up to 12 GL/a, due to mine dewatering and water supply requirements. Consideration may be given to the use of a water treatment facility (i.e. reverse osmosis desalination) should it be required to provide the necessary water quality.
Management of surplus water	Within the Development Envelope (**Figure 2-2**)	Up to 11 GL/a to be disposed of through MAR and/or pit infiltration within the Development Envelope. Temporary water storage may be required to assist in the management of water quality for supply or prior to discharge.
Evaporation ponds	Within the Development Envelope (**Figure 2-2**)	May be required to assist in the management of surplus water and discharge. These will preferentially be located in disturbed areas such as pit voids, however some ex-pit structures may be required within the WRD's
Crushing and screening plant(s)	Within the Development Envelope (**Figure 2-2**)	Dry processing of ore to produce up to 12 Million tonnes per annum (Mtpa) of iron ore product**.**
WRD	Within the Development Envelope (**Figure 2-2**)	Approximately 160 Mt of waste rock will be mined throughout the life of the Proposal. WRDs will be designed to integrate into the surrounding landforms where possible, with a maximum height defined by waste rock characterisation studies.
Proposal Elements with Greenhouse Gas Emissions		
Construction Elements- Peak Annual Average		
Scope 1	65,852.26 t CO_2-e	
Scope 2	0 t CO_2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).	
Construction Elements- Over period of construction		
Scope 1	263,409.02 t CO_2-e over ~4 years	
Scope 2	0 t CO_2-e	
Operation Elements- Peak Annual Average		
Scope 1	100,000 t CO2-e	
Scope 2	0 t CO_2-e	
Operation Elements- Annual average life of mine		
Scope 1	100,000 t CO2-e	
Commissioning		
Commissioning of the processing facility will be undertaken subject to the operational limits above.		
Rehabilitation		

Proposal Element	Location	Maximum Extent or Capacity
Where practicable, progressive rehabilitation will be undertaken over the LoM. Areas disturbed through the implementation of the Proposal will be designed to be safe and non-polluting and will be constructed so the final shape, size, stability, are comparable with the natural landforms in the area.		
Other elements which affect extent of effects on the environment		
Proposal duration	Maximum Proposal life	18 years

The key components of the Proposal are described in more detail in the following sections.

Figure 2-1: Regional Location of the Proposal



Legend

- Development Envelope
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve
- Yandeyarra Aboriginal Reserve (LGATE-227)

Directory of important wetlands (DBCA-045)

- Lower Fortescue River
- Upper Fortescue River including the Fortescue Marsh
- Watercourses (LGATE-053)

Roads (LGATE-195)

- Highway
- Major road

JBS&G

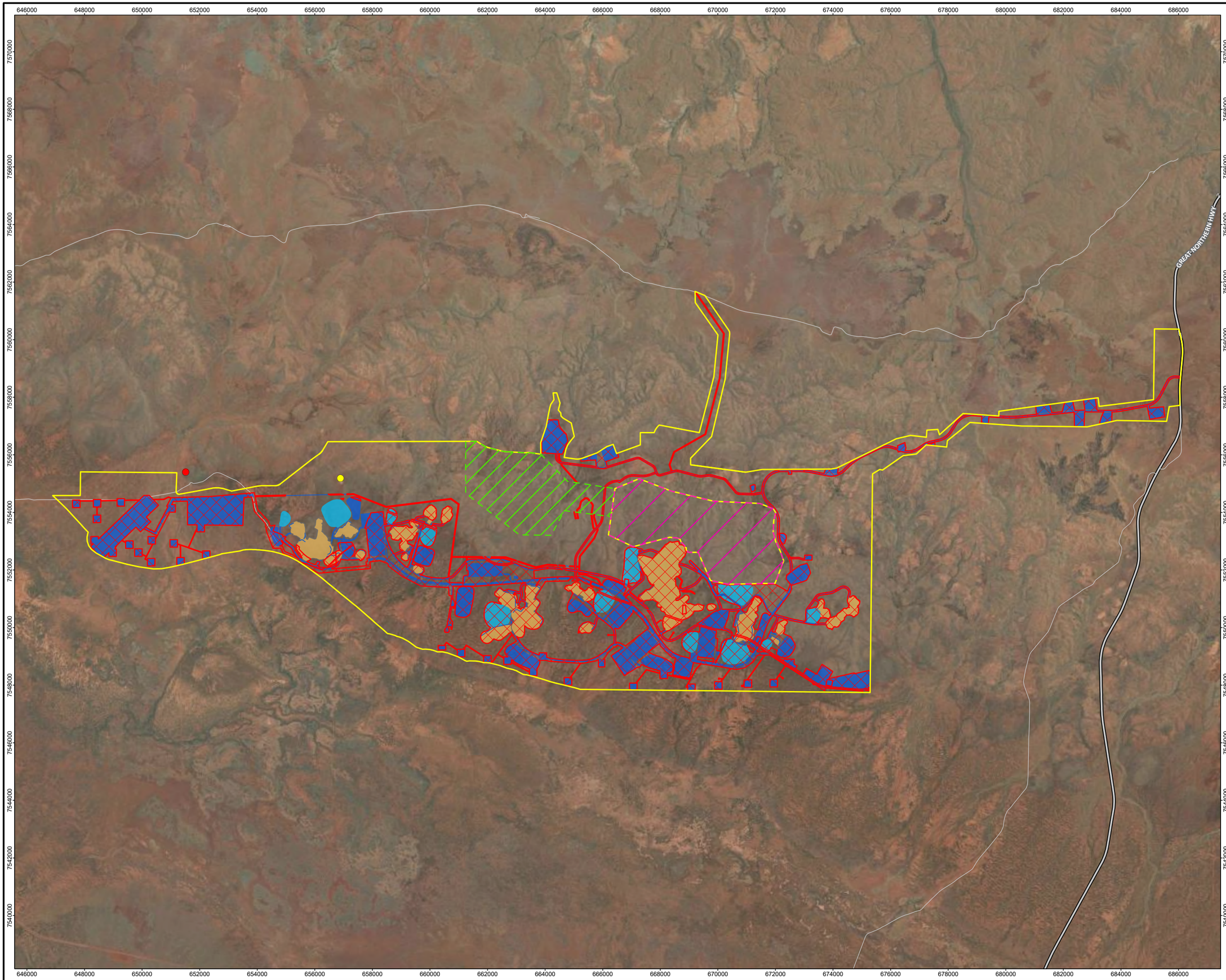
0 15 30
Kilometers

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

Job Number: 67751		Scale 1:1,200,000 at A3		**REGIONAL LOCATION OF THE PROPOSAL**
Client: Hancock Prospecting Pty Ltd		Coord. Sys. GDA2020 MGA Zone 50		
Drawn By: droberts	Checked By: VC	Version: Rev A	Date: 31-Oct-2024	**FIGURE: 2.1**

Document Path: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Figure 2-2: Proposal Location, Development Envelope and Indicative Footprint



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Mine Layout

- Supporting infrastructure
- Pit
- Waste Dump
- Mulga Downs Exploration Camp (LGATE-013)
- Mulga Downs Homestead (LGATE-013)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PROPOSAL LOCATION, DEVELOPMENT ENVELOPE AND INDICATIVE FOOTPRINT

FIGURE 2.2

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 2-3: Proposed Pits within the Proposal



Legend

- Development Envelope
- Indicative Footprint

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PROPOSED PITS WITHIN THE PROPOSAL

FIGURE 2.3

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

2.2.3 Detailed Description of Proposal Elements

2.2.3.1 Construction

Construction of the Proposal is anticipated to commence FY 2026 and is forecast to take approximately 24 months. Construction activities for the Proposal will involve the clearing of vegetation and development of associated infrastructure required to establish the Proposal. Associated infrastructure required as part of the Proposal includes:

- Facilities for dry crushing and screening of ore;
- Infrastructure to manage surface water (diversion of creeks and surface water flows);
- Linear infrastructure (haul roads, powerlines, pipelines and conveyor corridors); and
- Mine associated infrastructure and support facilities (including, but not limited to accommodation camp, energy supply infrastructure, airstrip, wastewater treatment plant, landfill, offices, workshops, laydown areas, etc.).

Pre-strip of the mine pits will commence in both the west at Murrays Hill and east at Fridge Hill, with pits developed over the LoM to allow for appropriate water management and grade control. Surplus water not required for the operation of the Proposal will be disposed of through Managed Aquifer Recharge (MAR) through reinjection and/or in-pit infiltration within the Development Envelope.

A construction water supply of approximately 1 GL per annum (GL/a) will be required over the duration of construction prior to mining. It is intended that the construction water supply will be sourced from mining / MAR areas, thereby providing advanced dewatering and / or increased MAR capacity.

The expected footprint of the Proposal is referred to as the Indicative Footprint. A Development Envelope approach for the Proposal has been proposed which allows for flexibility in placement of certain infrastructure elements. The Indicative Footprint is shown on all the maps and figures which will inform the impact assessment as per EPA guidance (EPA 2021d). The extent of impact of the Indicative Footprint is presented for each key environmental factor in this ERD. The exact location of the footprint may change within the Development Envelope as the design progresses and to reduce environmental impacts where possible.

Clearing of up to 4,339.16 ha of vegetation will be required within a Development Envelope of 16,848.53 ha. Where possible, topsoil and vegetation will be removed and stockpiled in adjacent well-drained areas.

2.2.3.2 Operation

The Proposal is expected to operate for up to 18 years and will involve mining within the Mulga East area, establishing WRDs, processing (dry) ore and operation of associated supporting infrastructure. Supporting infrastructure to the primary operation is detailed in **Section 2.2.3.7**. Ore from third-party iron ore mines may also be processed at the Proposal.

The Proposal will be undertaken in accordance with a Mining Proposal, which will require approval by the Department of Energy, Mines, Industry Regulation and Safety (DEMIRS) under the *Mining Act 1978* (Mining Act) prior to construction commencing. The key operational activities for the Proposal are detailed below.

2.2.3.3 Mining

The open pits are described by seven domains (refer to **Section 2.2.5.1**). These are: Murray's Hill, Anticline Hill, Fridge West, Fridge Central, Fridge Hill, Horseshoe West, and Horseshoe Hill (**Figure 2-3**). Mining will be undertaken using conventional drill and blast, load, and haul methods. The maximum production capacity will be up to 12 Mtpa. It is expected the iron ore will be mined with an average strip ratio of 1:1.4. A portion of the ore is located below the water table and dewatering of groundwater will be required for dry-floor mining.

Groundwater abstraction for water supply and to dewater is projected to increase over the LoM, to a maximum of 12 GL/a. Dewatering rates are expected to decrease rapidly in the last year of mining. The operation of the mine is driven by the mine dewatering volumes.

Mining will be undertaken on a 24-hour basis, seven days a week.

Where possible, topsoil and vegetation will be removed in stages prior to construction. The topsoil will be stockpiled in adjacent, well-drained areas. Topsoil stockpiles will be managed so the material will be available for future rehabilitation operations.

Mined ore will be transported (loaded and hauled) from the open pits after blasting to the run of mine (RoM) pads. Three RoM pads at approximately 5 m height are anticipated to be constructed across the Development Envelope (two operational at a time) over the LoM to service the various open pits.

At the end of mining (but before closure), Managed Aquifer Recharge (MAR) via in-pit infiltration and groundwater recharge will result in temporary standing water within some of the pits. At closure, HPPL will backfill pits to above the water table after settlement to avoid formation of permanent pit lakes. This will be further informed by future infield study work as part of the closure planning process. A preliminary Mine Closure Plan is provided in **Appendix 3**.

2.2.3.4 Waste Rock Dumps

The indicative locations of the WRDs are shown in **Figure 2-2**. Approximately 160 Mt of waste rock will be mined throughout the life of the mine. Waste rock will initially be used to construct infrastructure (e.g. access roads and ramps, RoM and stockpile bases, drainage structures and safety bunds) with the remainder stored in above ground WRDs or used to backfill pits.

WRDs will be designed to minimise the area of disturbance, maintain the overall surface water flows feeding into the Fortescue Valley and integrate into the surrounding landforms, with a height that enables a stable landform and minimises visual impacts.

2.2.3.5 Processing

Ore from the Proposal will be transported to two crushing plants to produce combined up to 12 Mtpa (dry) iron ore -14 mm fines product. One crushing plant will be located at the West Crusher location and the other plant will be located at the East Crusher location. The West Crusher will operate in its location for the first 11 years before relocation to a Central Crusher location for the remainder of the LoM. The East Crusher will remain in its position for the entire LoM.

Each crushing plant consists of:

- RoM bin/feed hopper;
- Vibrating grizzly;
- 1 x primary jaw crusher;
- Rock breaker;
- Primary screening unit;
- Surge bins above secondary and tertiary crushers;
- 1 x secondary cone crusher;
- 1 x tertiary cone crusher;
- 2 x secondary screening units;
- Conveyors;
- Sampling station; and
- Radial stacker.

Each crushing plant will be fed ore by front end loaders into the RoM bin/feed hopper. The product will be stacked by a radial stacker at each of the crushing plants, prior to being loaded by front end loaders into road trains and transported out of the Development Envelope.

2.2.3.6 Non-process Infrastructure

Linear Infrastructure

Linear infrastructure associated with the Proposal includes:

- Pipelines and powerlines and associated corridors;
- Haul and light vehicle roads; and
- Conveyor corridors.

Power Supply

HPPL is considering several energy solutions for the Proposal. These include a combination of gas and renewable energy or diesel and renewable energy for onsite power generation.

To reduce greenhouse gas emissions associated with the Proposal, HPPL plans to construct a 9-13 Megawatt (MW) solar farm including the installation of piles, photovoltaic panels, and related infrastructure. It is important to note that the solar farm will be dedicated solely to meet the power needs of the Proposal and will not export electricity offsite.

Water Supply and Demand

HPPL estimates a raw water demand of between 1,750 kL/d and 2,250 kL/d throughout the mining period water demands will be preferentially met by dewatering volumes and, if required, water treatment will ensure that the water quality criteria are met. It is intended that construction water will be sourced from the mining area and, as such will either provide advance dewatering and / or increased aquifer capacity for the disposal of excess water, dependent on the source area.

Surplus Water Management

As dewatering exceeds the required water demand, excess water will be disposed of by MAR within the Development Envelope. MAR is proposed on the slopes of the valley (i.e., in, and along strike of, the proposed mining areas) and will be implemented via purpose-built injection bores, re-purposed dewatering bores and in-pit infiltration.

Temporary water storages may be required to assist in managing water quality, for supply or prior to discharge.

The mining sequence is being determined based on the dewatering required and excess water management.

2.2.3.7 Support Infrastructure

The supporting infrastructure for the Proposal will include an airstrip and aerodrome facility, accommodation camp, and ancillary buildings such as workshops, telecommunications, and offices. Wastewater treatment plants (WWTP) to manage waste from the accommodation camp and ancillary buildings and a landfill to dispose of wastes generated from the mine are proposed within the Development Envelope.

Haul and light vehicle roads will be built to access areas of the mine and to allow for ore to be hauled to Port Hedland or rail siding along the Roy Hill rail mainline for export. Areas to store hydrocarbons and explosives and a mixing facility will be required, along with laydown areas and conveyors for the transportation of ore.

Other infrastructure required includes energy supply infrastructure; water abstraction borefields and water reinjection infrastructure; and pipelines and above ground water dams to manage supply or disposal of mine water. Evaporative ponds and water diversion channels and catchment ponds are also proposed.

The elements of the Proposal are listed in the PCD (**Appendix 1**) as required for EIA (EPA 2021).

2.2.3.8 Closure

Site-specific closure objectives and plans will be prepared for the Proposal. A PMCP (**Appendix 3**) has been developed with regard to the *Statutory Guidelines for Mine Closure Plans* (DMIRS 2023) and describes the process by which site rehabilitation will meet the planned objectives.

HPPL's overall closure vision for the MDIOP is to:

Establish a safe, stable and non-polluting environment with a self-sustaining and resilient vegetative cover, similar in species richness and density to the surrounding landscape, which supports the re-establishment of the pre-mining or other agreed land use and is compliant with all conditions and commitments.

The closure outcomes are necessary to provide the basis for developing completion criteria (DEMIRS, 2020a). The HPPL closure outcomes have been split into a number of environmental aspects impacted by the operation as detailed below:

Compliance

- Comply with all legally binding conditions and commitments relevant to rehabilitation and closure as summarised in a Legal Obligations Register (to be developed).

Landform

- Confirm that all closure landforms ensure the safety and health of workers and the general public; and
- Final mine landform designs achieve long term geotechnical stability and effective containment of any toxic or other deleterious material(s).

Water

- To minimise impact to hydrogeological regimes, quality and quantity of groundwater and surface water to the extent that existing and potential uses, including the ecosystem, are protected; and
- Any water runoff or leaching from rehabilitated WRDs, creek diversions/reinstatements and residual infrastructure will not result in a decline of surface water or groundwater quality.

Revegetation

- To utilise closure strategies that return relinquished leases/tenements to a self-sustaining condition with little or no need for ongoing care and maintenance;
- To rehabilitate all previously disturbed areas to a self-sustaining and functional ecosystem, comprised of locally occurring species, that where practically possible blends with the surrounding landscape; and
- Soil properties of rehabilitated disturbed areas will be appropriate to support target ecosystems.

Waste

- All reagents, hydrocarbons and chemicals are removed from site with any residual site contamination neutralised or remediated through treatment such as not to detrimentally impact on future land use and water resources.

Post-Mining Land Use

- All Infrastructure associated with the mine will be removed unless value to the local community and/or landowners is recognised in which it is to be retained in an operational condition for transfer to local and regional authorities or appropriate stakeholder. Ongoing maintenance and liability for such structures shall be passed to the approved stakeholder;
- Where possible items of Aboriginal heritage value that were removed prior to mining are returned to their pre-mining location as agreed by the Aboriginal stakeholders; and
- Mine closure planning includes effective internal and external stakeholder consultation ensuring that all concerns/issues are considered during the development and implementation of the MCP.

Mine closure for the Proposal will be managed in accordance with the requirements of the Mining Act as regulated by DEMIRS. Where possible, rehabilitation will be undertaken progressively during the operational phase of the Proposal through phasing of works.

Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Native Title groups and the objectives of the PMCP, as required under the Mining Act. HPPL will back fill the pit voids to ensure backfill is above the water table after settlement, and as such permanent pit lakes after closure will be avoided. This will be further informed by future infield study work as part of the closure planning process.

HPPL has been in early consultation with key stakeholders, including pastoralists, during exploration and pre-feasibility studies. These consultations have included discussions relating to post mining land use and mine closure. From discussions held with stakeholders to date, the expectation is that, on completion of mining, the Development Envelope will be rehabilitated and returned to pastoral and low intensity cattle grazing land-use. HPPL will continue to consult with key stakeholders, including Traditional Owners, throughout the development of the Mine Closure Plan (MCP) on post mining land use and mine closure.

HPPL will liaise with key stakeholders to investigate opportunities to diversify into activities that utilise resources occurring naturally in the rangelands (e.g., seed collection for revegetation). HPPL will also engage with the Shire of Ashburton, Pilbara Development Commission and other stakeholders, including Traditional Owners, to understand any potential for retaining assets at closure (i.e. airstrip and mining infrastructure). Consultation with Traditional Owners will be undertaken regarding the burying of concrete, and the abandonment of buried infrastructure.

2.2.3.9 Rehabilitation

Where possible, topsoil and vegetation will be removed prior to construction or development and stockpiled in adjacent well-drained areas. Topsoil stockpiles will be managed so the material will be available for future rehabilitation operations. Rehabilitation will occur progressively across the LoM where feasible.

Each element of the Proposal will be rehabilitated as described below.

Open Pits

HPPL will back fill the pit voids to ensure backfill is above the water table after settlement, and as such pit lakes after closure will be avoided. This will be further informed by future infield study work as part of the closure planning process.

Waste Rock Dumps

Waste rock will be used to backfill open pits with excess located in waste landforms of maximum 35 m height that will be reprofiled to minimise lift height to a slope angle of ≤20°. WRDs will be designed to minimise erosion and the potential for surface water to pond. Consultation on the final WRDs at closure will be undertaken with Traditional Owners.

Processing Plant

The RoM will be reprofiled to a slope angle of ≤20°. The process plant will be removed and concrete footings either removed or buried at least 1 m below ground level. Consultation will be undertaken with Traditional Owners regarding the burying of concrete, and the abandonment of buried infrastructure.

Ancillary Infrastructure

All surface infrastructure not subject to a sequential use agreement will be removed. Suspected contaminated sites will be investigated as per the *Contaminated Sites Act 2003* (CS Act). Any culverts will be removed, and the surface will be re-shaped to blend into adjacent ground levels, reinstating natural drainage lines where feasible.

Consultation will be undertaken with Traditional Owners regarding the repurposing, removal, or the reallocation of ancillary infrastructure.

Rehabilitation Performance Monitoring

The environmental performance of rehabilitated landforms will be monitored until all completion criteria have been met. HPPL will select preliminary analogue rehabilitation monitoring sites which will be communicated to DEMIRS and the Department of Water and Environmental Regulation (DWER). Monitoring will be established as required throughout the LoM as rehabilitation progresses. Site inspections and general observations will be taken at rehabilitation sites. Regular monitoring of rehabilitated areas will be carried out where necessary and may include:

- Vegetation community structural attributes such as cover and species density;
- Vegetation community composition including the presence of desired species and weeds species;
- Soil assessment including development of erosion features, infiltration/runoff, and nutrient cycling;
- Habitat complexity assessment and vertebrate/invertebrate fauna abundance and richness (including pest species);
- Assessment of vegetative and soil structures of rehabilitated sites against that of nearby undisturbed areas, analogue sites, or landforms of best achievable rehabilitation; and
- Assessment of the stability and function of the rehabilitated soil profile against that of appropriate analogue sites.

As required under the Mining Act, the Mining Proposal (MP) and MCP will include completion criteria that has been developed based on a framework for developing mine-site completion criteria in Western Australia (Young et al. 2019). HPPL will consult with the Banjima People on the proposed completion criteria for the Proposal.

2.2.3.10 Fauna Habitat Exclusion Zone and Corridor

The Proposal includes areas of moderate and high value habitat for conservation significant fauna, including Rocky Hills, Drainage Line/ Floodplains, and Stony Spinifex Plains and Hillslopes habitats. These habitats provide foraging habitat proximal to the Category 4 nocturnal roosts for the Pilbara Leaf-nosed Bat and Ghost Bat. HPPL has identified two areas that represent increased fauna habitat value that will not be developed:

- Fauna Habitat Exclusion Zone (FHEZ) - comprising an area of 1,320.82 ha. This area was excluded from the referred Development Envelope under a section 43A application (see Section 2.3.3.3).

- FHEZ Corridor - comprising an area of 991.45 ha within the Development Envelope.

The FHEZ and FHEZ Corridor have been identified as areas that represent increased fauna habitat value and play a key role in maintaining fauna values within the wider region. The purpose of the FHEZ and FHEZ Corridor is to mitigate, through avoidance, impacts to conservation significant fauna. The value of the FHEZ is enhanced and maintained by the inclusion of the FHEZ Corridor which comprises similar and supporting habitats. The purpose of the FHEZ Corridor is to ensure connection of the high value habitat within the FHEZ to habitat outside of the Development Envelope, to allow for the dispersal of fauna from the FHEZ to the Chichester Ranges and preventing fragmentation of terrestrial fauna habitat for MNES species such as the Northern Quoll.

The FHEZ is outside of the Development Envelope and will not support any Proposal activities. The FHEZ Corridor will remain within the Development Envelope and will accommodate minor, low impact activities including an un-sealed light vehicle access road to support infrequent light vehicle access to a communications tower (which will be located approximately 200 m south of the FHEZ Corridor) and monitoring activities. An infrastructure corridor is also proposed within the FHEZ Corridor however this will only be developed if the related Mulga Downs Hub and Rail Spur Proposal (Assessment No. 2358) is approved. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal.

The FHEZ and FHEZ Corridor will be subject to ongoing monitoring, see the Conservation Significant Fauna Management Plan (CSFMP) (**Appendix 12**).

2.2.4 Timeframes

The anticipated timeframes for the key Proposal construction, operation, decommissioning and rehabilitation dates are presented in **Table 2-3**. Note that all timeframes are subject to obtaining necessary approvals.

Table 2-3: Expected Timeframes

Activity	Timeline
Construction of associated mine infrastructure	FY 2026 – FY 2027
Construction of mine pits	Commencing in FY 2026
Operation	FY 2027 – FY 2045
Decommissioning	Progressively over the LoM
Rehabilitation	Progressively over the LoM

2.2.5 Exclusions

The scope of the Proposal which is under assessment (Part IV) of the EP Act specifically excludes the following:

- Investigative activities, including drilling and associated activities, for the purposes of resource evaluation, geotechnical assessment and hydrogeological investigations required to inform assessment of the Proposal. These activities are managed under other assessment and approval processes;
- Development and use of bores and monitoring sites to support studies and early works described above;
- Murray's Hill (EPA Assessment number: 13-243207) (refer to **Section 2.2.5.1**); and
- Mulga Downs Hub and Rail Spur (EPA Assessment number 2358) (refer to **Section 2.2.5.2**).

Separate approvals will be submitted for these activities / projects, as required.

2.2.5.1 Murray's Hill Project

The Murray's Hill Project (Murray's Hill) is a stand-alone, 5 Mtpa direct shipping ore (DSO) mine with a life of up to five years (including decommissioning and rehabilitation) proposed by HPPL. Murray's Hill involves only the above water table mining portion of the Murray's Hill pit, crushing and screening, associated mining infrastructure, accommodation camp and roads. The project comprises a disturbance footprint of up to 890 ha within a 3,018 ha Development Envelope. Up to 100 ha of the 890 ha footprint was already disturbed, therefore a total of 790 ha of native vegetation clearing is required to facilitate the project.

The Murray's Hill Project was referred to the EPA in 2013 (reference number 13-0000243207 EPA 2013). The EPA's decision was that it did not require environmental assessment under Part IV of the EP Act (Do Not Assess). It was determined that the Proposal was unlikely to result in a significant effect on the environment.

Impacts from Murray's Hill can be managed under Part V, Division 2, of the EP Act (Native Vegetation Clearing Permit) and the Mining Act administered by the DEMIRS. HPPL may commence construction of the Murray's Hill component earlier than the Proposal dependent on the granting of all necessary approvals (noting it forms part of the Commonwealth assessment).

The assessment of impacts for Murray's Hill was based on the Development Envelope within which an Indicative Footprint was used to indicate the likely extent of disturbance. The impact assessment was based on both a worst case (i.e., up to 890 ha disturbance anywhere within the Development Envelope, with a maximum of 790 ha of native vegetation clearing) and an indicative (i.e., clearing only within the Indicative Footprint) scenario. As such, the assessment approach for flora and vegetation and terrestrial fauna provided flexibility in terms of the final Disturbance Footprint for the Murray's Hill Project, provided:

- The Disturbance Footprint and maximum extent of clearing remains within the specified limits; and
- Environmental values that were to be avoided, are not impacted by the revised location.

Based on the above, the Murray's Hill Disturbance Footprint is consistent with the Murray's Hill Proposal referred to the EPA in 2013 and upon which a 'not assessed' decision by the EPA was based.

Given Murray's Hill (5 Mtpa DSO, above the water table mine) has been previously referred under the EP Act, it is specifically excluded from the assessment of the Proposal. As such, the MDIOM Indicative Footprint excludes the Murray's Hill Project. Within the Development Envelope for the Proposal, 394.60 ha of clearing is attributable to the Murray's Hill project and has therefore been removed from the impact assessment calculations for the Proposal. As the current Proposal includes dewatering there is an opportunity to access ore from below the water table within the Murray's Hill pit. Access to below the water table ore at Murray's Hill pit is therefore included in the current Proposal.

2.2.5.2 Hub and Rail Spur

The Mulga Downs Hub and Rail Spur (Hub and Rail) Project is a stand-alone project proposed by Roy Hill Infrastructure Pty Ltd (RHI).

RHI is undertaking planning for the Hub and Rail to service iron ore mining and export developments in the Pilbara region. The Hub and Rail Project will support the Proposal and other future ore developments and facilitate export opportunities for third party stranded ore from the region. The Hub and Rail is subject to a separate and independent assessment and approval process.

The Hub and Rail project includes:

- A Hub that will facilitate ore receival via truck unloading from third parties and via conveyor from the (adjacent) Proposal;
- Train loading and product rehandling facilities;
- Stockyards; and

- A connecting rail spur of up to approximately 63 km, to where it will connect with the existing Roy Hill Railway at approximate chainage 185 km.

The Hub and Rail project will support the export of approximately 45 Mtpa of iron ore.

The Hub and Rail was referred under both the EP Act and EPBC Act in December 2022. On 7 March 2022, the EPA determined the project should be assessed on referral Information (ARI) (additional information required) (EPA Assessment: 2358). DCCEEW determined on 8 March 2022 that the project is a 'Controlled Action' with an accredited assessment approach (EPBC 2022/09425).

2.3 Proposal Alternatives

2.3.1 Proposal Justification and Benefits

The Proposal will supply ore for approximately 18 years and will contribute to the supply of ore to the global market from HPPL's Pilbara Operations. The ore from the Proposal will ensure continued supply of tonnes and optimal product blending.

There are a number of significant social, economic and environmental benefits to be gained from the Proposal, including:

- Capital expenditure to benefit the economy;
- Earnings which generate royalties and taxes to government;
- Permanent employment positions;
- Direct and indirect employment and training opportunities;
- Opportunities for indigenous employment; and
- Baseline environmental studies that have been undertaken to support this Proposal and ongoing environmental monitoring during the life of the mine, which expands on the knowledge base of the flora and fauna in the Pilbara region of WA.

The Proposal is anticipated to provide approximately 438 permanent positions during operation with additional personnel required during construction.

2.3.2 Feasible Alternatives

2.3.2.1 Not Proceeding with the Proposal

Not proceeding with the Proposal would result in no impacts to key environmental factors aside from that which has already occurred through use of the land for pastoral purposes and exploration activities. The disadvantage in the short, medium, and long term would be the unrealised social and economic benefit from employment, and direct and indirect revenue generated from the mine. Given this, HPPL has designed the Proposal to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope to the extent possible through consideration of alternatives. These measures are discussed further in **Section 2.3.2.2**.

2.3.2.2 Alternative Location and Designs Considered

The location of the Proposal is determined by the iron ore mineralisation as identified by the mineral exploration program undertaken by HPPL since 2009. HPPL has undertaken comprehensive baseline studies and investigations to understand the environmental and social values surrounding and within the Development Envelope. These studies have informed the design of the Proposal and ensured potential impacts are avoided or minimised as far as possible. The Proposal is therefore the result of an iterative design and review process that has optimised specific elements, balanced with a precautionary approach to avoid, mitigate and manage potential environmental impacts.

The location of the Proposal allows for the utilisation of the proposed Mulga Downs Hub and Rail Spur, which (if approved) will facilitate transport of ore via rail from the Proposal (and other third party mines) to Port Hedland. The location of the open pits is fixed mine site assets as their location is determined by the prevailing geology and mineralisation. The area that the Proposal will permanently disturb may be reduced through outcomes of baseline studies, iterative mine planning, and consideration of closure options including in-pit backfilling with mine waste.

Non-fixed mine assets that have greater flexibility in terms of location within the Development Envelope include:

- Processing plant(s) and WRDs;
- Mine infrastructure: haul roads, conveyors, light vehicle roads, airport, landfill, WWTPs;
- Supporting infrastructure: accommodation camps, workshops, storage facilities, telecommunications, offices; and
- Energy supply infrastructure: diesel, gas, solar farm.

The location of these non-fixed assets has been optimised within the Development Envelope through applying the risk management hierarchy and minimising habitats that may support MNES. This process included consideration of:

- Land access;
- Heritage values (both archaeological and ethnographical sites);
- Environmental values (e.g. environmentally sensitive areas, threatened and priority flora, significant fauna habitats);
- Water management;
- Geotechnical and geomorphological risks;
- Materials availability;
- Economics;
- Constructability; and
- Ongoing stakeholder engagement.

The design of the Proposal has been planned to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope where possible since the referral of the Proposal on 24 December 2021. Three applications to amend the Proposal (under s43A of the EP Act) have been submitted by HPPL, each change resulting in a reduction in the potential environmental impacts of the Proposal

on key environmental factors. An overview of each application is provided in **Section 2.3.3**. In summary, the key changes / alternatives have been made to the Proposal since the referral of the Proposal that avoid or minimise impacts include:

- A total reduction in the Development Envelope and Indicative Footprint of 23,804.47 ha and 5,288.84 ha respectively since referral of the Proposal in 2021.
- The addition of a Fauna Habitat Exclusion Zone (FHEZ). The area of the FHEZ also increased from 793.51 ha to 1,320.82 ha to protect a greater number of known Category 4 roosts and high-quality foraging habitat for the Pilbara Leaf-nosed and Ghost Bats. The area also provides important habitat for the Northern Quoll. The FHEZ is located within the boundary of the Development Envelope; however, has been excluded from, and does not form part of the 16,848.53 ha Development Envelope.
- The addition of a FHEZ Corridor within the Development Envelope. The Corridor will contain limited, low impact infrastructure and will provide connectivity between high value habitat within the FHEZ and the boundary of the Development Envelope. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal.
- Removal of the Mulga West Borefield and associated infrastructure, reducing the Indicative Footprint and avoiding habitat suitable for breeding by the Night Parrot (EN) and Grey Falcon (VU). In addition, by removing the Mulga West Borefield, the potential impacts to the dispersal of any Northern Quoll population on Mt Florance were reduced.
- Removal of the Malay Well tenement from the Development Envelope (E47/2117 and western section of R47/12), therefore removing the lodged Mungurrdu heritage site from within the Development Envelope.
- Removal of the southern mine access road referred to as ‘Fenceline Road’ and inclusion of an alternate haul road alignment from the MDIOM to Great Northern Highway (Northern Haul Road Access);
- Dry ore crushing and screening only (no wet processing) of up to 12 Mtpa;
- Waste rock volume reduced from 800 Mt to 160 Mt;
- Removal of Anticline South and Horseshoe South pits (a reduction from nine pit domains to seven pit domains), the reduction resulting in reduced associated lighting, noise and vibration;
- Removal of Malay Well tenement borefield removing the requirement for any mining infrastructure in the Mungurrdu lodged heritage site and any potential barriers to the movement of fauna across this area;
- A reduction in peak groundwater abstraction rate from 36.5 GL/a to 12 GL/a for water supply and mine dewatering, resulting in a reduction in the maximum extent of drawdown and mounding over the life of mine; and
- No requirement for in pit or ex pit Tailings Storage Facilities (TSF), removing any potential impacts to surface water, fauna habitat (including that for Migratory Birds) or sensitive areas as a result of contamination.

As the design of the Proposal develops, HPPL will continue to ensure impacts are minimised as far as practicable. Further detail around specific alternatives considered are outlined in **Table 2-4**.

Table 2-4: Consideration of Alternatives

Aspect	Proposal Description	Alternatives Considered	Justification for Chosen Option
Development Envelope	16,848.53 ha	Referred Development Envelope was 40,653 ha (reduced by 23,804.47 ha) and comprised: • Mulga West Borefield to the west; • Malay Well to the south, which intersects the recently Mungurrdu lodged heritage site; • Fenceline Road corridor to Great Northern Highway; and • Intersection with the Wittenoom Asbestos Management Area (WAMA).	As mine design progressed the Development Envelope (and elements and activities within the Development Envelope) was reduced wherever possible to reduce the area of potential disturbance to environmental and cultural values.
Indicative Footprint	4,339.16 ha	Referred Indicative Footprint was 9,628 ha (reduced by 5,288.84 ha) and comprised: • Infrastructure associated with Mulga West Borefield to the west; • Infrastructure associated with Malay Well to the south, which intersects the recently Mungurrdu lodged heritage site; • Clearing and disturbance associated with Fenceline Road haulage route to Great Northern Highway; • Three additional Pit domains: Murray's Hill West pit (now the FHEZ); Anticline South and Horseshoe South; and • Infrastructure and activities with the WAMA.	The alternatives to the Indicative Footprint are a direct result of continued mine design and updated information on the resource base knowledge, consultation with key stakeholders (including Traditional Owners) and to reduce potential environmental impacts associated with the Proposal, the Proposal has been amended to a reduced scale mine with a reduced Indicative Footprint.
Mining rate	12 Mtpa dry iron ore with an operational life of 18 years.	The referred mine was to produce 20 Mtpa (dry) iron ore with an operational life of 30 years.	The final option selected allows reduced potential environmental impacts as a direct result of continued mine design and updated information on the resource base knowledge, consultation with key stakeholders (including Traditional Owners) associated with the Proposal, and the most appropriate ore quality/ blending and pit optimisation.

Aspect	Proposal Description	Alternatives Considered	Justification for Chosen Option
Mine Pit Design	Seven pit domains, up to a depth of 1 bench (15 m) of Below Water Table (BWT).	The referred Proposal comprised 10 pit domains, three of which have now been removed. The proposed pit depth was up to 9 benches (108 m) of BWT.	The reduced pit deign is a direct result of consultation with key stakeholders (including Traditional Owners) and to reduce potential environmental impacts associated with the Proposal. The reduced pit scale reduces the Indicative Footprint and the extent of potential impacts to subterranean fauna and associated impacts from dewatering and MAR.
Tailings and processing	No wet processing of ore required. No tailings will be produced with DSO product (dry process), therefore no facility required to store tailings or wet waste product	The referred Proposal included wet processing of ore to produce 20 Mtpa (dry) iron ore product. Tailings was proposed to be initially stored in an above ground tailings facility for a maximum capacity of seven years. As an alternative, where possible mining will be scheduled to in-pit tailings disposal to provide a long-term solution.	The alternatives to the Indicative Footprint are a direct result of continued mine design and updated information on the resource base knowledge, consultation with key stakeholders (including Traditional Owners) and to reduce potential environmental impacts associated with the Proposal, the Proposal has been amended to a reduced scale mine. This has resulted in the following: • Reduction in clearing footprint (construction and operations) to reduce impact to flora and vegetation and fauna habitat; • Reduced closure requirements especially for the tailings facility; • Removed the risk of contamination from TSF facilities; and • Reduced water supply for processing of ore.
Site layout	The layout of infrastructure associated with the mine has been designed to avoid significant environmental and heritage assets, where possible.	The referred Proposal impacted the following: • Fauna habitat, including caves within the FHEZ; • Mungurrdu lodged heritage site; • Buffers of claypans know to support Migratory Bird species, when inundated.	The site layout has been developed to: • Avoid significant fauna habitat features; • Avoid significant heritage assets where possible; • Enable the establishment of a FHEZ corridor; • Minimise clearing requirements;

Aspect	Proposal Description	Alternatives Considered	Justification for Chosen Option
			• Reduce haul distances; and • Minimise cumulative impacts with the Mulga Downs Hub and rail Project by sharing infrastructure and haulage routes.
Transport Options	Northern Haulage Road (co-located with haulage for the Mulga Downs Hub and Rail Spur Project which minimises cumulative disturbance).	The referred Proposal proposed Fenceline Road for transport of ore from the mine to Great Northern Highway as an option in addition to transport via the Mulga Downs Hub and Rail Spur Project.	Removal of Fenceline Road is a direct result of consultation with Traditional Owners to reduce potential environmental impacts associated with the Proposal. The removal of Fenceline Road avoids areas of cultural significance to Traditional Owners.
Excess water disposal	Peak groundwater abstraction rate reduced to 12 GL/a for water supply and mine dewatering, resulting in a reduction in the maximum extent of drawdown and mounding over the life of mine. Up to 11 GL/a of mine dewater to be disposed of through Managed Aquifer Infiltration (MAR) and/or pit infiltration within the Development Envelope.	Peak groundwater abstraction rate of 36.5 GL/a for water supply and mine dewatering. Up to 33 GL/a of mine dewater to be disposed of through MAR.	Peak groundwater abstraction rate reduced resulting in a reduction in the maximum extent of drawdown and mounding over the life of mine and associate impacts on subterranean fauna,

2.3.3 Changes to the Proposal during Assessment

As a result of ongoing mine design and with greater knowledge gained from the studies and investigations undertaken to inform the environmental impact assessment, HPPL has made applications under Section 43A (s43A) of the EP Act to change the Proposal under assessment.

2.3.3.1 Section 43A Application – March 2023

As a result of ongoing mine design and with greater knowledge gained from the studies and investigations undertaken to inform the environmental impact assessment, HPPL submitted an application to amend the Proposal under s43A of the EP Act in March 2023. The amendments included the following:

- An overall reduction in the total area of the Development Envelope by 2,375.16 hectares (ha) to 38,277.84 ha (5.8% reduction). This reduction includes a 1,455.67 ha portion of the Development Envelope that was located within the Wittenoom Asbestos Management Area (WAMA).
- Overall reduction of the Indicative Footprint by 869.15 ha to 8,758.85 ha (9.0% reduction). This net reduction includes removing the Mulga West Pit (902.75 ha) and moving the evaporation pond(s) into pit void(s) (354.62 ha), as well as several minor additions to the Indicative Footprint.
- Reduction in waste rock extracted by 1,755.5 million tonnes (Mt) to 800 Mt (54.4% reduction).
- Surface water discharge will not be used, and surplus water will be managed through managed aquifer reinjection.
- Increase the abstraction of groundwater from 25 gigalitres per annum (GL/a) to 36.5 GL/a.
- Realigning the pipeline route to follow existing roads.
- Addition of a solar farm, an access road, and associated ancillary infrastructure.
- Excision of 791.91 ha from the Development Envelope for a Fauna Habitat Exclusion Zone.

The change to Proposal was approved on 29 May 2023. The assessment of impacts of the Proposal described in detail in this ERD incorporates these changes.

2.3.3.2 Section 43A Application – December 2023

A s43A was submitted to the EPA in December 2023 for the removal of the Mulga West Borefield. Based on the hydrogeological and groundwater quality constraints identified by the 2021 work, in combination with heritage and engineering challenges, the Mulga West tenure is no longer being considered as a contingency MAR option and as such, the Mulga West borefield is no longer proposed as part of the Proposal. The current process water demand can be met from the Mulga East tenure, given there is no shortage of similar quality groundwater within this area. The proposed approach for the Proposal is to limit impact and conserve water through “local” aquifer re-injection on the Mulga East and Malay Wells tenure, and therefore, these areas have become a key component of the current water management strategy, removing the requirement for the Mulga West borefield contingency area. The s43A application submitted in December 2023 was approved on 23 February 2024 and therefore this revision of the ERD incorporates the approved changes.

2.3.3.3 Section 43A Application – September 2024

The requested amendments to the Proposal are the result of ongoing mine design, increased knowledge gained from studies and investigations being undertaken to inform the impact assessment and continual investigation into application of the mitigation hierarchy to reduce potential environmental impacts from the Proposal. The following changes to the Proposal were approved under this s43A application:

- An amendment to and reduction of the extent of the Development Envelope as follows:
  - An overall reduction in the Development Envelope of from 24,851.5 ha to 16,848.53 ha (a difference of 8,003.47 ha);
  - An increase in the Fauna Habitat Exclusion Zone (FHEZ) from 793.51 ha to 1,320.82 ha;
  - Removal of the Malay Well tenement from the Development Envelope (E47/2117 and western section of R47/12), therefore removing the lodged Mungurrdu heritage site (DPLH reference 40484) from the Development Envelope; and
  - Inclusion of a haul road alignment from the MDIOM to Great Northern Highway (Northern Haul Road Access) to facilitate mine access.
- An amendment to and reduction of the extent of the Indicative Footprint as follows:
  - A reduction in the extent of the Indicative Footprint from 8,422.5 ha to 4,339.16 ha (a difference of 4,081.30 ha);
  - Removal of Anticline South and Horseshoe South pits (a reduction from nine pit domains to seven pit domains);
  - Removal of Malay Well tenement borefield, removing the requirement for any mining infrastructure in the Mungurrdu lodged heritage site (DPLH reference 40484); and
  - Inclusion of the Northern Haul Road Access for mine access.
- An amendment to the following key Proposal operational elements:
  - Dry ore crushing and screening only (no wet processing) of up to 12 Mtpa;
  - A reduction in peak groundwater abstraction rate from 36.5 GL/a to 12 GL/a for water supply and mine dewatering, resulting in a reduction in the maximum extent of drawdown and mounding over the LoM;
  - Up to 11 GL/a of mine dewater to be disposed of through MAR and/or pit infiltration within the Development Envelope;
  - No requirement for in pit or ex pit TSF, removing any potential impacts to inland waters, subterranean fauna or social surroundings from contamination;
  - Reduced greenhouse gas emissions; and
  - Waste rock volume reduced from 800 Mt to 160 Mt.

The s43A application submitted in September 2024 was approved on 4 October 2024 and therefore this revision of the ERD incorporates the approved changes.

3 Local and Regional Context

The information presented in the following sections has been sourced from the various baseline surveys desktop reports undertaken for the Development Envelope since 2018 and publicly available datasets. These sections are provided to describe the regional and local context of environmental values across the Development Envelope.

3.1 Interim Biogeographic Regionalisation of Australia

The Proposal occurs entirely within the Pilbara region (assigned the IBRA7 code PIL) as defined by the Interim Biogeographic Regionalisation of Australia (IBRA). IBRA is a national framework for establishing conservation planning and management which uses attributes to delineate boundaries and define regions, identifying key conservation values, types of threats and other attributes (Thackway & Cresswell 1995).

The Pilbara bioregion is divided into four IBRA subregions – Chichester (PIL01), Fortescue (PIL02), Hamersley (PIL03) and Roebourne (PIL04). The Development Envelope lies predominantly in the Fortescue subregion with very small sections in the Chichester subregion (**Table 3-1; Figure 3-1**).

The Pilbara IBRA region occupies 17, 823,126 ha of Western Australia. It is bordered to the west and east by the more recent sedimentary Carnarvon and Canning basins respectively. The southern boundary of the Pilbara region is the biogeographic boundary known as the *Acacia-Triodia* line. This line, or more accurately transition zone, marks the transition from a landscape dominated by woody *Acacia* vegetation in the south to one dominated by spinifex vegetation in the north (Beard 1975, Beard 1990, Maslin & van Leeuwen 2008).

Table 3-1: The IBRA Bioregion and Subregions within the Development Envelope (IBRA7)

Bioregion	Biogeographic Subregion	Total Area (ha)	Extent within the Development Envelope (ha)
Pilbara Characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges. Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses (Bastin, 2008).	**Chichester (PIL01)** Comprises the northern section of the Pilbara Craton (Kendrick & McKenzie, 2001). Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. The basalt plains host a shrub steppe characterised by *Acacia inaequilatera* over *Triodia* spp. hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The Chichester subregion drains to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock).	8,374,728.00	1,703.00

Bioregion	Biogeographic Subregion	Total Area (ha)	Extent within the Development Envelope (ha)
	Fortescue (PIL02) Characterised by alluvial plains and river frontage. The Fortescue Plains contains extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains, and river gum woodlands fringing major drainage lines (Kendrick, 2001). The significant and dominant feature of this subregion is the Fortescue Marsh (the Marsh) – an ephemeral wetland which is the terminus of the Upper Fortescue River (EPA, 2013). The Lower Fortescue River arises from streams draining the Chichester and Hamersley Ranges below the Marsh and west of the Goodiadarrie Hills.	1,951,435.00	15,145.53
Total		**10,326,163.00**	**16,848.53**

Figure 3-1: Pilbara IBRA Subregions

640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000 695000

7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000

GREAT NORTHERN HWY

MUNJINA RD

Legend

- Development Envelope
- Indicative Footprint

IBRA Sub-regions (DCCEEW, 2020)

- Chichester
- Fortescue
- Hamersley

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: 2	Date: 31-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:180,000 at A3

0 4 8
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PILBARA IBRA SUBREGIONS

FIGURE 3.1

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

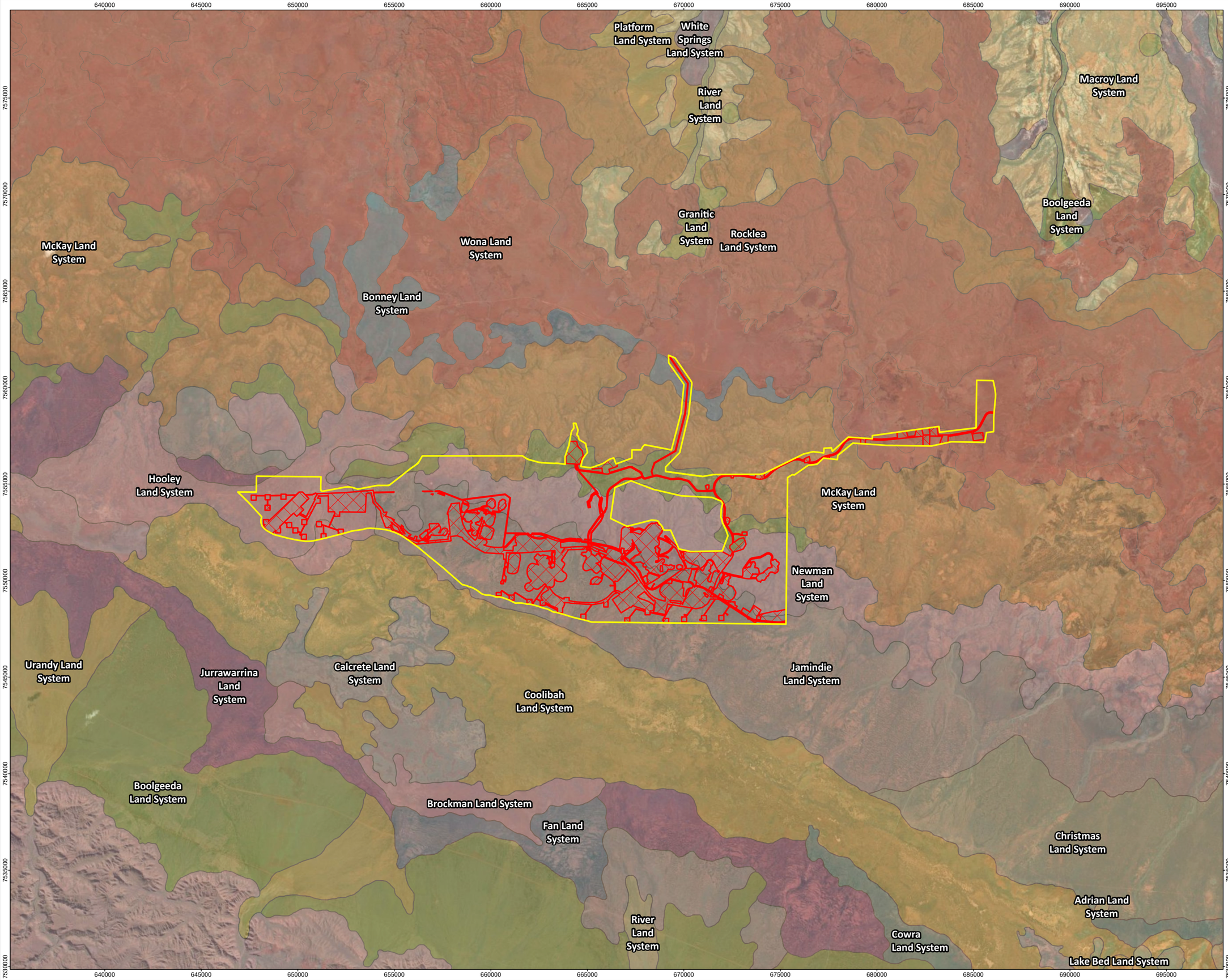
3.2 Land Systems

The Department of Primary Industries and Regional Development (DPIRD) has mapped and described the land systems of WA rangelands, providing a comprehensive description of biophysical resources, including soil and vegetation condition (DPIRD 063). The Development Envelope contains ten land systems as described in **Table 3-2** and shown in **Figure 3-2**.

Table 3-2: Land Systems within the Development Envelope

Land System	Description	Current Extent in the Pilbara Bioregion (ha)	Extent within Development Envelope (ha)	% of mapped extent in the Pilbara Bioregion that occurs within Development Envelope
Bonney System	Low rounded hills and undulating stony plains supporting soft spinifex grasslands.	74,940.55	61.07	0.08
Boolgeeda System	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	961,637.09	1,681.94	0.17
Brockman System	Level non-saline alluvial plains with clay soils and gilgai microrelief and flanked by slightly more elevated hardpan wash plains.	74,108.02	91.39	0.12
Hooley System	Level plains of clayey and stony alluvium as a mosaic of surfaces with gilgai microrelief, sometimes stony and non-gilgaied surfaces with abundant stony mantles.	59,081.14	1,578.16	2.67
Jamindie System	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.	192,227.17	6,881.74	3.58
Jurrawarrina System	Plains receiving overland sheet flow and with prominent drainage groves.	66,474.69	17.79	0.03
McKay System	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands with acacias and occasional eucalypts.	426,144.89	1,514.26	0.36
Newman System	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,993,744.45	4,282.30	0.21
Rocklea System	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands with scattered shrubs.	2,881,635.56	156.49	0.005
Wona System	Basalt upland gilgai plains supporting Roebourne Plains grass and Mitchell grass tussock grasslands, minor hard spinifex grasslands or annual grasslands/herbfields.	194,821.41	583.40	0.30
TOTAL		**6,924,814.97**	**16,848.54**	**0.24**

Figure 3-2: Land Systems within the Development Envelope



Legend

- Development Envelope
- Indicative Footprint

Landsystems (DPIRD-063)

- Adrian Land System
- Bonney Land System
- Boolgeeda Land System
- Brockman Land System
- Calcrete Land System
- Christmas Land System
- Coolibah Land System
- Cowra Land System
- Fan Land System
- Granitic Land System
- Hooley Land System
- Jamindie Land System
- Jurrawarrina Land System
- Lake Bed Land System
- Macroy Land System
- McKay Land System
- Newman Land System
- Platform Land System
- River Land System
- Rocklea Land System
- Urandy Land System
- White Springs Land System
- Wona Land System

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 22-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:180,000 at A3

0 4 8
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LAND SYSTEMS WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 3-2

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

3.3 Vegetation Associations

Vegetation at a pre-European regional scale has been described by Beard (1975). These vegetation units (vegetation associations) are broad scale and are aligned with landform, soil and topography. The Development Envelope comprises four broad pre-European vegetation associations (Beard 1975).

The pre-European and current extent of the vegetation associations mapped, and the extent of these vegetation associations within the Development Envelope are summarised in **Table 3-3** (Maia 2022) and shown in **Figure 3-3.**

Table 3-3: Vegetation Associations within the Development Envelope

Vegetation Association	Description	Pre-European Extent in the Pilbara IBRA (ha)	Current Extent Remaining in Pilbara IBRA (ha)	Extent remaining in the Pilbara IBRA (%)	Extent within the Development Envelope (ha)	% Represented in the Development Envelope
29	Low woodland, open low woodland or sparse woodland. Mulga (*Acacia aneura*) and associated species.	1,133,219.76	1,131,712.01	99.87	9,194.77	0.81
173	Shrub-steppe. Flora: Hummock grassland with scattered shrubs or mallee. *Triodia spp., Acacia spp., Grevillea spp.*, and *Eucalyptus spp.*	1,752,520.89	1,747,677.63	99.72	1,220.52	0.07
175	Grasslands, short bunch-grass savanna. Flora: Annual grasses *Enneapogon spp., Aristida spp*. etc on dry plains and saltwater grasses, *Sporobolus virginicus* on the coast.	507,860.16	507,466.80	99.92	466.42	0.09
562	Low tree-steppe. Flora: Hummock grassland with scattered bloodwoods and snappy gum *Triodia spp., Corymbia dichromophloia* and *Eucalyptus leucophloia*	103,606.82	103,606.82	100	5,966.82	5.76
Total		**4,049,940.67**	**4,043,141.76**		**16,848.53**	

Figure 3-3: Beard Vegetation Associations within the Development Envelope

640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000 695000

7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000

619

93

173

GREAT NORTHERN HWY

562

29

175

111

NANUTARRA RD

82

MUNJINA RD

157

Legend

- Development Envelope
- Indicative Footprint

Pre European Vegetation (DPIRD-006)

- 29,Low woodland, open low woodland or sparse woodland
- 82,Low tree-steppe
- 93,Shrub-steppe
- 111,Shrub-steppe
- 157,Grass-steppe
- 173,Shrub-steppe
- 175,Grasslands, short bunch-grass savanna
- 562,Low tree-steppe
- 619,Woodland other
- Highway
- Major road
- Minor Road

JBS&G

Job No: 64593

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 07-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:180,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

BEARD VEGETATION ASSOCIATIONS WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 3.3

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

3.4 Climate

The Proposal is located within the inland portion of the Pilbara which has a semi-arid climate with hot dry summers and mild winters, low rainfall and high evaporation. The region may experience periods of more than12 months of dry weather. Rainfall is typically associated with cyclonic and storm weather systems (van Vreeswyk et al 2004).

Additional climate information for the Development Envelope is further discussed in the Groundwater and Surface Water Impact Assessment (AQ2 2024a). An assessment of climate trends is also provided in the Mulga Downs Ecohydrology Study (AQ2 2024b).

3.5 Temperature

Prior to the establishment of a weather station at Mulga Downs circa 2022, the closest Bureau of Meteorology (BoM) weather station with climate recording data is Wittenoom (station number 005026), approximately 35 km south-west of the south-western section of the Development Envelope. Wittenoom station closed in 2019 and Karijini North (station number 005098), approximately 13 km southeast of Wittenoom and 32 km south-west of the Development Envelope, is now the closest and used for the most recent climate trends in the region. Data from both stations was used to provide temperature statistics for the Proposal (Maia 2021a).

Average daily maximum temperatures across the Pilbara are typically around 20°C in winter and exceed 30°C across the region in summer and early autumn. Average daily maximum temperatures tend to exceed 35°C from October to March and it is not uncommon to see temperatures more than 40-45°C (AQ2, 2024a).

3.6 Rainfall

Rainfall across the Pilbara region may be described as seasonal and highly variable. It is possible for significant rainfall events to be recorded in one location with minimal rainfall being recorded at the nearest alternative weather station. Rainfall is typically associated with cyclonic and storm weather systems (van Vreeswyk et al 2004). AQ2 (2024a) define three broad climatic periods:

- From 1900 until approximately 1970, there is an increasingly negative deviation from the long-term average rainfall, which indicates a dry period. There was a similarly increasingly negative deviation from the long-term average maximum temperature. Over this time only, average rainfall at Mulga East was 321 mm/year (compared with 359 mm/year as the long-term SILO average rainfall).
- For a circa 25-year period from 1970 to 1995, actual rainfall appeared to be close to the long-term average. Average rainfall at Mulga East over this period was 378 mm/year. Average maximum temperature was relatively stable.
- From 1995 to the present, the cumulative deviation became increasingly less negative indicating a wetter than average period. Average rainfall at Mulga East over this period was 445 mm/year. Maximum temperature shows a strongly increasing trend, and mean annual maximum temperature was 0.5˚C greater than preceding periods.

Rainfall has been recorded at Mulga Downs station since 1898, however continuous recording ceased in 2018 and only intermittent data has been available since (BOM, 2021). Annual rainfall can vary significantly in this area, ranging from a minimum of less than 30 mm to a maximum of over 1,000 mm in a single year. The average

annual rainfall across the Mulga Downs record was 363 mm (**Table 3-4**). A plot of the annual rainfall over the Mulga Downs rainfall record is shown in **Figure 3-4** and a time series is shown in **Figure 3-5.**

Table 3-4: Average Rainfall, Mulga Downs BoM Station 1898 – 2018 (AQ2, 2024a)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Annual
Mean Rainfall (mm)	84.2	77.3	61.4	23.6	24.1	23.2	13.2	6.8	2.4	2.9	8.5	35.1	**362.7**

The highest mean monthly rainfall is experienced between December and March with the mean highest monthly rainfall of 84 mm occurring in July. The lowest rainfall period typically falls between February and May, with a mean rainfall < 5 mm in March and April.

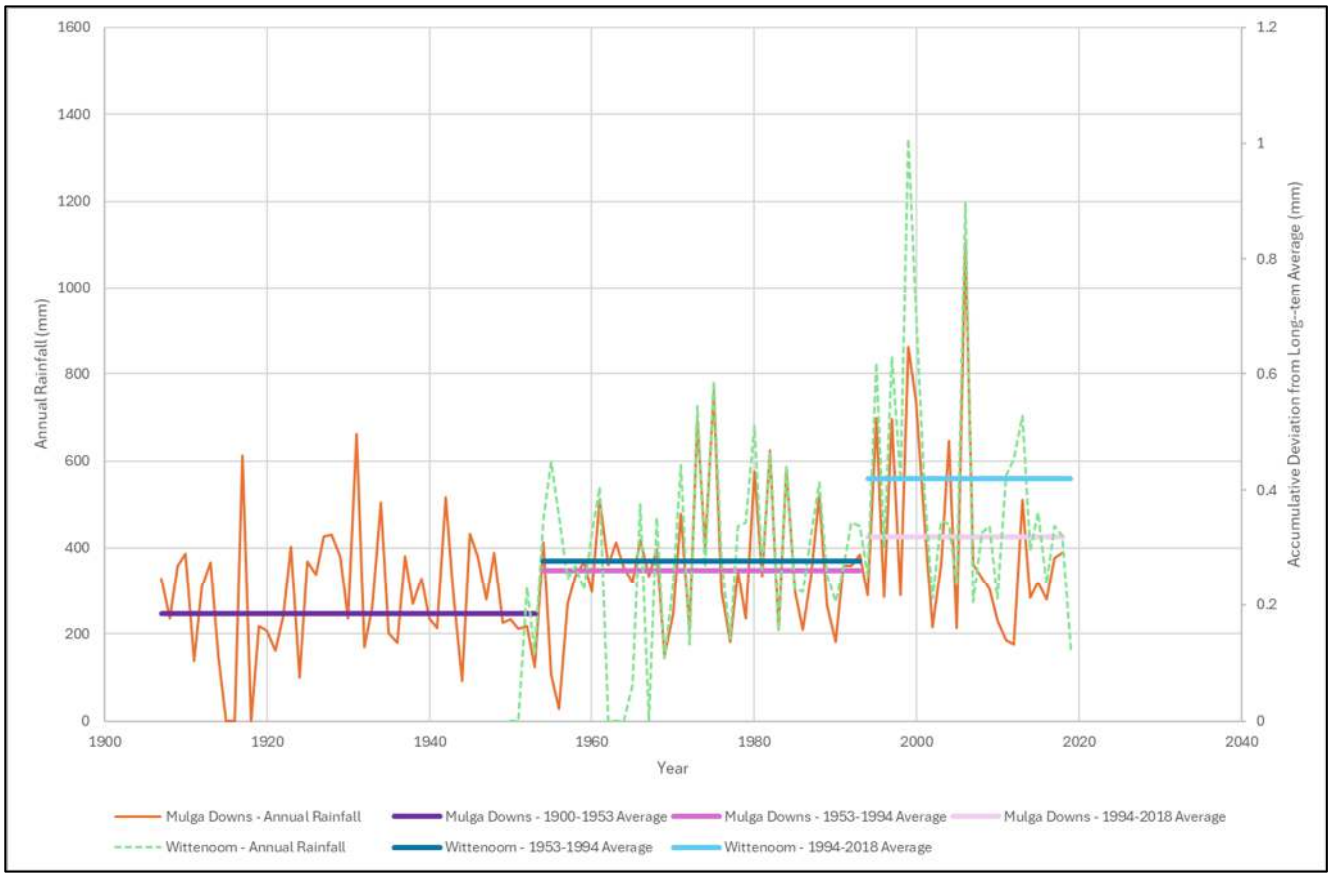


Figure 3-4: Annual Rainfall – Mulga Downs (AQ2 2024a)

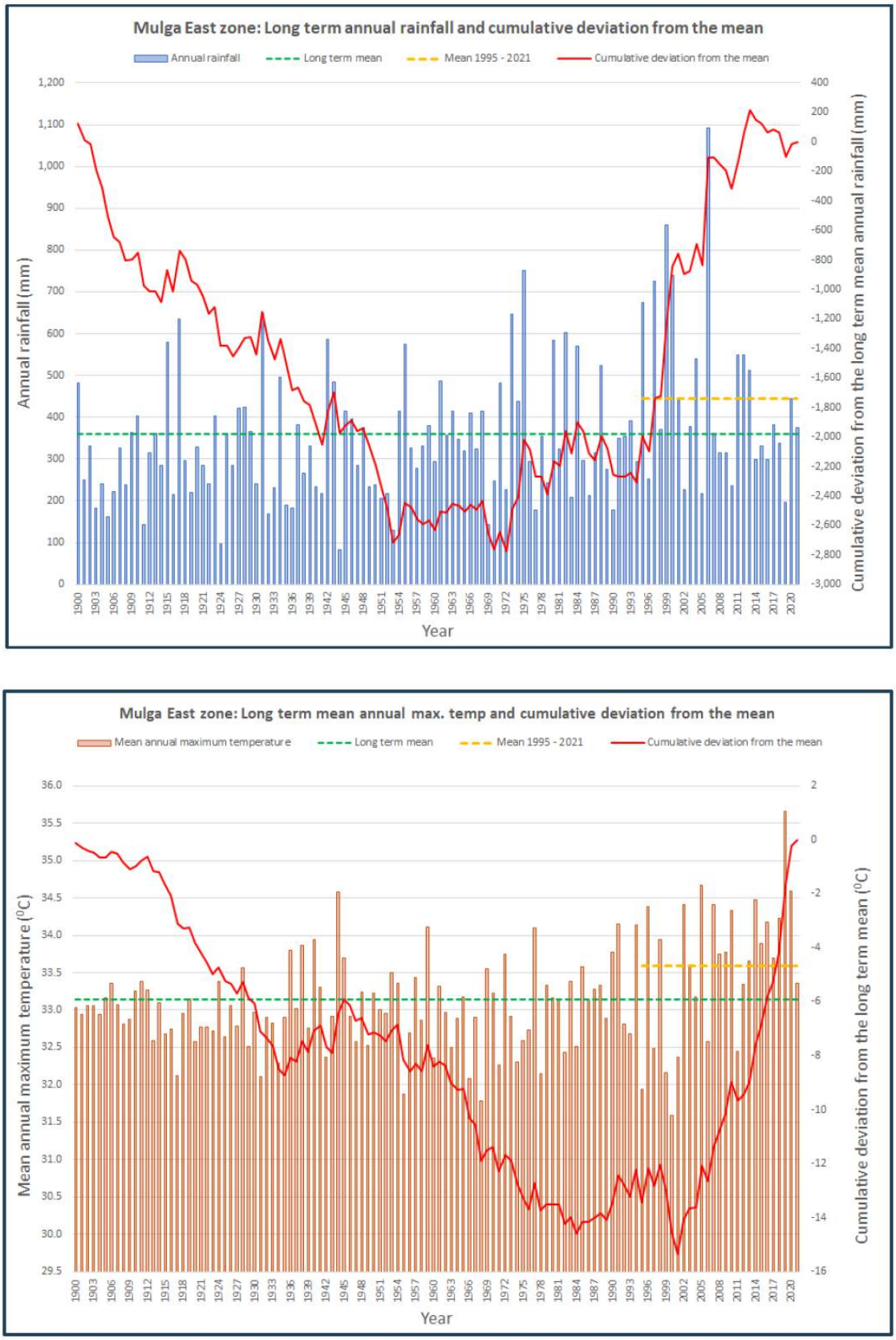


Figure 3-5: Time series of rainfall and temperature at Mulga East (AQ2, 2024a)

3.7 Wind

Wind rose data is only available from the Karijini North weather station. The wind roses in **Figure 3-6** and wind speed frequency in **Figure 3-7** suggest then the dominant winds are typically from the east and south-west, with little variation between the wet and dry seasons (SLR 2021a).

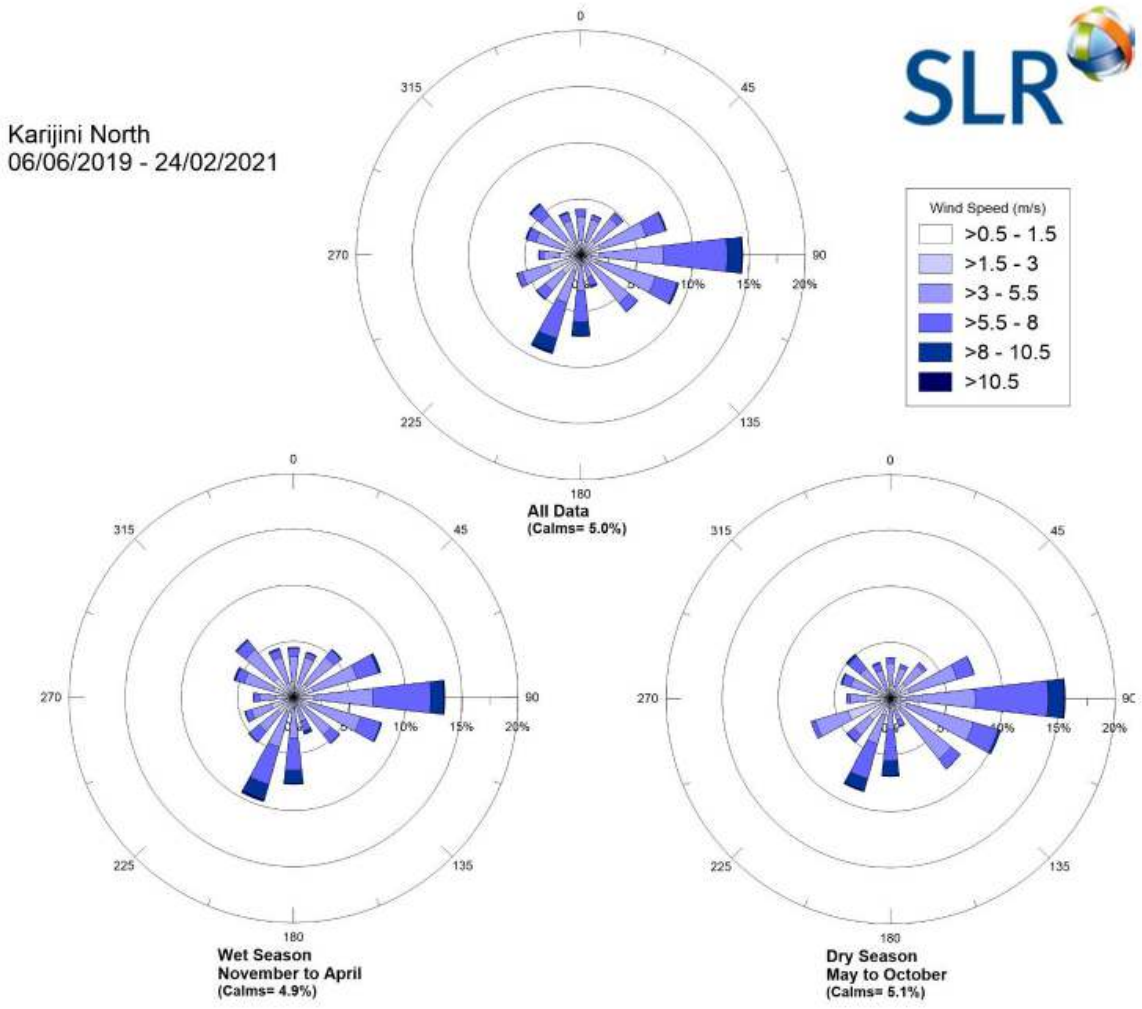
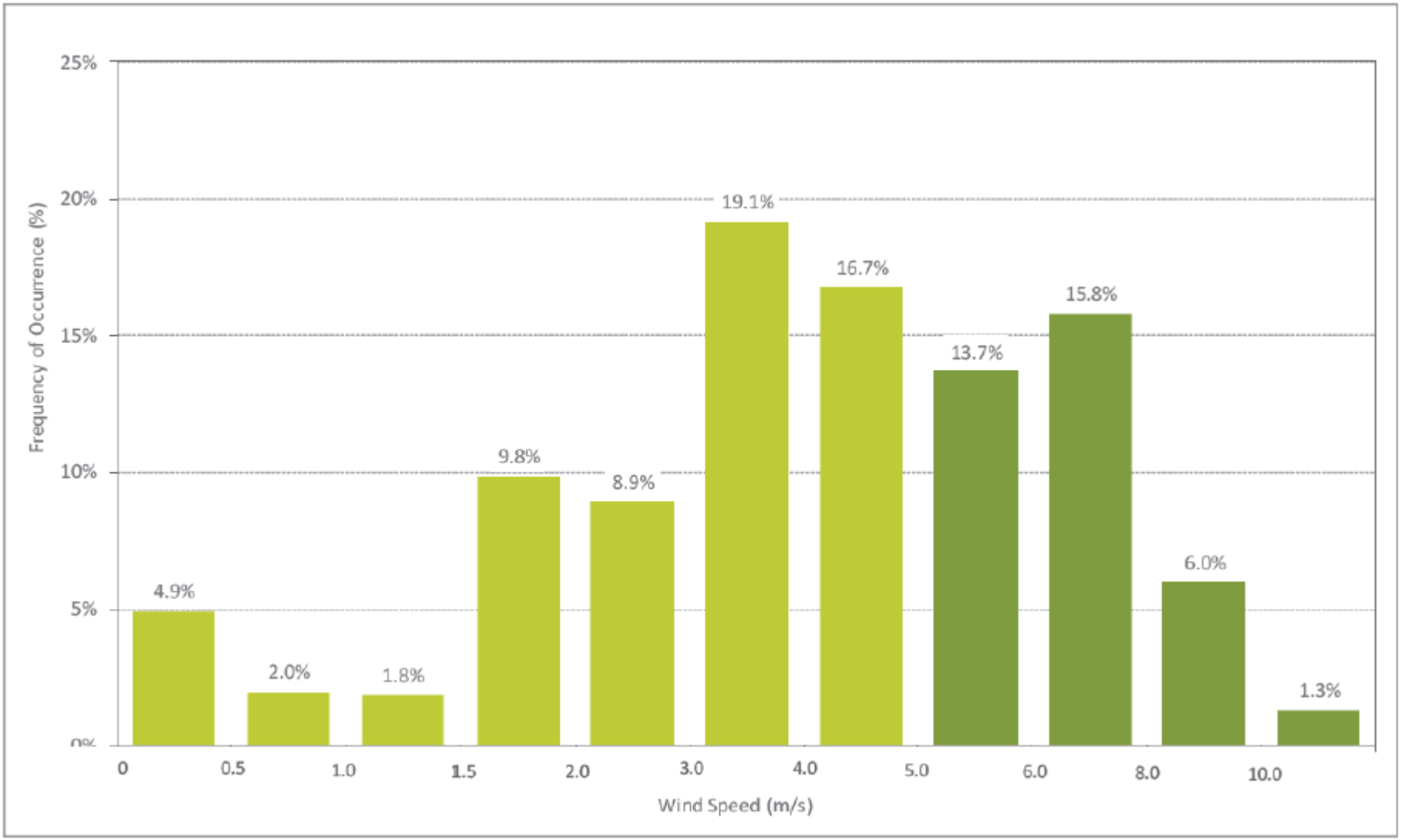


Figure 3-6. Wind data from Karijini North (Station 05098) (Source SLR 2021a)

Figure 3-7: Karijini North Wind Speed Frequencies June 2019 to February 2021. (Source: SLR 2021a)



Note: wind erosion of exposed surfaces is generally accepted to occur at windspeeds greater than 5 m/s, indicated here by the darker bars.

3.8 Evaporation

Evaporation is the most important factor regarding water loss across the region. Potential evaporation exceeds annual rainfall by a factor of at least eight and has a significant influence on both flora and fauna (McKenzie et al. 2009). Average pan evaporation data across Australia is illustrated in **Figure 3-8**. In the Pilbara pan evaporation rates vary between 3,200 mm and 4,000 mm per year. Average monthly and annual pan evaporation values obtained from BoM are presented in (BoM 2023) (**Table 3-5**) (AQ2 2024a).

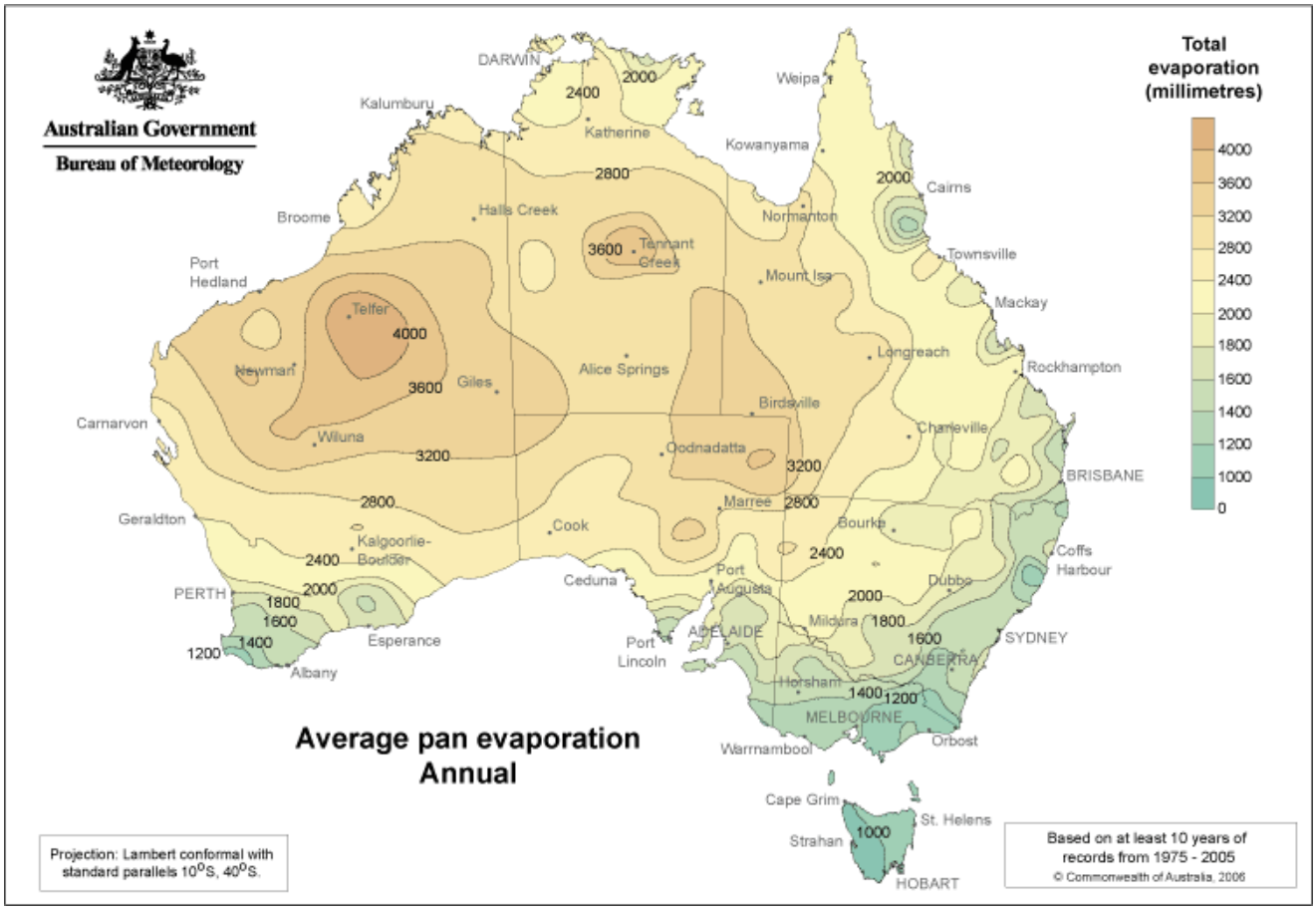


Figure 3-8: Annual Average Pan Evaporation Rate (Source: BoM, 2023)

Table 3-5: Wittenoom Mean Pan Evaporation (BoM) (AQ2, 2024a)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Annual
Mean Pan Evaporation (mm)	149	189	258	344	372	384	350	274	279	231	177	135	3,143

3.9 Geology

The Pilbara region occupies the northernmost portion of the ancient Western Shield (Beard 1990). The region is defined by the underlying sedimentary, volcanic, and igneous rocks of the Pilbara craton some of which are up to 3.72 billion years old (Pepper et al 2013).

To the north, the Archaean granites and metamorphosed volcanic rocks of the Pilbara Block form the undulating hills and plains observed throughout the Abydos Plain and Yule and De Grey River catchments. To the south, these older rocks are stratigraphically overlain by Archaean and Proterozoic basalts and iron rich sedimentary rocks (Banded Iron Formation – BIF) that comprise the Hamersley Basin (Beard 1990, van Vreeswyk et al 2004, Van Kranendonk et al 2002 in Pepper et al 2013). The Fortescue Valley forms part of the larger Hamersley Basin.

The Hamersley Basin comprises the geological strata that is key to the iron ore sector: the Marra Mamba and Brockman Formations. Both are hard and resistant and typically form dominant features in the landscape. The Hamersley Range forms the dominant geological (and topographic feature) to the south of the Development Envelope.

The Proposal is within the Fortescue Valley which is between the Hamersley Basin Province to the south and Pilbara Terrain to the north. **Figure 3-9** illustrates the spatial area occupied by these geological provinces. Local geology is further discussed in **Section7.3.5**.

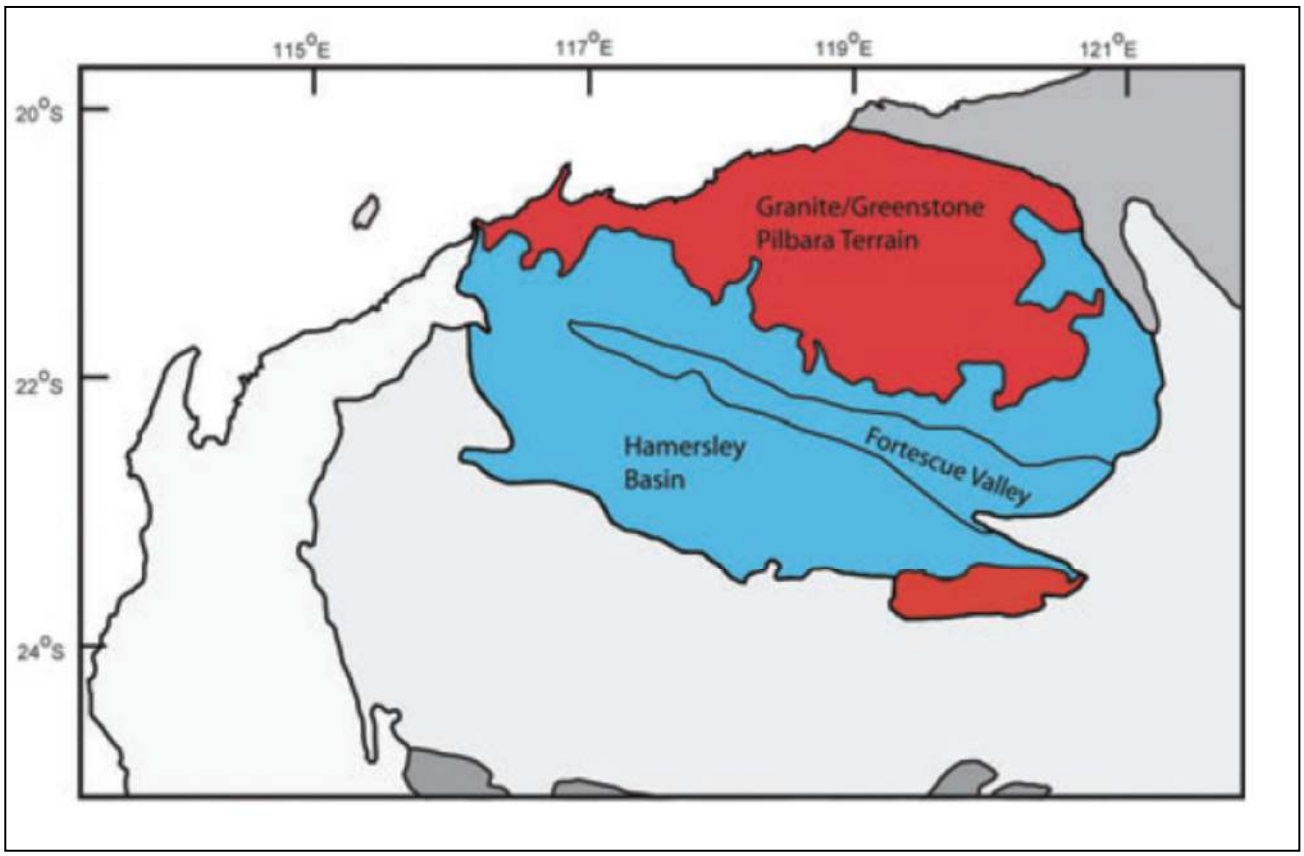


Figure 3-9: Simplified Pilbara Geology (Source Pepper et al 2013)

3.10 Soils

In general terms, soil development across the Pilbara region and associated ranges is poor. This is especially the case in the highest areas in the landscape. Soils are typically skeletal, shallow and stony having been derived either in situ or deposited as colluvial or fluvial materials with finer grained soils being more prevalent in the valleys. The parent geology and subsequent deep weathering of these rocks and leaching of the weathered materials has resulted in the soil being low in nutrients, slightly acidic, and of low fertility (Beard 1990, McKenzie et al 2009). Shallower soils were typically found in upland areas, with lowland soil profiles tending to be deeper (Landloch 2009; Mine Earth 2021).

The most extensive soils within the region comprise shallow stony soils on hills and ranges and sand on the sandplains (Landloch 2009, Mine Earth 2021). With reference to the landforms and assessment by van Vreeswyk et al (2004). The dominant Soil Groups occurring in the Land Systems across the Development Envelope are:

- Stony soils;
- Red shallow loams;
- Red loamy earths;
- Calcareous shallow loams; and
- Red-brown hardpan shallow loams.

Soils are classified as moderately permeable and tend to be moderately well-drained with water movement being limited by underlying rock. All soils are likely to have moderate plant availability water holding capacity (Mine Earth 2021).

3.11 Hydrology and Hydrogeology

3.11.1 Surface Water

The Fortescue Valley is dissected by the Goodiadarrie Hills into the Fortescue Marsh to the east, and the Goodiadarrie Swamp to the west (**Figure 3-10**). The Upper Fortescue River terminates at the Fortescue Marsh and the Lower Fortescue River rises to the west of Goodiadarrie Hills.

The Proposal is fully contained within the Goodiadarrie Swamp catchment. The Goodiadarrie Swamp comprises a series of variably interconnected ephemeral swamps, claypans, and floodplains that form a wetland mosaic over a distance of 70 km. Collectively, the Goodiadarrie Swamp catchment has an area of approximately 4,138 km². The Goodiadarrie Swamp catchment is bounded by the Chichester Range to the north and the Hamersley Range to the south (AQ2 2024b). Following rainfall events, surface water runoff reports to the Fortescue Valley from the northern Chichester Range and the southern Hamersley Range for a short duration.

Runoff from smaller rainfall events is likely to be contained within the Goodiadarrie Swamp area. Larger rainfall events may result in discharge to the Lower Fortescue River Valley which flows in a westerly direction towards the Indian Ocean (located approximately 500 km to the west). No permanent surface water sources are mapped within the Development Envelope; however, numerous non-perennial water courses are mapped across the area.

The incised drainage lines exit from the Chichester Range across a series of alluvial fans and across the sheetwash plains characterised by the Jamindie Land System. These drainage lines spread out and become braided as they flow into and across the various alluvial fans and claypans that exist along the valley. The multiple discharge points have contributed to the complex surface water environment that exists in this section of the Lower Fortescue River Valley.

The alluvial outwash fan deposits from the various drainage channels (and calcrete deposits) have influenced the evolution of the river valley and location of claypans (**Figure 3-11**). These have interrupted, diverted, and blocked the flow of water leading to the development of the swamp as observed today.

Further discussion on surface water is provided in **Section 7.**

Figure 3-10: Fortescue Valley including Goodiadarrie Swamp (SourceAQ2 2024a) *(Development Envelope no longer falls in E47/135)*

610000 620000 630000 640000 650000 660000 670000 680000 690000 700000 710000

7600000 7590000 7580000 7570000 7560000 7550000 7540000 7530000 7520000

E 47/1315-I

E 47/2044-I

M 47/1621

NANUTARRA RD

Koodjeepindarranna Pool Extents

Central Claypan Flood Extent

GREAT NORTHERN HWY

MUNJINA RD

MUNJINA-ROY HILL RD

Legend

- Development Envelope
- Indicative Footprint
- Tenement boundary
- Potential Claypan Inundation Area (AQ2)
- Appoximate Goodiadarrie Swamp Region (AQ2)
- BHP rail
- TPIG rail
- Roy Hill rail
- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 21-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:310,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

FORTESCUE VALLEY INCLUDING GOODIADARRIE SWAMP (SOURCE AQ2 2024A (DEVELOPMENT ENVELOPE NO LONGER FALLS IN E47/1315)

FIGURE 3.10

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 3-11: Surface water flows including claypans of the Fortescue River Valley

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000 688000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000 7538000

GREAT NORTHERN HWY

KOODJEEPINDARRANNA CLAYPAN

GNALKA GNOONA CLAYPAN

Legend

- Development Envelope
- Indicative Footprint
- Claypans (AQ2)

Directory of Important Wetlands in Australia (DBCA-045)

- Fortescue Marshes [WA066]
- Surface Water Flow Direction (AQ2)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 23-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:123,686 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

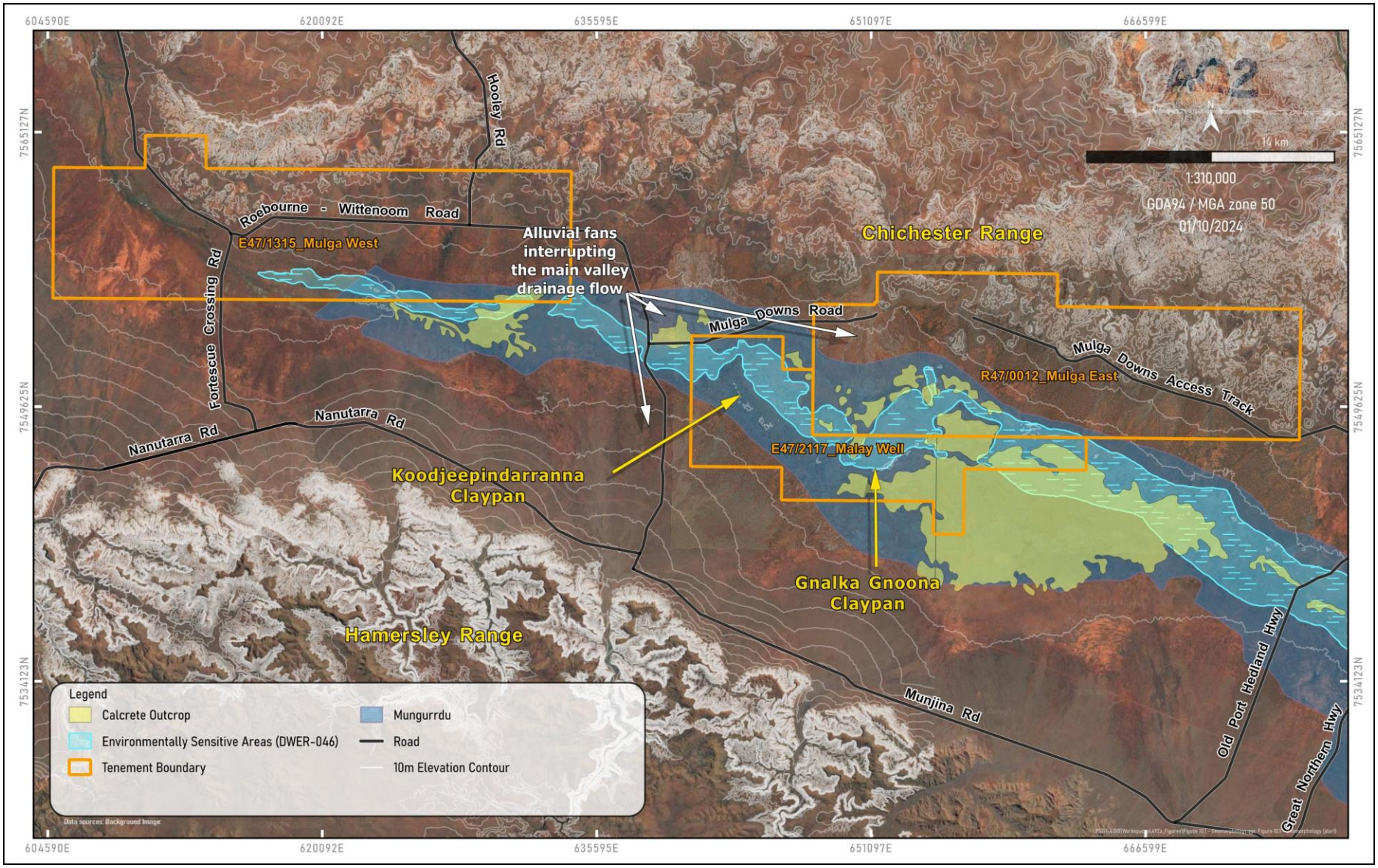
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SURFACE WATER FLOWS INCLUDING CLAYPANS OF THE FORTESCUE RIVER VALLEY

FIGURE 3.11

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 3-12: Geomorphology influencing claypans (Source AQ2 2024a)


604590E
620092E
635595E
651097E
666599E
7565127N
7549625N
7534123N
Roebourne - Wittenoom Road
Hooley Rd
Fortescue Crossing Rd
E47/1315_Mulga West
Alluvial fans interrupting the main valley drainage flow
Chichester Range
Mulga Downs Road
Mulga Downs Access Track
R47/0012_Mulga East
E47/2117_Malay Well
Nanutarra Rd
Nanutarra Rd
Koodjeepindarranna Claypan
Gnalka Gnoona Claypan
Hamersley Range
Munjina Rd
Old Port Hedland Hwy
Great Northern Hwy
N
14 km
1:310,000
GDA94 / MGA zone 50
01/10/2024
Legend
Calcrete Outcrop
Environmentally Sensitive Areas (DWER-046)
Tenement Boundary
Mungurrdu
Road
10m Elevation Contour
Data sources: Background Image

3.11.2 Claypans

The Koodjeepindarranna Claypan and Gnalka Gnoona Claypans are not located within the Development Envelope, however, the Development Envelope is located within their catchment areas **(Figure 3-12**). These two claypans are hydraulically linked by an overflow channel with surface flows from east to west following high rainfall events. Overflow from Gnalka Gnoona claypan into Koodjeepindarranna claypan would occur when water levels are above 402.75 m, Australian Height Datum (AHD).

The Gnalka Gnoona Claypan can form into an extensive (> 1,000 ha) waterbody that may persist for extended periods. There are records of these claypans being inundated for several years following continuous favourable climate sequences. In combination with channels and smaller depressions, the claypans form an interconnected mosaic of wetlands supporting biological metacommunities. This is characteristic of arid zone wetlands and the pattern of delayed emergence of dormant biota. These areas are considered significant habitat for migratory, transient and resident birds. They also form vital refugia for many invertebrates (Pinder et al. 2017; Biologic 2023). Maintaining the connection between the two claypans is important in maintaining biodiversity values with a more resilient population developing from a greater gene pool than if isolated for extended periods.

The claypans appear to be inundated on a regular basis and it is likely that hydrologic responses from average, relatively frequent rainfall events are important in maintaining ecosystem function at the claypans (i.e. ecosystem function does not just rely on high magnitude low frequency runoff events).

3.11.3 Groundwater

Hydrogeology across the Development Envelope and surrounding area is dominated by four units within the stratigraphic sequence (**Figure 3-13** and **Figure 7-13** to **Figure 7-16**; AQ2 2024a):

- Tertiary and Quaternary cover (comprising Basal Crete, CID/Pisolite, Undifferentiated Tertiary and Upper Calcrete);
- Dolomite of the Wittenoom Formation;
- Altered Marra Mamba Iron Formation (including the West Angela member); and
- Fresh Jeerinah and Marra Mamba Iron Formations.

These bedrock and valley units host the groundwater system across the Development Envelope and surrounding area. Secondary permeability, which is typically related to mineralisation of the bedrock, fracturing, and weathering was observed throughout the majority of the Marra Mamba Iron Formation and the overlying West Angela Member. The baseline studies and conceptual model indicates these units are in hydraulic connection and form a transmissive basement aquifer.

The permeable bedrock units are sandwiched between the two aquitards: the underlying Jeerinah Formation and Nammuldi Member, and the overlying Wittenoom Formation within the valley area (as identified during the baseline survey and from the exploration geological records).

The Jeerinah Formation comprises black, pyritic and carbonaceous shales with minor chert beds which weather to a pink, brown and white clay. Together with the overlying Marra Mamba Member it forms the basement aquitard. The overlying aquitard comprises the light grey, fresh, crystalline and hard Wittenoom dolomite the

majority of which has low permeability. Locally there may be areas or zones of higher permeability as a result of localised weathering and fracturing of the Paraburdoo Member of the dolomite sequence. Elsewhere in the Pilbara the Paraburdoo Member is considered as a regional aquifer. The baseline survey has demonstrated this is not the case in the vicinity of the Development Envelope.

The bedrock sequence is overlain by the Tertiary (and later Quaternary) materials that have been derived from the erosion of the adjacent Chichester and Hamersley Ranges and deposited within the Fortescue River valley, hence their collective name: detritals. The Tertiary detritals form an unconfined aquifer.

Recharge to the groundwater system occurs through infiltration or seepage following rainfall events, typically during the summer wet season (AQ2 2024a).

The groundwater levels across the Development Envelope vary between 398 metres Relative Level (mRL) to 420 mRL. Depths to groundwater vary between 3 to 4 m below existing ground level across the river valley to in excess of 40 m across the upper areas of the Chichester Range. Groundwater flows are, as expected, from the topographically higher areas in the north and north east to the river valley in the south, which in turn flows in a westerly direction along the valley (**Figure 3-14**). The groundwater gradient is low in response to the transmissivity of the materials across the Proposal and surrounding area.

Groundwater across the Development Envelope has the following water quality characteristics (AQ2 2024a):

- Groundwater quality varies from fresh to saline. The fresher groundwater (total dissolved solids (TDS) 180 mg/L or EC 330 µS/cm) was observed in the upper areas of the groundwater system whilst the more saline groundwater was observed in the valley (TDS 18,000 mg/L or 23,000 µS/cm).
- The saline groundwater is caused by the evaporation in the claypans following periods of rainfall and surface water runoff to the claypans. Further, mobilisation of salts in the unsaturated zone contributes to saline groundwater.
- Groundwater down gradient of the orebodies, in the valley area, is generally chloride and sodium dominant, indicative of an end point (“older”) water, suggesting the groundwater has been subject to evapotranspiration and / or mineral dissolution since it was recharged or it has been affected by the leaching of salts from the claypan areas .

Figure 3-13: Hydrogeological Cross Sections in Mulga East (AQ2 2024a)

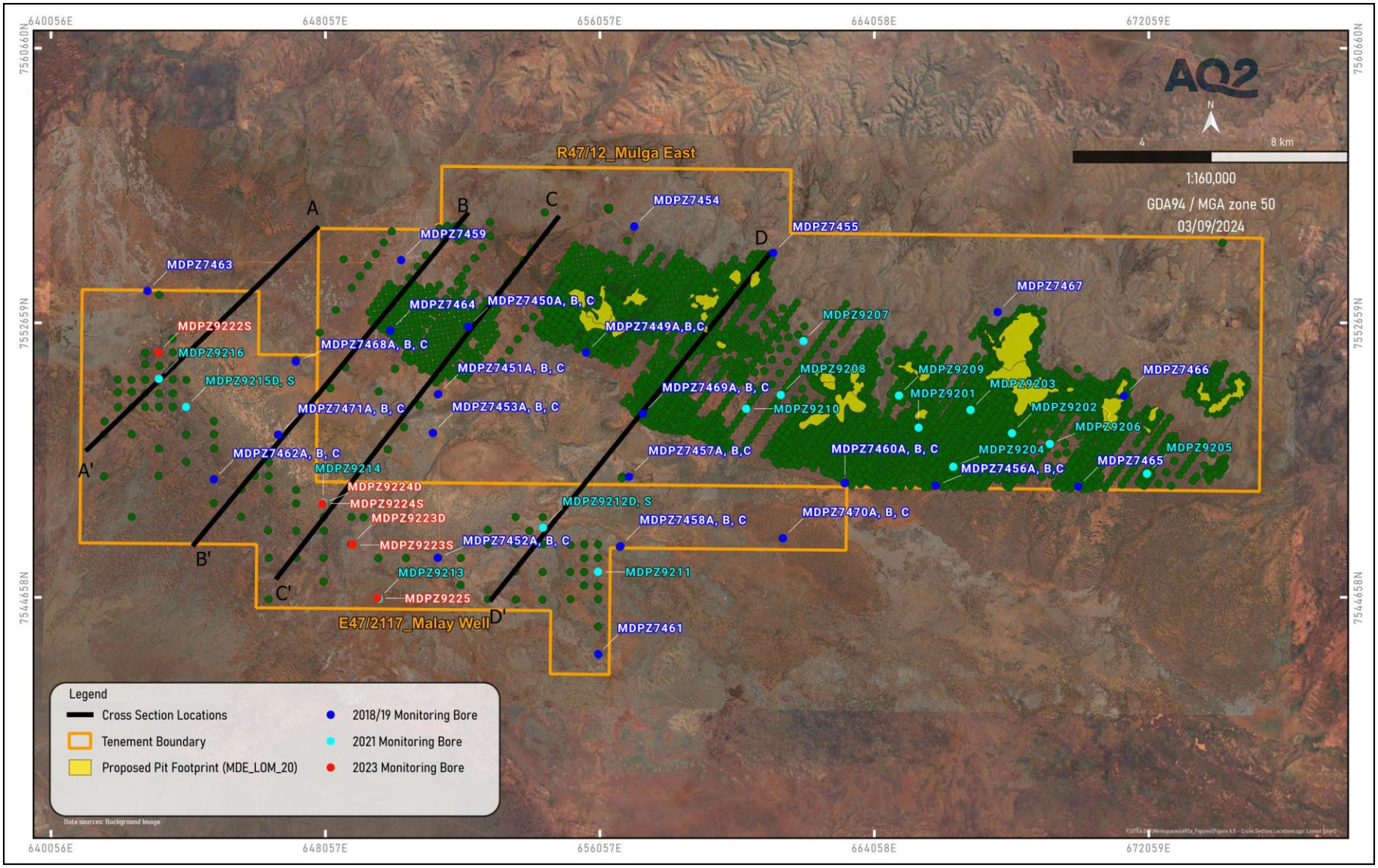
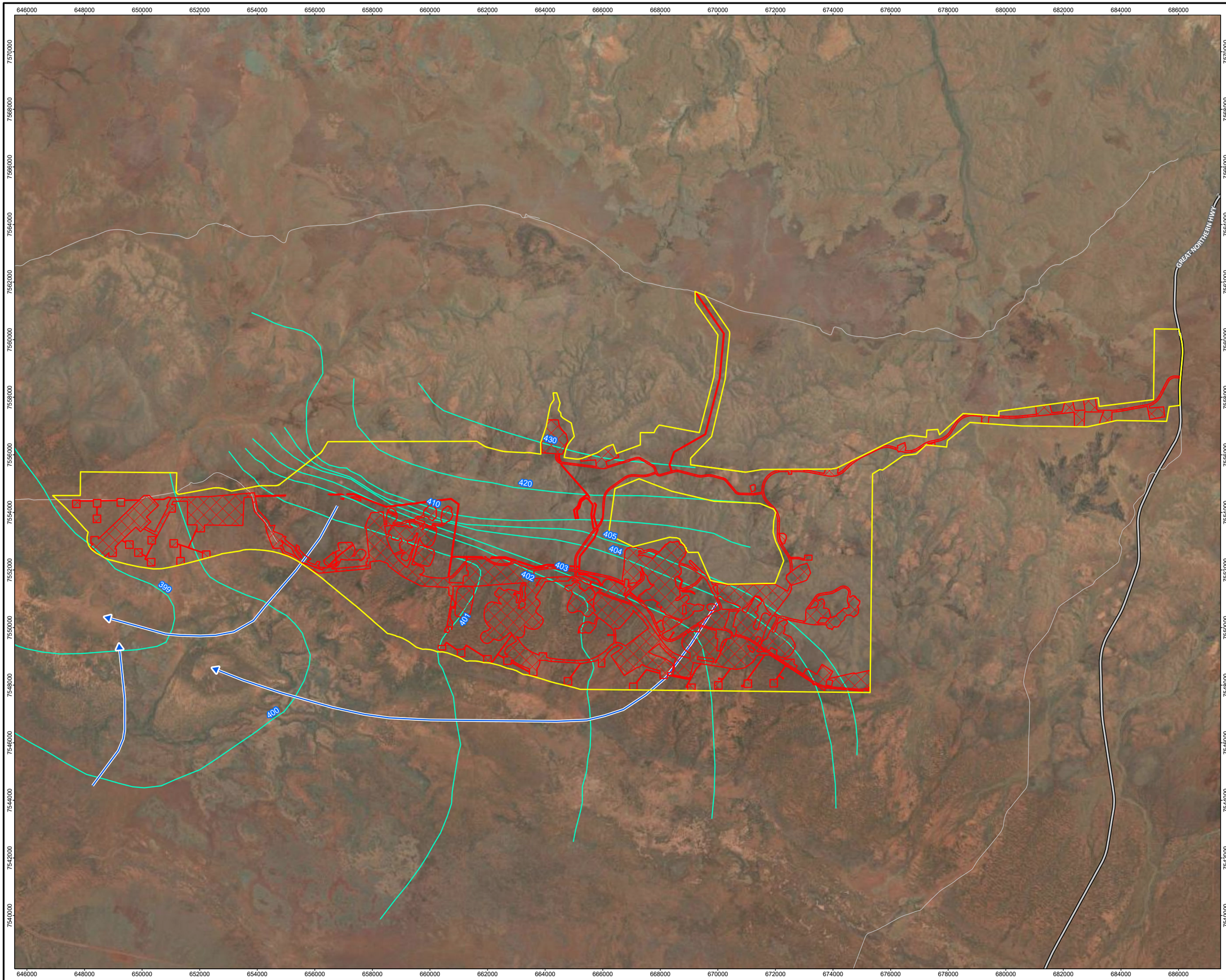

640056E
648057E
656057E
664058E
672059E
7560660N
7552659N
7544658N
AQ2
N
4
8 km
1:160,000
GDA94 / MGA zone 50
03/09/2024
R47/12_Mulga East
E47/2117_Malay Well
A
A'
B
B'
C
C'
D
D'
MDPZ7454
MDPZ7455
MDPZ7459
MDPZ7463
MDPZ7464
MDPZ7450A, B, C
MDPZ7449A,B,C
MDPZ7467
MDPZ9222S
MDPZ9216
MDPZ7468A, B, C
MDPZ9207
MDPZ9215D, S
MDPZ7451A, B, C
MDPZ9208
MDPZ9209
MDPZ7466
MDPZ7469A, B, C
MDPZ9201
MDPZ9203
MDPZ7471A, B, C
MDPZ7453A, B, C
MDPZ9210
MDPZ9202
MDPZ9206
MDPZ7462A, B, C
MDPZ7457A, B,C
MDPZ7460A, B, C
MDPZ9204
MDPZ9205
MDPZ9214
MDPZ7456A, B,C
MDPZ7465
MDPZ9224D
MDPZ9224S
MDPZ9212D, S
MDPZ9223D
MDPZ7458A, B, C
MDPZ7470A, B, C
MDPZ9223S
MDPZ7452A, B, C
MDPZ9213
MDPZ9211
MDPZ9225
MDPZ7461
Legend
Cross Section Locations
Tenement Boundary
Proposed Pit Footprint (MDE_LOM_20)
2018/19 Monitoring Bore
2021 Monitoring Bore
2023 Monitoring Bore
Data sources: Background Image

Figure 3-14: Groundwater Level Contours (AQ2 2024a)



Legend

- Development Envelope
- Indicative Footprint
- Groundwater flow direction
- Groundwater contours (m AHD)

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 07-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GROUNDWATER LEVEL CONTOURS

FIGURE 3.14

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

3.12 Land Use and Heritage

3.12.1 Conservation Reserves and Wetlands

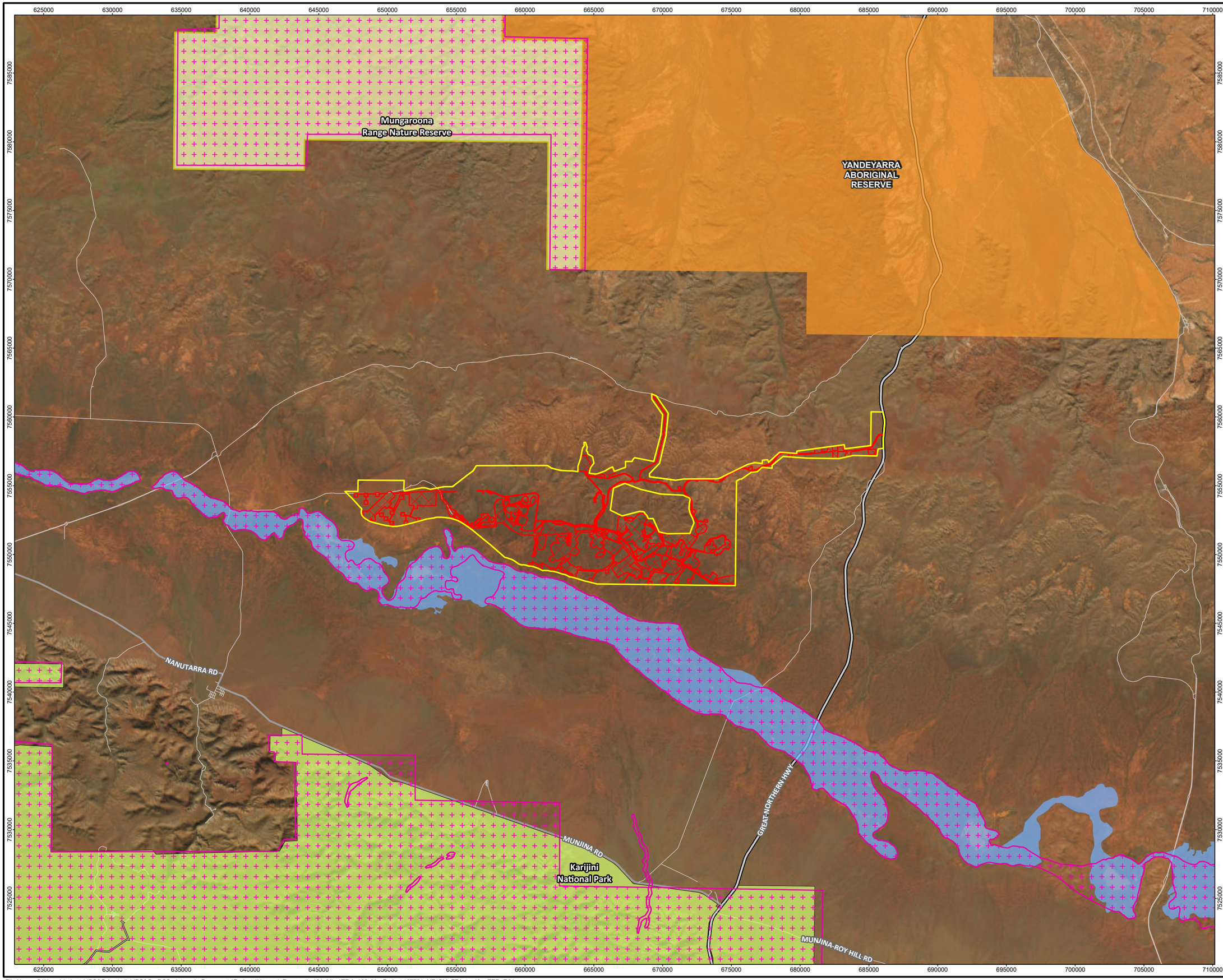
The Development Envelope does not overlap any recognised conservation areas. Two land areas managed for conservation purposes by Department of Biodiversity and Conservation and Attractions (DBCA), Karijini National Park and the Mungaroona Range, occur in close proximity to the Proposal.

The Development Envelope is located to the north of the Fortescue Valley, a designated ESA (Fortescue Marshes WA066 – DIWA, refer to **Section 3.12.2**). The Development Envelope is offset from and completely avoids this ESA (**Table 3-6; Figure 3-15**). There are no Ramsar listed wetlands within the Development Envelope or that the Proposal intersects. There is no nomination for a Ramsar listing within or immediately adjacent to the Development Envelope.

Table 3-6: Managed Lands within proximity to the Development Envelope

Type	Name	Description	Consideration
National Park	Karijini	Karijini National Park occupies an area of 627,422 ha. The park comprises a high plateau with mountains and escarpments which is dissected by steep sided, deep gorges.	Approximately 16 km from southern Development Envelope boundary. No impacts anticipated as a result of the Proposal; however, the location of the park in proximity to the Proposal is considered where relevant.
Nature Reserve	Mungaroona Range	The Mungaroona Range occupies an area of 105,842 ha.	Approximately 13 km to the north of the Development Envelope boundary. No impacts anticipated as a result of the Proposal, however, the location of the range in proximity to the Proposal is considered where relevant.
Nature Reserve	Fortescue Marsh	Fortescue Marsh Nature Reserve occupies an area of approximately 107,000 ha.	Approximately 43 kilometres from the closest point of the Development Envelope. No impacts anticipated as a result of the Proposal, however, the location of the reserve in proximity to the Proposal is considered where relevant.
Aboriginal Community / Pastoral Station	Yandeyarra Reserve	Yandeyarra (also referred to as Mugarinya) is a large Aboriginal community, with a population of over 400 people. The community is located within the Yandeyarra pastoral station.	Approximately 6 km from the closest point of the Development Envelope (where the haul road meets the GNH). No impacts anticipated as a result of the Proposal, however, the location of the reserve in proximity to the Proposal is considered where relevant.
ESA	Fortescue Valley	The area of the Fortescue Valley, located in proximity to the Development Envelope, is a wetland of national importance and is listed (WA066) in the Directory of Important Wetlands (DIWA) (national). Refer to **Section 3.12.2**.	The Development Envelope is offset from and avoids the ESA. Potential impacts to the Fortescue Valley are discussed throughout this ERD.

Figure 3-15: Conservation Reserves and Wetlands



Legend

- Development Envelope
- Indicative Footprint
- Yandeyarra Aboriginal Reserve (LGATE-227)
- Environmentally Sensitive Areas (DWER-046)

Directory of Important Wetlands in Australia (DBCA-045)

- Fortescue Marshes [WA066]

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:250,000 at A3

0 4 8
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION RESERVES AND WETLANDS

FIGURE 3.15

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

3.12.2 Fortescue Valley

The Fortescue Valley contains two consecutive Fortescue Rivers: the Upper Fortescue which terminates at the Fortescue Marsh (the Marsh) and the Lower Fortescue which starts below the Marsh eventually discharging to the ocean. Above the permanent pools of Millstream National Park, the Fortescue River flows episodically only after significant rains so that for the majority surface water in only present in isolated pools (Pinder et al 2017).

The Fortescue Valley is split by the Goodiadarrie Hills (a ~5 m barrier that forms a surface water and potential groundwater divide) into the (eastern) Fortescue Marsh and the (western) Goodiadarrie Swamp. The Fortescue Marsh is the largest ephemeral wetland in the Pilbara region and is recognised as a nationally important wetland. A second groundwater and surface water divide exists to the west of the Goodiadarrie Swamp, separating the Goodiadarrie Swamp from the Lower Fortescue River (AQ2 2024b). Downstream of Goodiadarrie the Fortescue starts a new catchment receiving intermittent flows from the Chichester and Hamersley Ranges. The Fortescue River does not form distinct continuous channels until 90 km downstream of Mt Florance Station (Pinder et al 2017).

The Marsh is located approximately 60 km from the Development Envelope and is the largest ephemeral wetland in the Pilbara with the water regime supporting a number of environmental values (EPA 2013). The Marsh is currently managed by the DBCA in accordance with the Fortescue Marsh Management Strategy 2018-24 (DBCA 2018). The Marsh is considered to be geographically, hydrologically and hydrogeologically separate to the Lower Fortescue River system.

In respect to being recognised as a wetland of national significance, the Fortescue Valley is listed in the Directory of Important Wetlands in Australia (DIWA). The DIWA boundary extends well west of Goodiadarrie Hills and includes the floodplains and the wetland complexes of the Mulga Downs area up until the Roebourne – Wittenoom Road (Pinder et al 2017). This area is listed in DIWA as the Fortescue Marshes - WA066.

The Fortescue Marsh (DIWA - WA066) above the Goodiadarrie Hills, was previously proposed to be nominated as a potential Ramsar site providing refuge, habitat and feeding areas for waterbirds, including many migratory species, when inundated (Trainor *et al*. 2016; EPA 2013). The RAMSAR nomination is no longer being pursued, however following an exercise to excise targeted parcels of lands from pastoral leases, a Nature Reserve was created in September 2024.

The Fortescue Marsh Management Strategy 2018-2024 (the strategy) was developed by the State Government and provided interim guidance during the creation of the nature reserve. The objective of the strategy was originally intended to "*develop an ecological character description and Ramsar Information Sheet to progress a recommendation to the Commonwealth for nomination*". The Strategy will now be replaced by a Management Plan developed to support future management via a Nyiyaparli ranger program, alongside the Department of Biodiversity, Conservation and Attractions. The Development Envelope is offset from, and does not intersect with the Nature reserve boundary.

3.13 Local Development

The Development Envelope is located within the Shire of Ashburton. The nearest town is Tom Price, which is located approximately 110 km to the southwest of the Development Envelope. Port Hedland is located approximately 210 km to the north, whilst Newman is located approximately 180 km to the east.

Transport infrastructure, notably the Great Northern Highway connects to the east of the Development Envelope, and the Wittenoom-Mujina Road is 17 km south of the southern westerly boundary. The Roebourne-Wittenoom Road is approximately 8 km west of the Development Envelope. There are several existing rail alignments. The Pilbara Infrastructure (TPI) Solomon Rail traverses north of the Proposal before crossing the Great Northern Highway.

3.13.1 Pastoralism

Land uses surrounding the Proposal are shown on **Figure 3-16.** The primary land use within the vicinity of the Proposal is currently pastoral, involving free-range grazing of stock. In the Pilbara, pastoralism commenced in the 1860s and continued to contribute to the Pilbara economy to provide employment in the region. The Development Envelope is located within the boundaries of the Mulga Downs Pastoral Station. Access agreement negotiations are proposed to be undertaken for areas of the Proposal within the Mulga Downs Pastoral Station.

3.13.2 Tourism

The nearest major tourist attraction is the Karijini National Park. The northern boundary of the National Park is located approximately 16 km to the southwest of the Development Envelope and the park covers almost 630,000 ha of the Hamersley Range. This conservation area is an important tourism asset with accommodation, hiking trails and other ecotourism facilities. The Mungaroona Range Nature Reserve is approximately 13 km north of the Development Envelope and extends over an area of 105,842 ha.

The Auski Roadhouse, which includes overnight accommodation and camping facilities, is located 23 km to the south west of the Development Envelope at the junction of Great Northern Hwy and Nanutarra-Munjina Road.

These areas, and their proximity to the Proposal are shown in **Figure 3-16**.

3.13.3 Communities, Traditional Ownership and Cultural Heritage

There are two remote communities within the vicinity of the Development Envelope: Youngaleena and Wirrilimarra located 10 km south and 7.5 km southeast of the Development Envelope respectively (**Figure 3-16).** In addition, there are several named meeting places of significance and heritage restricted zones within and outside the Development Envelope. The Yandeyarra Reserve is located approximately 6 km to the north of the Development Envelope and comprises an area of 473,529 ha managed by the Mugarinya Community Association Incorporated. The Mugarinya (Yandeyarra) Community is located 87.5 km to the northeast of the Development Envelope.

The Proposal is within one Native Title determination area, discussed in **Section 5.2.2.**

3.13.4 Wittenoom Asbestos Management Area

Wittenoom Asbestos Management Area (WAMA), a registered contaminated site located approximately 13 km to the south-west of the Development Envelope. There is no community at Wittenoom as the town was degazetted in 2007 and closed in 2013 (DPLH 2022) (**Figure 3-16**). The Development Envelope does not intersect the WAMA.

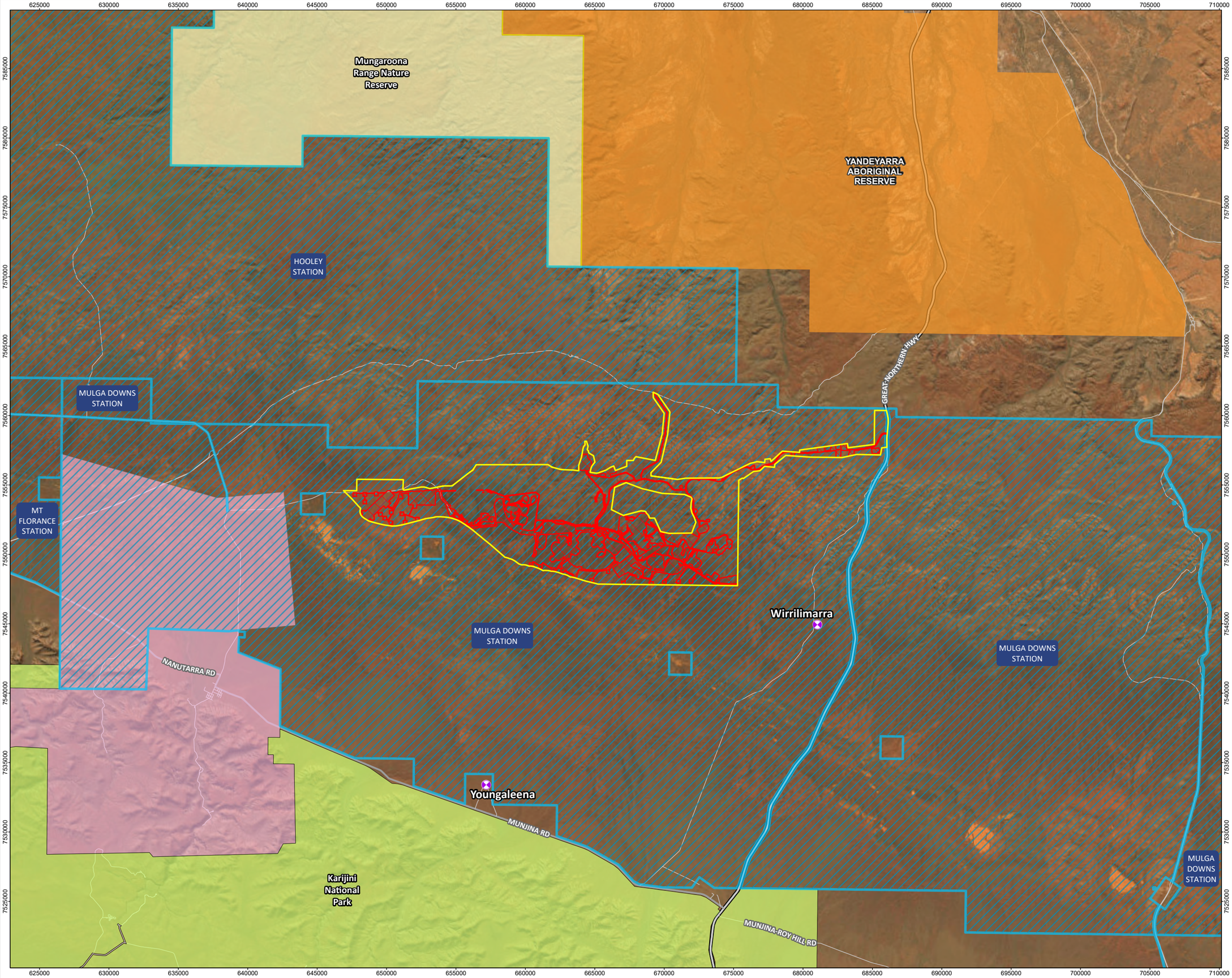
3.13.5 Other Nearby Projects

There are several existing and reasonably foreseeable projects within 100 km of the Proposal (as specified in the ESD), including:

- Gudai-Darri (Koodaideri) Iron Ore Mine and Infrastructure Project;
- Roy Hill Iron Ore Mine;
- Roy Hill Infrastructure Mulga Downs Hub and Rail;
- Fortescue Metals Group (FMG) Christmas Creek Iron Ore Mine;
- FMG Cloudbreak Iron ore Mine;
- FMG Eliwana Railway Project
- FMG Solomon Mine and Railway; and
- FMG Eliwana Mine and Railway;
- BHP Strategic Assessment area current and future projects.

These projects are considered in the cumulative impact assessment for the Proposal and further details are provided in **Section 17**.

Figure 3-16: Land Use within/adjacent to the Proposal



Legend

- Development Envelope
- Indicative Footprint
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)
- Yandeyarra Aboriginal Reserve (LGATE-227)
- Pastoral station boundaries (DPIRD-018)

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve
- Aboriginal Communities and Town Reserves (DPLH-002)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 31-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:250,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LAND USE WITHIN/ADJACENT TO THE PROPOSAL

FIGURE 3.16

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

4 Legislative Context

4.1 Environmental Impact Assessment Process

The Proposal is being assessed under Part IV of the EP Act. The Proposal has also been separately referred for assessment under the EPBC Act (EPBC 2021/09255). The assessment process by the Commonwealth is not an accredited assessment. This ERD has been prepared for assessment under Part IV of the EP Act and provides an assessment of key environmental factors which fall under the EP Act. MNES are being assessed separately by the Commonwealth under the EPBC Act.

EPA guidance which has been considered in the preparation of this ERD is listed in **Table 4-1.**

Table 4-1: EPA Procedures and Guidance for EIA.

Date	Title
EPA 2014	Cumulative environmental impacts of development in the Pilbara region: Advice of the Environmental Protection Authority to the Minister for Environment under Section 16(e) of the *Environmental Protection Act 1986*
EPA 2021a	Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures; (Administrative Procedures)
EPA 2021b	Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual (Procedures Manual).
EPA 2021c	Statement of Environmental Principles, Factors and Objectives
EPA 2021d	Instructions – How to identify the content of a Proposal
EPA 2021e	Instructions – How to prepare an Environmental Review Document
EPA 2021f	Instructions – Environmental outcomes and outcomes-based conditions
EPA 2021g	Instructions on how to prepare EP Act Part IV Environmental Management Plans (EMPs)
EPA 2021h	Instructions for the referral of a Proposal to the Environmental Protection Authority under Section 38 of the *Environmental Protection Act 198*6

4.2 Environmental Protection Act 1986 (Part IV)

The EP Act is the primary environmental legislation governing environmental protection and impact assessment in Western Australia. Environmental impact assessment (EIA) for the development of Proposals is undertaken by the EPA in accordance with Part IV Division 1 of the EP Act and the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016.*

Part IV of the EP Act provides for the consideration and assessment of Proposals that may, or will, have a significant impact on the environment. The Part IV process is administered by EPA Services of DWER.

The Proposal was referred to the EPA on 24 December 2021. On 24 February 2022 the EPA provided notice that the Proposal would be assessed (Assessment Number 2326) under Part IV of the EP Act and the level of assessment was set at PER with a 6-week public review period for the ERD. The EPA identified the preliminary key environmental factors for the Proposal as:

- Inland Waters;
- Subterranean Fauna;

- Flora and Vegetation;
- Terrestrial Fauna;
- Terrestrial Environmental Quality;
- Greenhouse Gas Emissions;
- Air Quality; and
- Social Surroundings.

The ESD, prepared by HPPL, was approved by the EPA on 24 August 2022. This ERD has been prepared in accordance with the ESD, Administrative Procedures (GoWA 2016) and the Procedures Manual (EPA 2021b) to meet the requirements of s 40(2)(b) of the EP Act. This ERD is required to be published for a period of six weeks, during which time the public is invited to comment on the ERD.

An invitation to make a submission is outlined at the beginning of this document for guidance on how to make a submission, including the closing date for submissions. After the public review period, the EPA will assess the Proposal, considering the ERD, any submissions received, and HPPL's responses to submissions. The EPA also considers relevant policies and guidelines and may seek advice from relevant government agencies.

The EPA will prepare an assessment report recommending whether the Proposal should be approved and, if recommending approval, any implementation conditions that should apply. The EPA Report and Recommendations will be made public and is subject to appeal. Following the determination of any appeals by the Minister for Environment (the Minister), the Minister will then decide whether the Proposal may be implemented and, if so, any implementation conditions and procedures which will apply in consultation with other relevant decision-making authorities (DMA).

4.3 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's key environmental legislation, which enables protection of MNES. The EPBC Act is administered by the DCCEEW. The Proposal was referred to DCCEEW as a Proposed Action under the EPBC Act in May 2022 and the Commonwealth Minister for the Environment determined the Proposed Action to be a 'Controlled Action' under s75 of the EPBC Act on 6 August 2022 (ref. EPBC 2022/09255) with an assessment approach set at Public Environmental Report (PER).

The Proposed Action referred under the EPBC Act differs slightly from the Proposal being assessed under the EP Act (i.e. the subject of this ERD). The Proposed Action being assessed by DCCEEW includes the Murray's Hill Project, which does not form a part of the EP Act Proposal. The Murray's Hill Project is a stand-alone, 5 Mtpa direct shipping ore (DSO) mine with a life of up to five years (including decommissioning and rehabilitation) proposed by HPPL (refer to **Section 2.2.5.1**).

Murray's Hill was referred to the WA EPA in 2013 as a stand-alone project and was deemed not required to be assessed. As a result, Murray's Hill and impacts associated with this project has been removed from the WA EPA referral of the Proposal. At the time, Murray's Hill was not referred to the Commonwealth under the EPBC Act as the project was not considered to have a significant impact on MNES. Consultation with DCCEEW during 2022 (prior to referral of the Proposed Action) indicated that Murray's Hill was considered part of the larger action

and is required to be considered during the assessment of the Proposed Action under the EPBC Act. As such, the area of Murray's Hill forms part of the Proposed Action.

The relevant MNES (the controlling provisions) identified in the decision on assessment are:

- Listed threatened species and communities (sections 18 and 18A); and
- Listed migratory species (sections 20 and 20A).

DCCEEW issued PER guidelines to HPPL in October 2022. DCCEEW identified the following MNES as relevant to the assessment of the Proposed Action, as the Proposed Action may have a significant impact on these MNES species:

- Northern Quoll (*Dasyurus hallucatus*) – Endangered;
- Greater Bilby (*Macrotis lagotis*) – Vulnerable;
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form) – Vulnerable;
- Ghost Bat (*Macroderma gigas*) – Vulnerable;
- Pilbara Olive Python (*Liasis olivaceus barroni)* – Vulnerable;
- Night Parrot (*Pezoporus occidentalis*) – Critically Endangered;
- Grey Falcon (*Falco hypoleucos*) – Vulnerable; and
- Blind Cave Eel (*Ophisternon candidum*) – Vulnerable.

The following listed migratory species (sections 20 & 20A) were also identified:

- Common Greenshank (*Tringa nebularia*) – Migratory;
- Wood Sandpiper (*Tringa glareola*) – Migratory;
- Red-necked Stint (*Calidris ruficollis*) – Migratory;
- Glossy Ibis (*Plegadis falcinellus*) – Migratory; and
- Fork Tailed Swift (*Apus pacificus)* – Migratory.

The significance of potential impacts from the Proposed Action on MNES will be assessed separately by DCCEEW. Following the assessment of the Proposed Action, the Commonwealth Minister for the Environment will make an approval decision. On approval, a Decision Notice will be issued, including implementation conditions to be applied to the Proposed Action.

4.4 Native Title Act 1993

The *Native Title Act 1993* (Cth) recognises the rights and interests of Aboriginal and Torres Strait Islander people in land and waters according to their traditional laws and customs.

The Proposal is located within the Banjima Native Title determination area. The Banjima Traditional Owners hold native title rights and interests over approximately 10,185 km^2 as determined by the Federal Court in September 2018 WCD 2014/001/WAD6096/1998). Banjima Native Title Aboriginal Corporation RNTBC (BNTAC) hold the native title rights and interests on behalf of the Banjima People.

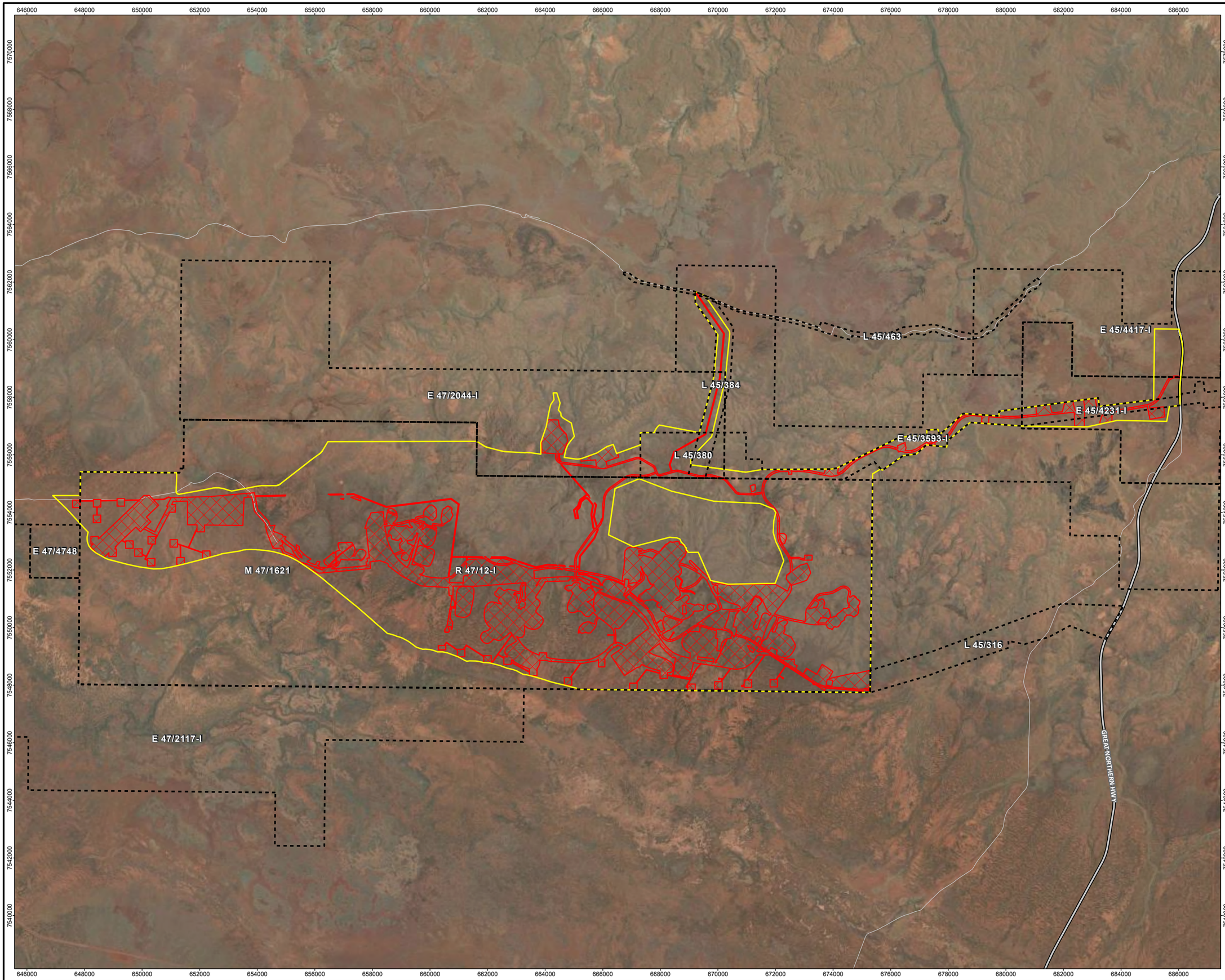
4.5 Land Tenure

The Proposal is located within the following tenements and leases which are held by HPPL or one of a series of wholly owned subsidiary companies. These have been granted or are pending under the Mining Act (refer **Figure 4-1, Table 4-2**). Tenement types will be amended as necessary for the required activities.

Table 4-2: Tenement Holder Details

Tenement	Tenement Holder	HPPL Stake	Area (ha)
R47-12-I (pending) (Mine Area)	Mulga Downs Iron Ore Pty Ltd	100%	22,186.41
M47/1621 (pending) (Mine Area)	Mulga Downs Iron Ore Pty Ltd	100%	22,186.41
L 45/384	Mulga Downs Iron Ore Pty Ltd Mulga Downs Investments Pty Ltd	100%	397.23
G45/358 (pending) (solar farm)	Mulga Downs Iron Ore Pty Ltd	100%	654.57
L 45/380 (haul road)	Mulga Downs Investments Pty Ltd Mulga Downs Iron Pty Ltd	100%	1,785.65
L45/652 (pending) (haul road)	Mulga Downs Iron Ore Pty Ltd	100%	2,331.24
L45/654 (pending) (haul road)	Mulga Downs Iron Ore Pty Ltd	100%	904.81
L45/655 (pending) (haul road)	Mulga Downs Iron Ore Pty Ltd	100%	815.42
L45/687 (pending) (powerline)	Mulga Downs Iron Ore Pty Ltd	100%	511.49
L45/823 (pending) (haul road-(GNH intersection connection)	Mulga Downs Iron Ore Pty Ltd	100%	50.08

Figure 4-1: Tenement Boundaries



Legend

- Indicative Footprint
- Development Envelope
- Mining tenements (DMIRS-003)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 11-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TENEMENT BOUNDARIES

FIGURE 4.1

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

4.6 Other Approvals and Regulation

The key environmental legislation and associated approvals applying to the Proposal are identified in Table 4-3.

Table 4-3: Other relevant approvals (Decision making authorities)

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
DWER	EP Act Environmental Protection Regulations 1987 (WA) Environmental Protection (Noise) Regulations 1997 (WA)	Under Part V of the EP Act a works approval is required for the construction of a premises listed as prescribed under the EP Act and associated Regulations.	The works approval application process administered by DWER can mitigate the following potential impacts of the Proposal on the environment: • Emissions to air (dust) causing amenity impacts to nearby sensitive receptors; • Emissions of noise causing impacts to nearby sensitive receptors; • Discharges of sewage or environmentally hazardous liquids causing contamination; and • Contamination from landfilling of inert or putrescible materials.	There are aspects of the Proposal considered to be a prescribed premise under the Environmental Protection Regulations 1987 and, therefore, will be regulated under Part V, Division 3 of the EP Act. Section 52 of the EP Act specifies that "The occupier of a premises who carries out any work on or in relation to the premises, which causes the premises to become, or to become capable of being, a prescribed premises, commits an offence unless [the occupier] does so in accordance with a works approval." Therefore, HPPL will apply to DWER for a works approval before constructing relevant aspects of the Proposal. Works approval applications will be supported by detailed information regarding the premises, including: • Infrastructure, equipment, and activities (construction, environmental commissioning and operation); • Emissions, discharges and waste; and • Siting and location. This information will be supported by specific plans and assessments, including, but not limited to, air quality and noise assessments and environmental commissioning plan. The EP Act requires applications for works approvals that meet DWER's requirements and are accepted for assessment to be advertised for public comment. DWER advertises applications including publication of supporting documentation on its website for a period of 21 days. DWER can also seek comments from any public authority or person who is considered to have a direct interest in the subject matter of the application.	DWER regulates to ensure that there is not an unacceptable risk of harm to public health or the environment, consistent with the EPA's objectives for environmental factors. The DWER assessment and decision-making processes are governed by relevant legislation and DWER policies, guidelines and procedures. Consistent with the EIA process under Part IV of the EP Act, DWER's regulatory functions under Part V of the EP Act are guided by the statutory object and principles of the EP Act and the following principles of good regulatory practice: • Risk-based regulation; • Evidence-based decision making; • Application of Environmental Standards; • Appropriate conditions; • Fair and equitable decision making processes; • Engagement, consultation and transparency; and • Competitive neutrality. DWER uses the following risk assessment process, which has been mapped to the relevant elements of the EIA process to demonstrate consistency: • Establish the context of the risk (receiving environment); • Identify emissions (Proposal content); • Identify risk events through source-pathway-receptor analysis (potential environmental impacts) and applicant controls (mitigation);	Section 62 of the EP Act allows the Chief Executive Officer (CEO) of DWER to apply conditions to works approvals and licences that are considered to be necessary or convenient for the prevention, control, abatement or mitigation of pollution or environmental harm. DWER will set conditions to give effect to determined regulatory controls in accordance with its regulatory guidance. It is expected that granted works approvals for the Proposal will specify the infrastructure (works) that HPPL can construct and will regulate emissions and discharges associated with construction and commissioning, including dust, noise, emissions to air and discharges of wastewater and potentially contaminated stormwater. The works approval can also apply conditions to regulate the time limited operation of the premises while DWER assess the application for a licence. The works approvals may include conditions relating to compliance and commissioning reporting, atmospheric discharge points, air emission monitoring requirements, stack emission limits, emissions abatement equipment, and secondary containment of environmentally hazardous liquids. DWER undertakes proactive compliance inspections of activities regulated under the EP Act to ensure that they do not pose unacceptable risks to water, the environment and public health. Compliance inspections of prescribed premises also focus on determining whether emissions and discharges are managed by the current instrument and assessing compliance with the instrument and relevant associated legislation.	The EPA's objectives for the identified environmental factors are likely to be met through this decision making process.	The Part V process, through the completion of the works approval, associated commissioning works and licence, will provide adequate regulation of emissions and discharges from the Proposal. The provisions of Part V of the EP Act will meet the EPA's objectives with respect to the following environmental factors: • Terrestrial Environmental Quality; • Inland Waters; and • Air Quality.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
				Post decision, appeals can be lodged by third parties against granted works approvals within 21 days of the applicant being notified of the decision.	• Apply a risk rating using consequence and likelihood criteria (assessment and significance of residual impact); • Determine the risk rating (assessment and significance of residual impact); and • Determine the regulatory controls (EPA report on assessment and Ministerial statement). The assessment criteria used to determine the risk rating (consequence) will be the same as those identified for the EIA of the Proposal. In most cases, the technical experts providing advice for the assessments will be the same for DWER as for the EPA.			
DWER	EP Act Environmental Protection Regulations 1987 (WA) Environmental Protection (Noise) Regulations 1997 (WA)	On completion of construction and commissioning, a licence is required to allow the operation of a prescribed premise.	The licence applications will consider the same potential impacts as the works approval and any specific operational requirements.	Section 57(2) of the EP Act requires works completed under a works approval to be completed to the satisfaction of the CEO (of DWER) in accordance with the relevant conditions of the works approval before a licence application for the premises can be assessed by the department. However, DWER recognises that proponents will want to start operations as soon as construction of works is complete, during the time taken to assess the licence application. To facilitate this, the department uses a risk-based approach to determine whether a premises can undertake environmental commissioning and operate under a works approval, while the department assesses the licence application. The licence applications will be based on the information provided for the works approval and will also include an Environmental Compliance Report confirming that what has been installed is authorised by the works approval, and an Environmental	The licence applications will be assessed in accordance with the same regulatory framework described above for works approval.	It is expected that the licences will include conditions relating to the specification and operation of infrastructure and equipment, authorised emission points and parameters, emissions limits, and emissions monitoring and reporting. It is noted that licences granted by DWER under Part V of the EP Act do not currently regulate Greenhouse Gas (GHG) emissions. It is understood that this is typically because these emissions (where significant) are assessed by the EPA and regulated through implementation conditions on Ministerial statements. However, as an emission to air, it is understood that GHG emission could be regulated by a licence if deemed necessary by an appropriate risk assessment. The kinds of conditions that could be attached to a licence (as provided in section 62A of the EP Act) include, but are not limited to, the following: • Meet specified criteria or comply with specified limits as to the	The EPA's objectives for the identified environmental factors are likely to be met through this decision-making process.	The licensing process administered by DWER can mitigate the potential impacts of the operation of the Proposal. The provisions of Part V of the EP Act will meet the EPA's objectives with respect to the following environmental factors: • Terrestrial Environmental Quality; • Inland Waters; and • Air Quality.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
				Commissioning Report confirming that the premises can operate to the specification detailed in the works approval and that emissions and discharges from the premises meet the required specifications. Licence applications are advertised for public comment and granted licences are available for appeal.		characteristics, volume and effects of GHG emissions; • Comply with requirements set by specified programs; • Monitor operations; • Conduct analysis of monitoring data; • Investigate options for measures for preventing, controlling or abating GHG emissions; • Provide reports on monitoring data, and analysis of it; and • Prepare, implement and adhere to, GHG management plans. These kinds of condition are consistent with those applied to Ministerial Statements regarding GHG emissions, including the setting of five-yearly emission limits, preparation and implementation of GHG management plans, and monitoring and reporting of emissions. In addition to proactive compliance of activities carried out by DWER, licences typically include conditions for annual licence-holder audit of compliance. These Annual Audit Compliance Reports (AACRs) are submitted to DWER and published on the department's website.		
DWER	Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA)	Clearing permits may be required to facilitate the completion of investigative, minor or preliminary and early works associated with the Proposal development ahead of formal approval being granted. DWER has delegated powers, under the Clearing Regulations, to	The potential impacts to flora and vegetation and terrestrial fauna for these types of works can be mitigated through the decision-making process associated with clearing permits.	If required, HPPL will apply for a permit to clear native vegetation unless a valid exemption applies. The application will be made using the appropriate form and will be accompanied by all the required information. Under the EP Act, statutory requirements apply to clearing permit applications, including advertising, and seeking public submissions. The	Clearing permit applications are assessed according to environmental risk. The risk-based assessment approach is based on the size and location of the area to be cleared, sensitivity of the environment and the environmental values that occur within or adjacent to the area under application, the purpose of the clearing and public interest. DWER, in deciding about a clearing permit has regard to the clearing	Clearing permits may be subject to conditions. The types of conditions that are placed on a clearing permit depend on the outcome of the environmental assessment. Conditions are used to prevent, control, abate or mitigate environmental harm or to offset the loss of the cleared vegetation. Conditions can relate to record keeping, reporting, revegetating or other actions.	The EPA's objectives for the environmental factors Flora and Vegetation and Terrestrial Fauna are likely to be met through this decision-making process.	The Proposal is being formally assessed under Part IV of the EP Act. No permit will be required for the clearing of native vegetation associated with the Proposal under assessment. Clearing permits may be required to facilitate the completion of investigative, minor or preliminary and early works associated with the Proposal development ahead of formal Part IV approval being

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
		DEMIRS for clearing activities within mining and related tenements and under exploration permits. The clearing of native vegetation will be assessed against the 10 clearing principles. Native vegetation should not be cleared if the clearing is assessed to be at variance with the clearing principles.		decisions on applications are also subject to appeal.	principles contained in Schedule 5 of the EP Act. The clearing principles are consistent with the EPA's objectives for the environmental factors Flora and Vegetation and Terrestrial Fauna.			granted. If a clearing permit is required for early works (or similar), HPPL is of the view that the clearing of native vegetation can be adequately regulated through the NVCP process. The native vegetation clearing assessment process as administered by the DEMIRS will ensure the EPA's objectives for flora and vegetation are achieved. The provisions of Part V of the EP Act meet the EPA's objectives with respect to the following environmental factors: • Flora and Vegetation; • Terrestrial Fauna; and • Inland Waters.
DBCA	*Biodiversity Conservation Act 2016* (BC Act) and Biodiversity Conservation Regulations 2018	Licence to take flora or fauna	An Act to provide for: • The conservation and protection of biodiversity and biodiversity conservation; • Components in Western Australia; • The ecologically sustainable use of biodiversity components in Western Australia; • The repeal of the Wildlife Conservation Act 1950 and the Sandalwood Act 1929; and • Consequential amendments to other Acts, and for related purposes.	Provides authorisations to take or disturb threatened flora or fauna species.	No additional licence under the BC Act to take flora or fauna is required where clearing is approved under an EP Act Part IV approval, or where the clearing is for an exempt purpose under the EP Act. Where the flora to be taken is threatened flora, an authorisation to take threatened flora will also be required (under section 40 of the BC Act).	Licence to take contains conditions which must be adhered to.	The EPA's objectives are likely to be met through this decision-making process.	The BC Act provides coverage of important habitats and communities and provides for their protection. The BC Act requires Ministerial authorisation for the taking of threatened fauna and flora (section 40) and may include offset conditions for mitigating or offsetting impacts as part of the authorisation. The BC Act provides for assurance that threatened species or communities are reported from EP Act EIA surveys and consider their conservation. The provisions of the BC Act will meet the EPA's objectives with respect to the following environmental factors: • Flora and vegetation; and • Terrestrial fauna.
DEMIRS	Mining Act	An Act to provide for the completion of mining and extractive works. DEMIRS requires the completion of Mining Proposal (MP) and Mine Closure Plan (MCP) for all mining Proposals.	The purpose of the Mining Act is to control mining land tenure (tenements), mineral exploration and mining operations. Prior to undertaking mining operations on mining land tenure, a proponent is required to prepare a MP and a MCP in accordance with relevant DEMIRS guideline documents, with the	DEMIRS assesses mineral, petroleum and geothermal exploration and development applications within WA. The division also conducts environmental compliance audits and inspections to ensure approved activities comply with legislation, regulations, policies, and approval commitments and conditions.	**Mining Proposal** Impacts associated with the Proposal can be considered to ensure environmental outcomes are achieved. **Mine Closure Plan** The MCP will identify post-activity land use outcomes, stakeholder	HPPL will be required to implement the Proposal in accordance with tenement conditions and as described in the Mining Proposal and MCP.	The EPA's objectives are likely to be met through this decision-making process.	The Mining Act requires HPPL to complete a Mining Proposal and MCP, which will be submitted to DEMIRS for assessment. The provisions of the Mining Act, through the completion of the above documents, enables DEMIRS to regulate mining activities and meet

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
		These documents regulate: • Mine infrastructure; • Permanent surface water diversion structures to ensure they are stable and non-polluting; and • Mine closure, decommissioning and rehabilitation.	DEMIRS to then determine approval of the documents on behalf of the State Minister for Mines and Petroleum.		consultation and rehabilitation planning. The MCP ensures adequate closure planning and provisions are in place to manage agreed closure commitments until final relinquishment. **Tenure** The title issued defines the rights and obligations of the government and the tenement holder. It ensures HPPL (as the tenement holder) complies with the conditions of the land that their tenement is based on and rehabilitates the land after operations have finished.		the EPA's objectives with respect to the following environmental factors: • Flora and vegetation; • Terrestrial fauna; • Inland Waters; • Landforms; and • Terrestrial Environmental Quality.
DEMIRS	Dangerous Goods Act 2004 (DG Act)	Dangerous Goods site licence	Licences are required for the storage, transportation and use of Dangerous Goods dependent on the quantities of materials/goods involved.	The DG Act relates to the manufacture, storage, possession handling, transport and use of dangerous goods (both non-explosives and explosives), including the operation of major hazard facilities across Western Australia The Dangerous Goods legislation covers the following Classes and Divisions of dangerous goods that may be required by the Proposal: • Class 1 explosives; • Class 2 gases; • Class 3 flammable liquids; • Class 4 flammable solids, substances liable to spontaneous combustion; • Class 5 oxidising substances; • Division 6.1 toxic substances; • Class 8 corrosive substances; • Class 9 miscellaneous dangerous goods and articles; • Goods too dangerous to be transported; and • C1 combustible liquids. Separate regulations may also apply.	The Dangerous Goods legislation is limited to specific substances and regulates the storage, handling and transport of them with a focus on minimising risk to minimising risk to people, property and the environment.	Dangerous Goods site licences contain requirements as to the types and quantities of substances that can be stored and how they must be stored. Safety reports follow a prescribed standard and template and include risk assessment and safety management systems.	The EPA's objective for the identified environmental factor is likely to be met through this decision-making process.	Compliance with the DG Act reduces the risk to the environment from dangerous goods (transport, storage, use and disposal) by regulating the user and ensuring correct use and adherence to standards. The provisions of the DG Act allow DEMIRS, through the licencing process, to regulate mining activities and meet the EPA's objectives with respect to the following environmental factors: • Inland Waters; and • Terrestrial Environmental Quality.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
DWER	*Rights in Water and Irrigation Act 1914* (RiWI Act)	5C Licence to Take Water; and 26D Licence to Construct or Alter Well Section 11/17/21A Permit (Beds and Banks)	The RiWI Act provides for the regulation, management, use and protection of water resources. A 5C licence allows the licence holder to take water from a watercourse, well, and or, underground source. A 26D licence is required to: • commence, construct, enlarge, deepen or alter an artesian well [26A(1)]; or • commence, construct, enlarge, deepen or alter any non-artesian well in a proclaimed groundwater area. Permits are granted by the department to authorise interference or obstruction of the bed and banks of a watercourse or wetland.	Licences and permits are regulatory instruments which define how much water can be taken and specify required management conditions. Policies and water allocation plans provide further guidance on specific licensing requirements and, where relevant, are identified through this document. The Western Australian Water in Mining Guideline (DoW, 2013) was prepared in recognition that proponents of mining projects may require approval from a number of government agencies. To reduce duplication, the guideline aligns with approval processes administered by the EPA, DBCA and DEMIRS. The guideline also links with the Administrative agreement between DEMIRS and DoW. It ensures an efficient pathway through the licence assessment process and aligns the licence assessment with other assessment processes, such as those established under the EP Act.	Assessment of the construction of bore(s) to access water during construction and operation; • Assessment of the abstraction of groundwater associated with water supply for the Proposal; • Assessment of the interference with bed and banks of a watercourse..	Conditions of: • 5C Licence to Take Water; • 26D Licence to Construct or Alter Well; and • Section 11/17/21A Permit (Beds and Banks).	The EPA's objective for Inland Waters identified environmental factor is likely to be met through this decision-making process.	The RiWI Act provides protections to the State's water resources to maintain the hydrological regimes and quality of groundwater and surface water. The provisions of the RiWI Act allow DWER, through the licencing process, to regulate activities and meet the EPA's objectives with respect to the following environmental factors: • Inland waters; • Flora and vegetation; and • Terrestrial Fauna.
Department of Planning, Lands and Heritage (DPLH)	AH Act	The following may be required under the AH Act for impacts or disturbance to sites of Aboriginal significance: s.16 authorisation to enter, excavate, examine or remove anything on an Aboriginal site; s.18 consent where the impact on an Aboriginal site is unavoidable; and Access authority.	The AH Act provides a modern framework for the recognition, protection, conservation and preservation of Aboriginal cultural heritage while recognising the fundamental importance of Aboriginal cultural heritage to Aboriginal people.	Under the AH Act it is an offence to excavate, destroy or damage a site unless the person is acting with the authorisation of the Registrar under section 16, or the consent of the Minister under section 18 of the AH Act.	The following approvals may be required under the AH Act for impacts of disturbance to sites of Aboriginal significance: • s.16 authorisation to enter, excavate, examine or remove anything on an Aboriginal site; • s.18 consent where the impact on an Aboriginal site is unavoidable. Consultation with Traditional Owners in respect of impacts to Aboriginal heritage is addressed in Section 5.2.2.	Conditions of approval.	The EPA's objective for the identified environmental factor is likely to be met through this decision-making process.	The provisions of the AH Act regulate activities and meet the EPA's objectives with respect to the following environmental factors: • Social surroundings.
DPLH	*Land Administration Act 1997* (LA Act)	S91 licence	Access authority.	A licence may be granted for an unmanaged reserve or Crown land under certain circumstances by the Minister for Lands under the LA Act. A licence does not grant an exclusive right to the land and members of the	Where required (temporary) access to Crown Land has been enabled through the s.91 permit as administered by DPLH under the LA Act.	The s91 permit as issued by DPLH is for a limited period of time and it does not grant HPPL an exclusive right to the land. Conditions can be applied to the access authority.	Access to the land is being sought from the relevant organisations, in addition to the obtaining of the s.91 LA Act permit	Ensures HPPL has authority to access and undertaken activities on unmanaged reserve or Crown land.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
				public cannot be excluded from licensed Crown land.				
Department of Health (DoH)	Disposal of Effluent and Liquid Waste) Regulations 1974 (Health Regulations)	Install an Apparatus for the Treatment of Sewage	Assessment and regulation of WWTP and irrigation to land.	The requirements associated with onsite wastewater systems are specified in the Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 (Wastewater Regulations). The Health Act requires all apparatus for the treatment of sewage to be approved by the Chief Health Officer (CHO). The Wastewater Regulations set out the approvals process for the construction, installation, use and operation of onsite wastewater systems. They also detail the specific design, sizing and construction/manufacturing requirements for primary treatment systems and the various receptacles for drainage.	Assessment and approval for the on-site WWTP will be required.	Conditions of approval can be applied to WWTP and irrigation specifications.	Ensures wastewater's generated from the Proposal are treated and discharged in an environmentally acceptable manner.	Provisions regulate WWTP's and meet the EPA's objectives with respect to the following environmental factors: • Inland Waters; and • Terrestrial Environmental Quality.
Shire of Ashburton	*Planning and Development Act 2005* Planning and Development (Local Planning Schemes) Regulations 2015 Planning regulation Amendment Regulations 2020.	Building and Health approvals.	An Act for a system of land use planning and development in the State and for related purposes.	Development approval applications are required to ensure a Proposal is consistent with the zoning for the area and complies with the local planning scheme and related Local planning policy requirements. The development application process and assessment of the Proposal against the relevant local planning schemes and policies can mitigate potential impacts to Social Surroundings, including nuisance aspects associated with air quality and noise.	Development application(s) will be assessed against the Shire's Local Planning Strategy and Local Planning Scheme. Allows for the Proposal to construct according to the local planning schemes as established by the Shire of Ashburton.	Most development approvals have conditions that form part of the development approval package and set out the circumstances in which the approved development may proceed. Often the purpose of conditions is to protect or reduce impacts on the environment and amenity. The conditions can include those, amongst others, for the mitigation of emissions of wastewater, waste, noise, fugitive dust and odour.	Construct of buildings and infrastructure in according with Shire of Ashburton local planning schemes and policies.	Provisions regulate WWTP's and meet the EPA's objectives with respect to the following environmental factors: • Social surrounds.
DWER	*Contaminated Sites Act 2003* Contaminated Sites Regulations 2006	Considered under Part V of the EP Act.	Under the Act the identification, recording, management and remediation of contaminated sites can be managed.	The Act and Regulations allow for the identification, recording, management and remediation of contaminated sites. The Regulation also provides direction on the Mandatory auditors report	The Proposal will intersect areas that are at risk of Asbestos Containing Material (ACM) contamination from historical anthropogenic activities. There is the potential to redistribute ACM through implementation of the Proposal and pre-mining activities.	Conditions can be applied through either Part IV or Part V of the EP Act.	Potential risks from contamination are identified, assessed, managed and remediation as required.	Provisions regulate the following environmental factors: • Air quality; and • Terrestrial Environmental Quality.
Clean Energy	*National Greenhouse and Energy Reporting*	Not applicable (reporting)	The Clean Energy Regulator is responsible for overseeing and enforcing the Safeguard Mechanism, which includes monitoring and	Under the NGER Act, companies are obligated to report on their GHG emissions in accordance with statutory requirements (CER 2021).	HPPL will report GHG emissions for the Proposal under the NGER Act.	Not applicable	Established reporting requirements.	Reporting of emissions is required under the NGER Act.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
Regulator (CER)	*Act 2007* (NGER Act)		regulating the greenhouse gas emissions of large industrial facilities, ensuring they meet specified emissions limits.	The NGER Act provides a single national framework for the reporting and dissemination of information relating to GHG emissions, energy production and energy consumption in Australia governed by the CER.				
	National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 (as amended 2023)	Not applicable (reporting)	Statutory reporting requirements for GHG emissions. The Safeguard Mechanism was established to support Australia's emissions reduction commitments under the Paris Agreement and is part of the National Greenhouse and Energy Reporting (NGER) scheme.	Pursuant to the Australian Government's Safeguard Mechanism Rule, if a facility is anticipated to emit more than 100,000 t CO2-e of Scope 1 emissions per financial year (i.e., the 'safeguard threshold'), it qualifies as a designated large facility (or safeguard facility) and is required to keep its net emissions levels at or below its emissions baseline set by the CER. Under the reformed Safeguard Mechanism, implemented in July 2023, emissions from designated large facilities are required to be reduced to net zero by 2049-50 along a straight line trajectory, commencing with baselines determined by the CER, which will reduce by 4.9% per year to 2030. For new facilities baselines, best practice emissions intensities will also be required, with site specific emissions intensity established at commencement, transitioning to an industry average emissions intensity by June 2030. Together with the reporting obligations under the NGER Act, the Safeguard Mechanism provides a national framework for Australia's largest emitters to measure, report and manage their emissions.	The Proposal involves Scope 1 emissions that are covered by the Safeguard Mechanism and those that are not. The emissions considered Scope 1 under the Safeguard Mechanism will not exceed the 100,000 t CO2-e per year threshold set for designated large facilities. However, the Scope 1 emissions not covered by Safeguard Mechanism will exceed the 100,000 t CO2-e per year threshold set for assessment by the EPA. As assessment of GHG Emissions is provided in **Section 12**	Not applicable	Established reporting requirements and emissions reduction targets.	Reporting of emissions is required under the Safeguard Mechanism against targets.

5 Stakeholder Engagement

5.1 Consultation Strategy

HPPL has actively engaged in stakeholder consultation throughout the planning of the Proposal. Stakeholder consultation will continue during the assessment of the Proposal, and through the detailed design, construction and operational phases, if approved. The methods of consultation vary depending on the forum, subject matter and purpose. The main forms of communication associated with the Proposal are:

- Broad Proposal briefings and presentations;
- HPPL/stakeholder meetings and discussions, including those undertaken on HPPLs' behalf by consultants;
- Environmental risk workshops;
- Written communications, distribution of updates and brochures;
- Specific native title discussions and briefings to Traditional Owners;
- Telephone discussions; and
- Distribution of environmental documentation.

The generalised strategies for engagement with key stakeholder groups are summarised below:

- Government agencies: ensure environmental acceptability (as determined through EP Act and EPBC Act) and meet the requirements of various regulatory approvals and legislation managed by various government agencies.
- Native Title groups: consultation to protect heritage, understand potential impacts on social surroundings, participation in planning of the Proposal to avoid or minimise potential impacts, compensation for impairment of rights and interests to land, participation in environmental surveys, employment opportunities and Proposal involvement.
- Pastoralists: management of access, planning to minimize disturbance to pastoral operations, compensation for identified and proposed activity losses, future land use requirements and water availability and use.
- Community groups and individuals: opportunities or community infrastructure upgrades, employment, enhanced environmental management, environmental research and community support/sponsorship, concerns with fly-in/fly-out workforce.

As well as regular stakeholder engagement, triggers for further specific engagement include, but are not limited to:

- Where new approvals are required;
- Where relevant conditions are received on approvals;
- Changes to the Proposal that may have significant impact on stakeholders; and
- Developing the closure strategy.

5.2 Key Stakeholders

The key stakeholders identified for the Proposal are detailed in the following sections. Consultation with these groups has commenced and will continue to be undertaken as required during the assessment, construction and operational phases of the Proposal.

5.2.1 Government Agencies

Consultation has commenced and is ongoing with the following key regulatory stakeholder groups:

- DWER (EPA Services; Part V; Water);
- DEMIRS - Environment and Mining Divisions;
- DBCA;
- DPLH;
- DCCEEW;
- Department of Jobs, Tourism, Science and Innovation (DJTSI);
- Main Roads Western Australia (MRWA);
- Pilbara Development Commission; and
- Shire of Ashburton.

5.2.2 Traditional Owners

Consultation has commenced and is ongoing with the relevant Traditional Owners and communities (**Table 5-1**). Detailed engagement plans are being prepared and agreed with these groups, to guide ongoing consultation. Traditional Owners and communities will continue to be engaged and consulted throughout the assessment, construction and operational phases of the Proposal. Key Traditional Owners and communities identified for the Proposal are as follows:

- Banjima Native Title Aboriginal Corporation RNTBC (BNTAC) is the registered native title body corporate which holds native title rights and interests in trust for the Banjima People ;
- Yindjibarndi Ngurra Aboriginal Corporation RNTBC (YNAC) is the Registered Native Title Body Corporate which holds native title rights and interests in trust for the Yindjibarndi People;
- Youngaleena Community; and
- Wirrilimarra Community.

The Development Envelope is located within the Banjima native title determination area.

HPPL submitted a s43A to the EPA in December 2023 for the removal of the Mulga West Borefield. The Mulga West Borefield and associated pipeline route was the only portion of the original Proposal located within the Yindjibarndi #1 native title determination area. Removal of this area removed any direct impact of the Proposal on the Yindjibarndi #1 determination area; however, HPPL has undertaken extensive consultation with Yindjibarndi People and will continue to consult with YNAC regarding any potential indirect impacts of the Proposal.

Consultation and engagement with the Banjima People has commenced. To date, the concept of Social Surroundings as a Key Factor for EPA assessment of Proposals under Part IV of the EP Act has been introduced and on-country consultation has occurred. In addition, numerous Perth-based consultations have also been conducted. Timeframes for consultation is subject to multiple factors including availability of Traditional Owners, ongoing negotiation of agreements and ongoing archaeological and ethnographical surveys.

HPPL is committed to ongoing consultation with the Banjima People that will continue throughout the life of the Proposal, including during operations and decommissioning/rehabilitation. A Social and Cultural Heritage Management Plan (SCHMP) will be co-developed between HPPL, and the Banjima People. Consultation will be used to explain the Proposal, identify concerns and impacts on country and culture, and discuss ways in which the Proposal can be aligned to avoid, minimise and/or manage potential impacts. The process includes an anthropologist and environmental consultant who can assist the Traditional Owners throughout the consultation process. It is anticipated a Social Surroundings report will be prepared based on the consultation which will identify and report the key outcomes of the consultation. The report will be used to inform the co-developed SCHMP.

HPPL is in consultation with the Banjima People through BNTAC. The parties will prepare a SCHMP that is designed to identify the issues that will require ongoing consultation and input. It is expected that a range of issues will need to be addressed in the SCHMP with an appropriate set of management actions identified to ensure active management of environmental issues based on ongoing consultation and input. The SCHMP is proposed to remain a 'live' document that details key outcomes of meetings and on-country consultations undertaken to date and those proposed through the life of the Proposal. HPPL acknowledge this consultation is in addition to Aboriginal heritage surveys and confirms all activities will be undertaken in compliance with the AH Act as applicable.

HPPL is committed to ongoing engagement over the life of the Proposal, as outlined in the engagement timeline plan presented in **Table 5-1.** The SCHMP will be considered confidential unless otherwise advised by BNTAC.

HPPL will provide notifications to Traditional Owners following submission of environmental approval documentation and other documentation as required. Traditional Owners are provided the ability to review and provide comments on submitted documentation, with HPPL taking into consideration these comments and updating documentation accordingly.

Table 5-1: Proposed ongoing communication and / or consultation schedule with Banjima Traditional Owners and Communities

Traditional Owner group	Type of Engagement	Proposed Timing[1]	Detail of Engagement
Banjima	Hancock Heritage and Environment Reference Committee (HHERC) Meetings	Quarterly. Subject to Traditional Owner availability.	Overview of the Proposal and any changes since the last HHERC meeting. Discussion/overview of potential impacts to Social Surrounding, environment impacts, heritage impacts and government approvals relevant to the Proposal. Consultation and formal decisions on key environmental and heritage matters under FPIC principles.
	Social surroundings consultation	As required. Subject to Traditional Owner availability.	Discussion of Proposal. Identification of concerns and impacts. Discussion of ways the Proposal can be aligned to avoid, minimise and/or manage impacts.
	Ethnographic/archaeological surveys	Ongoing.	On-site ethnographical/archaeological surveys Presence of Traditional Owners during surveys
	Ongoing consultation	Throughout the life of the Proposal.	Continual discussions of relevant aspects or concerns related to the Proposal
	Native Title agreement negotiations	Prior to implementation of the Proposal. Substantially progressed.	As per Project Negotiation Agreement.
	Agreement Implementation Committee	Throughout life of the Project	As per Native Title Agreement
Wirrilimarra	Community consultation	Bi-annually. Subject to willingness of the Community to engage with HPPL.	Discussion of Proposal. Identification of concerns and impacts. Discussion of ways the Proposal can be aligned to avoid, minimise and/or manage impacts to the communities. Provision of an operational management plan template to facilitate discussions.
	Ongoing consultation	Throughout the life of the Proposal. Subject to willingness of the Community to engage with HPPL.	Continual discussions of relevant aspects or concerns related to the Proposal
Youngaleena	Community consultation	Bi-annually. Subject to willingness of the Community to engage with HPPL.	Discussion of Proposal. Identification of concerns and impacts. Discussion of ways the Proposal can be aligned to avoid, minimise and/or manage impacts to the communities. Provision of an operational management plan template to facilitate discussions.

Traditional Owner group	Type of Engagement	Proposed Timing[1]	Detail of Engagement
	Ongoing consultation	Throughout the life of the Proposal. Subject to willingness of the Community to engage with HPPL.	Continual discussions of relevant aspects or concerns related to the Proposal

5.2.3 Industry

The following industry stakeholder groups have been identified and consultation will continue as required:

- Chamber of Minerals and Energy (WA);
- Chamber of Commerce and Industry;
- Regional Chambers of Commerce and Industry – Karratha, Port Hedland and Newman;
- Australian Miners and Mineral Associations;
- Association of Mining and Exploration Companies; and
- FMG.

5.2.4 Community

The following key community stakeholders have been identified and consultation is ongoing:

- Mulga Downs Station; and
- Auski Munjina Roadhouse.

The Mt Florance and Hooley Pastoral Stations are now outside of the Development Envelope; however, HPPL will continue to engage with these pastoral stations given their proximity to the Proposal.

5.3 Stakeholder Consultation Outcomes

Details of stakeholder consultation undertaken to date for the Proposal are shown in **Table 5-2**. Consultation has commenced (and will continue) with key regulatory bodies, Traditional Owners, Industry and community groups.

A pre-referral consultation with EPA Services (DWER) in relation to the Proposal was held on 1 December 2021.

Table 5-2: Consultation and Communication undertaken to date with Key Stakeholder Groups

Date	Department	Activity	Key Comments
Regulatory Stakeholders			
26/03/2025	EPA DWER	Discussion about request for further information	Meeting with EPA-S assessing officers to discuss updates to be made to the Environmental Review Document following the request for further information
21/03/2025	EPA DWER	Request for further information	EPA issue a request for further information following review of the Environmental Review Document
20/12/2024	EPA DWER	Submission of ERD	ERD issued to the EPA for review
19/12/2024	EPA DWER	Pre-ERD submission discussion	Meeting with DWER and the EPA to discuss Proposal updates prior to submission of the updated ERD.
10/12/2024	DCCEEW	Pre-PER submission discussion	Meeting with DCCEEW to discuss Proposal updates, and key impacts and proposed mitigation measures prior to submission on the updated PER.
03/12/2024	EPA DWER	Project introduction meeting with the EPA chairman	Meeting with DWER and the EPA to provide Proposal overview to the recently appointed EPA chairman, and discuss relevant project queries (i.e., updated GHG emissions guidelines).
16/10/2024 to 17/10/2024	DCCEEW	Mulga Downs site visit	Site visit with DCCEEW to provide understanding of the site, impacts and proposed mitigation measures.
3/09/2024	DCCEEW	Section 156A briefing	Meeting with DCCEEW to discuss the proposed s156A amendment from the 20 Mtpa mine to the reduced scale 12 Mtpa mine.
29/08/2024	EPA DWER	Section 43A briefing	Meeting with DWER and the EPA to discuss the proposed s43A amendment from the 20 Mtpa mine to the reduced scale 12 Mtpa mine.
19/07/2024	EPA DWER	Section 43A briefing	Meeting with DWER and the EPA to discuss the proposed s43A amendment from the 20 Mtpa mine to the reduced scale 12 Mtpa mine.

Date	Department	Activity	Key Comments
30/05/2024	DEMIRS	Mining Proposal Scoping Meeting	Meeting to brief DEMIRS on anticipated Part V/Mining Act approvals for the Mulga Mine, Hub and Rail and Murray's Hill.
28/05/2024	DWER	Part V Briefing	Meeting to brief DWER on anticipated Part V approvals for the Mulga Mine
27/07/2023	DEMIRS	Mining Proposal Scoping Meeting	Meeting to brief DEMIRS on anticipated Part V/Mining Act approvals for the Mulga Mine, Hub and Rail and Murray's Hill.
03/04/2023	DWER Contaminated Sites Branch	Targeted meeting / briefing	Provision of an update on the Proposal works proposed to be completed in relation to the WAMA and the TEQ environmental factor.
30/06/2022 – ongoing (monthly)	DWER	Monthly Proposal meetings	Monthly meeting to discuss Proposal updates and progress with DWER. Updates include management plans, studies and future approvals likely to be require. Items as discussed summarised in minutes.
28/02/2023	DCCEEW	Section 156A clarification	Clarification regarding the request for information provided to HPPL from DCCEEW on the s156A application.
21/02/2023	DWER State Water Team and DCCEEW	Surface and groundwater modelling meeting	Discussion regarding surface water and groundwater modelling requirements for the Proposal.
28/10/2022 – ongoing (monthly)	DCCEEW	Monthly Project Assessment Plan meeting	Monthly meeting to discuss the developments, guidance and queries relating to the PAP and the PER guidelines. Matter s discussed include the requirement for additional surveys, clarification of aspects in the PER guidelines. The monthly meeting also discusses timelines for both HPPL and DCCEEW.
13/07/2022	DWER Contaminated Sites Branch	Environmental Scoping Document and Terrestrial Environmental Quality meeting	Project overview was provided relating to terrestrial environmental quality factor (in relation to the WAMA. DWER recommended HPPL need to demonstrate that they have investigated the area to e disturbed by the Proposal. HPPL requested further information from DWER for information held by DWER on sites of possible asbestos that may occur across the MDIOM.

Date	Department	Activity	Key Comments
08/12/2021	DAWE (now DCCEEW)	Pre-referral meeting	HPPL presented information to meet the Departments pre-referral engagement requirements.
01/12/2021	EPA	Pre-referral meeting	HPPL presented information to meet the Departments pre-referral engagement requirements.
29/10/2021	DAWE (now DCCEEW) Office of Water Supply and Water Sciences	Follow up pre-referral meeting	HPPL presented information on the Proposal to staff from the Office of Water Supply and Science.
22/10/2021	EPA	Pre-referral meeting	HPPL presented information to meet the Departments pre-referral engagement requirements.
21/10/2021	DAWE (now DCCEEW)	Pre-referral meeting	HPPL presented information to meet the Departments pre-referral engagement requirements.
16/07/2019	DWER (includes industry regulation)	Targeted meeting/briefing	Briefing for DWER Terrestrial Ecosystems Branch on proposed baseline subterranean survey.
2/04/2019	DWER (includes industry regulation)	Targeted meeting/briefing	HPPL project staff briefed DWER air quality and noise officers on proposed baseline survey. Sought guidance on and endorsement of approach in readiness for procurement of sampling equipment and mobilisation to site. DWER stated proposed methodology acceptable and provided some commentary to assist improve the works.
7/03/2019	DWER (includes industry regulation)	Targeted meeting/briefing	HPPL project staff sought guidance for schedule Level 2 flora, vegetation and terrestrial fauna surveys. Items specifically discussed summarised in the minutes.

Date	Department	Activity	Key Comments
22/11/2018	Department of Energy and Environment (DoEE) (now DCCEEW)	Briefing	HPPL provided a briefing on the Proposal which is in the early planning stage and hence Proposal scope is yet to be determined. It is expected that the Proposal will be referred under the EPBC Act. HPPL may decide to treat the rail as a separate referral if it is likely to have a different ownership to the mine. This is so each owner is only responsible for their own set of EPBC approval conditions (assuming approval is required). DoEE accepted the rationale for that approach and noted there were a number of precedents with other projects where this was done for the same reason. DoEE advised key matters for concern included MNES, Night parrot and migratory species.
7/11/2018	DWER (includes industry regulation)	Briefing	HPPL project staff provided an overview and update on Proposal. Requested guidance on content/approach for surveys in 2019 re-survey component, use of guidelines, key risk. DWER committed to arranging meeting Terrestrial Ecosystems Branch in December 2018 to further advice.
7/09/2018	DWER (includes industry regulation)	Briefing	DWER was briefed by HPPL project staff on the proposed groundwater drilling programme and surface water programme. Sought clarification on the extent of the Fortescue Marsh. Requested advice on which government department is responsible for approving work in the wetland area. DWER requested HPPL apply for a 26D licence for completeness. Work can start prior to approval on boreholes in non-confined aquifers (as these are exempt).
16/07/2018	DEMIRS	Targeted meeting/briefing	DEMIRS focus is mine Proposal and mine closure. Refer to and consult with EPA, DWER and others with respect to flora, fauna, water and provision of assistance on safety/engineering where relevant to EP Act Pt V licensing (e.g. TSF).

Date	Department	Activity	Key Comments
31/01/2018	DWER (includes industry regulation)	Targeted meeting/briefing	2013 referral decision for Murray's Hill (provide to HPPL) on 13 August project was "Not Assessed" as the significance of impact (on key factors including groundwater and subterranean fauna) was considered below the threshold of assessment. EPA and DWER suggested that unless the project has changed significantly, the referral decision would still be considered appropriate. EPA staff indicated that should HPPL submit an updated referral, the 2013 decision would become null and void. The EPA urged HPPL to consider a second submission until they finalise their commercial decisions.
30/01/2018	DEMIRS	Targeted meeting/briefing	DEMIRS stated questions regarding environmental baseline monitoring will largely be deferred internally to the EPA or DWER, including water quality, flora, fauna and air quality. HPPL highlighted the concerns Roy Hill has had with respect to inadequate waste characterisation, leading to significant 'incompetent material' from a slope stability perspective. Indicated that the mine TSF is of particular interest to the DEMIRS.
Banjima Traditional Owners and Community			
Various	Banjima Traditional Owners	Attendance during ecological surveys	Banjima Traditional Owners were invited to all and have attended the majority of ecological surveys.

Date	Department	Activity	Key Comments
14 February 2025	BNTAC Board of Directors BNTAC Representatives HPPL	Targeted meeting/briefing	HPPL presentation to BNTAC Board – update on scope of project and negotiation matters.
26/11/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Correspondence/notification	HPPL issued a draft Environmental Review Document to BNTAC for review and comment.
8/10/2024	BNTAC Representatives HPPL	Targeted meeting/briefing	BNTAC presentation on Banjima's closure principles. HPPL commit that Banjima's overarching goal "and disturbed by mining is rehabilitated and returned to the Banjima People in a condition that is physically safe, stable, non-polluting and consistent with restoration of Banjima's Native Title Rights" will be progressed with Banjima throughout the development of the detailed Closure Plan required under the Mining Act 1978.
03/10/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	HPPL-BNTAC MDIOP negotiation meeting with overview of MDIOPs revised base case (12Mtpa), including discussion of revised MDIOP parameters and impacts.

Date	Department	Activity	Key Comments
13/08/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/ briefing	Presentation of the MDIOP's revised base case (12Mtpa) to an internal session of BNTAC's negotiation committee. Description of revised MDIOP parameters and discussion of proposed impacts and mitigations.
14/05/2024 to 15/05/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	Perth-based consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Discussions involved heritage sites, overview of approvals documentation and management measures and updates to the SCHMP.
6/05/2024 to 10/05/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	On-country consultation	On-country social surroundings consultation with Banjima and BNTAC to visit sites of significance on-country and to co-develop the SCHMP.
15/04/2024 to 16/04/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	Perth-based consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Discussions involved heritage sites, overview of approvals documentation and management measures.
27/02/2024	BNTAC Representatives BNTAC Technical Advisors HPPL	Workshop	Workshop to discuss BNTAC Technical Advisors review of the environmental approval documentation for the Proposal. Comments received from BNTAC have been updated within this ERD.
20/02/2024	BNTAC Representatives BNTAC Technical Advisors HPPL	Notification	Notification of s156A approval to remove Borefield West from the Proposal.

Date	Department	Activity	Key Comments
7/11/2023 to 8/11/2023	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	Perth-based consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Discussions involved the Fortescue Valley buffer, rock shelter investigations and Proposal design elements such as the airport and the camp.
30/10/2023	BNTAC Representatives BNTAC Technical Advisors HPPL	Targeted meeting/briefing	Face to face meeting to provide BNTAC and BNTAC Technical Advisors with an overview of the rationale and approach to the Groundwater Management Plan prepared for the Proposal.
Fortnightly (dependent on availability)	BNTAC Representatives BNTAC Technical Advisors HPPL	Targeted meeting/briefing	HPPL meets weekly with BNTAC Representatives and Technical Advisors to discuss developments of the Proposal, identify key concerns and appropriate pathways for mitigating these concerns.
17/10/2023	Letters to BNTAC requesting access to the Youngaleena and Wirrilimarra Communities	Correspondence	HPPL provided letters to BNTAC outlining a request to access the Youngaleena and Wirrilimarra Communities prior to undertaking formal consultation with the communities in 2024. The access requested was to collect baseline environmental information and establish a 'meet and greet' with the communities. No response has yet been received from the communities. Formal consultation is proposed with the Youngaleena and Wirrilimarra Communities during 2024. This consultation will be facilitated through BNTAC.

Date	Department	Activity	Key Comments
5/09/2023 – 7/09/2023	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	On-country consultation	On-country consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Consultation discussed the Fortescue Valley buffer, rock shelter investigations and Proposal design elements such as the airport and the camp. An overview of a proposed heritage management pathway was discussed. Banjima Traditional Owners were provided the opportunity to provide feedback in relation to any key items discussed and identify any additional issues with the Proposal. HPPL requested formal resolutions from BNTAC with regards to surface water and claypan monitoring and rock shelter investigations. **Response**: Formal minutes were circulated to all attendees on 22/09/2023. BNTAC provided a formal letter outlining the resolutions discussed during the trip. These included access to heritage restricted zones for the purpose of claypan and surface water monitoring, and the ability of HPPL to begin the section 16 process for specified rock shelters.
15/08/2023	BNTAC	Correspondence	Letter provided to BNTAC providing notification of submission of environmental approval documentation relating to the Proposal.

Date	Department	Activity	Key Comments
24/07/2023 – 25/07/2023	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	Perth-based consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Discussions involved environmental and heritage aspects, as well as provision of an overview of the Proposal. The consultation provides Banjima representatives the opportunity to engage and discuss important aspects of the Proposal as they relate to Banjima Traditional Owners. HPPL sought formal resolutions relating to water monitoring and other key environmental and heritage aspects of the Proposal. **Response**: Formal minutes were circulated to all attendees for approval.
24/05/2023	BNTAC	Targeted meeting/briefing	Water and ecohydrological studies presentation to BNTAC technical advisors. Overview of studies undertaken for the Proposal and key results. Proposed future works to inform key focus areas.
11/05/2023	BNTAC	Correspondence (email and attachments)	Provision of BNTAC with proposed presentation material for the following Social Surroundings and HHERC meeting (proposed for end of June 2023). Discussion on presentation and delivery of material.
16/03/2023	BNTAC	Correspondence (letter)	Letter requesting the establishment of the HanRoy Heritage and Environment Reference Committee (HHERC).

Date	Department	Activity	Key Comments
13/03/2023 to 17/03/2023	Banjima Traditional Owners, BNTAC	Targeted meeting/briefing On-country	The trip allowed interactive consultation with Banjima Traditional Owner representatives. The purpose was to discuss the Proposal with Banjima Traditional Owner representatives so that they could understand the Proposal. The trip provided an opportunity for Banjima Traditional Owner representatives to visit the country proposed to be impacted and understand the proposed works. Banjima Traditional Owner representatives also had the opportunity to provide feedback about the Proposal and how that may affect their relationship with the land, their cultural and social activities, and any indirect impacts on heritage sites. HPPL propose to work with Banjima Traditional Owners to address the concerns raised during the consultation and what impacts can be avoided, what will be reduced and managed and how this will be done.
2/02/2023	BNTAC	Correspondence (letter)	Letter requesting dates to be confirmed for the social surroundings consultation, noting the planned on-country consultation planned for 13-17 March 2023.
25/11/2022	BNTAC	Correspondence (letter)	Follow up letter to BNTAC requesting to schedule future social surroundings consultation.
13/07/2022	BNTAC	Correspondence (letter)	Introducing social surroundings consultation and eagerness for HPPL to engage with Banjima Traditional Owners. The letter requested HPPL to work with Banjima Traditional Owners to plan and schedule on country consultations and identify timing for preparation of key documents that are required for the relevant approvals.
10/06/2022 to 12/06/2022	Banjima Traditional Owners, BNTAC	Targeted meeting/briefing	Provision of the Banjima Negotiation Committee (BNC) (and advisors) the opportunity to visit Banjima Country for on the ground context and orientation of the Mulga Downs Iron Ore Project.

Date	Department	Activity	Key Comments
20/05/2022	BNTAC	Targeted meeting/briefing	HPPL and BNTAC Advisors meet and greet.
2/05/2022	BNTAC	Correspondence (document)	Letter requesting contact details for the appropriate persons/people within the Youngaleena and Wirrilimarra Communities to commence social surroundings consultation.
27/04/2022	BNTAC	Correspondence (letter)	Letter requesting contact details for the appropriate persons/people within the Youngaleena and Wirrilimarra Communities to commence social surroundings
13/07/2021	BNTAC Board, HPPL, Roe Legal, BNTAC	Targeted meeting/briefing	Presentation on the Proposal and requirement for a mining agreement.
1/10/2020	BNTAC Board, HPPL, Roe Legal, BNTAC	Targeted meeting/briefing	Presentation on the Mulga Downs Project including rail corridor and requirement for a mining agreement.
Yindjibarndi Traditional Owners and Community			
25/05/2023	YNAC (face to face meeting)	Targeted meeting/briefing	Continue to develop relationship with Yindjibarndi Traditional Owners. Provide expert hydrogeologist to provide overview of water management. Commence co-development of SCHMP. Promote discussion of Proposal in the context of SCHMPs. Listen and document matters of concern for inclusion in the SCHMP.
13/04/2023	YNAC (email)	Correspondence (email and attachments)	Email regarding field trip report from September on-country visit Email contained the report.
09/03/2023 and	YNAC (email)	Correspondence (email and attachments)	Request for the Yindjibarndi Social Surroundings report from the September 2022 on-country trip.

Date	Department	Activity	Key Comments
12/12/2022	Yindjibarndi People, YNAC (face to face meeting)	Targeted meeting/briefing	Continue to develop relationship with Yindjibarndi Traditional Owners. Present an update on the Proposal (design and approvals). Discuss planned field and investigative work. SCHMP presentation. Allow Yindjibarndi Traditional Owners to discuss the Proposal and SCHMP in private.
18/10/2022	Yindjibarndi People, YNAC (letter)	Targeted meeting/briefing	Proposal to undertake consultation for Social Surroundings Development of the SCHMP.
18/09/2022 to 22/09/2022	Yindjibarndi People, YNAC (face-to-face meeting (on-country))	Targeted meeting/briefing	Develop relationship with Yindjibarndi Traditional Owners. Identify important cultural associations between Yindjibarndi and their Country. The Yindjibarndi Traditional Owners were able to share their rich history and cultural connection with Country. HPPL were given opportunities to present the activities proposed to be conducted as per the Proposal. Identify the interests and concerns of the Yindjibarndi Traditional Owners.
24/11/2021	Yindjibarndi Aboriginal, Corporation Board, Yindjibarndi Ngurra Aboriginal Corporation Board, Yindjibarndi Elders, HPPL Roy Hill	Targeted meeting/briefing	Presentation on the Mulga Downs Project including water supply borefield
Pastoral Stations/Other Community Groups			
15/08/2023	Hooley Station (letter) Mt Florance Stations (letter) Mulga Downs Station (letter)	Correspondence (email and attachments)	Notification of submission of environmental approval document was provided via letter to Hooley Station, Mt Florance Station and Mulga Downs Station.

Date	Department	Activity	Key Comments
19/09/2022	Meeting (face to face) with Hooley Station and Mt Florance Station	Targeted meeting/briefing	Meeting to provide Hooley Station and Mt Florance Station with an overview of the Proposal. The meeting also provided opportunities for discussion and questions from the stations on the Proposal.
10/11/2022	Meeting with Mulga Downs Pastoral Station (Microsoft teams meeting)	Targeted meeting/briefing	Meeting to provide Mulga Downs Station with an overview of the Proposal. The meeting also provided opportunities for discussion and questions from Mulga Downs Station on the Proposal.
29/08/2023	Meeting the Town of Port Hedland	Targeted meeting/briefing	Meeting to provide an overview of the Mulga Down Iron Ore Projects and the status of approvals for each project.

6 Object and Principles of the Environmental Protection Act 1986

The objective of the EP Act is to protect the environment of the State through the establishment of a series of principles for environmental protection. HPPL has considered and/or addressed each of the principles regarding the Proposal and has therefore considered the object of the EP Act. The principles for environmental protection have been considered by HPPL and are summarised in **Table 6-1.**

Table 6-1: Principles of Environmental Protection

Principle		Consideration
1	**The Precautionary Principle** Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and An assessment of the risk-weighted consequences of various options.	The Proposal is being developed through a detailed process of review to ensure impacts to the environment are minimised through application of the mitigation hierarchy. HPPL is using existing environmental data for the region supplemented with site specific baseline and targeted data collected through the completion of the following studies: • Flora and vegetation; • Ecohydrological; • Terrestrial fauna including short range endemics; • Subterranean fauna; • Surface and groundwater; • Air quality; • Noise; • Visual assessments; • Heritage surveys; and • Soil and Materials characterisation. These studies have informed the design of the Proposal and modifications to the Development Envelope and Indicative Footprint to avoid and minimise environmental impacts to high value areas, where practicable. Consultation has been undertaken and is ongoing with key stakeholders to identify potential environmental impacts, appropriate measures to avoid and reduce impacts and management for the Proposal. HPPL also commits to implement specific management plans to ensure ongoing avoidance and minimisation of impacts to environmental values in the Development Envelope.
2	**The Principle of Intergenerational Equity** The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	The Proposal meets the principle of intergenerational equity by ensuring the health of the environmental values, maintaining ecological functions for future generations, whilst minimising any impacts on the environment. The Proposal has been designed to address the EPA's objectives for the key environmental factors, with mitigation measures to reduce residual environmental impacts and offsets proposed for any significant residual impacts. The Proposal responds to the growing demand for mineral resources and provides environmentally responsible and economically sustainable means of meeting this demand.

Principle		Consideration
		The Proposal can be implemented without unacceptable impacts on the health, diversity or productivity of the environment. The area is to be returned to pastoral land use on completion of mining.
3	**The Principle of the Conservation of Biological Diversity and Ecological Integrity** Conservation of biological diversity and ecological integrity should be a fundamental consideration.	The conservation of biological diversity and ecological integrity is a fundamental consideration in the assessment of this Proposal. Wherever possible: • Non-fixed Proposal elements for mine infrastructure (e.g. WRDs, RoM pads, conveyors, roads, administration and maintenance buildings) will be located to minimise clearing and disturbance and maximise separation distances to sensitive receptors and known environmental values as identified by the baseline and targeted surveys; • Where practicable, the possibility of adopting separation distances has been and will be considered to minimise impacts to area of critical habitat and known environmental values as identified by the baseline and targeted surveys; • Identify possible areas that may be categorised as exclusion zones to avoid direct impacts. For example, sites of heritage significance, significant fauna habitat, and the claypans; • Ecological integrity outside of the footprint is expected to be maintained.
4	**Principles Relating to Improved Valuation, Pricing and Incentive Mechanisms** Environmental factors should be included in the valuation of assets and services. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	Environmental constraint, avoidance and management costs will be considered in the planning and design of the Proposal. Detailed flora and vegetation and terrestrial fauna surveys have been undertaken to identify key environmental values within the Development Envelope. Survey findings have been used to review the Indicative Footprint to avoid and minimise impacts to significant values. HPPL also commits to implement specific management plans for the ongoing avoidance and minimisation of potential impacts. Following the application of the mitigation hierarchy, significant residual impacts are predicted. HPPL will be responsible for funding the cost of measures to avoid, reduce, mitigate and manage environmental impacts and commits to providing offset funds, where required, to the Pilbara Environmental Offsets Fund (PEOF), to maximise the benefit of offset expenditure. • The following validation, pricing and incentive measures are incorporated into the Proposal: • Reduction of waste to landfill through implementation of recycling schemes. • Minimisation of clearing which represents a cost saving associated with earthworks as well as a reduced environmental impact. Progressive rehabilitation to assist in restoring natural ecosystems, which reduces the costs associated with the Mining Rehabilitation Fund. Improve energy efficiency resulting in overall reductions in fuel consumption, costs and greenhouse gas emissions.

Principle		Consideration
5	**The Principle of Waste Minimisation** All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	HPPL commits to minimising waste as far as practicable during construction, operation and closure by adopting the hierarchy of waste controls: avoid, minimise, reuse, recycle and safe disposal.

6.1 Identification of Key Environmental Factors

This section identifies the environmental factors and objectives relevant to the Proposal, outlines the overall assessment methodology presented in this document and the environmental impact assessment undertaken for each environmental factor.

Environmental factors are those parts of the environment that may be impacted by an aspect of a Proposal. The EPA has 14 environmental factors. The EPA has identified the following key environmental factors as relevant to the assessment of the Proposal (as identified in the ESD):

- Inland waters (**Section 7**);
- Subterranean fauna (**Section 8**);
- Flora and vegetation (**Section 9**);
- Terrestrial fauna (**Section 10**);
- Terrestrial environmental quality (**Section 11**);
- Greenhouse gas emissions (**Section 12**);
- Air Quality (**Section 13**); and
- Social surroundings (including Aboriginal heritage) (**Section 14**).

Consideration of other environmental factors occurred during the scoping and referral process. With the exception of Human Health and Landforms (**Section 15**) all other factors are not relevant to the Proposal and therefore do not require assessment in this ERD.

The key environmental factors associated with the Proposal are addressed in this ERD in the following format, and consistent with EPA's *Instructions on how to prepare an Environmental Review Document* (EPA 2021e):

- Statement of EPA objective;
- Discussion of relevant policy and guidance, and summary of how this guidance has been addressed;
- Description of the receiving environment relevant to the environmental factor;
- Definition of potential direct and indirect impacts on the environmental values for the environmental factor;
- Description of mitigation, including application of the mitigation hierarchy (i.e., avoid, minimise, rehabilitate and offset);
- Assessment of the extent and significance of residual impacts to the environmental values of the environmental factor;
- Description of the predicted environmental outcome as assessed against the EPA's objective for the environmental factor; and
- Cumulative and Holistic impact assessments are addressed in **Section 17** and **Section 18,** respectively.

7 Inland Waters

7.1 EPA Objective

The EPA's objective for the environmental factor Inland Waters is:

"To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected" (EPA 2018a).

For the purpose of this assessment inland waters includes groundwater, such as superficial and confined aquifers, and hydrology, such as waterways, wetlands and estuaries. A 'waterway' is any river, creek, stream or brook, including its floodplain and estuary or inlet. This includes systems that flow permanently, for part of the year or occasionally, and waterways that have been artificially modified (EPA 2018a).

7.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to this factor which have informed the planning for the Proposal are listed in **Table 7-1.** HPPL has specifically considered guidance documents in the following ways:

- Surveys and analyses undertaken to describe the receiving environment and the significance of that environment;
- Identification of activities which may lead to impacts to inland water; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 7-1: Inland Waters Policy and Guidance

Reference	Report
DoW 2010	Pilbara - Regional Water Plan 2010 - 2030
DoW 2013	Western Australian Water in Mining Guideline
EPA 2018a	Environmental Factor Guideline: Inland Waters
ANZECC/ARMCANZ 2000	National Water Quality Management Strategy
NHMRC 2004	Australian Drinking Water Guidelines 6; Endorsed by NHMRC 10-11 April 2003.
DMIRS 2020a	Statutory Guidelines for Mine Closure Plans

Specific additional work required for assessment of the Proposal, relating to Inland Waters was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this section.

7.3 Receiving Environment

The following sections describe the key features of the receiving environment in relation to the Inland Waters factor, including details of the surveys and studies undertaken to support the Proposal.

7.3.1 Relevant Studies

HPPL has conducted numerous hydrological, ecohydrological, hydrogeological and modelling studies to inform the description of the receiving environment, with respect to inland waters, for the Proposal. **Table 7-2** lists the technical studies undertaken. Key study reports are provided in **Appendix 4** and **Appendix 5**.

Table 7-2: Completed Baseline Inland Water Surveys and Studies

Reference	Report Title	Description	Guidance
MWH 2008	Hydrology Study for the Mulga Downs project	Short report reviewing groundwater levels and water quality/supply.	Not Applicable (NA)
MWH 2009	Murray's Hill Groundwater Investigation – Stage 2	To expand and improve the Stage 1 understanding of the hydrogeology of the Murray's Hill deposit and surrounding environment by conducting Stage 2 field visit including site visit, installation of six data loggers, completion of two test pumping exercises, EC profiling and sampling.	Australian Drinking Water Guidelines 6, NHMRC 2004; Endorsed by NHMRC 10-11 April 2003.
MWH 2012a	Mulga Downs Project, Murray's Hill Minesite – Hydrology Assessment Report	Study undertaken to characterise the quantity and quality of the groundwater resources within the mining tenement.	NA
MWH 2012b	Hydrogeological Assessment of the Fence line Road Borefield Area (Mulga East)	Study undertaken to characterise the quantity and quality of the groundwater resources within the mining tenement.	NA
HPPL 2013	Mulga Downs Project – Section 38 Referral Supporting Document, Hancock Prospecting Pty Ltd, Perth	Referral document for Murray's Hill Mine.	NA
MWH 2014	Conceptual Hydrogeology of the Mulga East Deposit	Undertaken to develop a preliminary groundwater desktop study of the Mulga East deposit and compile a conceptual hydrogeological model of the area.	Australian Drinking Water Guidelines 6, NHMRC 2004; Endorsed by NHMRC 10-11 April 2003.
AQ2 2018a	Mulga East – Preliminary Conceptual Model	Stage 1 Desktop study review of all available data and previous work and develop a preliminary conceptual site model for the Development Envelope and current data gaps.	Environmental Factors Guideline Inland Water (EPA 2018a)
AQ2 2018b	Mulga East – Excess Water Management	Water management options for the anticipated excess water from dewatering at the Mulga East Project	Environmental Factors Guideline Inland Water (EPA 2018a)
AQ2 2020a	Mulga East Baseline Water Studies *(superseded by A)* ***Appendix 4 and Appendix 5))***	Baseline groundwater and surface water studies	Environmental Factors Guideline Inland Water (EPA 2018a)

Reference	Report Title	Description	Guidance
AQ2 2020b	Ecohydrological Baseline Study Superseded by **Appendix 4**	Baseline survey for GDV.	Environmental Factors Guideline Inland Flora and Vegetation (EPA 2016)
GHD 2023 **(Appendix 7a)**	Mulga Downs Water Studies: Groundwater & Surface Water Impact Assessment – Peer Review	Peer review of the AQ2 (2024a) Mulga Downs Water Studies: Groundwater and Surface Water Impact Assessment report as scoped in the Mulga Downs Iron Ore Mine ESD 2022. Note that only the surface water components of the report were reviewed in this study.	NA
HydroGeoLogic 2023 / Middlemis 2023 **(Appendix 7b)**	Mulga Downs Groundwater Modelling Independent Peer Review	Peer review into the groundwater modelling investigations conducted by Groundwater Consulting and AQ2 for the Mulga Downs Iron Ore Project	NA
AQ2 2025 **(Appendix 4)**	Mulga Downs Groundwater, Surface Water & Ecohydrological Studies – Baseline Assessment (171X_492d)	Baseline groundwater, surface water and ecohydrological studies , to support the environmental assessment of the Project. This report details all baseline and conceptualisation work undertaken from 2018 until November 2023	Environmental Factors Guideline Inland Water (EPA 2018a); Environmental Factors Guideline Flora and Vegetation (EPA 2016)
AQ2 2024a (**Appendix 5**)	Mulga Downs Groundwater, Surface Water & Ecohydrological Studies - Impact Assessment (171X_493a)	This assessment provides an environmental impact assessment of the Proposal, identifying key environmental assets and water management strategies.	Environmental Factors Guideline Inland Water (EPA 2018a); Environmental Factors Guideline Flora and Vegetation (EPA 2016)

7.3.2 Geomorphology and Hydrology

The Development Envelope is within the Chichester Ranges, on the northern flanks of the Lower Fortescue Valley. It is within the Goodiadarrie Swamp surface water catchment, which is approximately 4,138 km^2 (HPPL 2013; AQ2 2025) (**Figure 7-2**).

The Fortescue Valley (shown as the ESA) (**Figure 7-29**) is bound by the Chichester Range to the north and the Hamersley Range to the south. It comprises a network of interconnected ephemeral swamps, claypans and floodplains which extend further to the west into Mount Florance Station. The valley floor gently slopes to the west, is about 20 km wide and is bound to the south by the Hamersley Range (AQ2 2025).

The Chichester Range comprises hills which rise approximately 100 m above the Fortescue Valley floodplain. Surface water runoff into the Fortescue Valley is from the Chichester Range to the north and the Hamersley Range to the south. The hills of the Chichester Range are cross-cut by narrow, steep-sided gullies that feed into a series of alluvial fans extending into the valley floor. Numerous small tributaries cross the alluvial fan surfaces and deliver water into the Fortescue River valley wetland complex, including Goodiadarrie Swamp (AQ2 2025).

Runoff from smaller rainfall events is likely contained within the Goodiadarrie Swamp area, with discharge into the Lower Fortescue River requiring large rainfall events. The wide and gently sloping interfluvial zones are characterised by banded vegetation formations, indicating sheet flow behaviour in these areas. Similar (but

larger) drainage lines exist within the Hamersley Range to the south. The incised drainage lines are contained within larger gorges such as Wittenoom Gorge and Kalamina Gorge and discharge into large alluvial fans spread across the southern flank of the Lower Fortescue River valley.

East of the Development Envelope, the Goodiadarrie Hills form the western boundary of the Upper Fortescue River Catchment, separating the Fortescue Valley in the vicinity of the Proposal from the Fortescue Marsh to the east. The catchment terminus comprises the Fortescue Marsh, a vast endorheic wetland occupying an area of approximately 1,000 km^2. The Fortescue Marsh (the Marsh) is the largest ephemeral wetland in the Pilbara, the water regime supporting a number of environmental values (EPA 2013). The Marsh is currently managed by the Department of Biodiversity, Conservation and Attractions (DBCA) in accordance with the Fortescue Marsh Management Strategy 2018-24 (DBCA, 2018). The Fortescue Marsh is approximately 60 km east (upstream) of the Development Envelope, and is considered to be geographically, hydrologically and hydrogeologically separate to the Lower Fortescue River system.

With respect to being recognised as a wetland of national significance, the Fortescue Valley is listed in the Directory of Important Wetlands in Australia (DIWA) as Fortescue Marshes - WA066. This site comprises the more or less contiguous floodplain in the middle reaches of the Fortescue River, bisected by the Goodiadarrie Hills, but covering both the Fortescue Marsh and Goodiadarrie Swamp areas.

Locally, significant surface water features, the Koodjeepindarranna and Gnalka Gnoona Claypans (**Figure 7-2**), have developed at the interface of the alluvial fan margins and extensive shallow calcrete associated with the valley floor paleodrainage (AQ2 2025).

River and creek systems in the Pilbara generally only flow for a very short duration immediately following larger rainfall events which predominantly occur during the wet season (December through to March). Extended periods of no flow occur throughout the dry season. Multiple flood events are recorded across many years; however, in low rainfall years, or years where large rainfall events are absent, there may not be any flow responses in the main river/creek systems (AQ2 2025).

Sixteen surface water subcatchments have been delineated which have the potential to be impacted by the Development Envelope. Runoff from eleven of these catchments reports to the Fortescue Valley Environmentally Sensitive Area (ESA) as defined by DWER (AQ2 2025). The following datasets have been used to delineate the baseline catchment areas:

- 2023 LiDAR DEM;
- SRTM datasets;
- Aerial imagery; and
- Initial flood model results.

Baseline catchment areas are presented in **Figure 7-1**, with the size of each catchment area summarised in **Table 7-3**.

Table 7-3: Baseline Surface Water Catchment Summary

Catchment	Baseline Area (km^2)
1	23.1

Catchment	Baseline Area (km²)
2	164.4
3	39.8
4	28.4
5	33.8
6	13.5
7	29.0
8	11.9
9	43.3
10	53.9
11	65.5
12	1.7
13	6.3
14	2.1
15	4.5
16	7.3

Figure 7-1: Pre-development Catchment Areas

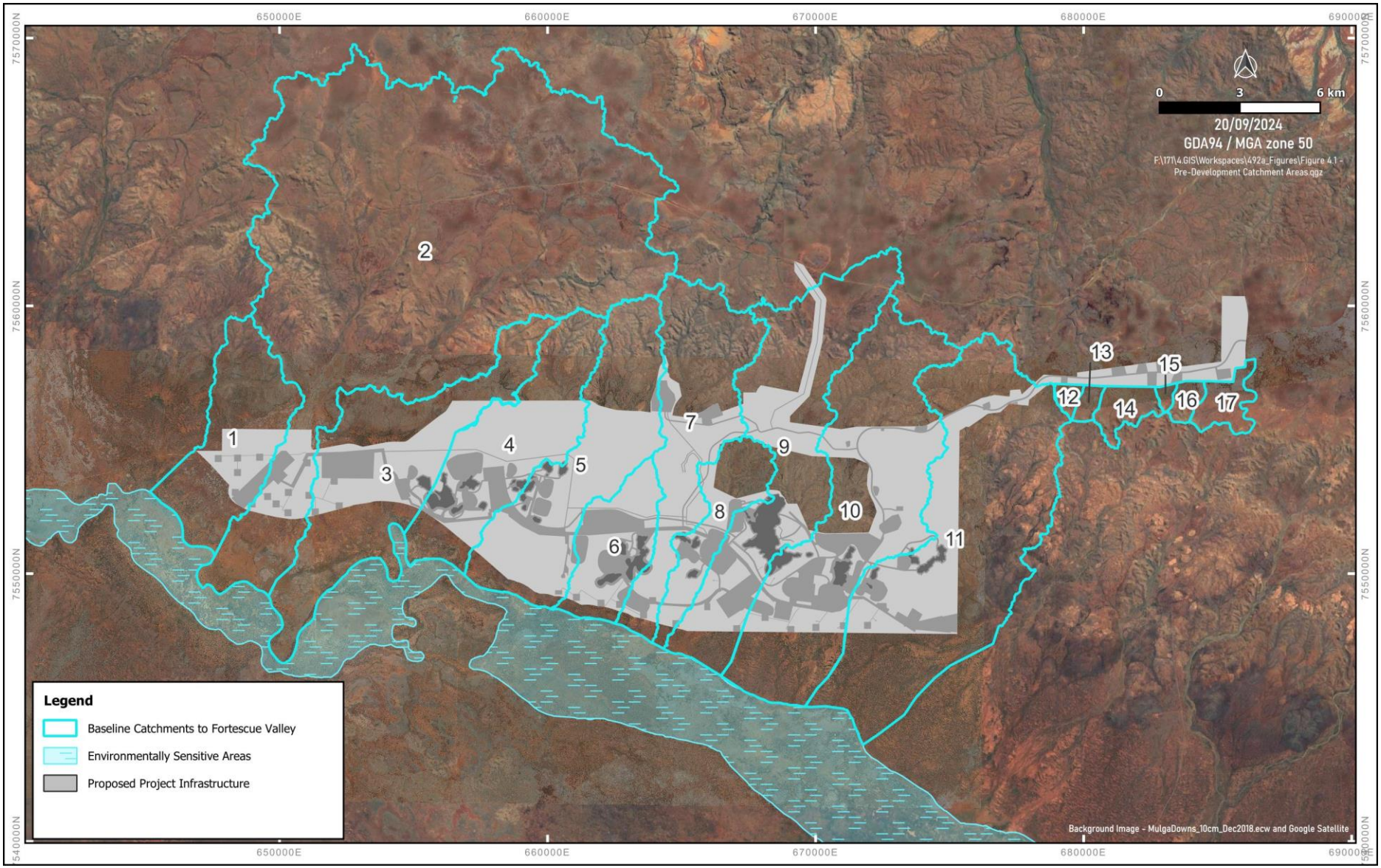

650000E
660000E
670000E
680000E
690000E
7570000N
7560000N
7550000N
7540000N
0
3
6 km
20/09/2024
GDA94 / MGA zone 50
F:\171\4.GIS\Workspaces\492a_Figures\Figure 4.1 - Pre-Development Catchment Areas.qgz
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Legend
Baseline Catchments to Fortescue Valley
Environmentally Sensitive Areas
Proposed Project Infrastructure
Background Image - MulgaDowns_10cm_Dec2018.ecw and Google Satellite

Figure 7-2: Geomorphology Overview (AQ2 2025)

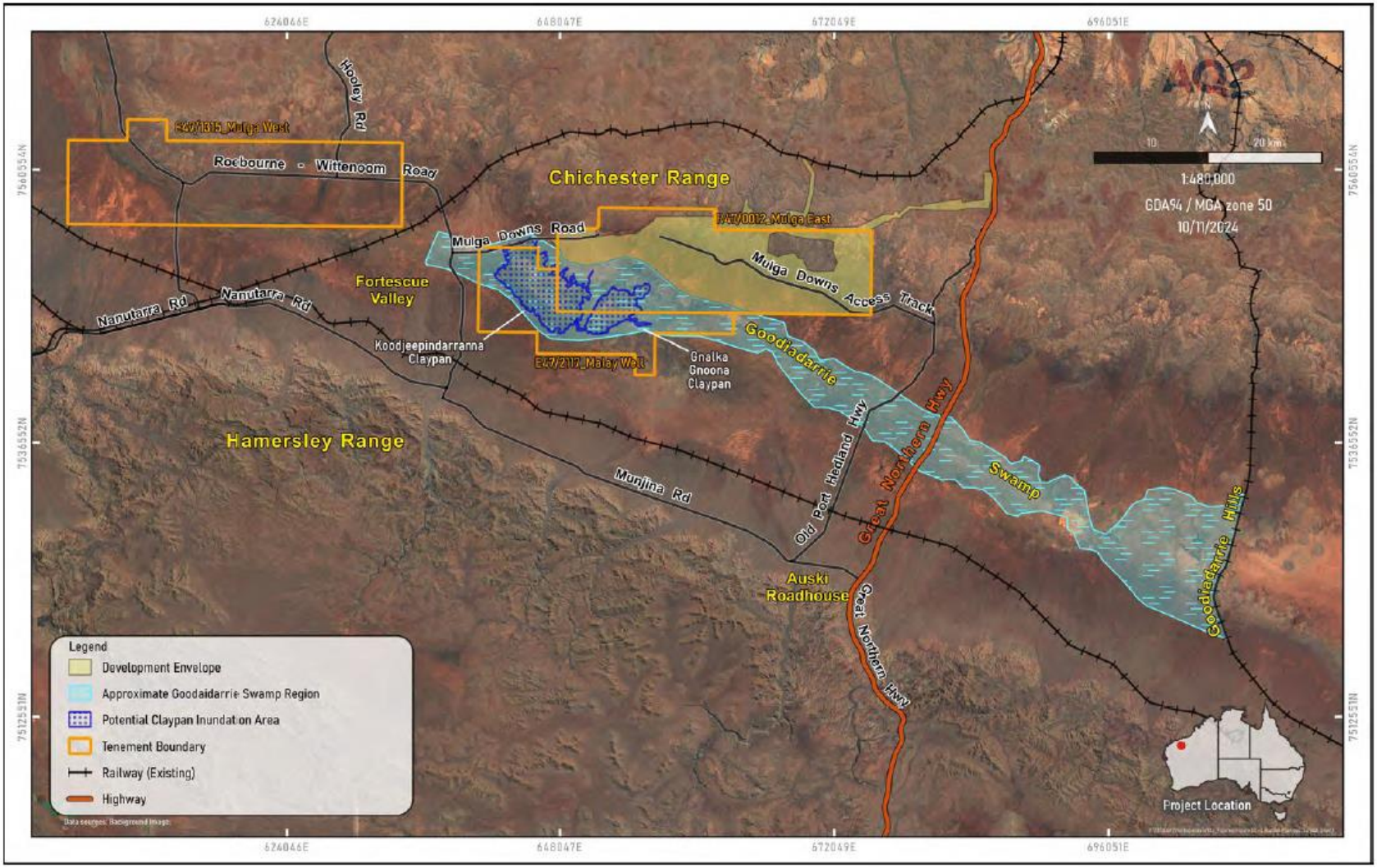
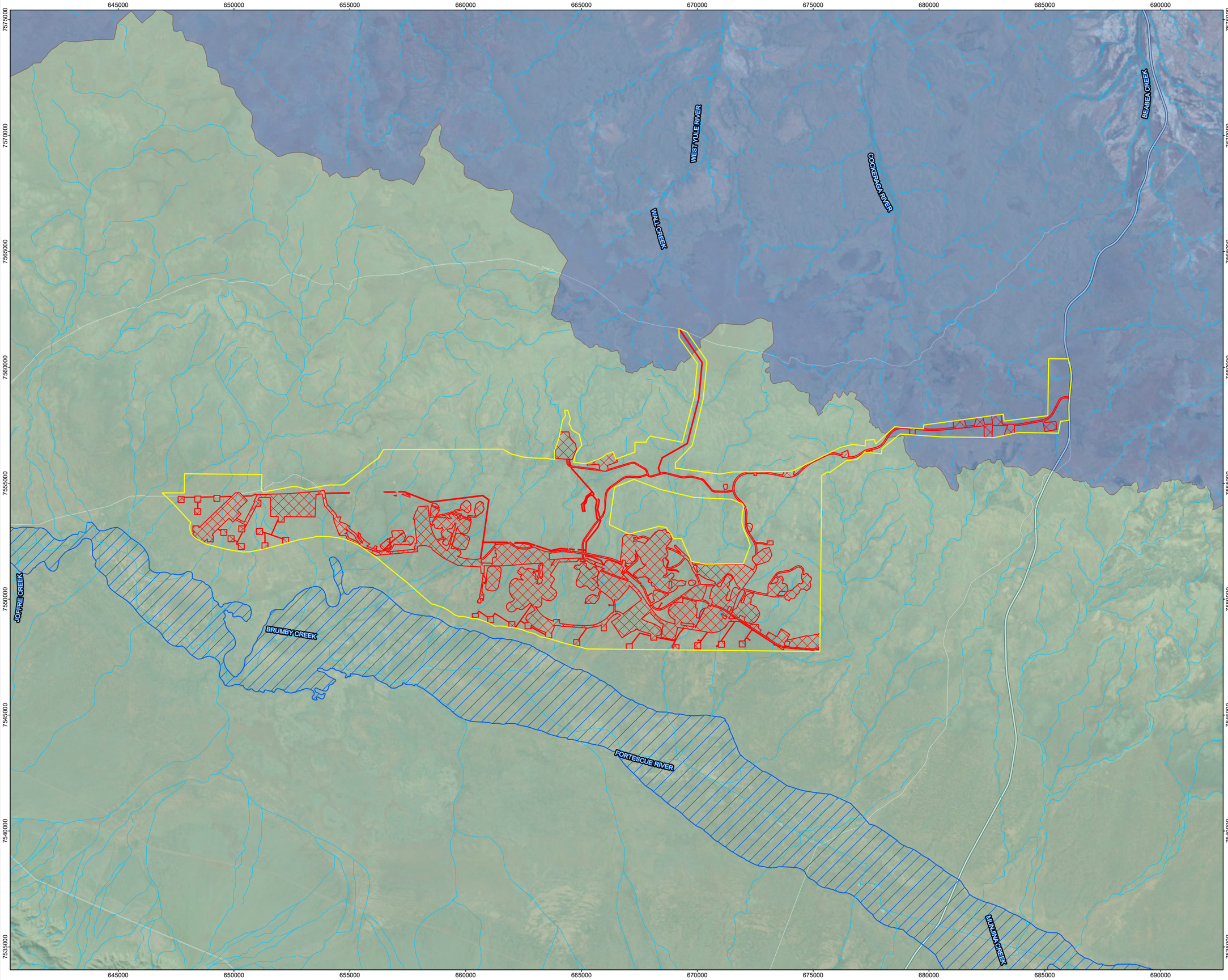

624046E
648047E
672049E
696051E
7560554N
7536552N
7512551N
Hooley Rd
E47/1315_Mulga West
Roebourne - Wittenoom Road
Chichester Range
E47/0012_Mulga East
Mulga Downs Road
Mulga Downs Access Track
Fortescue Valley
Nanutarra Rd
Nanutarra Rd
Koodjeepindarranna Claypan
E47/2117_Malay West
Gnalka Gnoona Claypan
Goodiadarrie
Hamersley Range
Munjina Rd
Old Port Hedland Hwy
Great Northern Hwy
Swamp
Goodiadarrie Hills
Auski Roadhouse
Great Northern Hwy
Legend
Development Envelope
Approximate Goodaidarrie Swamp Region
Potential Claypan Inundation Area
Tenement Boundary
Railway (Existing)
Highway
Project Location
10
20 km
1:480,000
GDA94 / MGA zone 50
10/11/2024

Figure 7-3: Regional Hydrology



Legend

- Indicative Footprint
- Development Envelope

Directory of Important Wetlands in Australia (DBCA-045)

- Fortescue Marshes

Catchment boundaries (DWER-028)

- Fortescue River
- Fortescue River- Upper
- Watercourse (DWER-031)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 22-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:150,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

REGIONAL HYDROLOGY

FIGURE 7.3

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

7.3.3 Surface Water Quality

Surface water samples were collected within creek lines, channel pools and claypans between 2020 and 2023, for laboratory analysis (AQ2 2024a). Sample locations are shown in **Figure 7-4**. The following water quality samples were collected:

- SWML01 (Creekline) – 5 samples.
- SWML02 (Creekline) – 4 samples.
- SWML03 (Claypan) – 4 samples.
- SWML04 (Claypan) – 5 samples.
- SWML05 (Creekline) – 3 samples.
- SWML09 (water quality only) – 1 sample.
- SWML13 (water quality only) – 1 sample.

The results of these samples are documented in Section 4.5 of AQ2 2025 (**Appendix 4**) and summarised in Table 7-4**.** It is noted that samples collected in 2019 from drainage lines have not been included as these were collected using a different methodology which likely resulted in abnormally high TDS water quality results.

Table 7-4: Summary of Key Baseline Surface Water Quality Results (mg/L)

	Drainage Line Samples		Claypan Samples	
	Range	**Typical**	**Range**	**Typical**
TDS	18 to 240	100	120 to 19,000	~4,000
Calcium	1.6 - 21	10	3.9 – 35	5
pH (pH Units)	3.7 – 8	6.4	7 – 8.3	7.2
Bicarbonate	<5 – 47	20	50 – 130	100
Carbonate	<5	<5	<5	<5
Ammonia – N	<00.2 – 9.5	1	<00.2 – 6	1
Nitrate-N	0.02 – 28	2	<0.01 -1.6	1
Filterable Reactive Phosphorus	<0.01 -1.8	0.1	<0.01 -0.44	0.1
Magnesium	0.4 – 5.6	4	1.2-180	3
Sulfate	2 - 43	5	< 1 to 230	40
Sodium	0.8 -15	5	22 -950	40
Chloride	2 -17	<5	11 – 1,600	50
Aluminium (dissolved)	0.015 – 1.6	0.1	1.8 – 7.4	5
Iron (dissolved)	0.02 – 0.85	0.08	0.06 -14	8

Notes - Variable water quality in the claypans reflects evapo-concentration of water stored in the claypans following runoff events

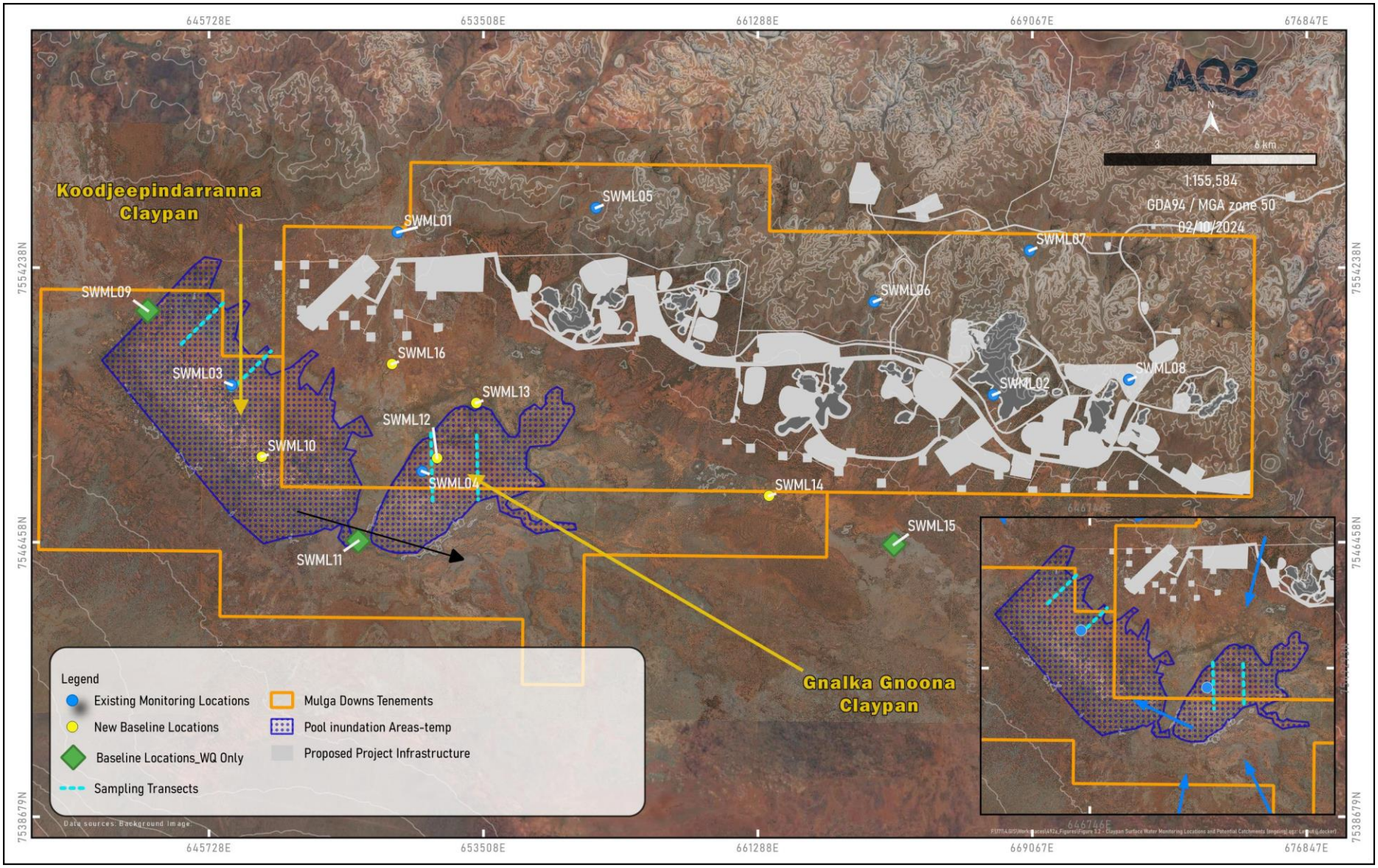
These water quality samples provide baseline water quality data within the Development Envelope. Given the naturally large variability in surface water runoff, additional samples are required to be collected over time to provide a more robust baseline dataset, and further characterise surface water quality for the Proposal.

The water quality sample results indicate that surface water runoff within the Development Envelope is fresh and generally pH neutral. There is the potential that the natural runoff can have high levels of suspended sediment. The salinity in the claypans tends to be fresh immediately following a runoff event, but salinity increases with time as the ponded water evapo-concentrates.

The baseline water quality data collected has been compared with the ANZECC Freshwater Aquatic Ecosystem trigger values, to show where runoff from the existing catchments exceeds them. The full provision and analysis of this data is detailed in AQ2 (2025) (**Appendix 4**).

The baseline data collected will provide a useful reference dataset to identify if any changes in surface water runoff quality occur following proposed catchment modifications as part of the Proposal. The potential impact of proposed catchment modifications are discussed in **Section 7.5**.

Figure 7-4: Surface Water Monitoring Locations (AQ2 2025)


645728E
653508E
661288E
669067E
676847E
7554238N
7546458N
7538679N
AO2
N
3
6 km
1:155,584
GDA94 / MGA zone 50
02/10/2024
Koodjeepindarranna Claypan
Gnalka Gnoona Claypan
SWML01
SWML02
SWML03
SWML04
SWML05
SWML06
SWML07
SWML08
SWML09
SWML10
SWML11
SWML12
SWML13
SWML14
SWML15
SWML16
Legend
Existing Monitoring Locations
New Baseline Locations
Baseline Locations_WQ Only
Sampling Transects
Mulga Downs Tenements
Pool inundation Areas-temp
Proposed Project Infrastructure
Data sources: Background Image

7.3.4 Claypans

The Koodjeepindarranna and Gnalka Gnoona claypans are not located within the Development Envelope; however, they may be considered proximal. The mapped DBCA buffers for the claypans do intersect the Development Envelope, however when dry, the boundary of the claypans can be delineated by the unvegetated areas, as mapped by *ecologia* (2021a) (refer to **Figure 9-4**). These delineated boundaries fall outside of the Development Envelope.

The Ebathcalby Claypan (Priority 1) Priority Ecological Community (PEC) is located approximately 9 km south of the Development Envelope (**Figure 7-29**) and has an elevation which is 5m higher than the valley floor directly downstream of the Development Envelope. As such, no surface water runoff from the Development Envelope will report to this claypan. Given this, no specific studies into surface water dependence at Ebathcalby Claypan were deemed necessary (AQ2 2024).

Baseline studies (AQ22025) on the hydrology and hydrogeology of the Koodjeepindarranna and Gnalka Gnoona claypans concluded that they are supported by direct rainfall and surface water flows and are not groundwater dependent. These claypans are illustrated in **Figure 7-5**, and the below summarises the hydrological function of these claypans.

Prior to development of the Project, surface water runoff from the Development Envelope would discharge to the Koodjeepindarranna and Gnalka Gnoona claypans (Priority 1) PEC (AQ2 2025). These claypans are hydraulically linked through an overflow channel which links the claypans during periods of high rainfall and inundation. Water flows between the claypans when water levels are above 402.9 m AHD (AQ2 2023a). To the east of the Gnalka Gnoona Claypan, there is evidence of surface water ponding on the northern side of the Fortescue Valley at the foot of the Chichester Range, indicating limited surface water connectivity with the Fortescue Valley to the east of the claypans.

The Koodjeepindarranna and Gnalka Gnoona claypans have catchments that drain from both the north (Chichester Range) and potentially the south (Hamersley Range) depending on the size of the rainfall event. The Development Envelope is confined to the Chichester catchments. The estimated catchment areas for the Koodjeepindarranna and Gnalka Gnoona claypans are illustrated in **Figure 7-6**; however, they are difficult to define, with contributions from different catchments likely to change depending on the size of the rainfall event. Catchment definition is also complicated by the behaviour of drainage lines across the alluvial fan, and the lack of defined drainage and presence of ponding areas within the Fortescue Valley (AQ2 2025). The larger drainage lines originating in Chichester (and Hamersley) Range build alluvial fans on reaching the valley. The drainage lines become braided where they flow across their alluvial fans. However, there often appears to be a preferred drainage channel across each fan for flows of smaller, frequent runoff events. This means there are multiple discharge points from these catchments that contribute to a complex wetland mosaic in the Fortescue Valley (AQ2 2025).

Typically, runoff from small rainfall events is retained within the Goodiadarrie Swamp. Water loss from the claypans is dominated by evaporation (80%) and seepage (20%) to the local groundwater regime. The Koodjeepindarranna and Gnalka Gnoona claypans are not connected to the regional groundwater system. Groundwater levels were monitored below the elevation of the claypans from 2018 to 2023 (AQ2 2024a) as shown in **Figure 7-7**. Groundwater levels near the claypans were generally 2 m to 3 m below the lowest ground

surface elevation in the claypans. The groundwater levels are ~400 m AHD compared to the claypan elevation of ~ 402 m AHD, indicating that groundwater does not flow into the claypans. Seasonal groundwater level fluctuation is also relatively low, at around 0.5 m, based on groundwater level data obtained as part of this assessment (refer to **Section 7.3.6.4**).

A portion of the ponded surface water in the claypans seeps into the underlying groundwater system. Groundwater monitoring bores near the claypans show increases in groundwater levels in response to rainfall events and extended periods of elevated groundwater levels coinciding with ponded surface water being contained in the claypans. This groundwater seepage from the claypans also appears to be a controlling factor in increased levels of groundwater salinity through the leaching of residual salts from evaporation. This seepage has given rise to a saline mound observed in the groundwater along the centre of the valley within the Development Envelope.

Figure 7-5: Claypan Hydrological Conceptualisation (AQ2 2025)

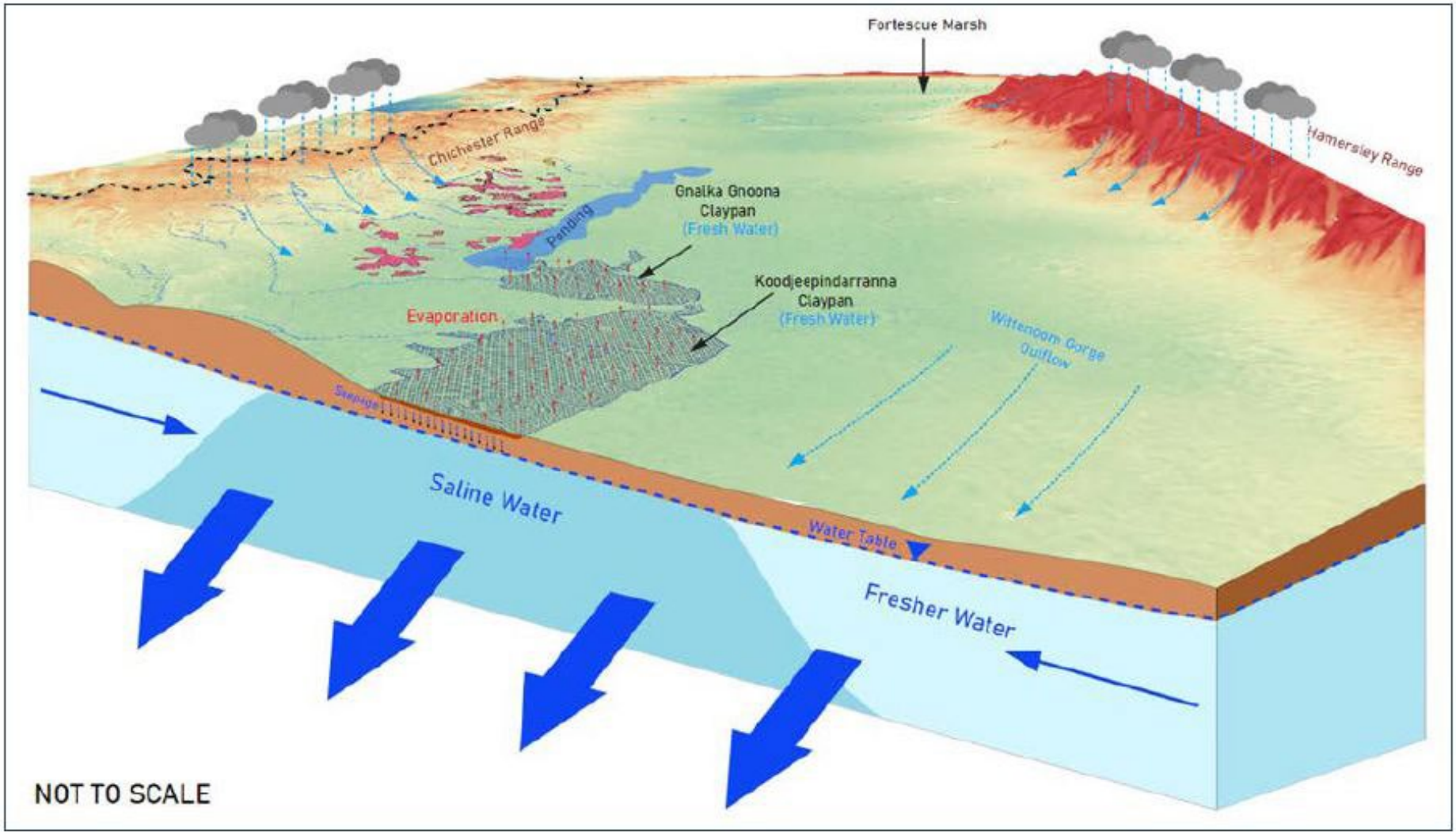

Fortescue Marsh
Chichester Range
Hamersley Range
Gnalka Gnoona
Claypan
(Fresh Water)
Ponding
Koodjeepindarranna
Claypan
(Fresh Water)
Evaporation
Wittenoom Gorge
Outflow
Seepage
Saline Water
Water Table
Fresher Water
NOT TO SCALE

Figure 7-6: Effective Catchment Areas for the Major Claypans (Mulga East) (AQ2 2025)

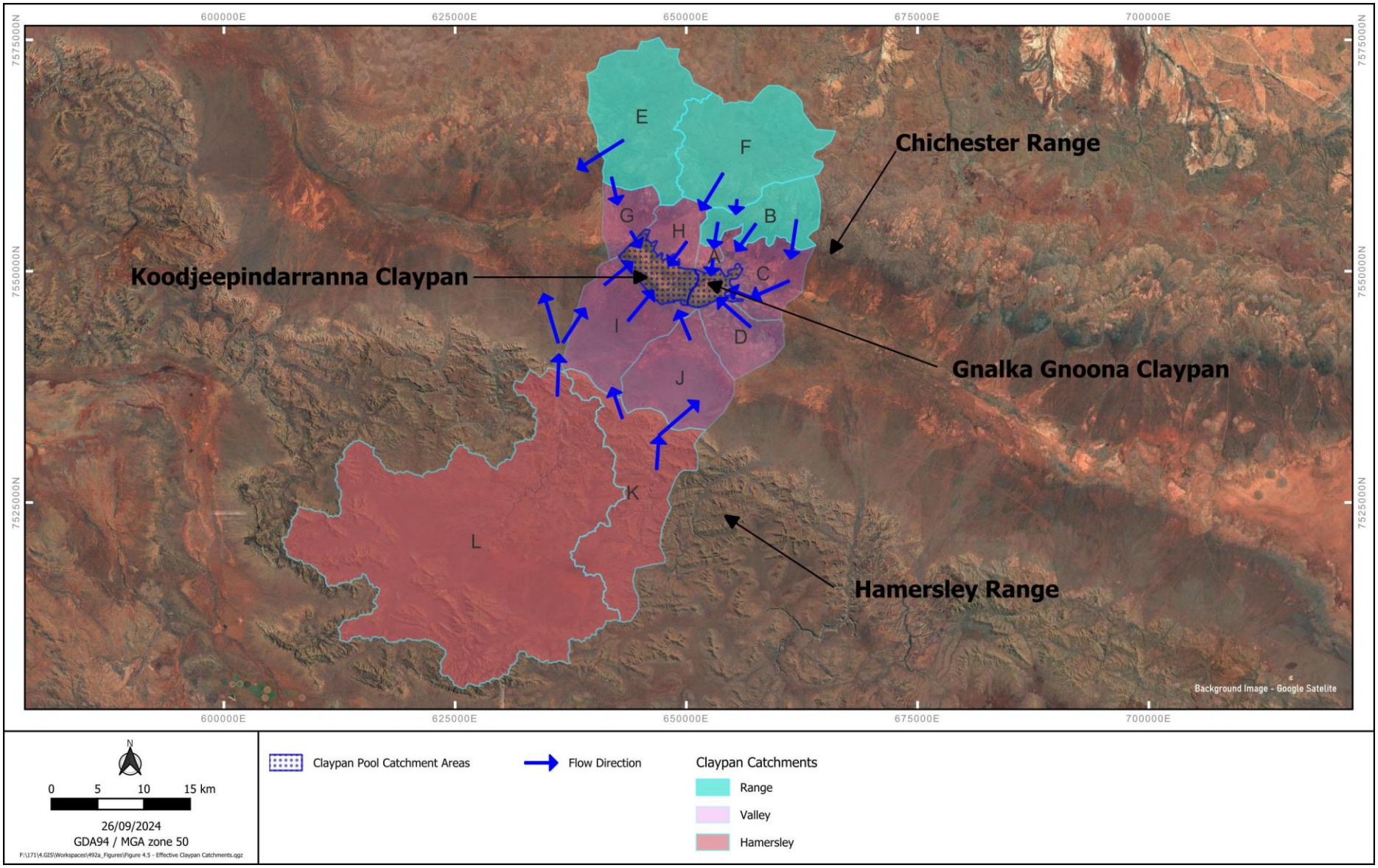

600000E
625000E
650000E
675000E
700000E
7575000N
7550000N
7525000N
E
F
G
H
B
A
C
I
D
J
K
L
Chichester Range
Koodjeepindarranna Claypan
Gnalka Gnoona Claypan
Hamersley Range
Background Image - Google Satelite
N
0 5 10 15 km
26/09/2024
GDA94 / MGA zone 50
F:\171\4.GIS\Workspaces\492a_Figures\Figure 4.5 - Effective Claypan Catchments.qgz
Claypan Pool Catchment Areas
Flow Direction
Claypan Catchments
Range
Valley
Hamersley

Figure 7-7: Groundwater and Surface Water Hydrographs for the Koodjeepindarranna Claypans and Gnalka Gnoona (AQ2 2025)

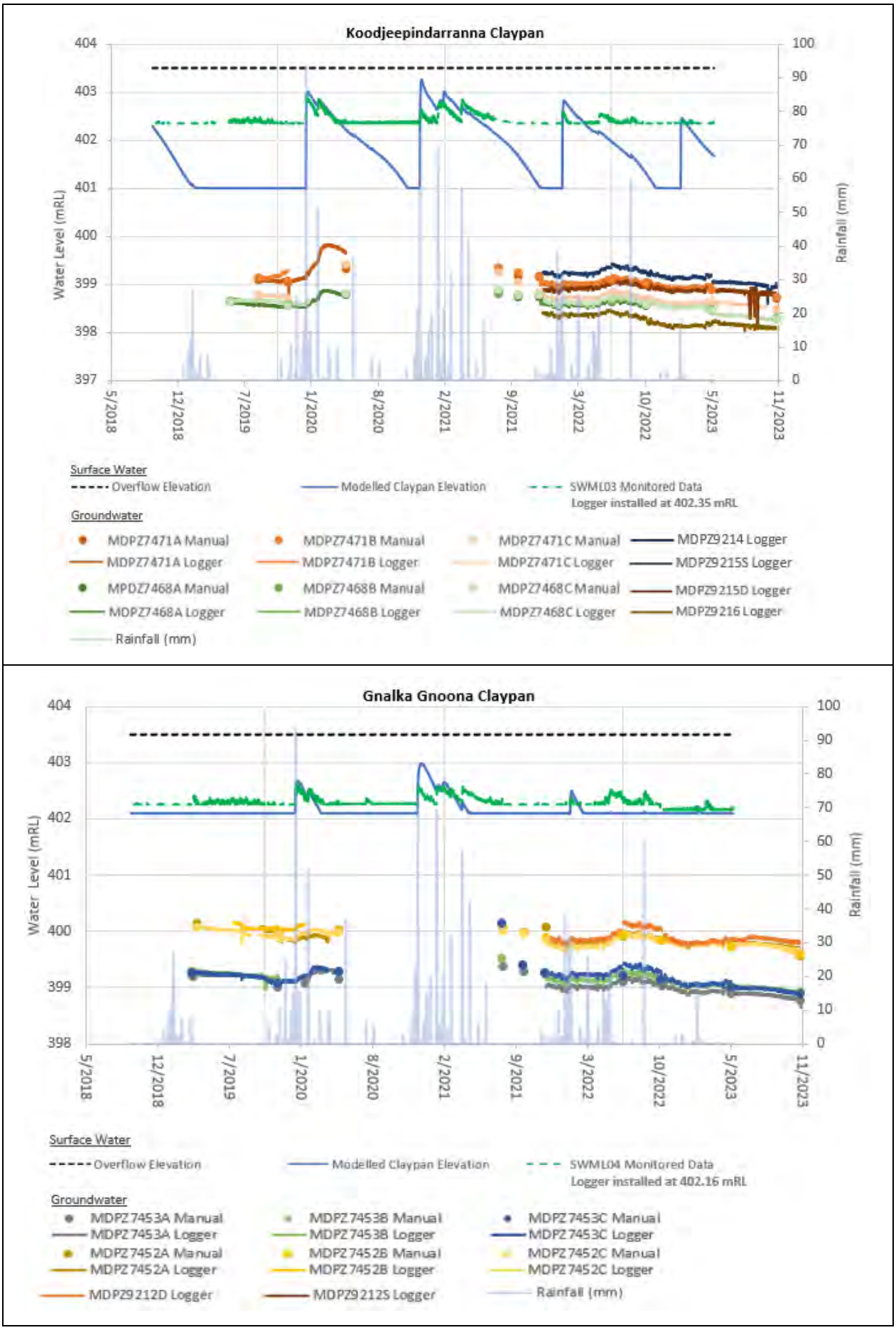


Figure 7.7 Groundwater and Surface Water Hydrographs for the Claypan Areas

7.3.5 Geology

Geology is discussed in **Section 3.9**. Further detail relevant to inland waters is discussed in the following sections.

The Pilbara region occupies the northernmost portion of the ancient Western Shield (Beard 1990). It comprises sedimentary, volcanic and igneous rocks of the Pilbara craton some of which are up to 3.72 billion years (Ga) old (Pepper et al 2013). To the north the Archaean granites and metamorphosed volcanic rocks of the Pilbara Block form the undulating hills and plains observed throughout the Abydos Plain and Yule River and De Grey River catchments. To the south these older rocks are overlain by Archaean and Proterozoic basalts and iron rich sedimentary rocks (Banded Iron Formation – BIF) that comprise the Hamersley Basin (Beard 1990, van Vreeswyk et al 2004, Van Kranendonk et al 2002 in Pepper et al 2013). The Fortescue Valley is part of the larger Hamersley Basin.

The Development Envelope is in the northern part of the Hamersley Basin, a late Archaean to early Proterozoic (2800 Ma - 2400 Ma) depositional basin exposed over most of the southern part of the Pilbara Craton. The Hamersley Basin is occupied by three groups of rocks; the lowermost mafic volcanic dominated Fortescue Group; the Banded Iron Formation (BIF) dominated Hamersley Group; and the uppermost clastic dominated Turee Creek Group (**Figure 7-8** and **Figure 7-9**).

The Development Envelope covers part of the Fortescue Valley and Chichester Ranges. The alluvium represents the Fortescue Valley in Figure 7-8. The Fortescue Valley separates the Hamersley Range to the south from the Chichester Range to the north. The sediments of the Fortescue Group along the Chichester Range are the oldest rocks which cover the Granite-Greenstone Terrain of the Pilbara Craton. The shales and BIFs of the Hamersley Group conformably overlie the Fortescue Group.

The Quaternary and Tertiary sediments (Cainozoic sediments) fill the Fortescue Valley and recent gorges. These sediments include, from youngest to oldest: the alluvium, colluvium, upper calcrete, undifferentiated tertiary (detritals), CID pisolite, basal crete, calcrete of the Oakover Formation. These Quaternary and Tertiary (Cainozoic) sediments overly the older rocks of the Hammersley Group.

The Mulga Downs mineralisation, which is the focus of the Proposal, is hosted by the lower part of the Marra Mamba Iron Formation (MMIF), with secondary mineralisation identified in the transported or detrital materials. The MMIF outcrops as small-rounded hills in the Mulga Downs area, with the hill slopes commonly covered with Cainozoic (Quaternary and Tertiary) sediments such as alluvium, colluvium and/or detritals.

A weathered, hydrated horizon or hard cap is recognised at M 47/1612 with elevated iron to above 50% in places. Localised patches of manganiferous material on outcrops of the MMIF occur at the lower central part of the Mine Area. Manganiferous material is closely associated with hard cap and detritals (Hancock Prospecting, 2015a).

A summary of the stratigraphic sequence in the Development Area is provided in **Table 7-5.** This follows the baseline studies completed by AQ2 (2020, 2024a, 2025) and Mine Earth (2020) for the Proposal.

Figure 7-8: Regional Geology and Geomorphology (Lascelles, 2002)

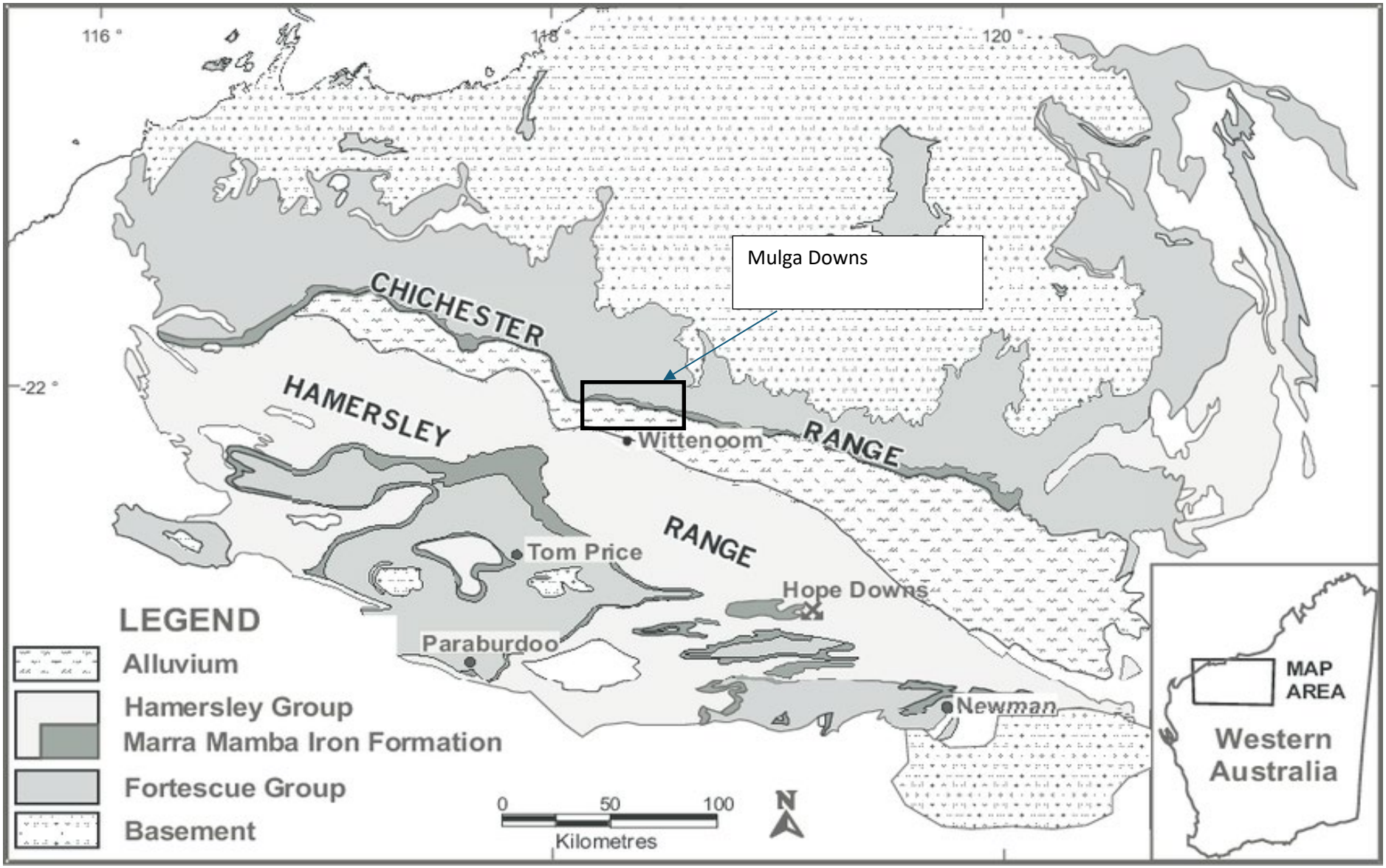

116 °
118 °
120 °
-22 °
Mulga Downs
CHICHESTER
HAMERSLEY
RANGE
Wittenoom
RANGE
Tom Price
Hope Downs
Paraburdoo
Newman
LEGEND
Alluvium
Hamersley Group
Marra Mamba Iron Formation
Fortescue Group
Basement
0
50
100
Kilometres
N
MAP AREA
Western Australia

Figure 7-9: Regional Geology (Kitzig et al 2018)

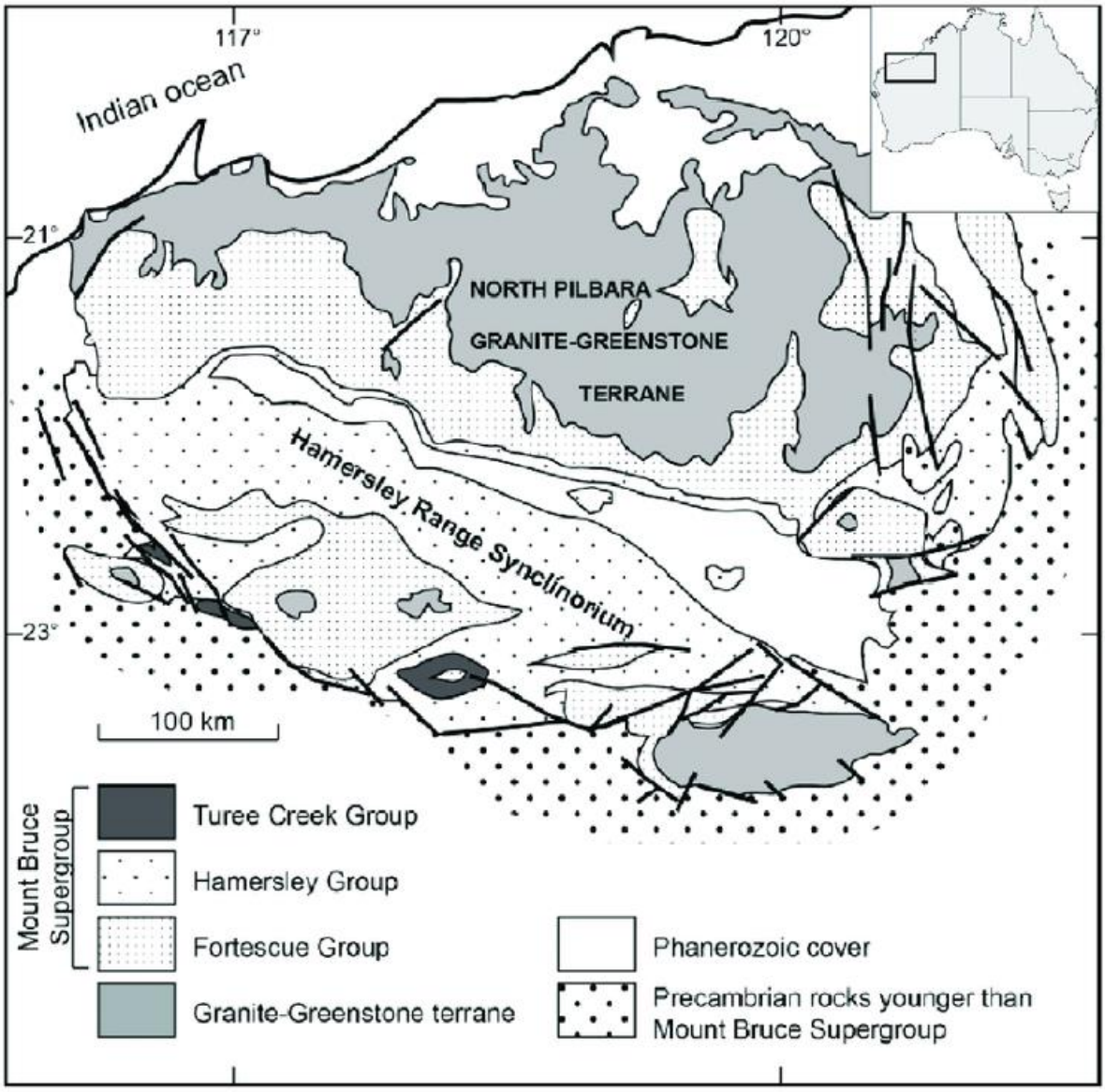

117°
120°
Indian ocean
21°
23°
NORTH PILBARA
GRANITE-GREENSTONE
TERRANE
Hamersley Range Synclinorium
100 km
Mount Bruce Supergroup
Turee Creek Group
Hamersley Group
Fortescue Group
Granite-Greenstone terrane
Phanerozoic cover
Precambrian rocks younger than Mount Bruce Supergroup

Table 7-5: Regional Stratigraphic Sequence within the Development Envelope (Source AQ2 2025, Mine Earth 2020)

Age	Group	Formation	Member	Lithological Description
Quaternary	Alluvium, colluvium			Unconsolidated silts, sand and gravel (claypans).
Tertiary	Detritals	TD3		Red haematitic scree on valley sides. Increasing silt and clay content with distance from slopes and fans. Upper calcrete
		TD2 (Oakover Formation)		Silcrete, calcrete, Channel Iron Deposit (CID) pisolite, basal crete, mottled clay.
	? unknown	? unknown	Pinjan Chert	Siliceous sediment with alternating laminated chert.
Early Proterozoic - Archaean	Hamersley Group	Wittenoom Formation	Bee Gorge Member	Graphitic shale with minor sequences of carbonate, chert, volcaniclastic rock and BIF. (not present in Development Envelope)
			Paraburdoo Member	Dolomite with minor amounts of chert and shale.
			West Angela Member	Dolomite, dolomitic/manganese rich shale, BIF and chert.
		Marra Mamba Iron Formation	Mt Newman Member	BIF with minor shale.
			MacLeod Member	Shale, chert and BIF.
			Nammuldi Member	BIF, chert and shale.
Archaean	Fortescue Group	Jeerinah Formation	Roy Hill Shale Member	Dark grey to black graphitic shale with chert; locally pyritic.
			Warrie Member	Grey dolomitic with inter-bedded chert (locally ferruginous), shale and mudstone.

In stratigraphic order, from oldest to youngest, a summary of the geology for the Development Envelope is provided below (AQ2 2025 and Mine Earth 2020).

7.3.5.1 Fortescue Group

The Fortescue Group is the lowermost unit of the Mount Bruce Supergroup. It unconformably overlies the crystalline East Pilbara Granite-Greenstone basement and is conformably overlain by the Hamersley Group.

7.3.5.2 Jeerinah Formation

The Jeerinah Formation is present in the northern part of the Development Envelope. It conformably overlies the Maddina Formation volcanic rocks and is conformably overlain by the Marra Mamba Iron Formation. The Jeerinah Formation comprises volcanic and interbedded sediments of sandstone, carbonaceous pelite, mudstone, chert and dark grey to black shale. It comprises four members, from oldest to youngest, Woodiana Member, Warrie Member, Nallanaring Member, Roy Hill Member.

The Roy Hill Member of the Jeerinah Formation outcrops along the northern part of the Development Envelope, in the Chichester Range and is characterised by pyritic black shale (Hancock Prospecting, 2015a).

The Jeerinah Formation is a potentially acid forming (PAF) material. Geological assay testing was completed across the Development Envelope from 2010 to 2016 (HPPL 2015) which recorded total sulfur concentrations of 0.3% and above. This indicates these sediments are a possible source of Acid Metalliferous Drainage (AMD) and require careful management throughout the LoM and during closure (Mine Earth 2020a).

7.3.5.3 Hammersley Group

In the Development Envelope the Hammersley Group comprises the Marra Mamba Iron Formation and the Wittenoom Formation.

7.3.5.4 Marra Mamba Iron Formation

The Marra Mamba Iron Formation (MMIF) is the oldest formation of the Hamersley Group. It overlies the Jeerinah Formation and outcrops in the northern part of the Mulga West and Mulga East areas. The MMIF is characterised by sedimentary rocks including BIF, chert and shale. It is host to major iron deposits in the province. It comprises three members, from oldest to youngest; Nammuldi Member, MacLeod Member and Mount Newman Member.

The Nammuldi Member overlies the Jeerinah Formation. It comprises similar carbonaceous black shale at its base and is often logged as Jeerinah Formation given the similarities between the two units (AQ2, 2024a).Stratigraphic analysis of the MMIF within the Chichester Range by HPPL geologists found that all three members of the MMIF occur at Mulga Downs, with a reduced thickness of approximately 105 m compared to a thickness greater than 250 m to the south of the Fortescue Valley (Hurst et al, 2013). In general, the Chichester Range MMIF is composed of interbedded wavy banded to lensoidal chert, BIF and shale units, with the various layers ranging in thickness from 0.5 – 20 cm. At Mulga East the mineralisation starts from the base of the MMIF and rises up through the stratigraphy with increasing distance from where it outcrops.

In the Development Envelope, the MMIF is largely composed of two major rock types; shale and BIF, forming an alternating macroband pattern. The oxide type BIF macrobands consist of two mesoband types, chert and chert-matrix, the latter composed of silicate, carbonate, quartz and magnetite. The intervening thinner shale macrobands consist of varying proportions of ferroan-dolomite and limestone with kaolinitic and ferruginous, shaly intercalations and chert beds referred to as either silicate-carbonate-chert macrobands or more commonly as shales.

The MMIF (Nammuldi Member and MacLeod Member) is considered a PAF material. Geological assay testing was completed across the Development Envelope from 2010 to 2016 (HPPL 2015) which recorded total sulphur contents of 0.3% and above. This indicates these sediments are a possible source of AMD and require careful management throughout the LoM and during closure (Mine Earth 2020).

A brief overview of the members of the MMIF is provided below.

The Nammuldi Member consists of a relatively carbonate rich sequence overlain by silicified cherty carbonate and cherty BIF with interbedded shales. Podded chert units are also present in this Member. Within the Mulga

East tenement, the Nammuldi Member hosts significant hematite mineralisation and has an approximate thickness of 48 m.

The MacLeod Member consists of BIF, cherts and carbonates with numerous interbedded shales and several prominent podded units which are useful markers for field mapping. These podded units can be observed in outcrop. Cherts typified by a granular weathering surface are indicative of a now silicified carbonate parent rock. Within the Mulga East and Murrays Hill tenements, the Macleod Member appears to host significant mineralisation with a thickness ranging 28 to 30m.

The Mount Newman Member is iron-rich and is the uppermost member of the MMIF. The type sections in the Hamersley Range consist of a podded BIF with interbedded carbonates and shales. This member has been identified in various parts of the tenement, commonly occurring undercover south of the range front with a thickness of approximately 46 m and occasionally hosting mineralisation.

7.3.5.5 Wittenoom Formation

The Wittenoom Formation overlies the MMIF (Hancock Prospecting, 2015a). It underlies the Quaternary and Tertiary sediments beneath the Fortescue Valley in the Development Envelope. The Wittenoom Formation consists of calcitic dolomite, interbedded chert and shale and volcanoclastic sandstone. Drilling in the south-western part of the combined tenement group (Malay Well) intersected massive dolomites of the Wittenoom Formation.

The Wittenoom Formation comprises three members, from oldest to youngest: West Angela, Paraburdoo and Bee Gorge. The Paraburdoo and West Angela Members occur within the Development Envelope. The Bee Gorge Member has not been encountered within the Development Envelope and may occur further to the south.

The West Angela Member is the lowermost unit of the Wittenoom Formation. It comprises interbedded BIF, shale, chert and dolomite. It has been observed as being formed of ‘residual’ manganiferous shale and chert with rare dolomite beds (Kepert, 2001).

The Paraburdoo Member comprises dolomite with minor amounts of chert and argillite mostly displaying even, tabular bedding. Most layers of dolomite are a few centimetres to decimetres thick, and less than 1 m. Argillite layers are thinner on average, occurring mostly in the form of sub-millimetre partings to thin beds up to a few centimetres thick separating the dolomite layers. While argillite is present in minor amounts throughout the Paraburdoo Member, chert is restricted to specific horizons of up to 2 m thick that generally contain scattered nodules of grey to black chert.

Tertiary sediments:

The tertiary sediments within the Fortescue Valley in the Development Envelope are collectively known as “detritals” comprising, calcrete (upper and basal), channel iron deposit (CID) pisolitic and clay with local lateritic hardcaps of calcrete and silcrete. Some of these units host secondary ‘detrital’ mineralisation at Mulga East (Hancock Prospecting, 2015a).

Channel iron deposits (CID) are iron-rich fluvial sedimentary deposits of possible Miocene age, occupying paleochannels of the early to middle Tertiary. There is a wide exposure of CID in the central part of Mulga Downs

East tenement. The thickness of the CID in the central part of this paleochannel is typically 8 – 10 m suggesting a shallow braided channel.

The Oakover Formation comprises extensive outcrops of calcrete (upper calcrete) in the Mulga Downs East and Malay Well areas. This unit exhibits massive structure and little evidence of bedding. The calcrete units are covered by white to grey, micritic carbonate fragments and silica rich mudstone.

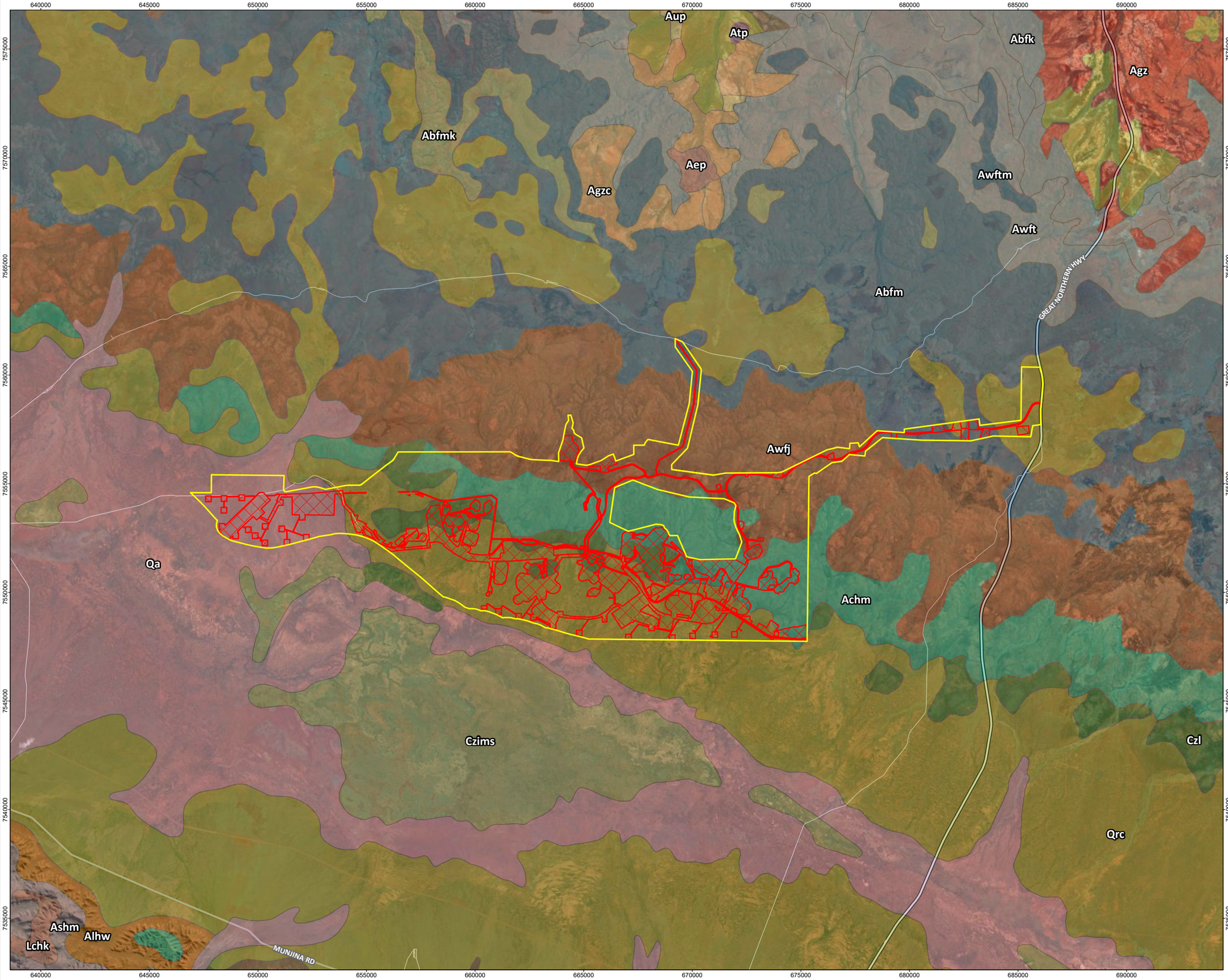
Quaternary sediments:

The Quaternary sediments were deposited from erosion and transport from the Chichester and Hamersley Ranges. The Quaternary sediments comprise alluvium and colluvium in the Fortescue Valley and overly the Tertiary sediments. The alluvial sediments include the modern creek associated bed load and over-bank deposits of unconsolidated brown and red-brown mud, sand, gravel and conglomerate (Qa). The colluvium covers extensive areas of gently sloping sheetwash plain (Qw), characteristic of the Fortescue valley.

The lithology comprises unconsolidated silt, sand and gravel of the ephemeral creeks and riverbeds and clay and silt of the adjacent flood plains of the Fortescue River. The alluvium is up to around 8 m thick and covers most of the Fortescue Valley (AQ2 2024). Calcrete tertiary sediments generally underly the alluvial deposits (Hancock Prospecting, 2015).

The surface geology (1:1,000,000) within the Development Envelope is illustrated in **Figure 7-10.**

Figure 7-10: Surface Geology within the Mulga Downs Iron Ore Mine



Legend

- Development Envelope
- Indicative Footprint

Surface Geology (DoIR)

- Abfk
- Abfm
- Abfmk
- Achm
- Aep
- Agz
- Agzc
- Alhw
- Ashm
- Atp
- Aup
- Awfj
- Awft
- Awftm
- Czims
- Czl
- Lchk
- Qa
- Qrc

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 64593

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 22-Oct-2024

Drawn By: droberts | Checked By: VC

Scale 1:160,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SURFACE GEOLOGY WITHIN THE MULGA DOWNS IRON ORE MINE

FIGURE 7.10

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

7.3.6 Hydrogeology

The baseline studies (refer to **Section 7.3.1**) have been used to characterise the hydrogeology of the Development Envelope.

7.3.6.1 Hydrostratigraphy

The bedrock within the Development Envelope mainly comprises fractured rock aquifers of the Hamersley Group and the Fortescue Groups youngest formation, the Jeerinah Formation. These are overlain by Tertiary and Quaternary sediments within the Fortescue Valley. The hydrostratigraphy is summarised for the Development Envelope in **Table 7-6** Table 76 and represented in the hydrogeological cross sections in **Figure 7-12** to **Figure 7-16**.

Table 7-6: Generalised Hydrostratigraphy across the Development Envelope

	Unit	Aquifer/Aquitard
Quaternary	Alluvium	Surficial
	Colluvium	Surficial
Tertiary	Upper Calcrete	Aquifer
	Undifferentiated Tertiary	Aquifer
	Pisolite / CID	Aquifer
	Basal Crete	Aquifer
Fractured Rock/Bedrock	West Angela Member	Aquifer
	Wittenoom Formation dolomite (Paraburdoo Member)	Aquitard (with a discontinuous fractured rock aquifer)
	Mineralised Marra Mamba Formation	Aquifer
	Unmineralised Fractured Marra Mamba Fm Fresh Marra Mamba Formation	Aquifer Aquitard
	Jeerinah Formation	Aquitard

The Quaternary / Tertiary sediments form an unconfined, unconsolidated sedimentary aquifer. The alluvium is up to approximately 4 m thick and extends across most of the Fortescue Valley. The alluvium and colluvium are generally unsaturated in the Development Envelope and therefore were not investigated for aquifer properties and not considered further in terms of the hydrogeological characterisation.

The Tertiary sediments form a highly transmissive and continuous aquifer (up to 60 m thick in the central part of the valley) within the Fortescue Valley.

In the vicinity of the MDIOM, the Paraburdoo Member comprises light grey, fresh, crystalline and hard Wittenoom dolomite, which mainly has low permeability. The Wittenoom Formation dolomite (Paraburdoo Member) underlies the Fortescue Valley, in the south of the Malay Well tenement. It is generally considered an aquitard unit in this area, with discontinuous fractures representing localised aquifer units. Elsewhere in the Pilbara the Paraburdoo Member is considered a regional aquifer. Johnson and Wright (2021) identified the dolomite of the Wittenoom and the Jeerinah Formation as major aquifer units. However, investigations

undertaken across the Malay Well tenement have generally indicated low permeability. Therefore, this unit is considered an aquitard in the vicinity of the MDIOM. This interpretation is based on the lithology encountered throughout the drilling investigations. The horizontal hydraulic conductivity of these sediments was not tested as part of the aquifer property assessment, summarised in **Section 11.3, Table 7-7.**

In the Mulga East / Malay Well area , the West Angela Member sub-crops the Tertiary sediments near the claypans and hosts a moderately transmissive and continuous aquifer with highly transmissive, discontinuous aquifers associated with localised mineralisation (as at MDPZ9211, 9212D and 9215D, refer to **Figure 7-11**), weathering and/or fractures/faults (as at MDPZ9212D and MDPB0020, refer to **Figure 7-12.** To the south of the claypan area, the West Angela Member aquifer unit is overlain by the Paraburdoo Member of the Wittenoom Formation. This forms a discontinuous fractured rock aquifer in generally low-permeability basement. The occurrence of faulting may result in the juxtaposition of the West Angela Member aquifer and the Paraburdoo Member aquitard units, potentially resulting in reduced hydraulic connection in these areas.

The Marra Mamba Formation hosts a highly transmissive and continuous aquifer across the Mulga East area. It comprises interbedded BIF, shale, chert and some beds of dolomite, with secondary permeability resulting from mineralisation, fracturing and weathering processes. The Marra Mamba outcrops along the northern flanks of the Fortescue Valley and sub-crops beneath the valley floor. A localised low permeability unit was identified around groundwater monitoring bores MDPZ7451 and MDPZ7464, where the bedrock shale has weathered to a 12 to 26 m thick saprolitic clay. This may also occur in other isolated areas across the Development Envelope.

Based on available data, the Marra Mamba aquifer is believed to be much less extensive in the Mulga West tenement, occurring in localised areas at shallow depths, below the Tertiary overburden. As such, most of the Marra Mamba Formation in the Mulga West tenement is considered a low permeability basement aquitard with minor local fractures (AQ2 2025).

The Marra Mamba Formation is underlain by the Jeerinah Formation, which acts as an aquitard in the Development Envelope, comprising black, pyritic and carbonaceous shale with minor chert beds when fresh and can weather to a pink, brown, white puggy clay. Available data suggest this unit, together with the lowermost unit of the Nammuldi Member (referred to as dolomitic Nammuldi by HPPL), is low permeability and forms a basement aquitard with minor local fractured aquifers.

A summary of hydraulic parameters for each of the identified hydrostratigraphic units in the Development Envelope is presented in **Table 7-7.**

Figure 7-11: Examples of possible inferred geological features from magnetics data (AQ2, 2025). Mine Pits are shown in orange.

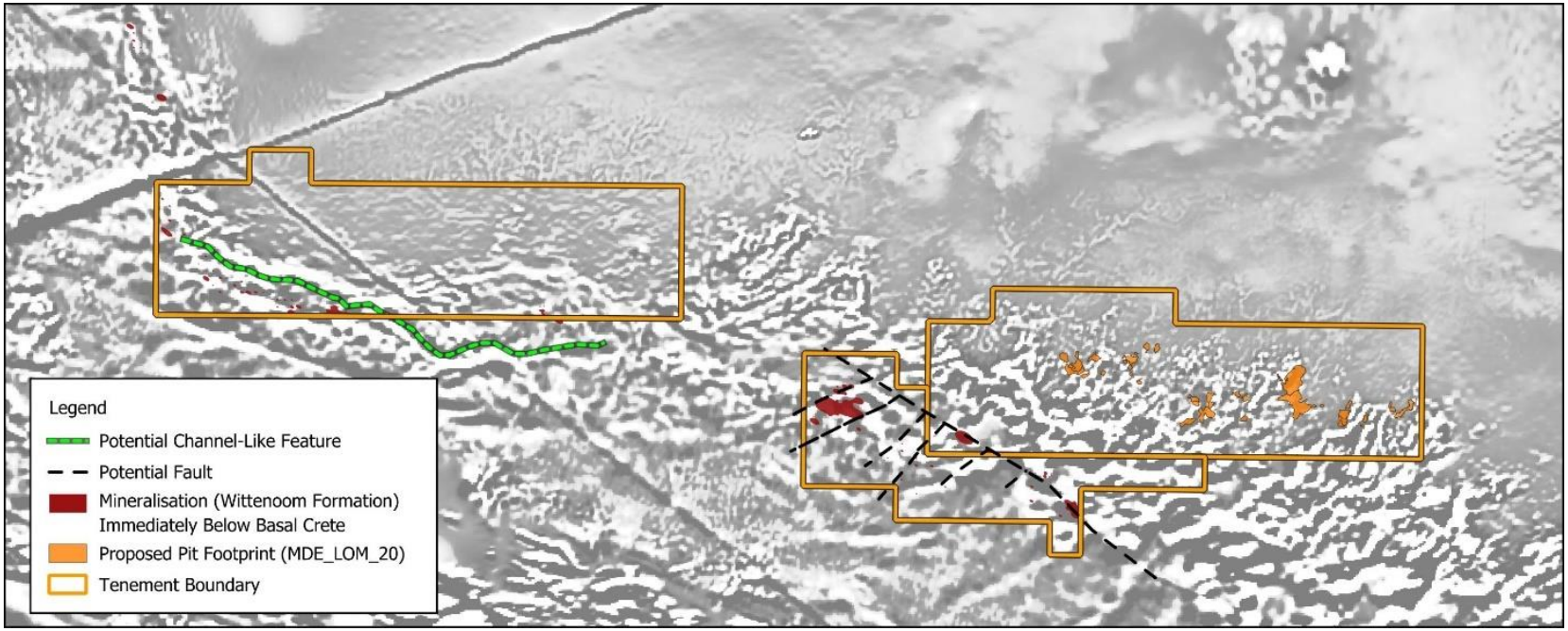

Legend
Potential Channel-Like Feature
Potential Fault
Mineralisation (Wittenoom Formation) Immediately Below Basal Crete
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary

Table 7-7: Summary of Aquifer Parameters (AQ2 2025)

UnitTable		Range in Thickness (m)	Range of Permeability (m/d)	Adopted Permeability[1] (m/d)	No of Aquifer Tests	Confined Storage (unitless)	Specific Yield (%)
Tertiary Cover	Upper Calcrete	0 to 30	2 to 63	10	13	1x10-6	1-5%
	Undifferentiated Tertiary	0 to 45	2 to 365	8	18	1x10-5	5%
	Pisolite / CID	0 to 23	5 to 92	14	10	1x10-5	5%
	Basal Crete	0 to 22	3 to 33	9	8	1x10-6	1-3%
Bedrock	Fresh Dolomite of Wittenoom Formation - Localised Weathering	-	0.001 to 10	0.01	0	1x10-4	1%
	West Angela Member	-	0.01 to 10	2	0	1x10-4	1%
	West Angela Member Hardcap / Ore	-	11 to 131	20	6	1x10-6	1-5%
	Marra Mamba Ore (with mineralised CID)	-	10 to 57	25*	8	1x10-6	3%
	Unmineralised / Fractured Marra Mamba Formation	-	2 to 174	10	12	1x10-3	1%
	Fresh Marra Mamba / Jeerinah Formation – Minor Fractures	-	0.015 to 0.022	0.01	4	1x10-4	1%

*Updated based on model calibration to test pumping (Refer AQ2 2025)

Maximum and minimum values based on 90% confidence limits (assessed using the two-tailed Student's t-test)

Figure 7-12: Location of Hydrogeological Sections – Mulga East (AQ2 2025)

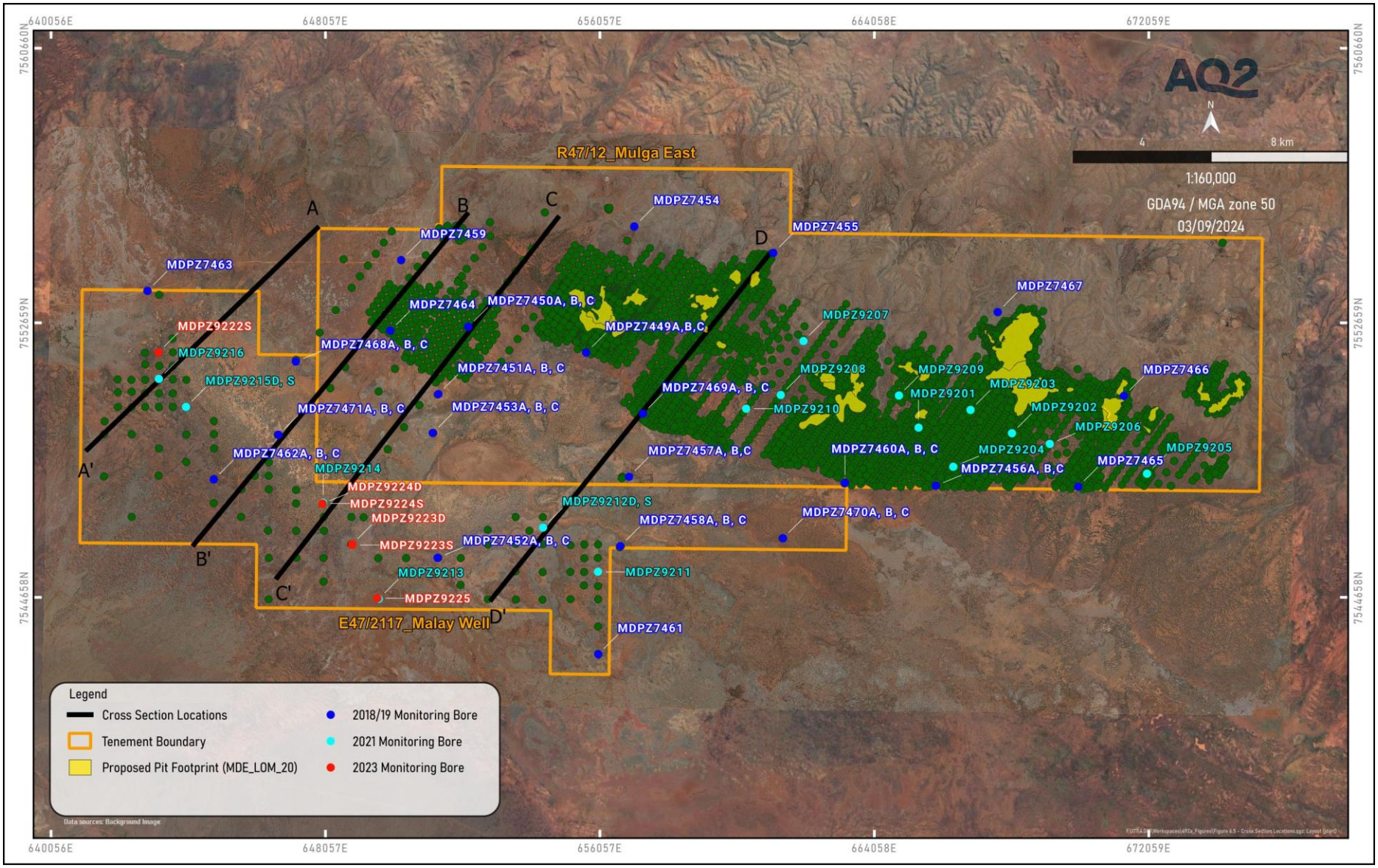

640056E
648057E
656057E
664058E
672059E
7560660N
7552659N
7544658N
AQ2
N
4
8 km
1:160,000
GDA94 / MGA zone 50
03/09/2024
R47/12_Mulga East
E47/2117_Malay Well
A
A'
B
B'
C
C'
D
D'
MDPZ7454
MDPZ7455
MDPZ7459
MDPZ7463
MDPZ7464
MDPZ7450A, B, C
MDPZ7449A,B,C
MDPZ7467
MDPZ9222S
MDPZ9216
MDPZ7468A, B, C
MDPZ9207
MDPZ9215D, S
MDPZ7451A, B, C
MDPZ9208
MDPZ9209
MDPZ7466
MDPZ7469A, B, C
MDPZ9201
MDPZ9203
MDPZ7471A, B, C
MDPZ7453A, B, C
MDPZ9210
MDPZ9202
MDPZ9206
MDPZ7462A, B, C
MDPZ7457A, B,C
MDPZ7460A, B, C
MDPZ9204
MDPZ9205
MDPZ9214
MDPZ7456A, B,C
MDPZ7465
MDPZ9224D
MDPZ9224S
MDPZ9212D, S
MDPZ9223D
MDPZ7458A, B, C
MDPZ7470A, B, C
MDPZ9223S
MDPZ7452A, B, C
MDPZ9213
MDPZ9211
MDPZ9225
MDPZ7461
Legend
Cross Section Locations
Tenement Boundary
Proposed Pit Footprint (MDE_LOM_20)
2018/19 Monitoring Bore
2021 Monitoring Bore
2023 Monitoring Bore
Data sources: Background Image

Figure 7-13: Hydrogeological Cross Section A – Mulga East (AQ2 2025)

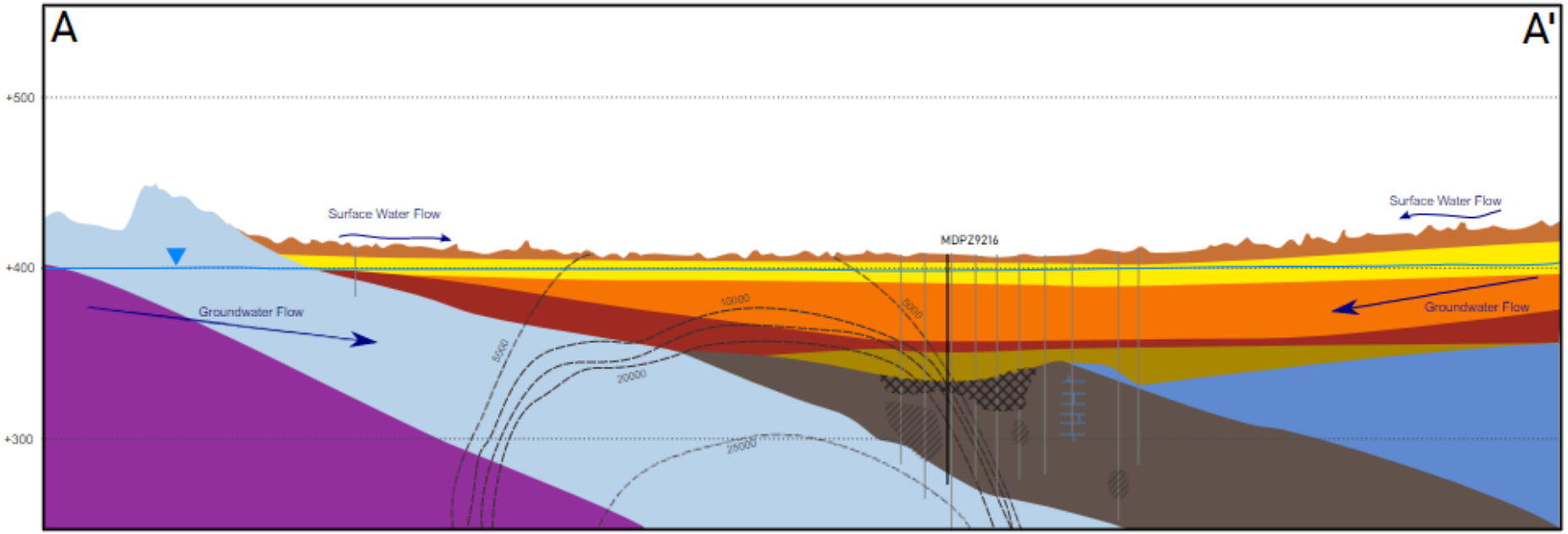

A
A'
+500
+400
+300
Surface Water Flow
Surface Water Flow
MDPZ9216
Groundwater Flow
Groundwater Flow
5000
10000
20000
25000
Legend
Alluvium
Upper Calcrete
Undifferentiated Tertiary
CID Pisolite
Basal Crete
Wittenoom Fm Dolomite
West Angela Mbr
Marra Mamba Fm
Jeerinah Formation
Mineralisation
Groundwater Level
Hardcap
Dolomite
Salinity Contour (uS/cm)

Figure 7-14: Hydrogeological Cross Section B – Mulga East (AQ2 2025)

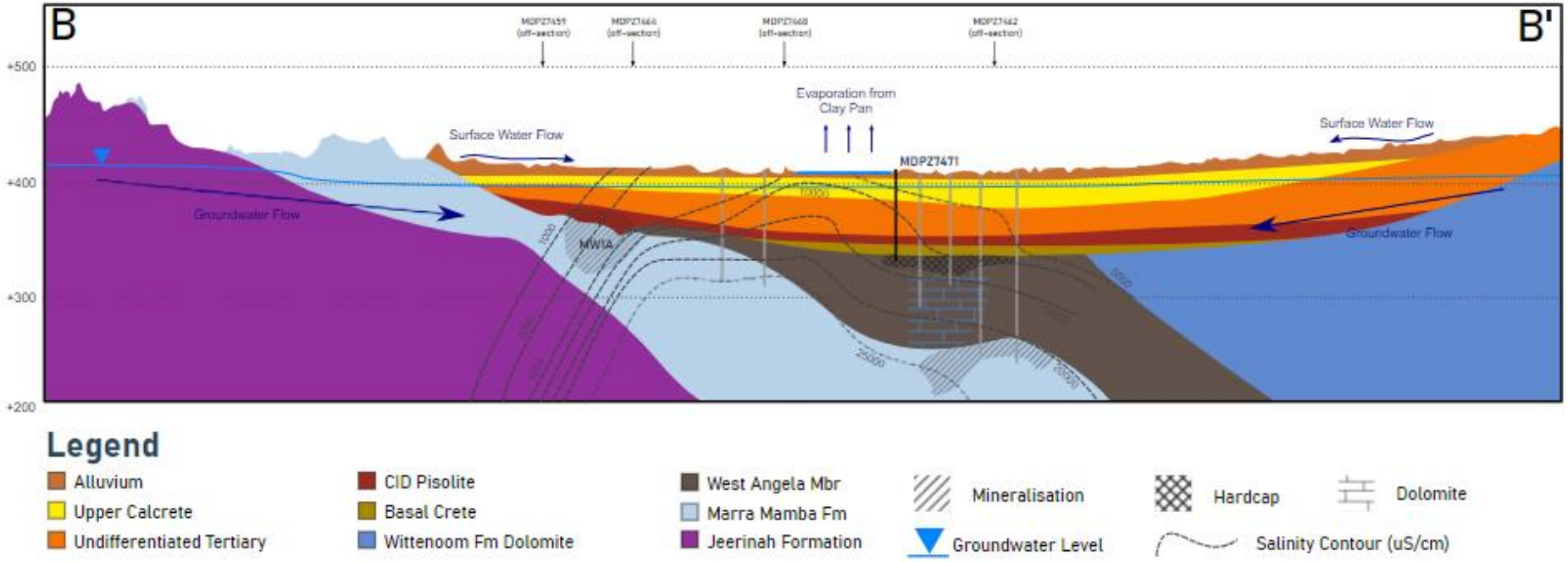
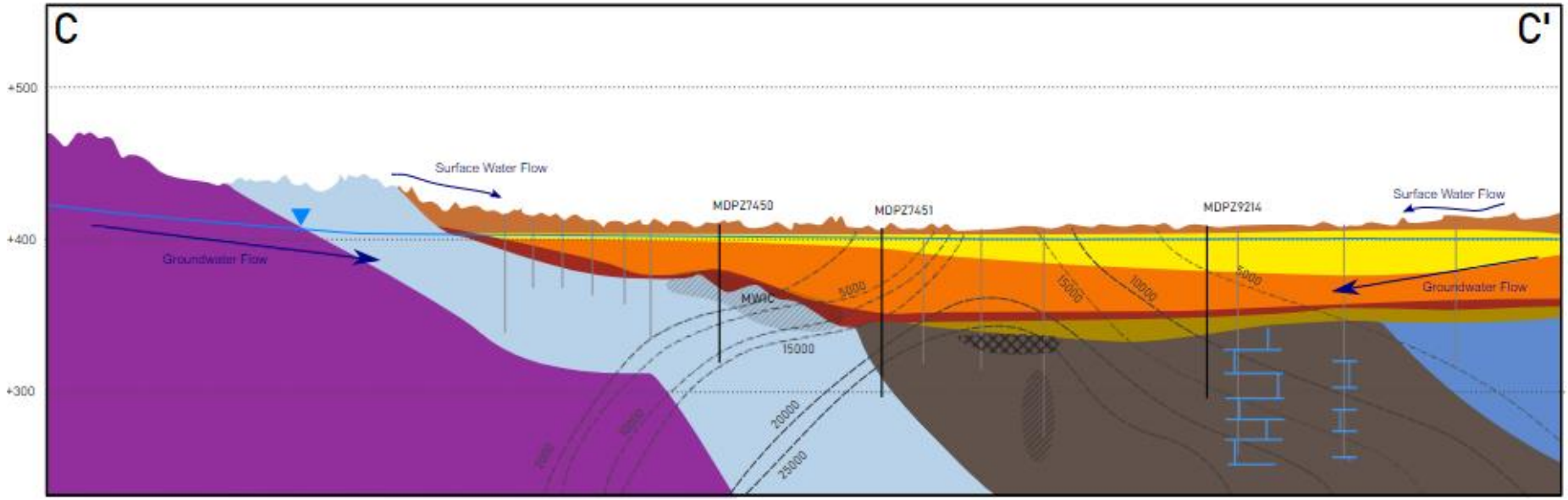

B
B'
MDPZ7459 (off-section)
MDPZ7464 (off-section)
MDPZ7468 (off-section)
MDPZ7462 (off-section)
+500
+400
+300
+200
Evaporation from Clay Pan
Surface Water Flow
Surface Water Flow
MDPZ7471
Groundwater Flow
Groundwater Flow
MW1A
1000
1500
2000
2500
3000
Legend
Alluvium
Upper Calcrete
Undifferentiated Tertiary
CID Pisolite
Basal Crete
Wittenoom Fm Dolomite
West Angela Mbr
Marra Mamba Fm
Jeerinah Formation
Mineralisation
Groundwater Level
Hardcap
Dolomite
Salinity Contour (uS/cm)

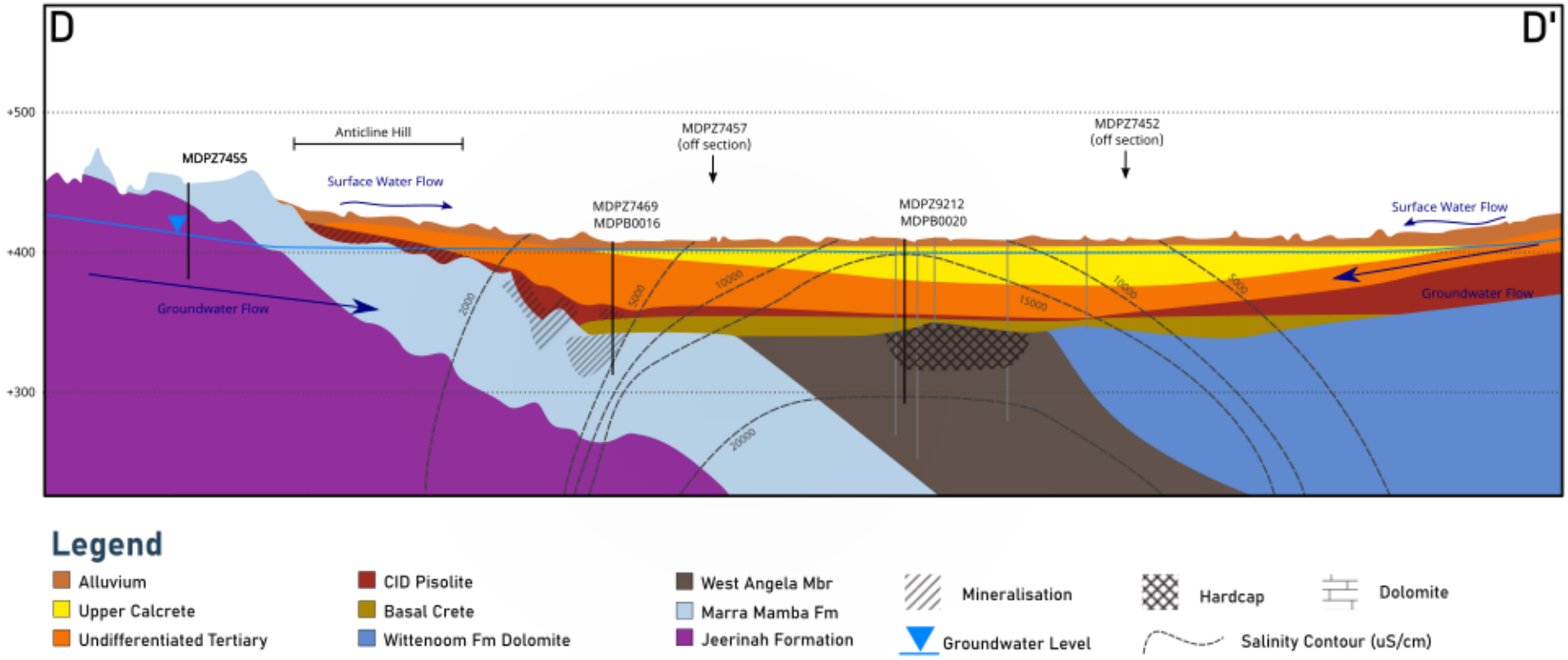
Figure 7-15: Hydrogeological Cross Section C – Mulga East (AQ2 2025)



Legend

- Alluvium
- Upper Calcrete
- Undifferentiated Tertiary
- CID Pisolite
- Basal Crete
- Wittenoom Fm Dolomite
- West Angela Mbr
- Marra Mamba Fm
- Jeerinah Formation
- Mineralisation
- Groundwater Level
- Hardcap
- Dolomite
- Salinity Contour (uS/cm)

Figure 7-16: Hydrogeological Cross Section D – Mulga East (AQ2 2025)



Legend

- Alluvium
- Upper Calcrete
- Undifferentiated Tertiary
- CID Pisolite
- Basal Crete
- Wittenoom Fm Dolomite
- West Angela Mbr
- Marra Mamba Fm
- Jeerinah Formation
- Mineralisation
- Groundwater Level
- Hardcap
- Dolomite
- Salinity Contour (uS/cm)

7.3.6.2 Aquifer connectivity

The hydrogeological conceptualisation of the MDIOM area indicates the Quaternary / Tertiary aquifer and fractured rock / bedrock aquifers are generally in hydraulic connection, while there are local areas of hydraulic disconnection between aquifers due to the presence of localised low permeable sediments such as clay, shales and saprolitic clay (AQ2 2025). This is based on assessment of lithology, hydraulic heads illustrated in the groundwater contour diagram (**Figure 7-19**), and the analysis of vertical hydraulic gradients at nested bore sites (**Figure 7-20** to **Figure 7-22)** and groundwater salinity.

Vertical gradients (upward or downward flow) were only evident at some nested bore locations where saprolitic clays or thin intervals of clay dominated Tertiary sediments were present, indicative of localised areas of hydraulic disconnection (AQ2 2024a).

Seasonal changes in hydraulic gradients were investigated near the major claypans, where changing gradient direction was observed following wet season recharge events. For example, at two sets of nested bores near the Koodjeepindarranna Claypan and the southern alluvial fan (MDPZ7471 and MDPZ7462 respectively), upward hydraulic gradients were measured during drier periods (November 2019) and downward hydraulic gradients were measured after the 2019/20 wet season (May 2020). This local change in hydraulic gradient was due to wet season recharge (**Figure 7-20**) (AQ2 2025).

7.3.6.3 Groundwater Recharge

The primary source of recharge to the groundwater system is rainfall. Recharge generally occurs on an annual basis during the summer wet season, with cyclonic events resulting in significant rises in water level.

Average annual rainfall for the Development Envelope is low, around 350 – 400 mm / year but is highly variable. Based on the regional groundwater level monitoring program undertaken since 2019, seasonal groundwater level increases have not exceeded 1 m, and generally recorded around 0.3 m – 0.5 m per year. However, longer-term monitoring across the Mulga East tenement, since 2008, indicates a groundwater level rise of up to 1.5 m in response to a cyclonic event in January 2012. The rate and volume of groundwater recharge varies across the area based on depth to groundwater, lithological heterogeneity, seepage from surface water features and/or vertical hydraulic gradients between aquifers. Bores at higher elevations and greater depths to groundwater generally show a muted response to rainfall.

7.3.6.4 Groundwater Levels and Groundwater Flow

Groundwater levels across the Development Envelope range from 398 m AHD to 420 m AHD. A groundwater contour diagram for the Development Envelope is provided in **Figure 7-18** and **Figure 7-19**.

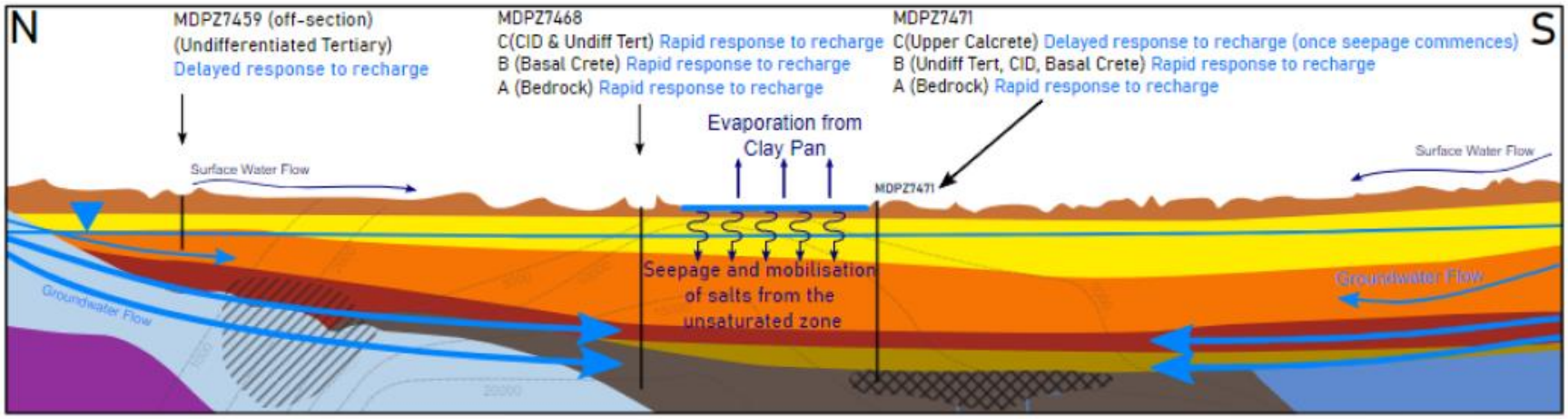
Depths to groundwater vary between around 3 – 5 m below ground level in the Fortescue Valley to around 45 m below ground level in the upper areas of the Chichester Range (bore MDPZ7467).

The groundwater contour diagram in **Figure 7-18** and **Figure 7-19** represents groundwater elevations in the fractured rock aquifers in the Chichester Range and the Quaternary / Tertiary aquifer in the Fortescue Valley.

Groundwater flows from the topographically higher areas into the Fortescue Valley, and then in a north westerly direction along the Fortescue Valley. Groundwater flow lines are presented in **Figure 7.18** and **Figure 7-19.**

In the Mulga East and Malay Well area, the hydraulic gradient is gentle across the lower lying areas, indicative of transmissive aquifers, and steepens along the northern boundary of the Development Envelope, indicative of lower permeable units, consistent with the occurrence of the Jeerinah Formation and fresh Marra Mamba aquitard (AQ2 2025).

Figure 7-17: Hydrogeological cross section highlighting recharge and discharge from claypans in Mulga East (SourceAQ2 2025)



Legend

- Alluvium
- Upper Calcrete
- Undifferentiated Tertiary
- CID Pisolite
- Basal Crete
- Wittenoom Fm Dolomite
- West Angela Mbr
- Marra Mamba Fm
- Jeerinah Formation
- Mineralisation
- Groundwater Level
- Hardcap
- Salinity Contour (uS/cm)
- Dolomite

Figure 7-18: Groundwater Level Contours (AQ2 2025)

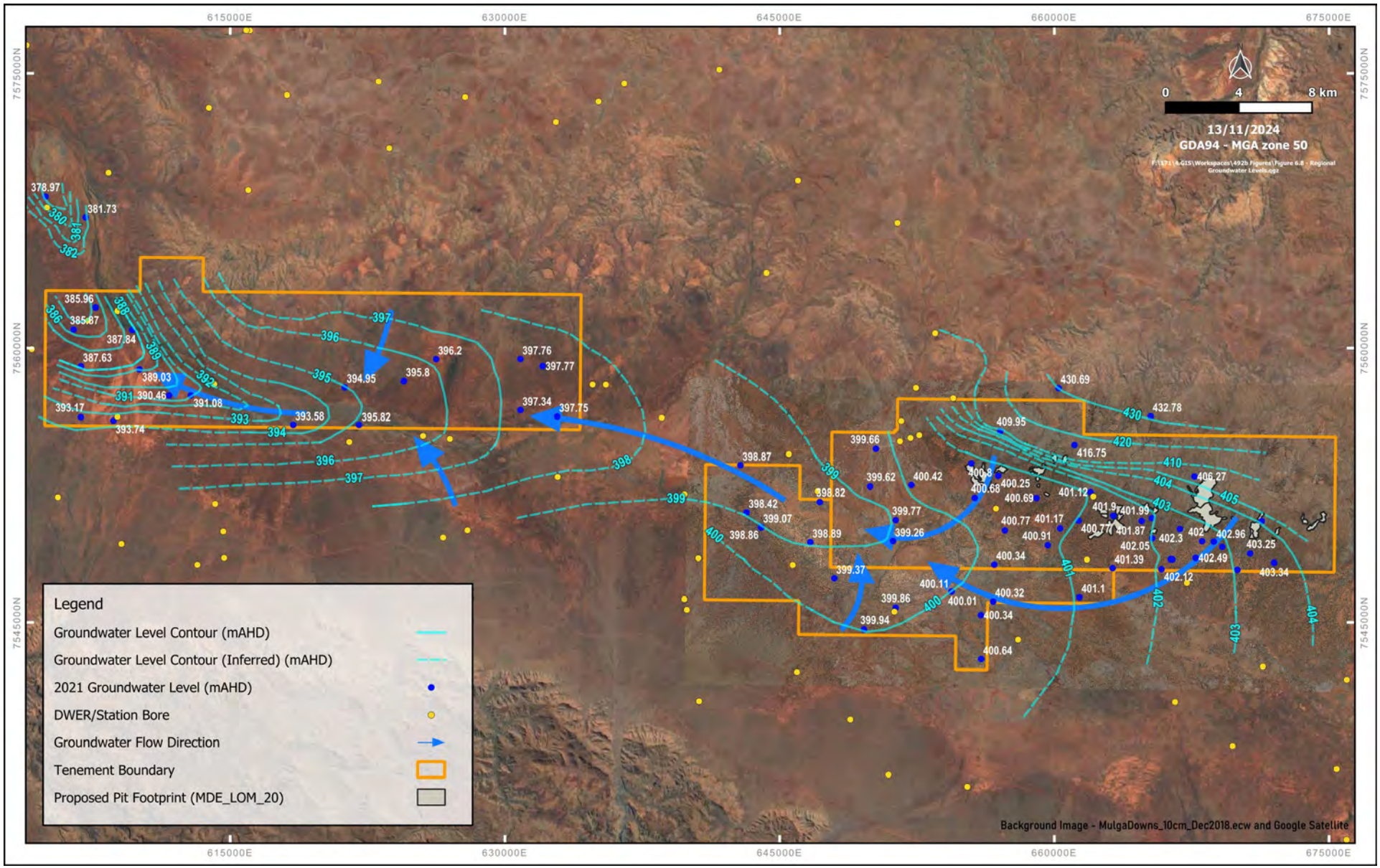
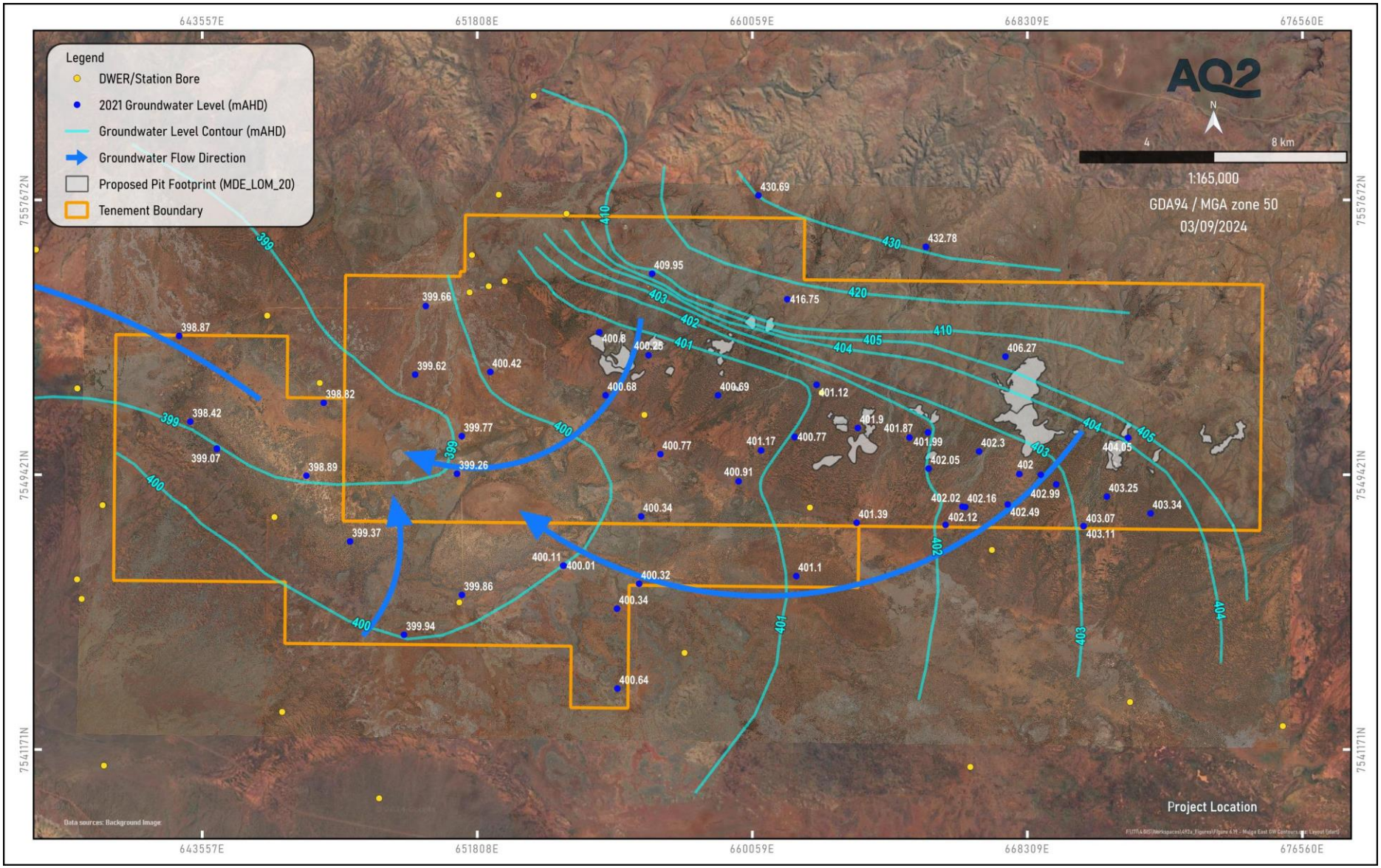


Figure 6.8 Regional Groundwater Level Contours (December 2021)

Figure 7-19: Groundwater Level Contours (AQ2 2025)


643557E
651808E
660059E
668309E
676560E
7557672N
7549421N
7541171N
Legend
DWER/Station Bore
2021 Groundwater Level (mAHD)
Groundwater Level Contour (mAHD)
Groundwater Flow Direction
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary
AQ2
N
4
8 km
1:165,000
GDA94 / MGA zone 50
03/09/2024
Project Location
Data sources: Background Image

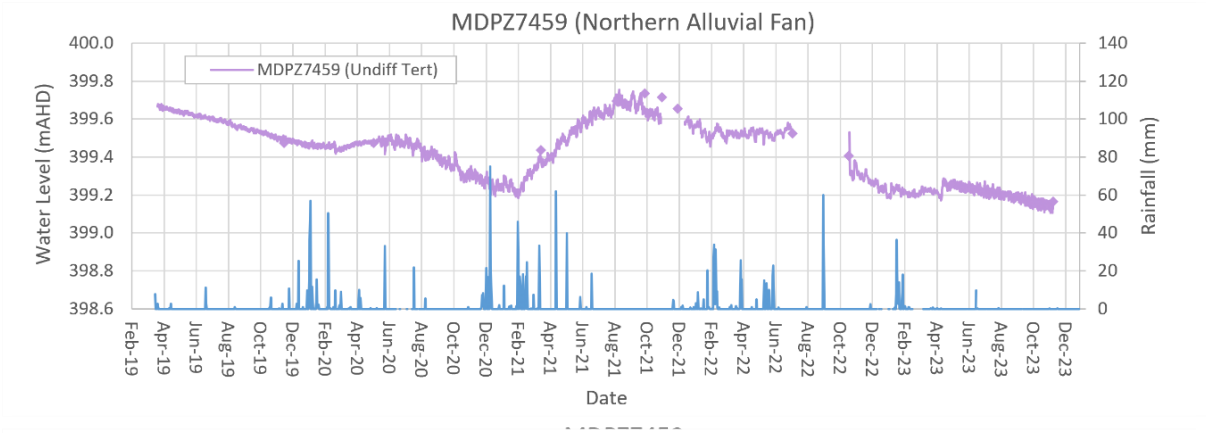
Time-series groundwater levels (hydrographs) for bores installed in 2018/19 are provided for the following areas:

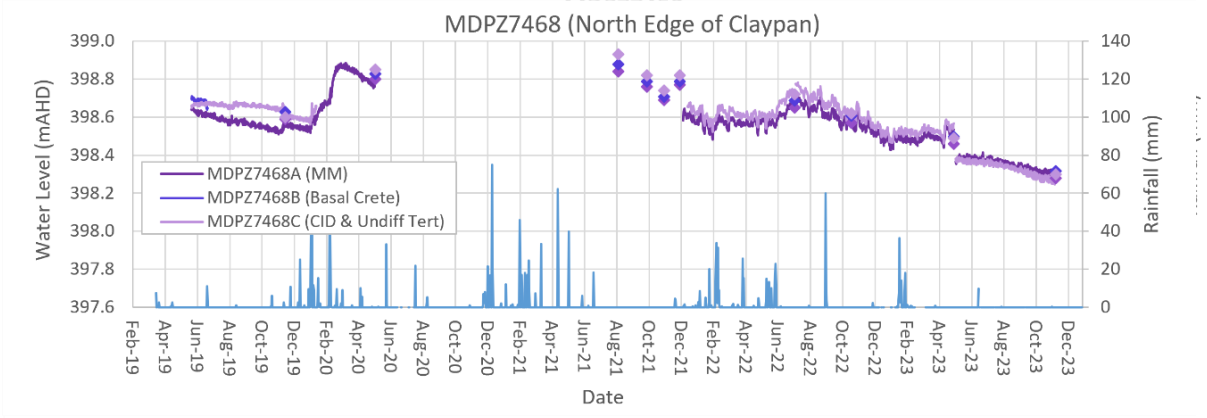
- Hydrogeological Cross Section B (**Figure 7-20**).
- Hydrogeological Cross Section C (**Figure 7-21**).
- Hydrogeological Cross Section D (**Figure 7-22**).
- Koodjeepindarranna Claypan Area (**Figure 7-23**).
- Gnalka Gnoona Claypan Area (**Figure 7-24**).

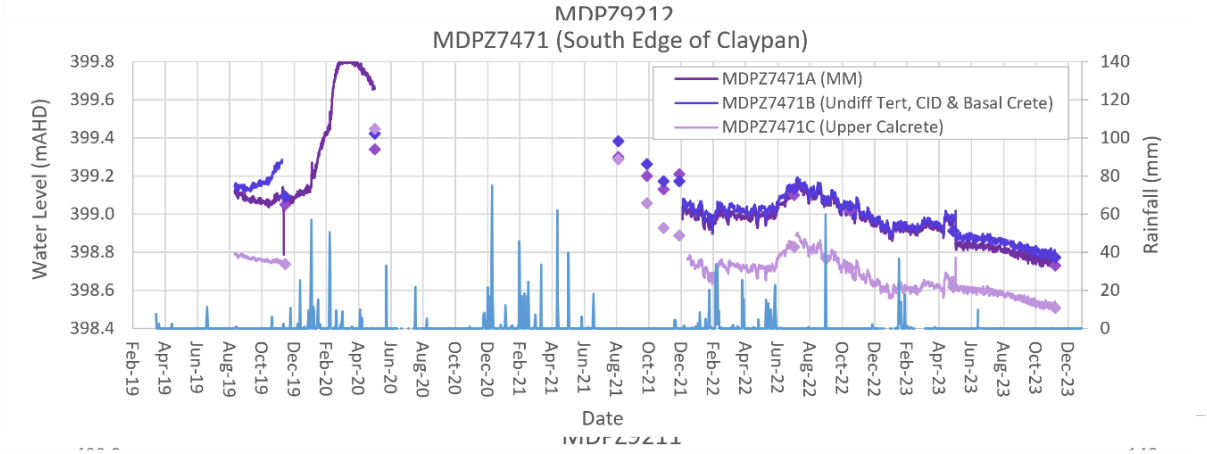
No cyclonic influenced rainfall events have occurred since the installation of the regional / extended monitoring bore network. The data in **Figure 7-20** to **Figure 7-24** therefore does not provide an assessment of groundwater level responses to a cyclonic or monsoonal rainfall event(s).

Bores installed in low permeability lithology record subdued and delayed responses to rainfall. Bore MDPZ7459 (20 m below ground) is installed beneath the northern alluvial fan between the two claypans. Bores MDPZ7454, 7455, 7466 and 7467 (on the upper slopes) are installed in low permeability (fresh) Marra Mamba Formation and / or Jeerinah Formation.

Figure 7-20: Hydrographs for Hydrogeological Cross Section B (AQ2 2025)


MDPZ7459 (Northern Alluvial Fan)
MDPZ7459 (Undiff Tert)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7468 (North Edge of Claypan)
MDPZ7468A (MM)
MDPZ7468B (Basal Crete)
MDPZ7468C (CID & Undiff Tert)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7471 (South Edge of Claypan)
MDPZ7471A (MM)
MDPZ7471B (Undiff Tert, CID & Basal Crete)
MDPZ7471C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date

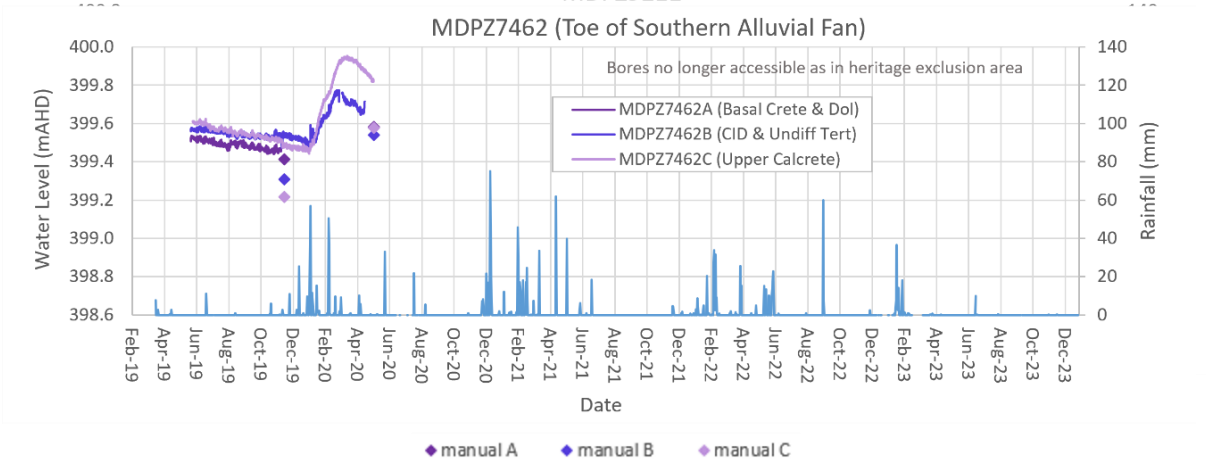
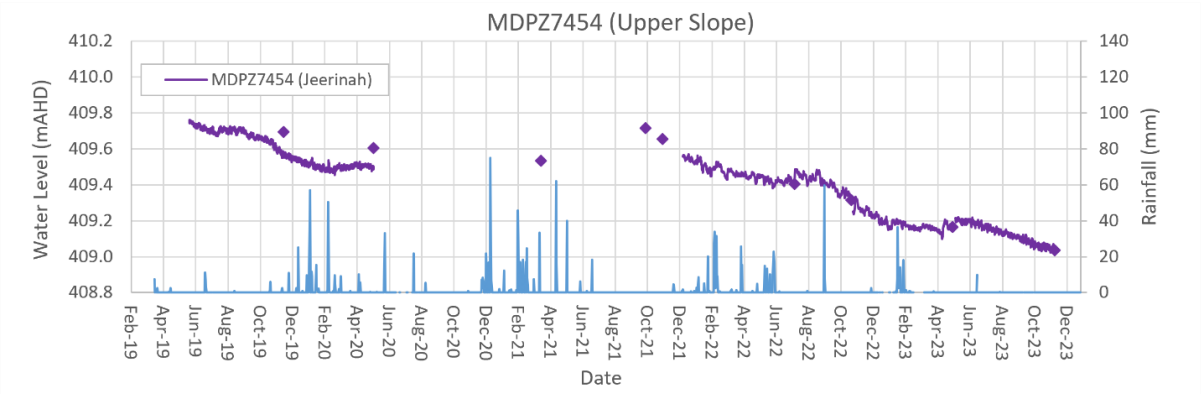
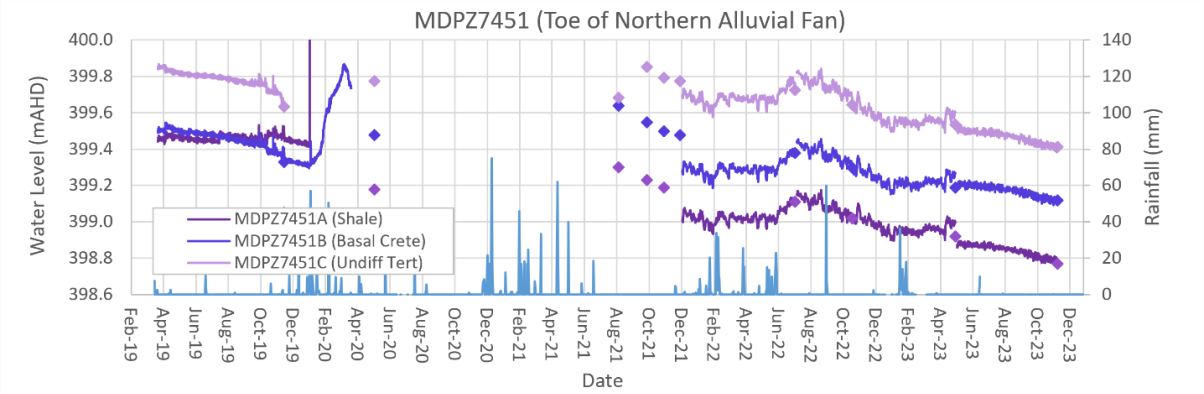
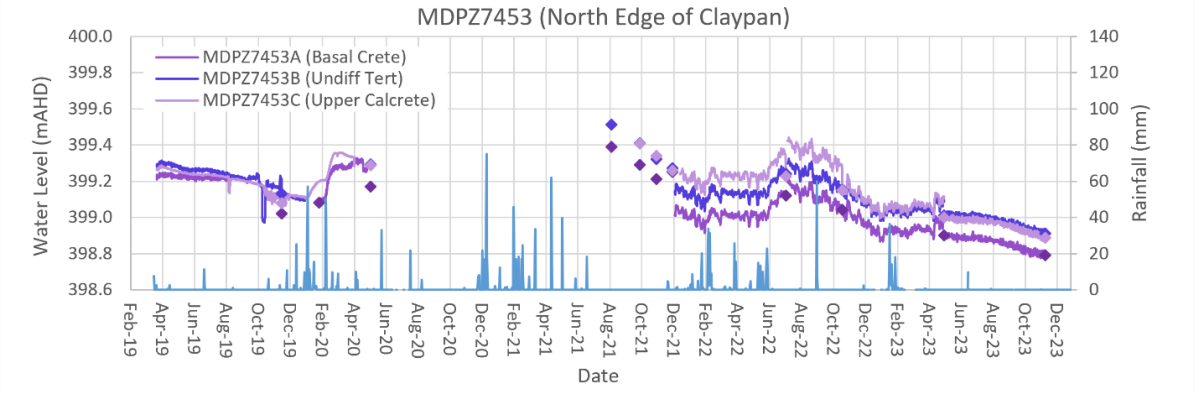

MDPZ7462 (Toe of Southern Alluvial Fan)
Bores no longer accessible as in heritage exclusion area
MDPZ7462A (Basal Crete & Dol)
MDPZ7462B (CID & Undiff Tert)
MDPZ7462C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date
manual A
manual B
manual C

Figure 7-21: Hydrographs for Hydrogeological Cross Section C (AQ2 2025)


MDPZ7454 (Upper Slope)
MDPZ7454 (Jeerinah)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7451 (Toe of Northern Alluvial Fan)
MDPZ7451A (Shale)
MDPZ7451B (Basal Crete)
MDPZ7451C (Undiff Tert)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7453 (North Edge of Claypan)
MDPZ7453A (Basal Crete)
MDPZ7453B (Undiff Tert)
MDPZ7453C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date

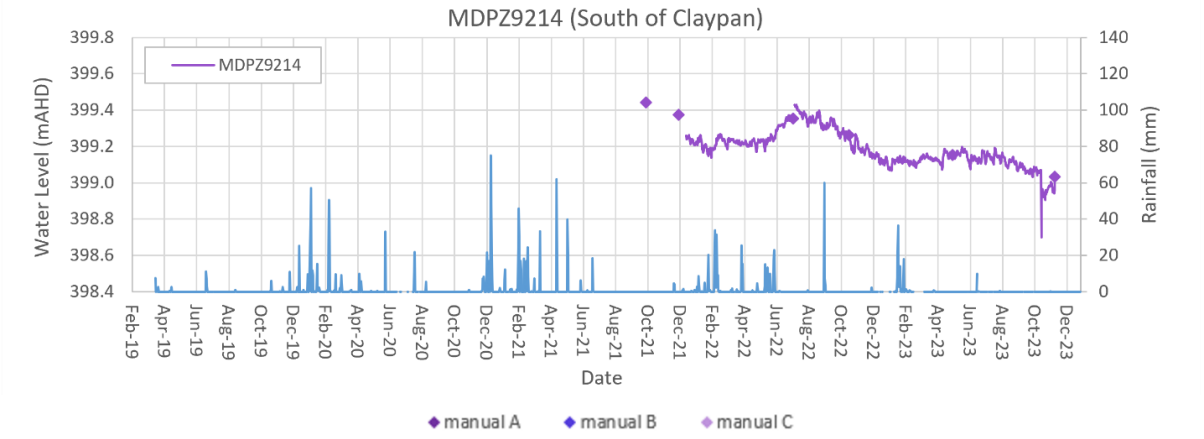
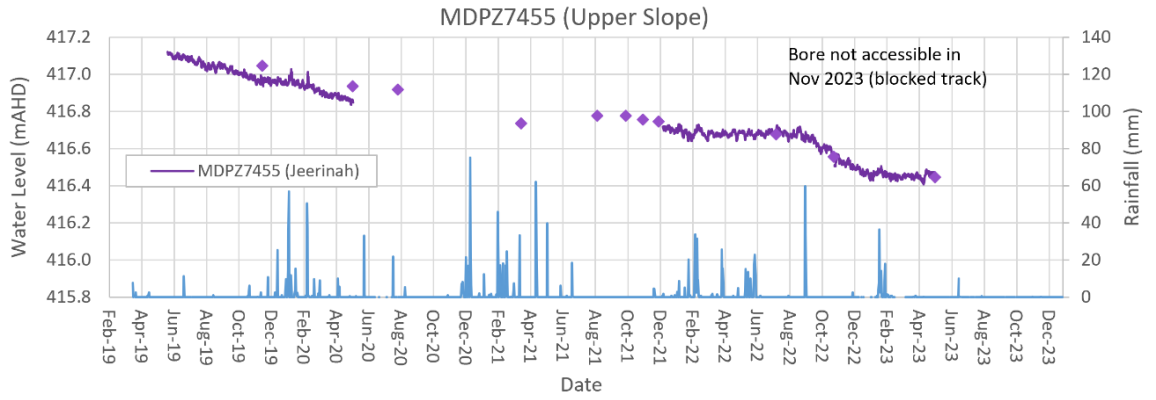
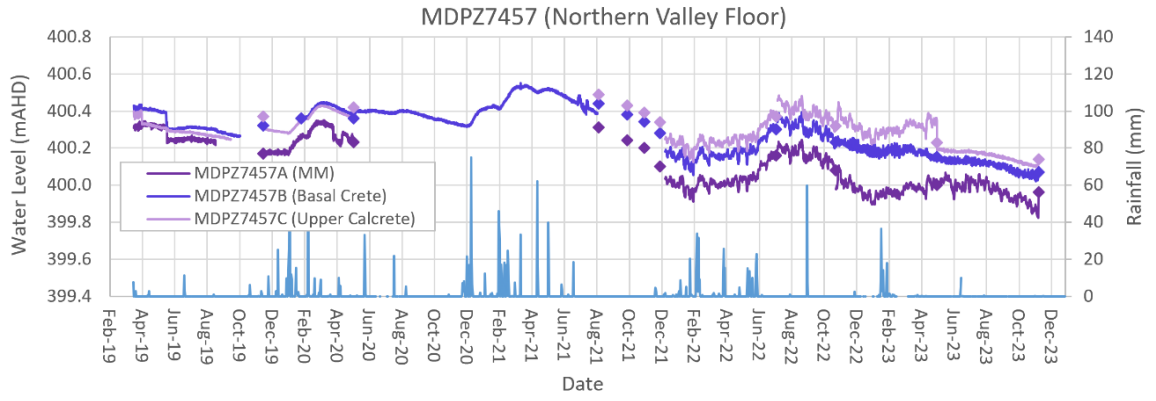
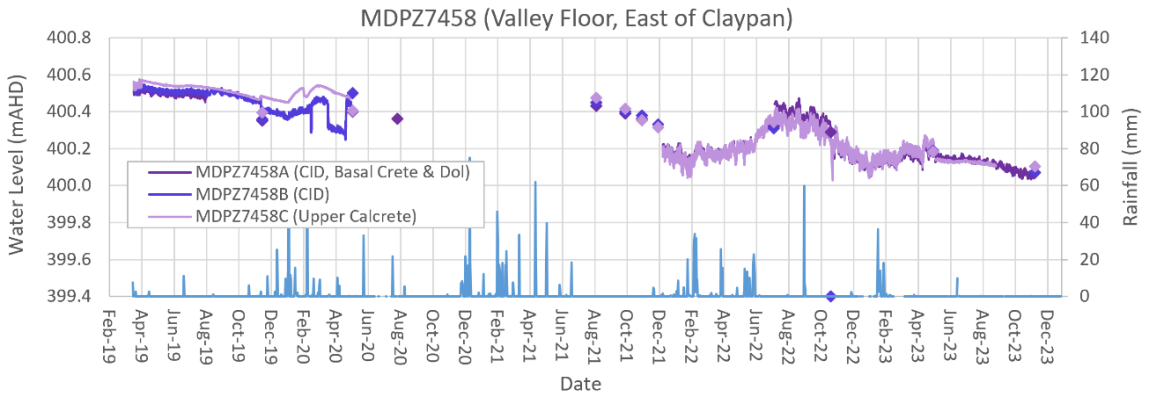
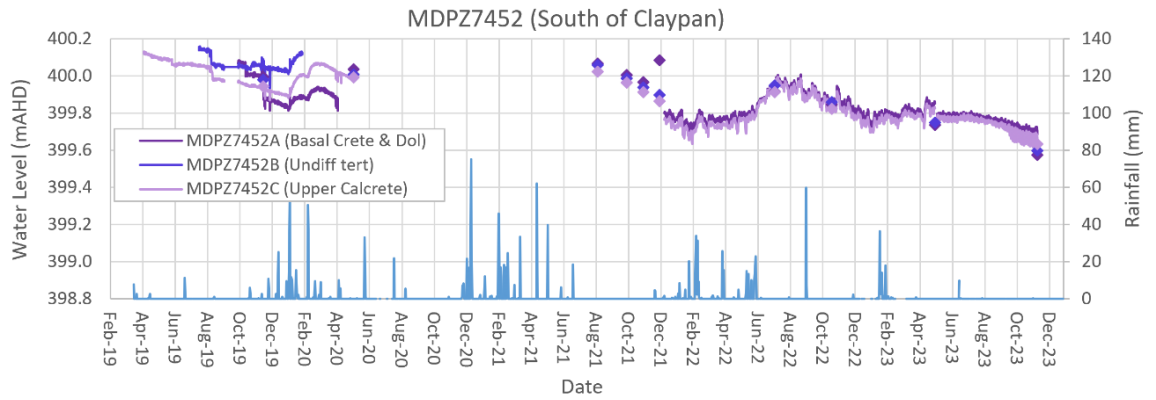

MDPZ9214 (South of Claypan)
MDPZ9214
Water Level (mAHD)
Rainfall (mm)
Date
manual A
manual B
manual C

Figure 7-22: Hydrographs for Hydrogeological Cross Section D (AQ2 2025)


MDPZ7455 (Upper Slope)
Bore not accessible in
Nov 2023 (blocked track)
MDPZ7455 (Jeerinah)
Water Level (mAHD)
Rainfall (mm)
Date

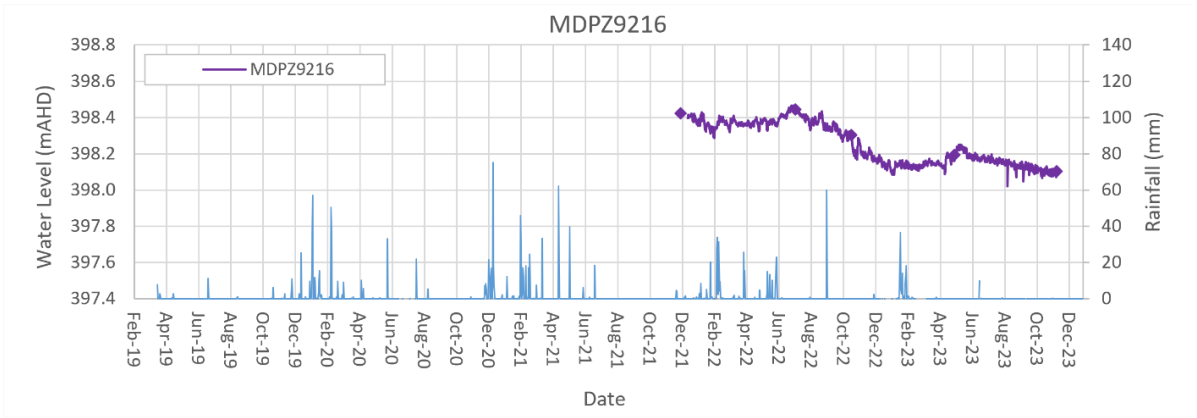

MDPZ7457 (Northern Valley Floor)
MDPZ7457A (MM)
MDPZ7457B (Basal Crete)
MDPZ7457C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date

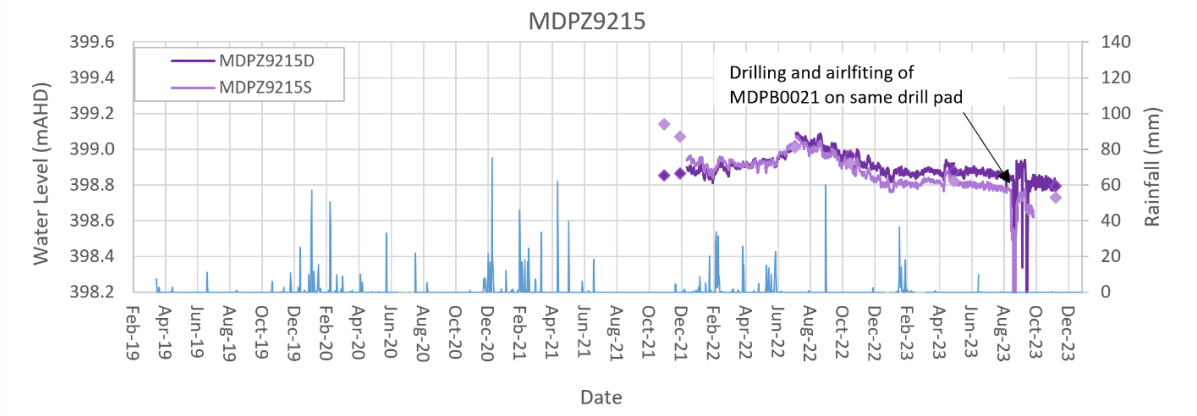

MDPZ7458 (Valley Floor, East of Claypan)
MDPZ7458A (CID, Basal Crete & Dol)
MDPZ7458B (CID)
MDPZ7458C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date

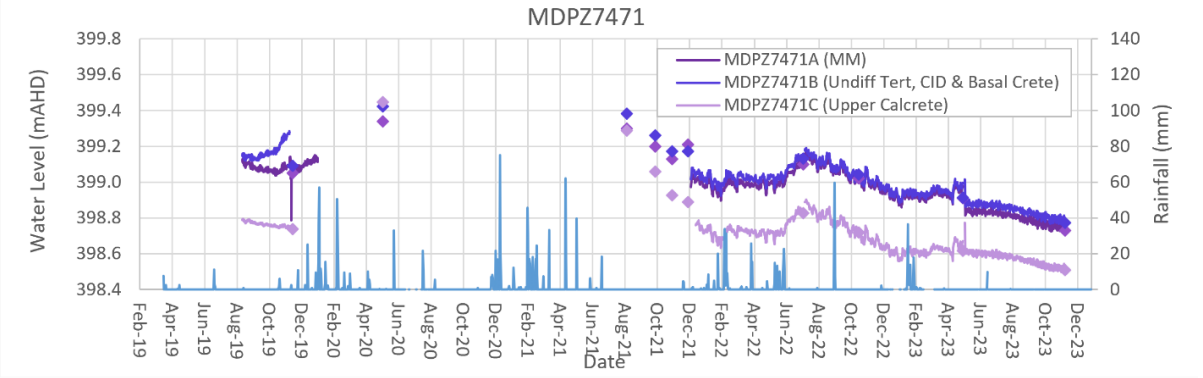

MDPZ7452 (South of Claypan)
MDPZ7452A (Basal Crete & Dol)
MDPZ7452B (Undiff tert)
MDPZ7452C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date

manual A
manual B
manual C

Figure 7-23: Hydrographs near the Koodjeepindarranna Claypan (AQ2 2025)


MDPZ9216
MDPZ9216
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ9215
MDPZ9215D
MDPZ9215S
Drilling and airlfiting of
MDPB0021 on same drill pad
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7471
MDPZ7471A (MM)
MDPZ7471B (Undiff Tert, CID & Basal Crete)
MDPZ7471C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date

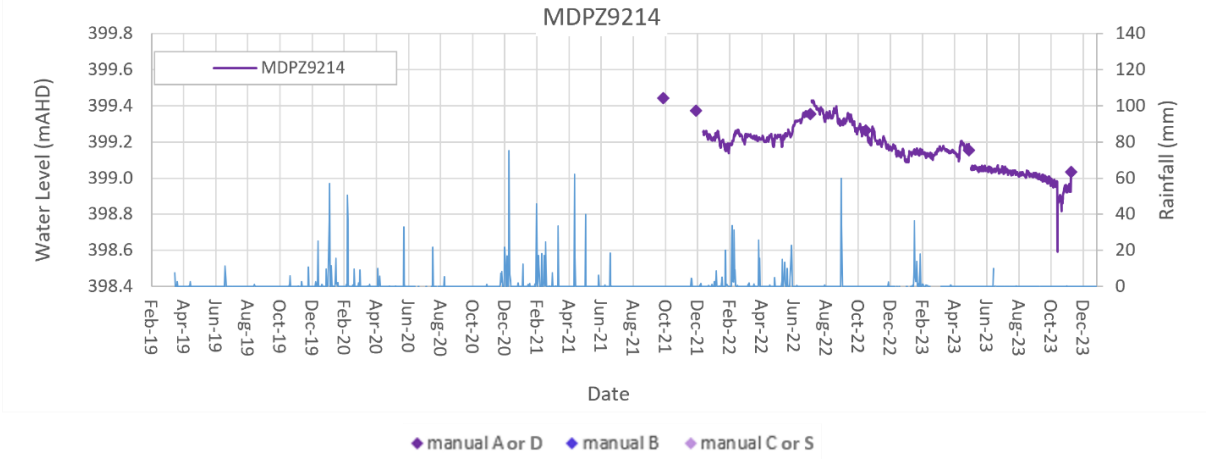
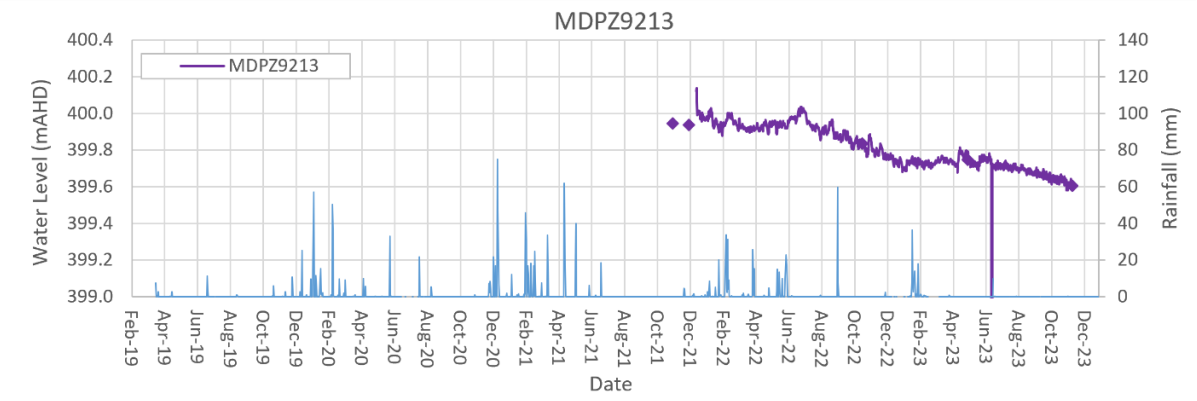
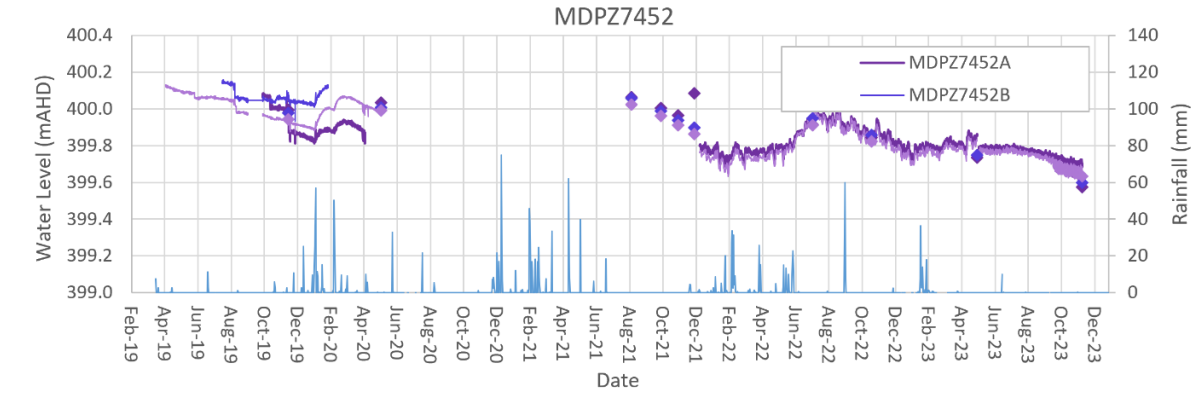
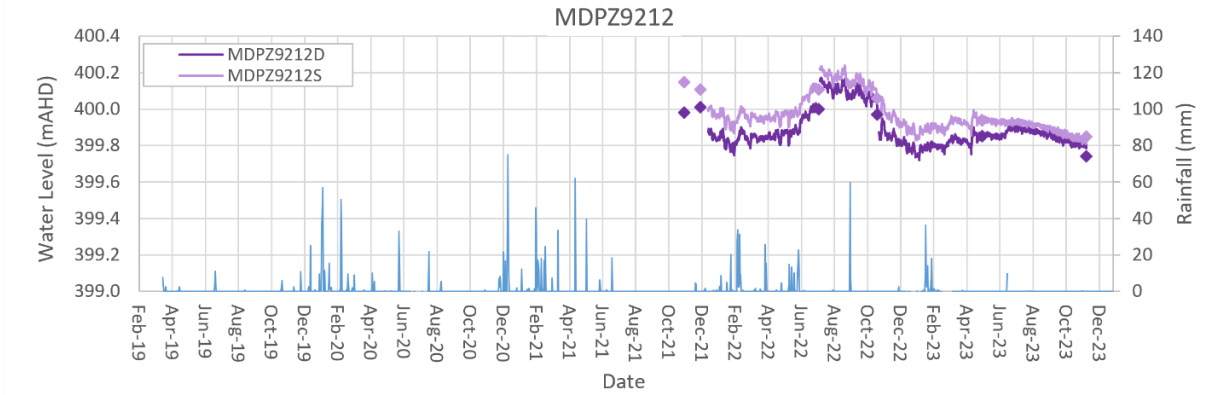
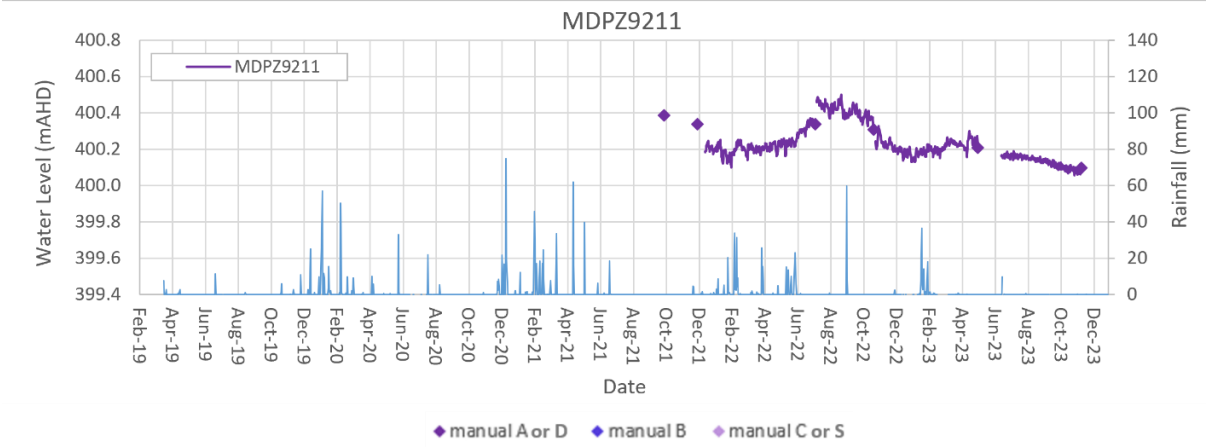

MDPZ9214
MDPZ9214
Water Level (mAHD)
Rainfall (mm)
Date
manual A or D
manual B
manual C or S

Figure 7-24: Hydrographs near Gnalka Gnalka Claypan (AQ2 2025)


MDPZ9213
MDPZ9213
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7452
MDPZ7452A
MDPZ7452B
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ9212
MDPZ9212D
MDPZ9212S
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ9211
MDPZ9211
Water Level (mAHD)
Rainfall (mm)
Date
manual A or D
manual B
manual C or S

Longer term, time series, groundwater level data is available for five bores across the orebody area. The locations of these bores are illustrated in Figure 7-25 and the hydrographs of these bores against rainfall, are presented in Figure 7-26. One bore (MDPZ0072) has a monitoring record from 2008 – 2014, while four bores have monitoring records from 2014 – 2022 (**Figure 7-25** and Figure 7-26).

The data shows gradual groundwater level decline with very limited seasonal response (< 1 m) from late 2008 to late 2010 when annual rainfall totals were lower than the long-term average (i.e. 316 mm, 325 mm and 231 mm in 2008, 2009 and 2010 respectively, compared to 395 mm in 2018). Thereafter (2011 to 2021), seasonal responses have ranged between ~0.2 and 1.5 m with the latter in response to a cyclonic event, where 270 mm of rain fell in January 2012. This cyclonic event provided most of the average annual rainfall in one month. This bore however has not been monitored since 2014.

These bores will be replaced before development of the mine pits.

Figure 7-25: Bore Locations for Long-Term Hydrographs (AQ2 2025)

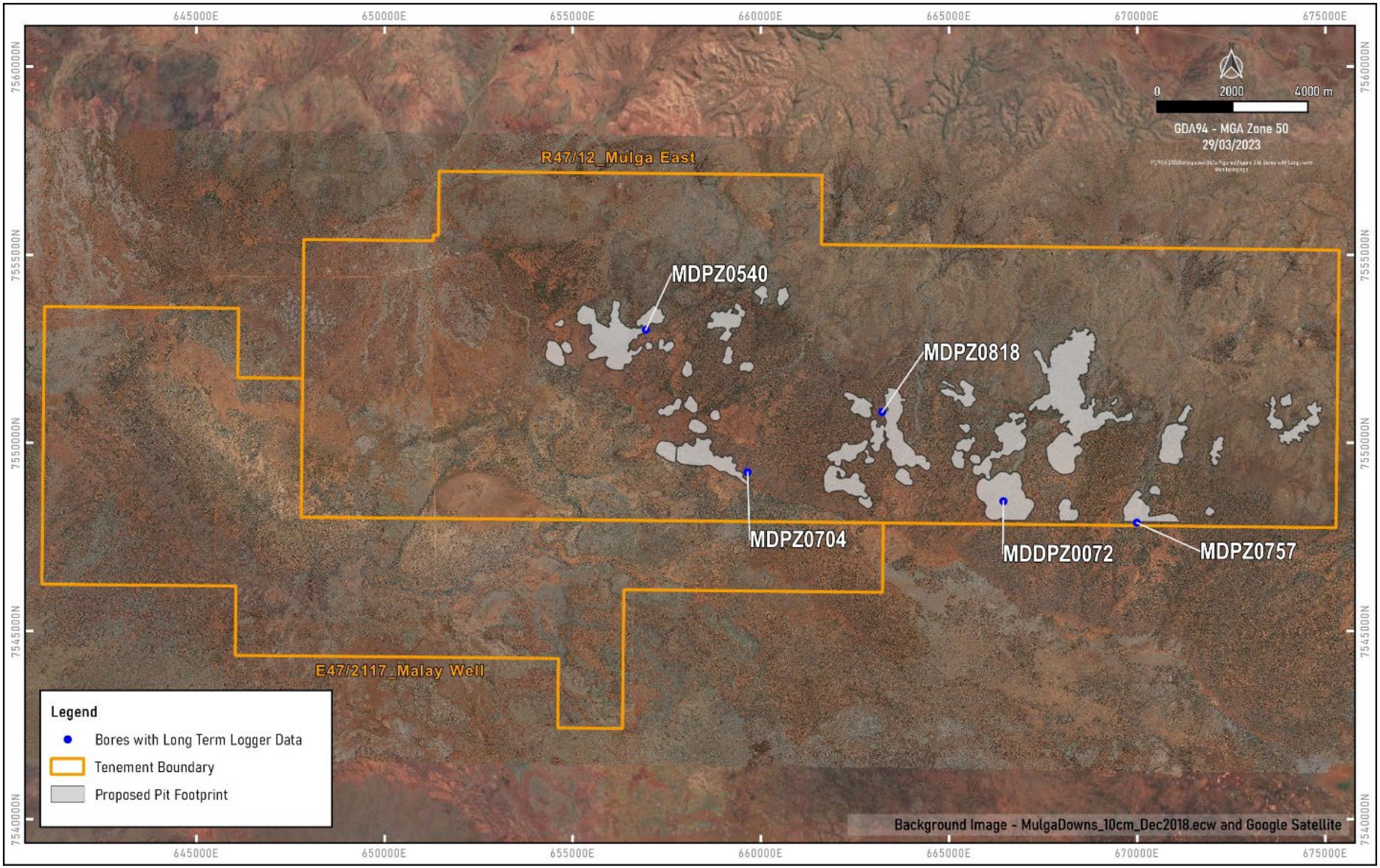
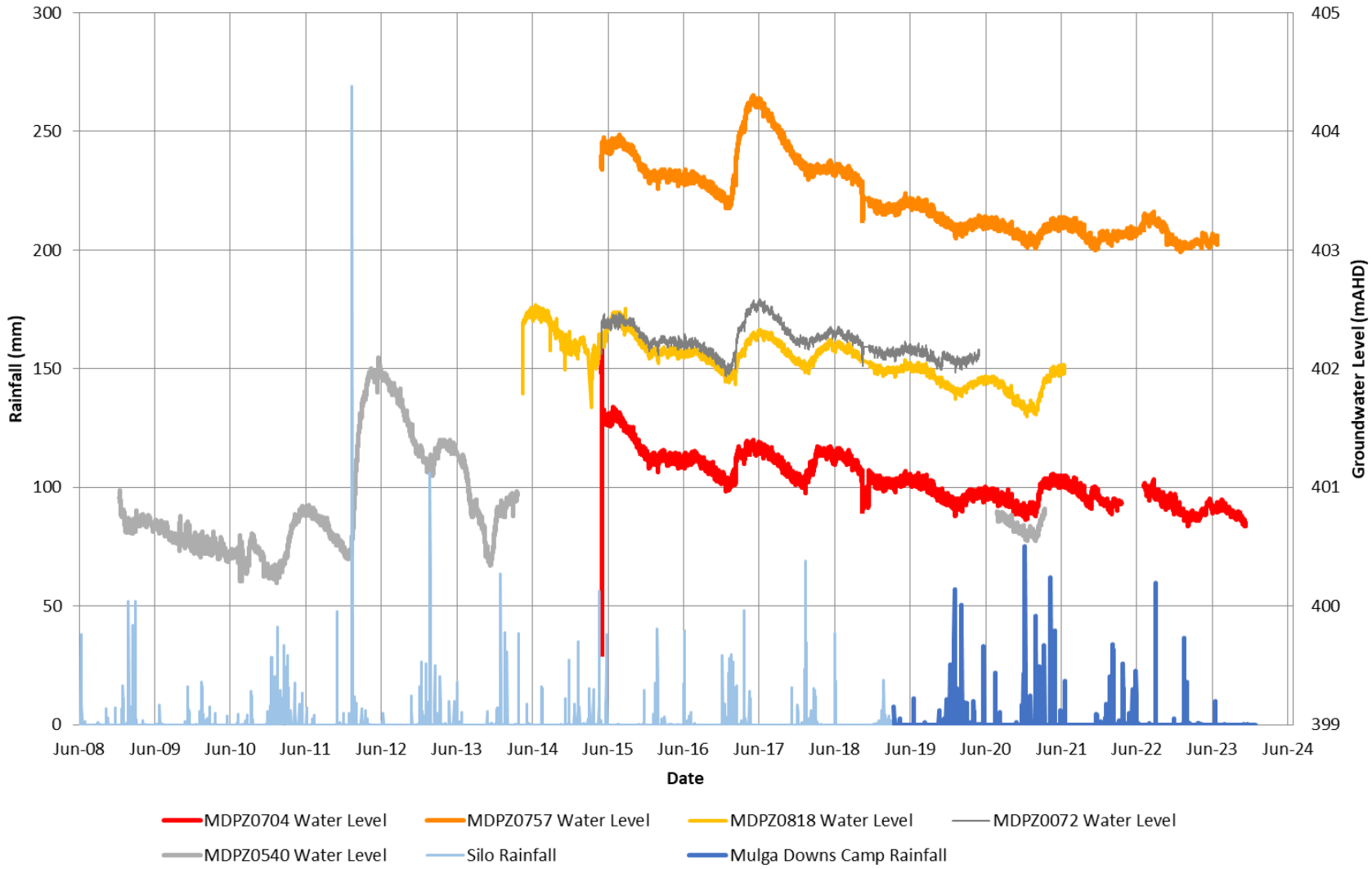

645000E
650000E
655000E
660000E
665000E
670000E
675000E
7560000N
7555000N
7550000N
7545000N
7540000N
0
2000
4000 m
GDA94 - MGA Zone 50
29/03/2023
R47/12_Mulga East
MDPZ0540
MDPZ0818
MDPZ0704
MDDPZ0072
MDPZ0757
E47/2117_Malay Well
Legend
Bores with Long Term Logger Data
Tenement Boundary
Proposed Pit Footprint
Background Image - MulgaDowns_10cm_Dec2018.ecw and Google Satellite

Figure 7-26: Long-Term Groundwater Level Hydrographs (AQ2 2025)


300
250
200
150
100
50
0
Rainfall (mm)
405
404
403
402
401
400
399
Groundwater Level (mAHD)
Jun-08
Jun-09
Jun-10
Jun-11
Jun-12
Jun-13
Jun-14
Jun-15
Jun-16
Jun-17
Jun-18
Jun-19
Jun-20
Jun-21
Jun-22
Jun-23
Jun-24
Date
MDPZ0704 Water Level
MDPZ0757 Water Level
MDPZ0818 Water Level
MDPZ0072 Water Level
MDPZ0540 Water Level
Silo Rainfall
Mulga Downs Camp Rainfall

7.3.6.5 Groundwater Quality

Groundwater salinity across the MDIOM area ranges from fresh (180 mg/L as TDS) to highly saline (18,000 mg/L as TDS). **Table 7-9** salinity groundwater is generally recorded in the upper parts of the system while higher groundwater salinity is associated with the Fortescue Valley, particularly around the claypan areas (AQ2 2025), noting the claypan area falls outside of the MDIOM Development Envelope.

Salinity profiling data shows higher groundwater salinity underlying the claypans. This is due to the evaporative concentration of salts in the claypans during dry periods. Time series salinity data shows the mobilisation of salts through the unsaturated zone beneath the claypans to the underlying groundwater system, during periods of rainfall. This indicates the saline water originates from surface water evaporation in the claypans. This has resulted in a high salinity groundwater mound greater than around 12,000 mg/L as TDS, extending approximately five kilometres along the valley from beneath the claypans. Groundwater salinity generally increases with depth (as would be expected, due to density effects), although further from the valley, the depth of the fresher groundwater increases such that the bores along the northern boundary of the Development Envelope (at higher elevations) show no change in salinity profiles. Some bores on the lower terrain show discrete intervals of increased or reduced salinity which generally correspond to zones of high permeability, indicating potential preferential lateral flow through these units (AQ2 2025).

A groundwater salinity contour diagram at the water table is provided in **Figure 7-27**.

Groundwater quality in the Fortescue Valley area is generally of sodium chloride type. Bicarbonate dominant groundwater, indicative of recharge waters, occurs in the vicinity of the alluvial fan between the two claypans, while groundwater within the Development Envelope have no dominant cations or anions, indicative of the mixing of different groundwater types or the ion exchange / dissolution processes during recharge or aquifer residency (AQ2 2024a). A summary of baseline groundwater quality results is provided **Table 7-8**.

Table 7-8: Summary of Baseline Groundwater Quality Results Compared to Livestock Drinking Water Guidelines (ANZECC & ARMCANZ 2000)

	Preferable Range / Limit (mg/L)	Trigger Range / Value (mg/L)	Maximum in Study Area (mg/L)	Valley Area (mg/L)	Valley Flanks (mg/L)	Upper Slopes (mg/L)	Comment
TDS[#]	0 to 5,000*	5,000 to 10,000**	18,000	1,200 to 18,000	300 to 16,000	180 to 1,400	Exceedances at many bores in vicinity of the claypans and at depth on the valley flanks
Calcium		1,000	700	42 to 530	22 to 700	7.1 to 170	
Nitrate	400	1,500	51	<0.01 to 33	0.01 to 51	<0.01 to 23	
Nitrite		30	5.3	0.012 to 5.3	<0.005 to 0.16	<0.05	
Sulfate	1,000	2,000	4,200	230 to 4,200	3 to 3,400	13 to 720	Exceedances in many deep and intermediate bores in the valley and flank areas. < 1,000 mg/L at all shallow bores except the following valley area bores: >1,000 mg/L at MDPZ7449C, MDPZ7458C, MDPZ7468C & MDPZ9212S; >2,000 mg/L at MDPZ7452C & MDPZ7453C (max: 2,700 mg/L)
Aluminium		5	9.6	<0.005 to 0.15	<0.005 to 0.31	<0.005 to 9.6	Exceedances at **MDPZ7455 & MDPZ7466** (Upper Slopes) Several bores with Total Aluminium exceeding the trigger value, but only in May 2020.
Arsenic	0.5	5	0.033	<0.001 to 0.025	<0.001 to 0.021	0.015 to 0.033	
Boron		5	5	0.26 to 5	0.19 to 4.4	0.15 to 0.75	Exceedances at MDPZ7451A (valley area)
Cadmium		0.01	0.0021	<0.0001 to 0.0011	<0.001 to 0.0020	0.0001 to 0.0021	
Chromium		1	0.025	<0.001 to 0.025	<0.001 to 0.016	<0.001	
Cobolt		1	0.098	<0.001 to 0.098	<0.001 to 0.014	<0.001 to 0.059	
Copper		1	0.016	<0.001 to 0.002	<0.001 to 0.016	<0.001 to 0.013	
Fluoride		2	11	0.6 to 11	0.2 to 2.8	0.2 to 1.3	Exceedances (2 to 3.5 mg/L) at many bores (predominantly in the valley); those with TDS <5,000 mg/L include: **MDPZ7470B, MDPZ7470C, MDPZ9217** 11 mg/L at MDPZ7458C (one sample)
Lead		0.1	0.005	<0.001 to < 0.005	<0.001 to 0.005	<0.001 to 0.003	

	Preferable Range / Limit (mg/L)	Trigger Range / Value (mg/L)	Maximum in Study Area (mg/L)	Valley Area (mg/L)	Valley Flanks (mg/L)	Upper Slopes (mg/L)	Comment
Mercury		0.002	0.0043	<0.0002 to 0.012	<0.0002 to 0.0043	<0.0001 to <0.002	Exceedances at **MDPZ7451C**, MDPZ7453A (valley area) & **MD6605 Lower** (Mulga West valley flank). 0.002 mg/L at MDPZ7452A & MDPZ7452B (valley area)
Molybdenum		0.15	0.025	<0.001 to 0.025	<0.001 to 0.009	<0.0001 to <0.005	
Nickel		1	0.22	<0.001 to 0.22	<0.001 to 0.04	<0.002 to 0.12	
Zinc		20	0.51	0.006 to 0.24	<0.005 to 0.51	0.034 to 0.51	

Bold indicates bores with groundwater salinity <5,000 mg/L TDS

Recommended TDS Concentrations for Beef Cattle

*TDS of 4,000 to 5,000 mg/L: Animals may have an initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production.

** Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually.

Hydrogeological investigations (AQ2 2025) assessed groundwater recharge through a combination of methods such as groundwater level and groundwater salinity monitoring using high frequency data loggers. AquaTROLL data loggers measure time series groundwater levels and salinity.

Declining groundwater levels were generally evident across all groundwater monitoring bores following the 2020/21 wet season, where rainfall was below average. This can be observed in the hydrographs presented in **Figure 7-20** to **Figure 7-24**. Small rainfall events in November / December 2021 resulted in different groundwater level responses. For example, a rapid increase in groundwater levels was recorded at bores installed in the fractured rock aquifer and the deeper Tertiary units (i.e. Basal Crete or CID), while a delayed response was recorded in the shallower Tertiary units (Upper Calcrete and / or the Undifferentiated Tertiary) (AQ2 2025).

Changes in groundwater salinity can show the impact of groundwater recharge. Short-term increases in groundwater salinity at shallow monitoring bores on the valley floor near the claypans indicate salts are leached from the unsaturated zone into the groundwater system during the “first flush” (i.e. the initial surface water seepage leaches accumulated salts). The reduced salinity recorded from some shallow salinity profiles after a wet season (i.e. in May 2020), show that after the first flush of salts, fresher surface water recharges the groundwater system (i.e. on-going seepage of surface water does not continue to leach high volumes of salt as this was flushed during the early stages) (AQ2 2025). An indicative salinity category guide is provided in **Table 7-9.**

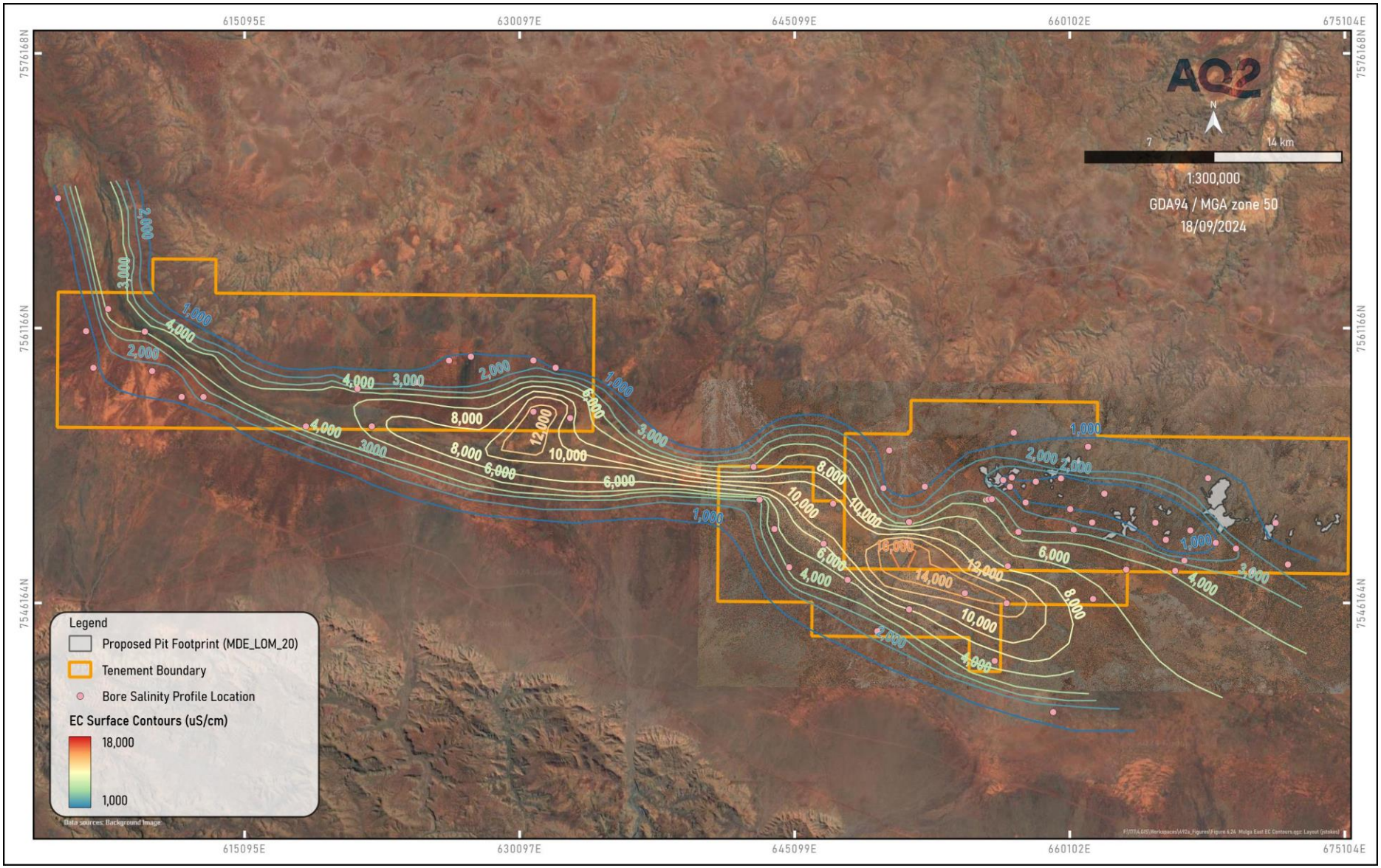
Table 7-9: Salinity threshold categories (Australian Government, 2004; DoW 2009)

Salinity Type	TDS (mg/L)
Fresh	< 500
Marginal	500 - 1000
Brackish	1000 - 2000
Moderately Saline	2000 - 5000
Saline	5000 - 10 000
Highly Saline	10 000 - 35 000
Brine	> 35 000

The pH of the groundwater generally ranges between 5.9 and 7.9 across the MDIOM area, however, in three bores in the most north-eastern section, the groundwater was found to have pH value ranging between 3.6 and 4.4. These low pH values are anticipated to be a result of the oxidation of sulphides in the Jeerinah Formation, with oxygenated groundwater flowing through minor local fractures. This is consistent with observations elsewhere in the Pilbara such as on the Wonnmunna Plateau adjacent to the West Angeles mine (AQ2 2025; Johnson & Wright 2001).

Within the MDIOM area, groundwater is used by pastoral stations for stock (beef cattle) watering. More regionally, groundwater is used for potable supplies at the Wirrilimarra and Youngaleena Communities. Given the predominant use of the land in the vicinity of the Proposal for pastoral activities groundwater quality data may be compared against livestock drinking water guidelines (ANZECC & ARMCANZ 2000). Exceedances of aluminium, fluoride and mercury have been recorded at bores where the groundwater salinity is within the preferable drinking water limits for beef cattle (i.e. < 5,000 mg/l).

Figure 7-27: Groundwater Salinity Contours at Water Table (AQ2 2025)


615095E
630097E
645099E
660102E
675104E
7576168N
7561166N
7546164N
AQ2
N
7
14 km
1:300,000
GDA94 / MGA zone 50
18/09/2024
Legend
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary
Bore Salinity Profile Location
EC Surface Contours (uS/cm)
18,000
1,000
Data sources: Background Image

7.3.7 Potential Environmental Receptors

7.3.7.1 Groundwater Dependent Ecosystems

Based on the combination of remote sensing (NDVI), field ecophysiological measurements and ecohydrological water balance modelling studies, no terrestrial groundwater dependent ecosystems were identified in or immediately adjacent to the Development Envelope (AQ2 2025).

A detailed ecohydrological baseline assessment of the Fortescue Valley environs has also been undertaken, involving characterisation of major vegetation types and evaluation of the ecological water requirements of the *E. victrix* woodland communities. The potential groundwater dependence of vegetation in the Fortescue Valley has been evaluated using seven assessment tools outlined in the Australian groundwater-dependent ecosystems toolbox (Richardson et al. 2011). It is concluded that groundwater dependent vegetation does not occur in or immediately adjacent to the Development Envelope, based on the following supporting evidence:

- Groundwater underlying the Fortescue Valley environs is generally brackish/saline and therefore does not constitute a favourable water source for floodplain vegetation.
- Regolith characteristics in the Fortescue Valley environs suggest that vegetation rooting depth is impeded by massive calcrete or dense, low permeability clay layers. Owing to access and ground disturbance constraints due to heritage values in these areas, direct observation of tree roots were limited to several sump pits associated with hydrogeological drilling.
- Across the MDIOM area and surrounds, there are no areas of persistently high greenness as measured by time series NDVI imagery.
- Time series pre-dawn leaf water potentials indicate the tree-root zones are in unsaturated media with widely varying soil matric pressure, that is generally lower (i.e. more negative) than -0.5 MPa. Also taking into consideration the potential influence of brackish groundwater, this precludes the roots being in groundwater or at the capillary fringe.
- Based on water balance modelling supported by on-ground vegetation measurements (i.e. woodland tree size and density), surface water inputs were calculated to be sufficient to support the density of trees occurring in the Fortescue Valley *E. victrix* woodland communities. The more dense woodland stands are associated with better structured soils with relatively higher plant-available water storage capacity.

Approximately 45 km to the west-northwest of the Development Envelope, a surface expression of groundwater was inferred by Pinder et al. (2017) at an unnamed channel pool on Mount Florance Station (GDA94 Lat -21.9848; Long 118.0411) (AQ2, 2025). This contention was supported by the presence of stygofauna taxa in this pool and measured pool water salinity of 6,400 µS/cm on 14 March 2017. The vegetation at this site was not found to be in hydraulic connectivity with groundwater. The vegetation was found to be more representative of halophytic communities of the Fortescue Marsh (AQ2 2024; Pinder et al 2017). Two additional pools further downstream were also sampled on the same date, with pool water salinity of 2,690 µS/cm and 1,290 µS/cm respectively recorded at these pools. These pools occur where channelised flow becomes more defined in lower the Fortescue Valley (AQ2, 2024a). Although no drilling has taken place at the channel pools due to the environmental and cultural heritage significance of these areas, the derived depth to water indicate these features are not groundwater-related (AQ2, 2025).

7.3.7.2 Surface Water Hydrology and Ecohydrology

The following provides a list of potential environmental receptors, relevant to surface water hydrology and ecohydrology, identified within and near the Development Envelope. Their locations are illustrated in **Figure 7-29** (AQ2 2024a).

- The area known as the Fortescue Marshe has been demarcated in the Directory of Important Wetlands in Australia (Environment Australia 2001) as DIWA WA066. This area includes the Fortescue Marsh upstream of Goodiadarrie Hills and includes the section of the Fortescue Valley downgradient of the Development Envelope containing Goodiadarrie Swamp, the claypans and floodplains which is registered as Environmentally Sensitive Area DWER-046 (AQ2 2025).
- Koodjeepindarranna and Gnalka Gnoona claypans and surrounding *E. victrix* dominated woodland. These claypans are part of the 'Freshwater claypans of the Fortescue Valley' (Priority 1) Priority Ecological Community (PEC) (AQ2 2025) in the Goodiadarrie Swamp system. These claypans are outside the Development Envelope. When flooded, the claypans are known to provide habitat for waterbirds including migratory species. Across the greater Fortescue Valley, larger claypans and river pools tend to support greater numbers and diversity of waterbirds than smaller shallower wetlands (Pinder et al. 2017).
- The Ebathcalby claypan is a Priority 1 PEC located about 9 km south (and to the east) of the eastern margin of R47/12. The Ebathcalby Claypan is unlikely to be impacted by runoff from the Proposal, as its elevation is approximately 5 m higher than the base of the Fortescue Valley below the Development Envelope.
- Millstream National Park is located more than 100 km west of the Development Envelope, further down the Fortescue Valley. During very large and infrequent cyclonic events, the Koodjeepindarranna Claypan may overtop and contribute to downstream flow into the Lower Fortescue River system towards Millstream.
- Surface water flows from Karijini National Park are towards the Fortescue River, on the opposite side of the Fortescue Valley to the proposal, so there is no mechanism or pathway for modified surface waters as a result of the Proposal to impact the National Park.
- The 'Four plant assemblages of the Wona Land System' Priority 1 PEC is a system of basalt upland gilgai plains comprising vegetation types MTGW and ASL (2) (Priority 1 – Priority 3)
- with grassland vegetation assemblages. The PEC occurs north of the Goodiadarrie Swamp sub-catchment divide and is therefore ecohydrologically disconnected from the proposed pit areas, however, the proposed haul road crosses through the PEC.
- Several small, surface water fed channel pools that hold water for a period of time following runoff events, in the Fortescue Valley, south of the Development Envelope occur. These pools are considered to have potential local conservation significance. They are within the Goodiadarrie Swamp and within drainage channels reporting to the valley floor, and persist, following runoff events. These pools include (but are not limited to):
  - Channel pool within the Koodjeepindarranna Claypan complex (Pinder et al. 2010).
  - Channel pool at UTM Zone 50 653300E and 7550400N. Identified from aerial photography.
  - Channel pool at UTM Zone 50 661600E and 7547770N. Identified from aerial photography.

- Gidyea pool south and east of the Development Envelope, near the Ebathcalby Claypan – has significant wetland floor vegetation in contrast with claypans further to the west (Pinder et al. 2017). As discussed above, this pool is not located downstream of the Development Envelope.

The proposed mine pit footprints will avoid the boundary of the ESA area with a buffer of 200 m.

Acacia stenophylla is a notable overstorey tree species in the Fortescue Valley floodplain woodlands to the south of the Development Envelope (AQ2 2025). This species is widespread in inland eastern Australia, with the Fortescue Valley population constituting a major outlier from its core distribution (AQ2 2025).

7.3.7.3 Subterranean Fauna

The Development Envelope and surrounding area host a particularly diverse range of subterranean fauna, including stygofauna and troglofauna (BEC 2019; 2021; 2024).

On the basis of geological logging, core photos and subterranean fauna survey results, lithological units have been grouped based on the potential to support a troglofauna or stygofauna habitat. The geological units identified as likely habitats for troglofauna and stygofauna are the Upper Calcrete and CID/Pisolite of the Tertiary sequence and Mineralised Marra Mamba (refer to AQ2 2024a **Appendix 9**). For troglofauna, these potenital habitat units are restricted to where they occur above the water table. For stygofauna (occurring in the groundwater):

- The likely Upper Calcrete habitat is a continuous unit that occurs to the south of the proposed mining area and extends both across the Fortescue Valley and along the strike of the valley.
- The likely habitats of Mineralised Marra Mamba and CID / Pisolite extend over much of the Chichester Range, with the CID / Pisolite occurring as a continuous unit, extending to the south across the valley and the Mineralised Marra Mamba occurring as discontinuous pods associated with the mineralisation.

These habitats are described in **Section 8** of this document. Refer to **Appendix 9** for 3D habitat assessment by AQ2.

7.3.8 Other Potential Users

Aside from the natural environment, existing groundwater users within and surrounding the Development Envelope include the local and nearby stations (Mulga Downs, Hooley and Mt Florance Stations), for stock watering. Additional, more regional, groundwater users are the Wirrilimarra and Youngaleena Communities and licenced water supplies associated with the operation of the existing FMG (Solomon) railway and Goodiadarrie transport corridor.

Figure 7-28: Conceptual Ecohydrological Model of the *E. victrix* woodland communities (AQ2 2024a)

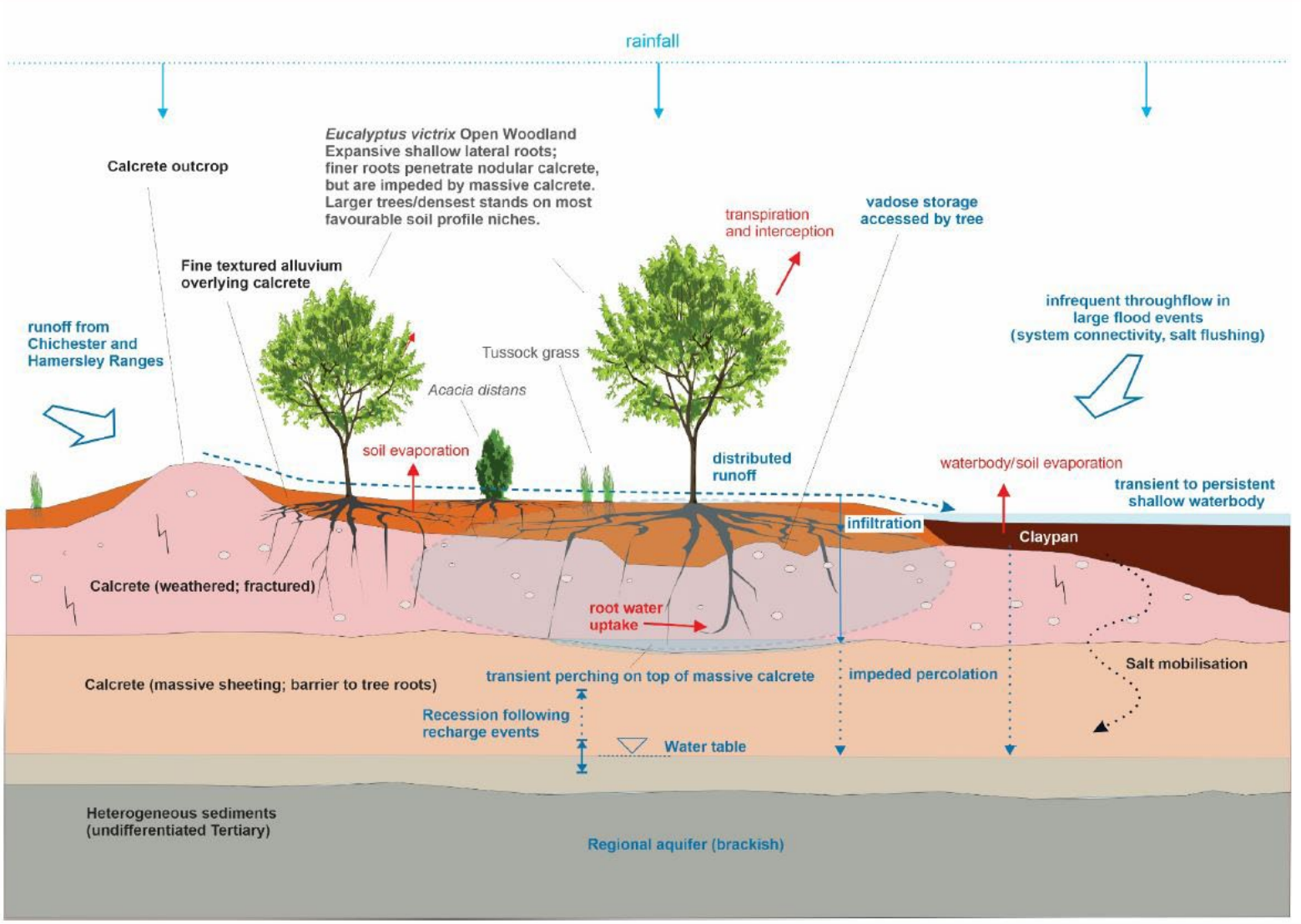
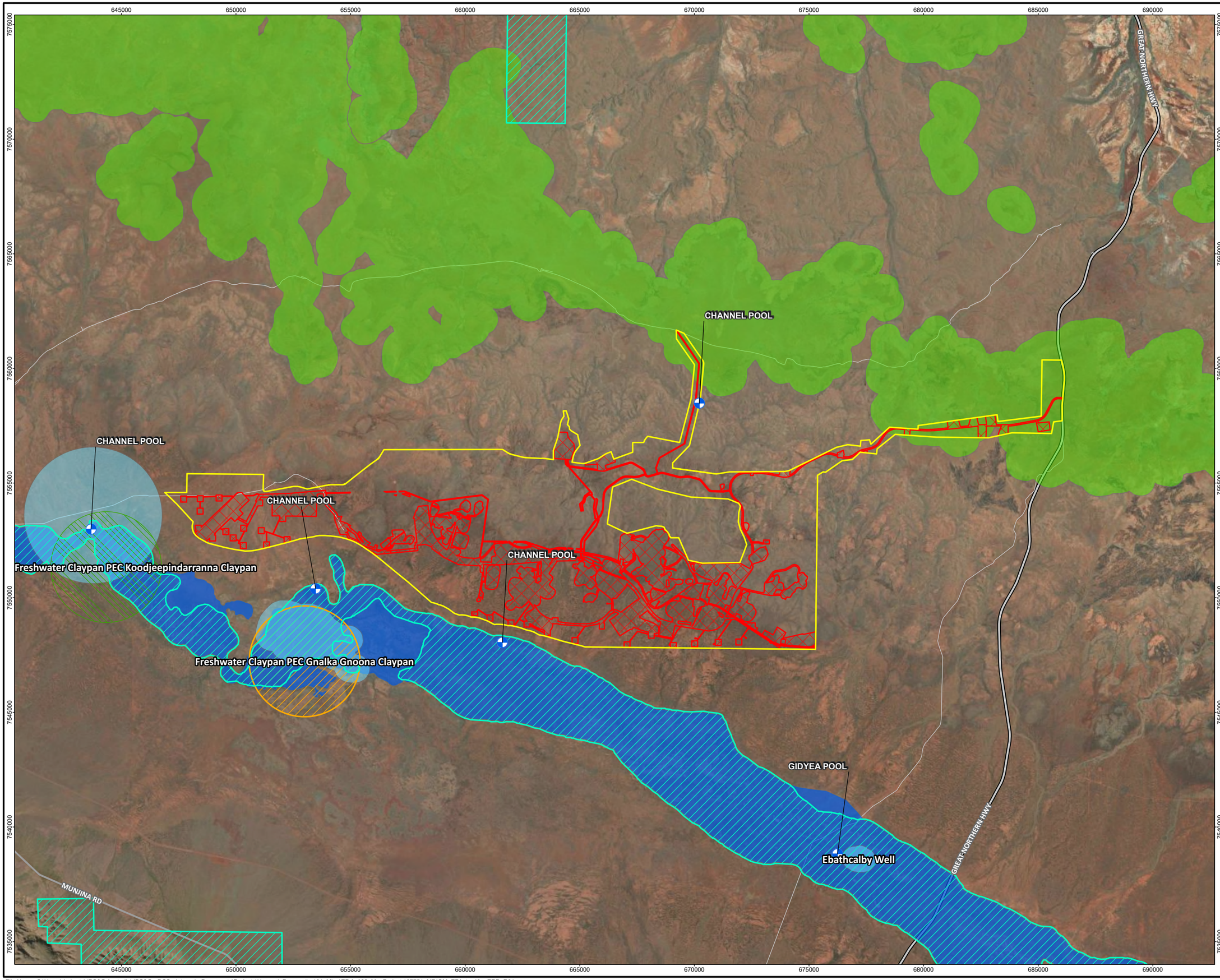

rainfall
Calcrete outcrop
Eucalyptus victrix Open Woodland
Expansive shallow lateral roots;
finer roots penetrate nodular calcrete,
but are impeded by massive calcrete.
Larger trees/densest stands on most
favourable soil profile niches.
transpiration
and interception
vadose storage
accessed by tree
Fine textured alluvium
overlying calcrete
runoff from
Chichester and
Hamersley Ranges
Tussock grass
Acacia distans
infrequent throughflow in
large flood events
(system connectivity, salt flushing)
soil evaporation
distributed
runoff
waterbody/soil evaporation
transient to persistent
shallow waterbody
infiltration
Claypan
Calcrete (weathered; fractured)
root water
uptake
Salt mobilisation
Calcrete (massive sheeting; barrier to tree roots)
transient perching on top of massive calcrete
impeded percolation
Recession following
recharge events
Water table
Heterogeneous sediments
(undifferentiated Tertiary)
Regional aquifer (brackish)

Figure 7-29: Location of Potential Environmental Receptors and other Potential Users



Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA-038)

- Freshwater claypans of the Fortescue Valley PEC buffer (P1)
- Four plant assemblages of the Wona Land System PEC buffer (P1)

Ecohydrology Focus Area (AQ2)

- Focus Area A: Gnalka Gnoona claypan and surround E.victrix woodland
- Focus Area B: The Koodjeepindarranna claypan and surrounding E.victrix woodland
- DIWA Wetland Boundary 066 (Fortescue Marshes) [not the Fortescue Marsh]
- Environmental Sensitive Areas (DWER-046
- Surface Water Channel Pool

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 17-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:150,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF POTENTIAL ENVIRONMENTAL RECEPTORS AND POTENTIAL USERS

FIGURE 7.29

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

7.4 Proposed Water Management Strategy

The location of the proposed pits for the Proposal are shown in **Figure 7-30.** It comprises seven mining domains (from west to east): Murray's Hill, Anticline Hill, Fridge West, Fridge Central, Fridge Hill, Horseshoe West and Horseshoe Hill. Approximately 20 of the pits are proposed to extend (to varying depths) below the groundwater level and will therefore require dewatering. The lowest estimated pit elevation is 388 mRL (i.e. ~12 to 16 m below the groundwater level) (AQ2 2024a).

7.4.1 Dewatering

The preferred approach to dewatering is via ex-pit dewatering bores with in-pit bores only used where additional abstraction is required to achieve required drawdown levels. In-pit sumps may be used towards the end of mining a pit to access the deepest part of the pit (AQ2 2024a).

For pits located closer to the claypan areas (i.e., in the Murray's Hill and Fridge West areas), there is the potential for dewatering discharge to become more saline over time as groundwater is drawn from the higher salinity, valley areas (as shown in **Figure 7-30**). As the proposed pits are only being mined to ~388 mRL and do not have saline water directly beneath them, up-coning of deeper, more saline water is not anticipated with the proposed dewatering abstraction (AQ2 2024a).

The mine plan has been developed to account for the constraints imposed by groundwater management. The adopted mining scenario has mining commencing in January 2027, with a 15.5-year life of mine. Below water table mining commences in 2028 in the west, in the Murray's Hill area, progressing east to Anticline Hill, followed by the mining of Horseshoe West and finally the Fridge West, Fridge Central and Fridge Hill areas. This is summarised and depicted in **Figure 7-31** (AQ2 2024a).

Predicted dewatering commences in April 2028 at ~8,600 kL/d (~3.2 GL/yr). Numerical groundwater modelling predicts peak dewatering rates of between ~30,000 and 31,300 kL/d (~11 to 11.4 GL/yr) during the concurrent dewatering of Murray's Hill, Anticline Hill and Horseshoe West during 2032 and 2033, with similar peaks (~30,200 kL/d) between 2037 and 2041, during the mining of Fridge Hill and Fridge West. Dewatering rates decline rapidly upon the completion of mining Fridge Hill, with rates of ~4,300 kL/d (~1.6 GL/yr) predicted for the final of year of mining Fridge West. The proposed Fridge Central pits (FC02 and FC03) only extend ~2 mbgl and, as such, these pits are dewatered passively by interference effects from the dewatering of neighbouring pits. Predicted dewatering for the adopted mine schedule is shown in **Figure 7-31** (AQ2 2024a).

Dewatering was simulated using 23 dewatering bores. The locations of the modelled bores are presented in **Figure 7-32**. The ex-pit dewatering bores are generally located immediately adjacent to the deepest parts of the pits and where the aquifer is deepest. Dewatering bores are therefore generally located on the down-dip side of the pits to ensure the maximum duration of pumping (with up-dip locations becoming dewatered first). Maximum dewatering rates at the individual bore sites range between 2,600 and 4,300 kL/d (30 and 50 L/s), with yields at some bores declining as the aquifer units are dewatered, particularly the northernmost bores (AQ2 2024a).

A conceptualisation of the potential impact of dewatering on the groundwater system is illustrated in **Figure 7-33**.

Figure 7-30: Simulated pits in the groundwater model (Mulga Downs) (AQ2 2025)

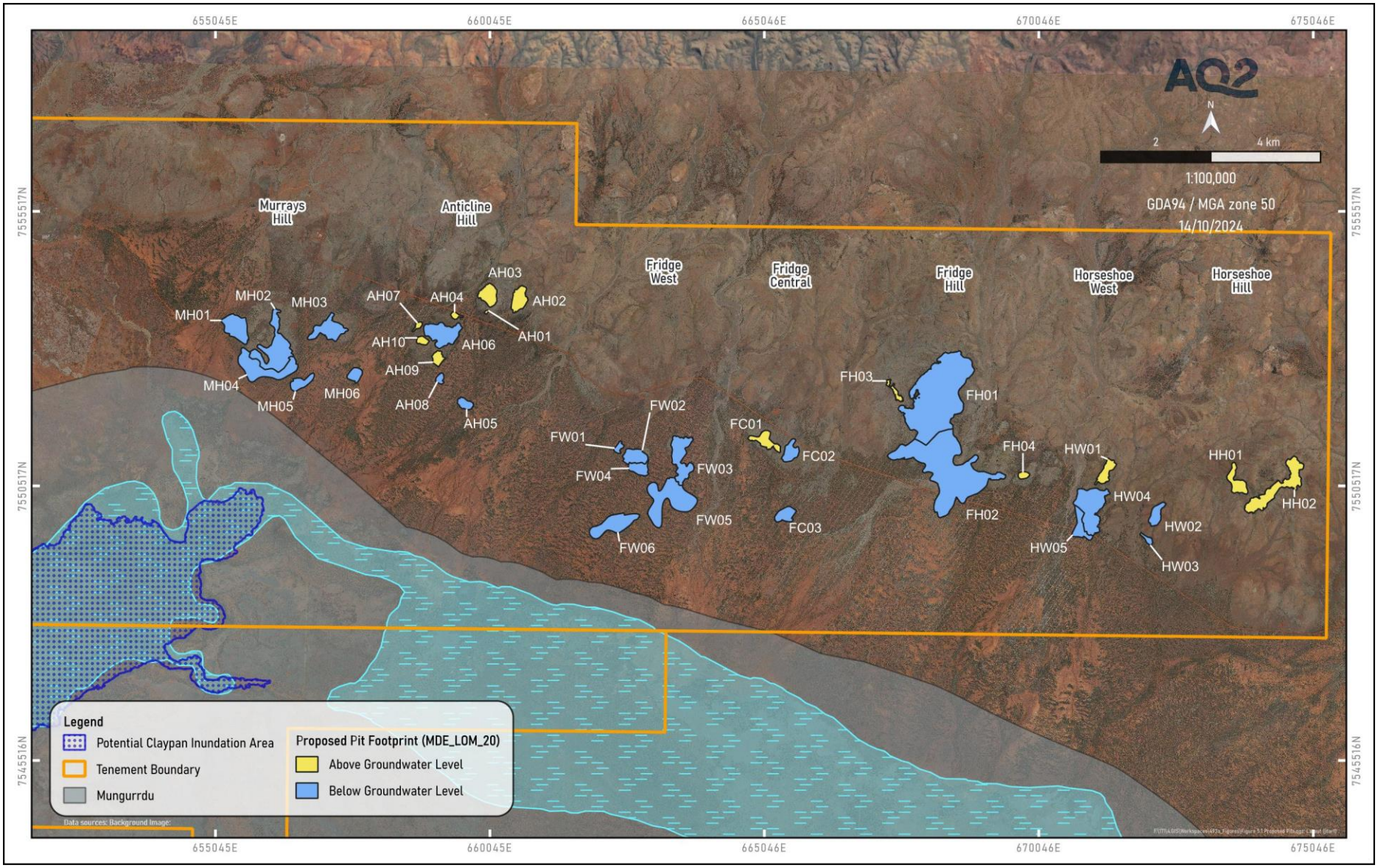
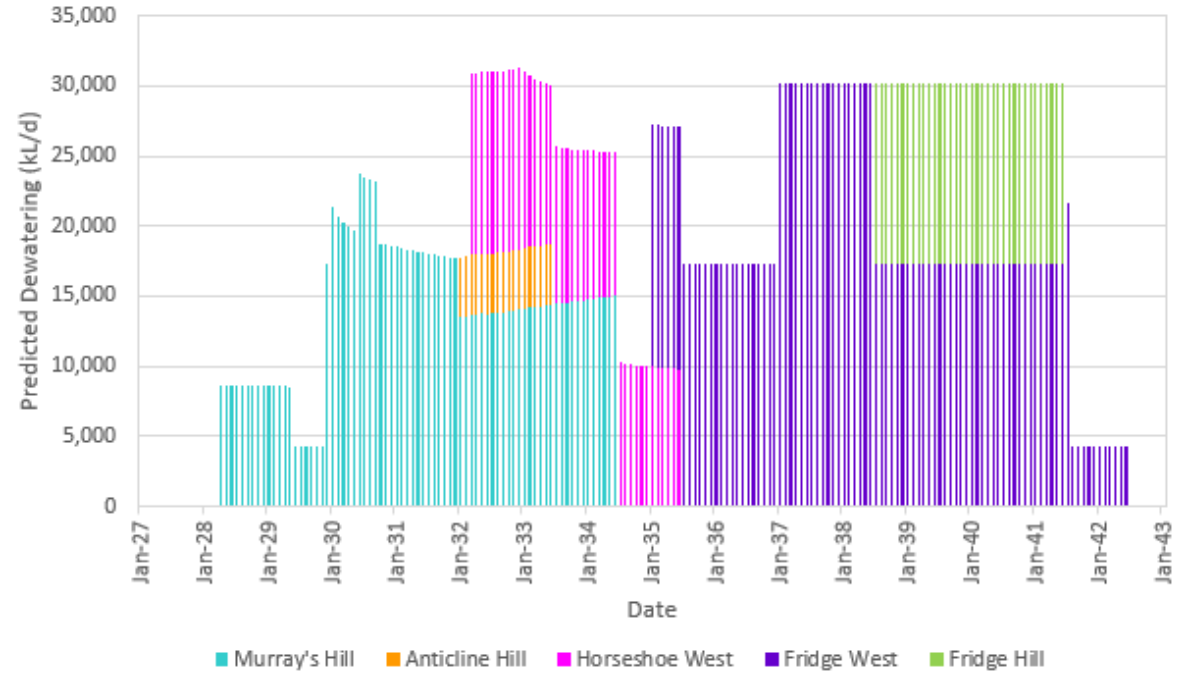

655045E
660045E
665046E
670046E
675046E
7555517N
7550517N
7545516N
AQ2
N
2
4 km
1:100,000
GDA94 / MGA zone 50
14/10/2024
Murrays Hill
Anticline Hill
Fridge West
Fridge Central
Fridge Hill
Horseshoe West
Horseshoe Hill
MH01
MH02
MH03
MH04
MH05
MH06
AH01
AH02
AH03
AH04
AH05
AH06
AH07
AH08
AH09
AH10
FW01
FW02
FW03
FW04
FW05
FW06
FC01
FC02
FC03
FH01
FH02
FH03
FH04
HW01
HW02
HW03
HW04
HW05
HH01
HH02
Legend
Potential Claypan Inundation Area
Tenement Boundary
Mungurrdu
Proposed Pit Footprint (MDE_LOM_20)
Above Groundwater Level
Below Groundwater Level
Data sources: Background Image:

Figure 7-31: Predicted dewatering Schedule (AQ2 2025)


35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Predicted Dewatering (kL/d)
Jan-27
Jan-28
Jan-29
Jan-30
Jan-31
Jan-32
Jan-33
Jan-34
Jan-35
Jan-36
Jan-37
Jan-38
Jan-39
Jan-40
Jan-41
Jan-42
Jan-43
Date
Murray's Hill
Anticline Hill
Horseshoe West
Fridge West
Fridge Hill

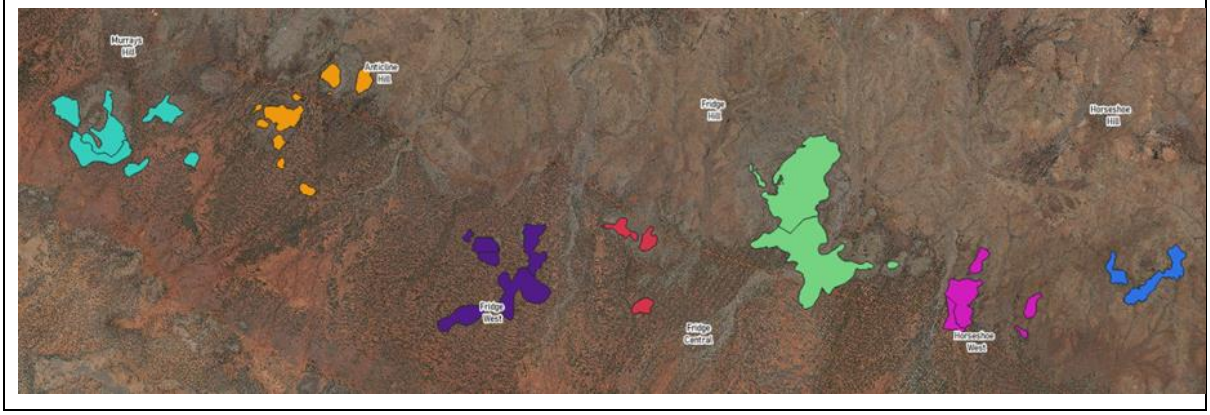
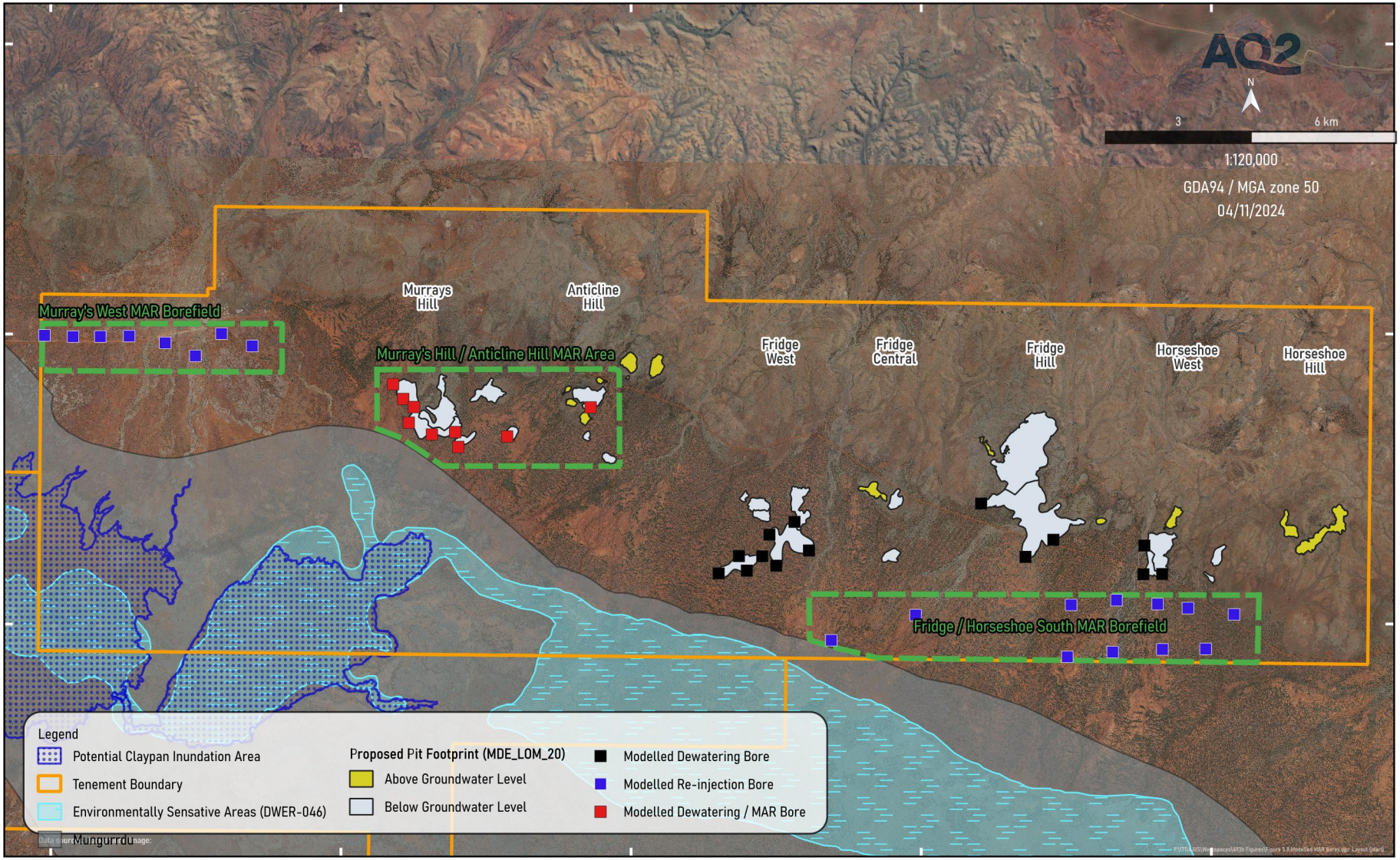

Murrays Hill
Anticline Hill
Fridge Hill
Horseshoe Hill
Fridge West
Fridge Central
Horseshoe West

Figure 7-32: Simulated Dewatering Bores (AQ2 2025).


648050E
654050E
660051E
666051E
672052E
7560583N
7554582N
7548582N
AQ2
N
3
6 km
1:120,000
GDA94 / MGA zone 50
04/11/2024
Murray's West MAR Borefield
Murrays Hill
Anticline Hill
Murray's Hill / Anticline Hill MAR Area
Fridge West
Fridge Central
Fridge Hill
Horseshoe West
Horseshoe Hill
Fridge / Horseshoe South MAR Borefield
Legend
Potential Claypan Inundation Area
Tenement Boundary
Environmentally Sensative Areas (DWER-046)
Proposed Pit Footprint (MDE_LOM_20)
Above Groundwater Level
Below Groundwater Level
Modelled Dewatering Bore
Modelled Re-injection Bore
Modelled Dewatering / MAR Bore
Mungurrdu

7.4.2 Construction and Operational Water Demand

HPPL estimates an approximate average water demand of 0.75GL/yr (2,000 kL/d) for both the construction period (i.e., a period of 1 to 2 years prior to mining) and throughout the life of mine.

Throughout the mining period water demands will be preferentially met by dewatering volumes and, if required, water treatment will ensure that the water quality criteria are met. It is intended that construction water will be sourced from the mining area and, as such will either provide advance dewatering and / or increased aquifer capacity for the disposal of excess water, dependent on the source area. As such, although the groundwater abstraction has only been modelled to meet dewatering requirements (i.e., commencing in April 2028), early groundwater abstraction for water supply purposes is not not anticipated to have a significant effect on the modelled drawdown / mounding with respect to impact assessment (AQ2 2024a).

7.4.3 Excess Water Disposal

Where dewatering exceeds water demands, excess water will be disposed of by MAR. The generally progressive west to east mining approach (with the exception Horseshoe West mining) allows excess water to be injected and/or infiltrated along strike (i.e., into other mining areas in advance of or after mining in that area) as well as across strike (i.e., to the south of the eastern mining areas) (AQ2 2024a).Initially, MAR is proposed via reinjection bores, with the potential for using repurposed dewatering bores and / or in-pit infiltration, once mining of a pit is complete (AQ2 2024a).

From the field investigations conducted to date, the following are key points relating to the MAR potential for this area (AQ2 2024a):

- The Altered Marra Mamba unit is an extensive and continuous aquifer, as is the Tertiary overburden.
- Although weathered shale and / or clay dominant intervals within the Tertiary overburden exist, no continuous, extensive confining layer to allow pressurised MAR has been identified by investigations completed to date.
- The generally unconfined nature of the identified Tertiary and bedrock aquifers means that MAR will be limited by the available freeboard (i.e., the unsaturated aquifer above the current groundwater level and below the ground surface / root zones). However, with regional groundwater levels being drawn down by the dewatering of the pit areas, the freeboard is likely to increase.
- The increased depth to groundwater in the eastern areas provides greater freeboard, however, these areas have inherently fresher groundwater, being further from the claypan areas, therefore potential changes to water quality will need to be assessed and managed.
- The MAR will reduce the extent of drawdown, however, the proximity of the proposed MAR areas to the pits is anticipated to result in re-circulation of the re-injected water back to the pits.
- With respect to the beneficial use of the groundwater in the Development Envelope: Although the groundwater salinity is naturally elevated near the claypans, the salinity reduces with increased distance from the claypans due to the lateral flow of fresher groundwater from the valley slopes; with preferential flow evident through the lower units of the Tertiary sequence (i.e., the CID / Pisolite and Basal Crete) and upper bedrock units. Station bores for livestock drinking water are installed in the Tertiary aquifer units.

Three MAR areas have been simulated, as shown in Figure 5.8 of **Appendix 5**. The simulated groundwater level rise at each modelled MAR bore was restricted to 2.5 mbgl, i.e, below the vegetation root zone, which is constrained by largely impenetrable subsoil/regolith materials (e.g. calcrete). Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl (AQ2 2024a).

The modelling indicates that all excess water can be disposed of by MAR. **Figure 7-31** presents the simulated MAR rates by area, in comparison to the dewatering by area. It can be seen that variable bores of the Fridge / Horseshoe South MAR Borefield are used throughout the LoM, with the exception of approximately two years (mid-2033 to mid-2035), during the mining of Horseshoe West. With the influence of dewatering creating additional freeboard across the area, maximum predicted re-injection rates reach ~28,000 kL/d (~10 GL/yr) for the Fridge / Horseshoe South Borefield, 23,000 kL/d (~8.5 GL/yr) for the Murray's West Borefield pit areas and ~25,000 kL/d (~9 GL/yr) for the Murray's Hill / Anticline Hill pit areas.

7.4.4 Surface Water

Storm water runoff across the Development Envelope (including the mining area and associated ancillary infrastructure) will be managed to limit environmental impacts of the Proposal on the surface water regime and downstream environment.

The general management objectives for the Proposal relating to surface water are as follows (AQ2 2024a):

- Maintain the existing hydrological regime as much as is practicable.
- Mitigate impacts on surface water quality from construction and operations by containing and treating impacted water on-site prior to release to the downstream environment.
- Reduce the risk of surface water having a significant impact on mining operations.

Proposed surface water management measures to meet the above objectives have been based on the following design philosophies (AQ2 2024a):

- Clean water should be diverted around mining areas to the downstream environment to prevent contamination of runoff from clean water catchments.
- Flood mitigation measures are required to prevent flood ingress to open pits and mine infrastructure areas.
- Surface water management infrastructure must incorporate measures to avoid excessive scour, erosion and sediment transport, and should be designed to prevent prolonged ponding following rainfall events.
- Surface water will be allowed to infiltrate waste rock dumps and/or runoff from waste rock dumps will be contained and diverted through sediment basins prior to release downstream following treatment.

7.5 Potential Environmental Impacts

An assessment of the potential direct, indirect and cumulative impacts of the Proposal to inland water values in consideration of the EPA objectives is provided below.

The potential impacts from mining are conceptualised in **Figure 7-33.**

7.5.1 Direct impacts

7.5.1.1 Surface Water

The identification of potential impacts from the Proposal on the hydrological environment was completed by comparing the proposed infrastructure layout to the existing catchments and baseline flood modelling results.

Direct impacts to the hydrological environment fall into the following categories (AQ2 2024a):

- Modification of the existing hydrological regime, by increasing or reducing water availability within the downstream environment. This can have impacts both immediately downstream of disturbance area footprints and surface water diversions, and further downstream as an accumulation of impacts from multiple disturbance areas. The receptors which may potentially be impacted by the Project are local vegetation and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools.
- Modification of the physical water quality (i.e., suspended sediments) in the downstream environment, which may be due to erosion of disturbed areas relating to construction, stockpiles, laydowns and waste rock dumps (among others). The environmental impacts from this would be increased sediment loads to the Fortescue Valley (including claypans and pools).
- Modification of the chemical water quality (for example hydrocarbon pollution) resulting in contamination of local waterways and the Fortescue Valley.

Modification of the existing hydrological regime

Modification of the existing hydrological regime can have impacts both immediately downstream of disturbance area footprints and surface water diversions, and further downstream as an accumulation of impacts from multiple disturbance areas. The receptors which may potentially be impacted by the Proposal are local vegetation and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools. Proposed surface water diversions for the MDIOM are shown in **Figure 7-34.**

The mine development will cause a reduction in surface water flows to the environment on the downstream side of the Proposal, particularly in the central section, due to a reduction in contributing catchment areas. This particularly applies to the development of the pit footprints which will capture rainfall. Runoff from other mine disturbance areas (such as waste rock dumps and stockpiles) will be diverted through sediment basins prior to the release of water downstream. As a conservative approach to the assessment of potential impact of the Project on the surface water regime, it is assumed that no runoff from within Surface Water Containment Areas (refer **Figure 7-34**) will report downstream. A reduction in surface water flows to the environment on the downstream side of linear infrastructure (such as road and pipeline installations) and ponding on the upstream side may occur due to the interruption of surface flow paths.

Diversion of surface water flows around development areas and into different drainage lines, and areas of the Fortescue Valley, also have the potential to impact the surface water regimes. Where diversions increase flow rates in local areas, there is the potential for an increase in erosion and water ponding to occur.

Across the 17 catchment areas, as identified in **Table 7-10**, the catchments to the west and east of the mine disturbance areas (1 to 3 and 11 to 16) experience small changes as a result of the disturbance footprints. The

central catchments that experience the greatest reductions are impacted either by the mine development reducing the catchment area contributing to downstream surface water flows, or by the proposed surface water diversions transferring water into an adjacent catchment that delivers flows to an alternative location downstream. Catchment 6 is almost completely developed upon, whereas Catchment 9 is partly developed and mostly diverted into Catchment 10 (AQ2 2024a).

Table 7-10: Proposal Catchment Area Changes (AQ2 2024a)

Catchment	Baseline Area (km^2)	Life-of-Mine Area (km^2)	Change in Area
1	23.1	22.0	-5%
2	164.4	164.3	0%
3	39.8	35.5	-11%
4	28.4	22.5	-21%
5	33.8	30.3	-10%
6	13.5	2.8	-79%
7	29.0	29.9	3%
8	11.9	2.6	-78%
9	43.3	13.2	-69%
10	53.9	73.7	37%
11	65.5	60.3	-8%
12	1.7	1.6	-4%
13	6.3	6.0	-5%
14	2.1	1.6	-22%
15	4.5	4.2	-8%
16	7.3	7.1	-3%

Figure 7-33: Conceptual cross section showing potential impact of mining (AQ2 2025)

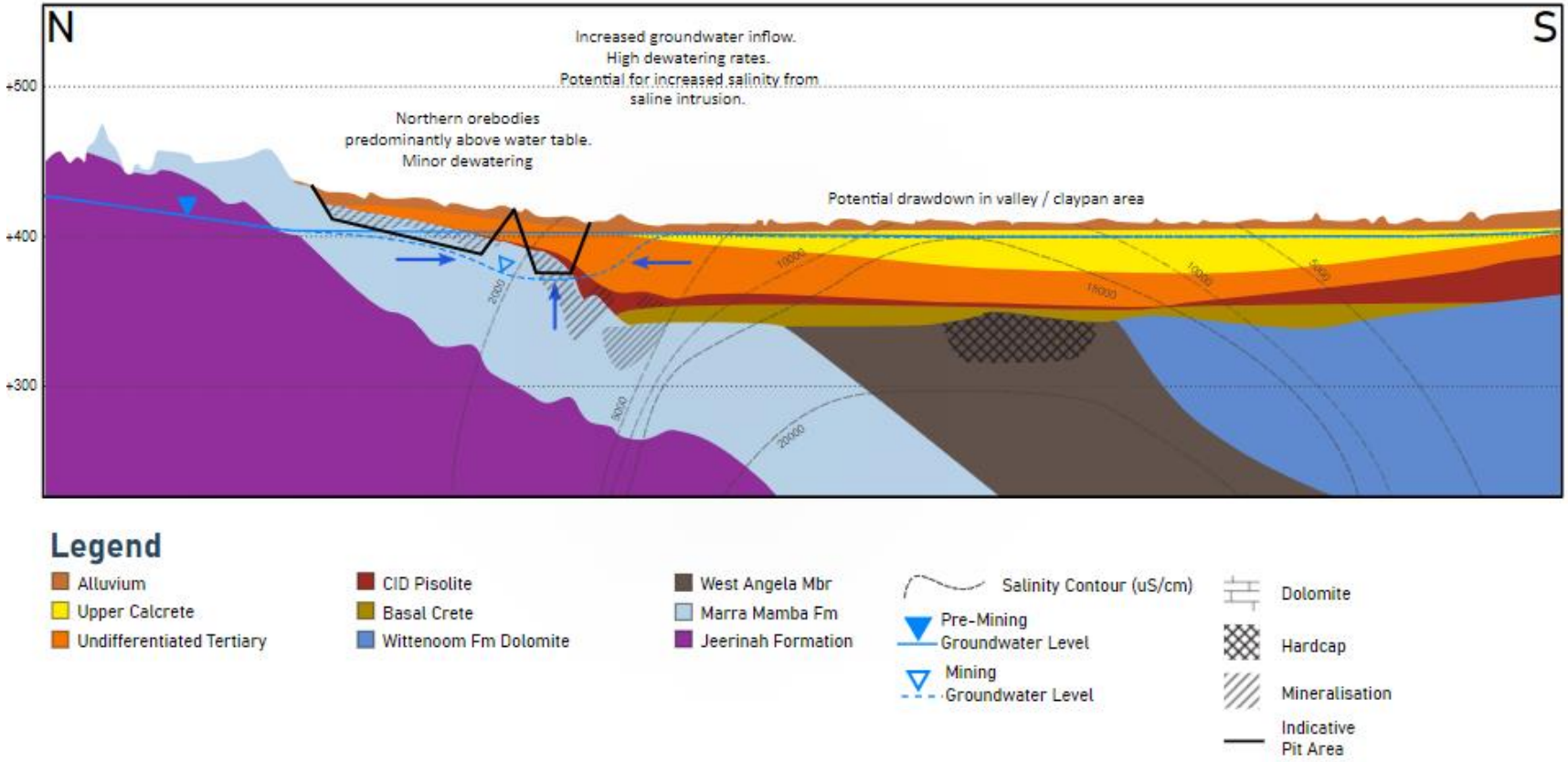
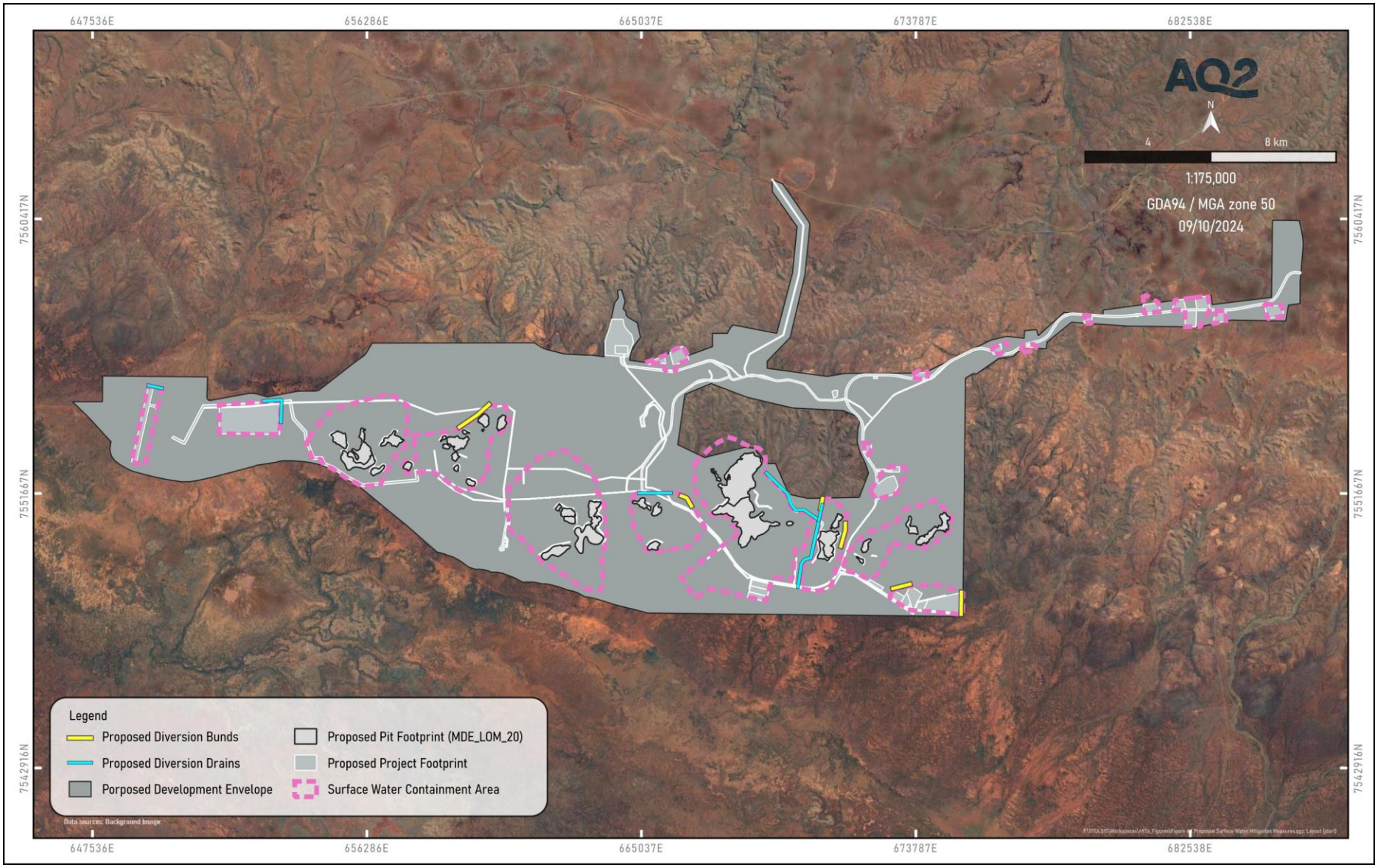

N
S
Increased groundwater inflow.
High dewatering rates.
Potential for increased salinity from saline intrusion.
Northern orebodies predominantly above water table.
Minor dewatering
Potential drawdown in valley / claypan area
+500
+400
+300
2000
3000
20000
10000
15000
5000
Legend
Alluvium
Upper Calcrete
Undifferentiated Tertiary
CID Pisolite
Basal Crete
Wittenoom Fm Dolomite
West Angela Mbr
Marra Mamba Fm
Jeerinah Formation
Salinity Contour (uS/cm)
Pre-Mining Groundwater Level
Mining Groundwater Level
Dolomite
Hardcap
Mineralisation
Indicative Pit Area

Figure 7-34: Proposed Surface Water Diversions (AQ2 2024a)


647536E
656286E
665037E
673787E
682538E
7560417N
7551667N
7542916N
AQ2
N
4
8 km
1:175,000
GDA94 / MGA zone 50
09/10/2024
Legend
Proposed Diversion Bunds
Proposed Diversion Drains
Porposed Development Envelope
Proposed Pit Footprint (MDE_LOM_20)
Proposed Project Footprint
Surface Water Containment Area
Data sources: Background Image

Modification of the physical water quality

Diversion of surface water flows around development areas and into different drainage lines, and areas of the Fortescue Valley, also add an additional risk to the downstream environment. The positioning of the pits, waste dumps, and stockpiles, will cause the diversion of several surface water flow paths towards alternative areas of the Valley. There is the potential for this to increase erosion.

Modification of the physical water quality (i.e. suspended sediments) may occur in the downstream environment due to erosion of disturbed areas relating to construction, stockpiles, laydowns and waste dumps (among others). The resulting environmental impacts include increased sediment loads to the Fortescue Valley (including claypans and pools).

The inherent risks to physical water quality from the Proposal have been identified as:

- Erosion from cleared areas for pits, infrastructure and along waste dump toes leading to sediment reporting to the Fortescue Valley and claypans.
- Ongoing sediment release to the downstream environment from frequent rainfall events leading to increased sediment loads to the Fortescue Valley and claypans.

7.5.1.2 Groundwater

Direct impacts that are anticipated to groundwater include:

- Changes in groundwater levels (groundwater drawdown and groundwater mounding).
- Changes to groundwater salinity.

Changes in groundwater levels

Predicted changes in groundwater levels resulting from the modelled dewatering and MAR have been plotted as drawdown / mounding contours at the end of selected periods of dewatering / MAR and for the end of mining (June 2042). These are presented in **Figure 7-35** to **Figure 7-37**.The maximum extents of the predicted 1 m mounding and 2 m drawdown contours, throughout the LOM, are shown in **Figure 7-38**.

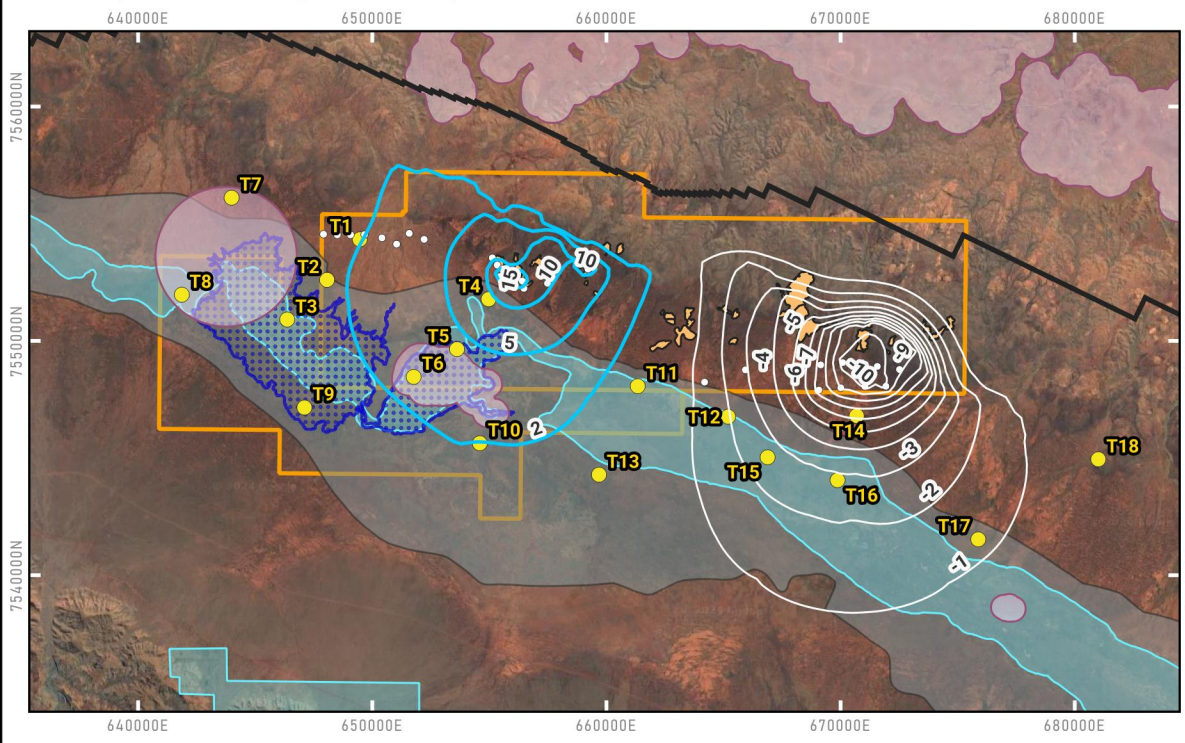
The following observations are made regarding the predicted groundwater level changes (AQ2 2024a):

- Maximum drawdowns are predicted in the active mining areas, with maximum drawdown depths of up to 25 m (i.e., in excess of the maximum proposed depths of mining below the groundwater level).
- Drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along the strike of the valley is curtailed by MAR in both the east and the west of the Mulga East tenement for various periods through the LoM.
- The maximum extent of the predicted 2 m drawdown contour across the valley occurs between July 2038 and the end of mining July 2042, extending ~8 km south-southwest of Fridge West. The drawdown is not predicted to reach the Hamersley Range (nor the model boundary).
- The maximum extent of the predicted 2 m drawdown contour in the vicinity of the claypans occurs in October 2032, extending ~7.5 km south-southwest of the Murray's Hill mining area, across the Gnalka Gnoona Claypan area.

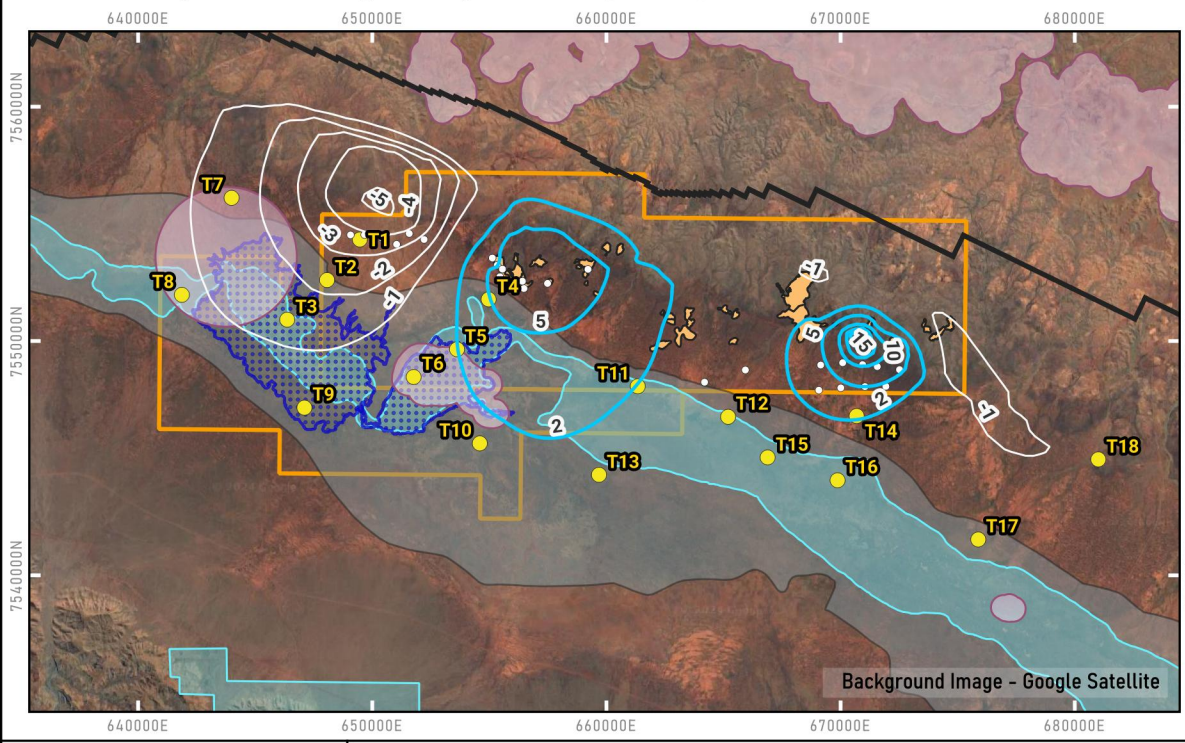
- The maximum western extent of the predicted 2 m drawdown contour occurs in January 2032, during the mining of Murry's Hill and prior to the commencement of MAR in the Murray's West Borefield; it extends ~6 km along strike to the west of the Murry's Hill mining area.
- The maximum eastern extent of the predicted 2 m drawdown contour occurs in July 2035, extending ~3.5 km to the east of the main Horseshoe West pit (HW05).
- Maximum peaks in groundwater mounding of ~11 to 12 m are predicted in the Fridge / Horseshoe South MAR Borefield area in January 2032 and through the latter half of 2038, with predicted hydrographs for the down-gradient observation points (T14 and T16) showing more subdued mounding responses over these periods (refer **Figure 7-36)**.
- The maximum extent of the 1 m mounding contour associated with the Fridge / Horseshoe South MAR Borefield is predicted to occur between January 2032 and July 2033, extending ~10 km to the south (across the valley) and ~5 km beyond the Mulga East tenement boundary in a southeasterly direction.
- Maximum peaks in groundwater mounding associated with the Murray's West MAR Borefield and Murray's Hill / Anticline Hill MAR area are predicted to be ~4 to 6 m occurring in 2033 to 2034 and July 2035 respectively (refer **Figure 7-35** observation points T1 and T4).
- The maximum extent of the 1 m mounding contour associated with the Murray's West MAR Borefield is predicted to occur in July 2034, extending ~7 km to the northwest (along strike) and ~5 to 5.5 km to the south and southwest (across the valley), in the vicinity of the Koodjeepindarranna Claypan.
- Predicted groundwater level hydrographs in the vicinity of the claypans (refer **Figure 7-35** and **Figure 7-36** observation points T3 and T6), show only subdued responses to dewatering and MAR, with predicted groundwater levels remaining below the maximum mounding criterion of 2.5 mbgl.

Figure 7-35: Predicted drawdown and mounding for January 2032 and July 2034 (AQ2 2024a)

Murray's Hill Dewatering Before Murray's West MAR (Jan 2032)



End of Murray's Hill Dewatering & Murray's West MAR (Jul 2034)



N

0 5 10 km

GDA94 / MGA zone 50

10/11/2024

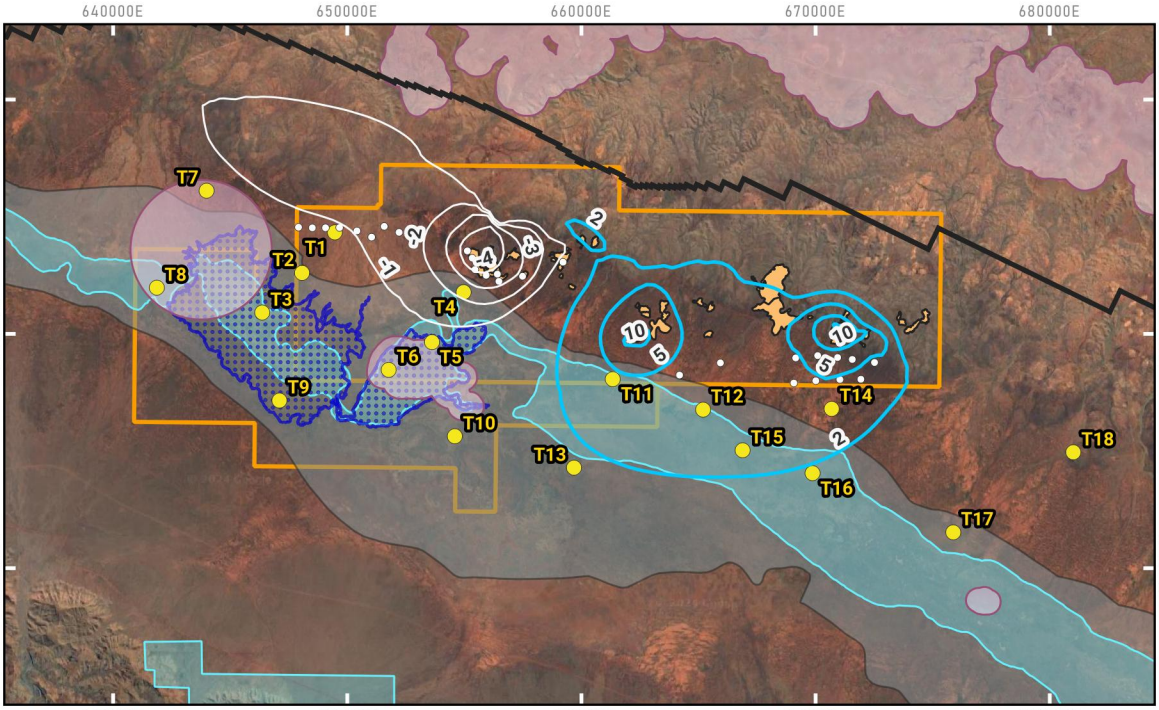
F:\177\A.GIS\Workspaces\493a_Figures\Figure 5.13 - WL Changes Template.qgz

Legend

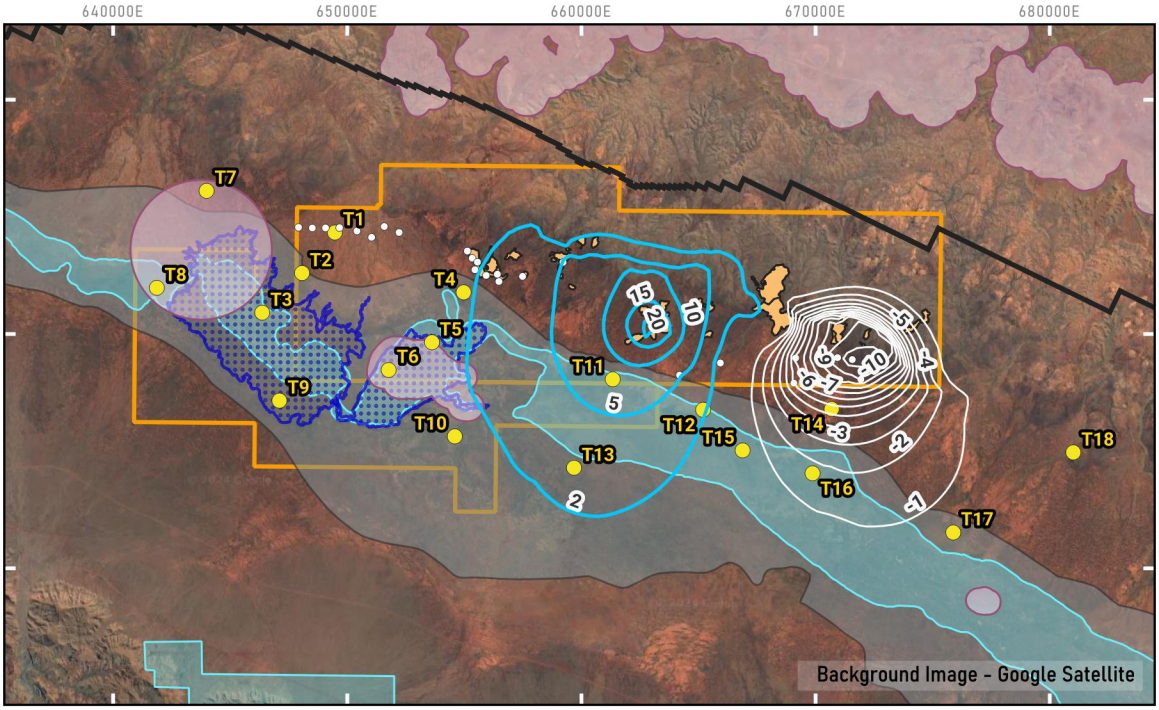
- Proposed Pit Footprint (MDE_LOM_20)
- Environmentally Sensitive Areas (DWER-046)
- Priority Ecological Community (PEC) Boundary
- Potential Claypan Inundation Area
- Simulated MAR Bore
- Model Boundary
- Drawdown (m)
- Mounding (m)
- Simulated Observation Points
- Mungurrdu

Figure 7-36: Predicted drawdown and mounding for July 2035 and July 2038 (AQ2 2024a)

End of Horseshoe Dewatering & Murray's Hill (MH) / Anticline Hill (AH) MAR (Jul 2035)



Fridge West Dewatering Before Fridge Hill Dewatering & MH / AH MAR (Jul 2038)



N

0 5 10 km

GDA94 / MGA zone 50

10/11/2024

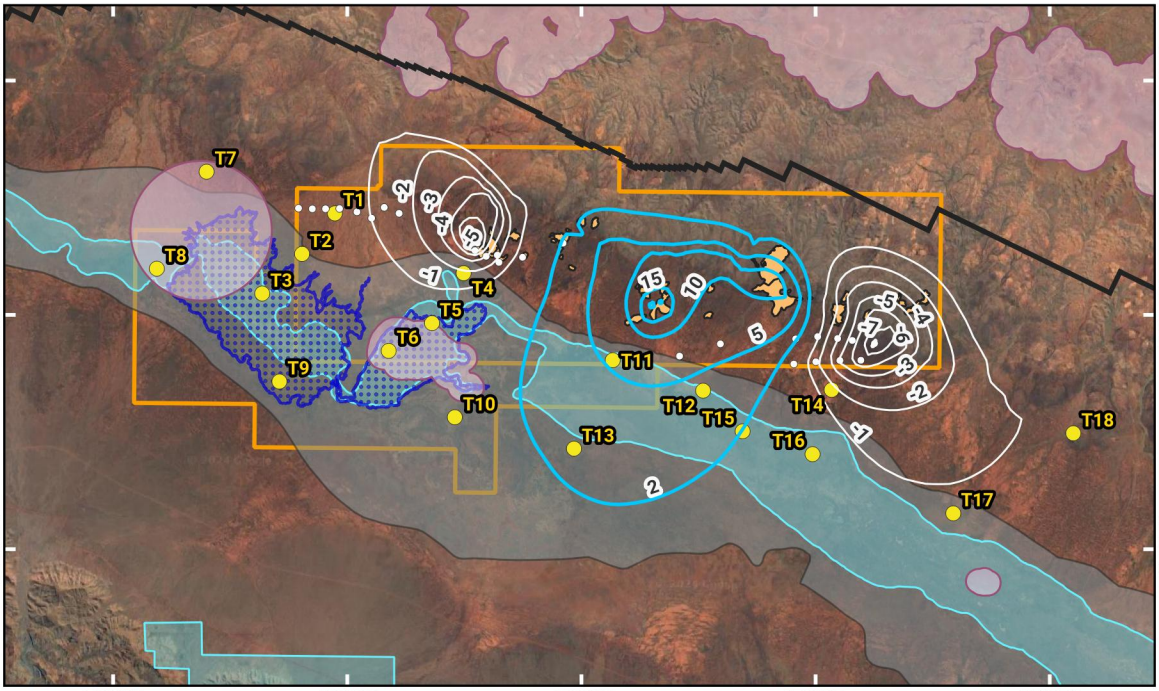
F:\177\A.GIS\Workspaces\493a_Figures\Figure 5.13 - WL Changes Template.qgz

Legend

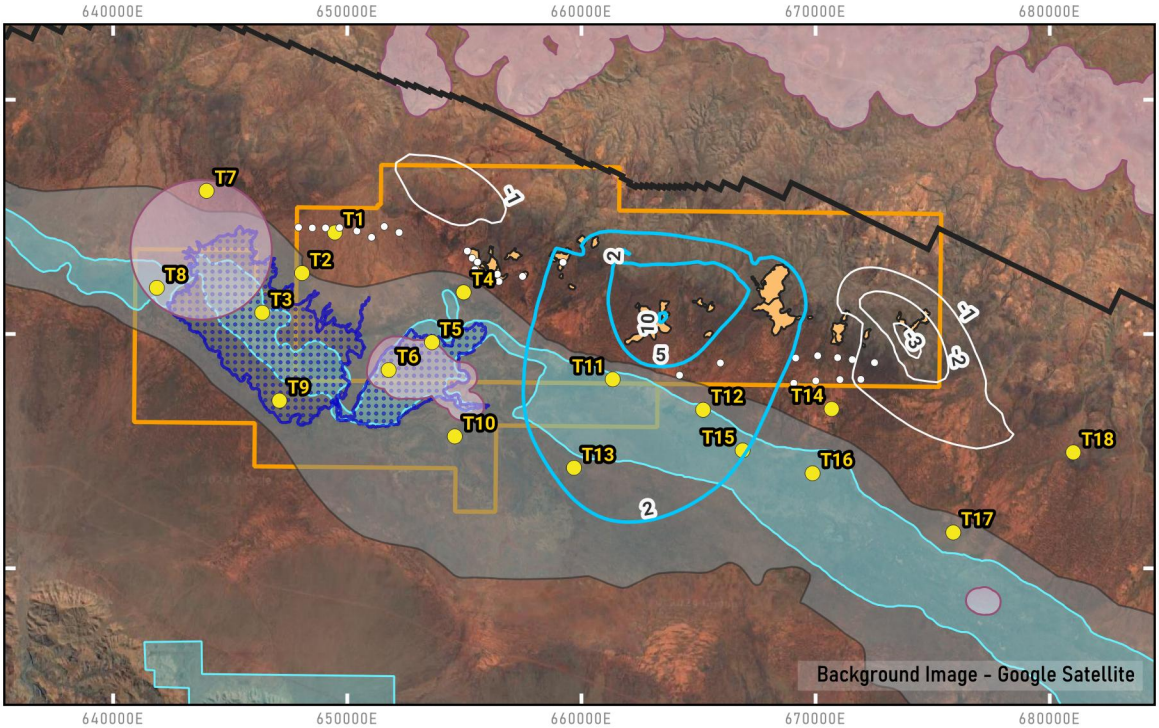
- Proposed Pit Footprint (MDE_LOM_20)
- Environmentally Sensitive Areas (DWER-046)
- Priority Ecological Community (PEC) Boundary
- Potential Claypan Inundation Area
- Simulated MAR Bore
- Model Boundary
- Drawdown (m)
- Mounding (m)
- Simulated Observation Points
- Mungurrdu

Figure 7-37: Predicted groundwater drawdown and mounding for July 2041 and July 2042 (AQ2 2024a)

End of Fridge Hill Dewatering & Murray's Hill / Anticline Hill MAR (Jul 2041)



End of Mining (June 2042)



N

0 5 10 km

GDA94 / MGA zone 50

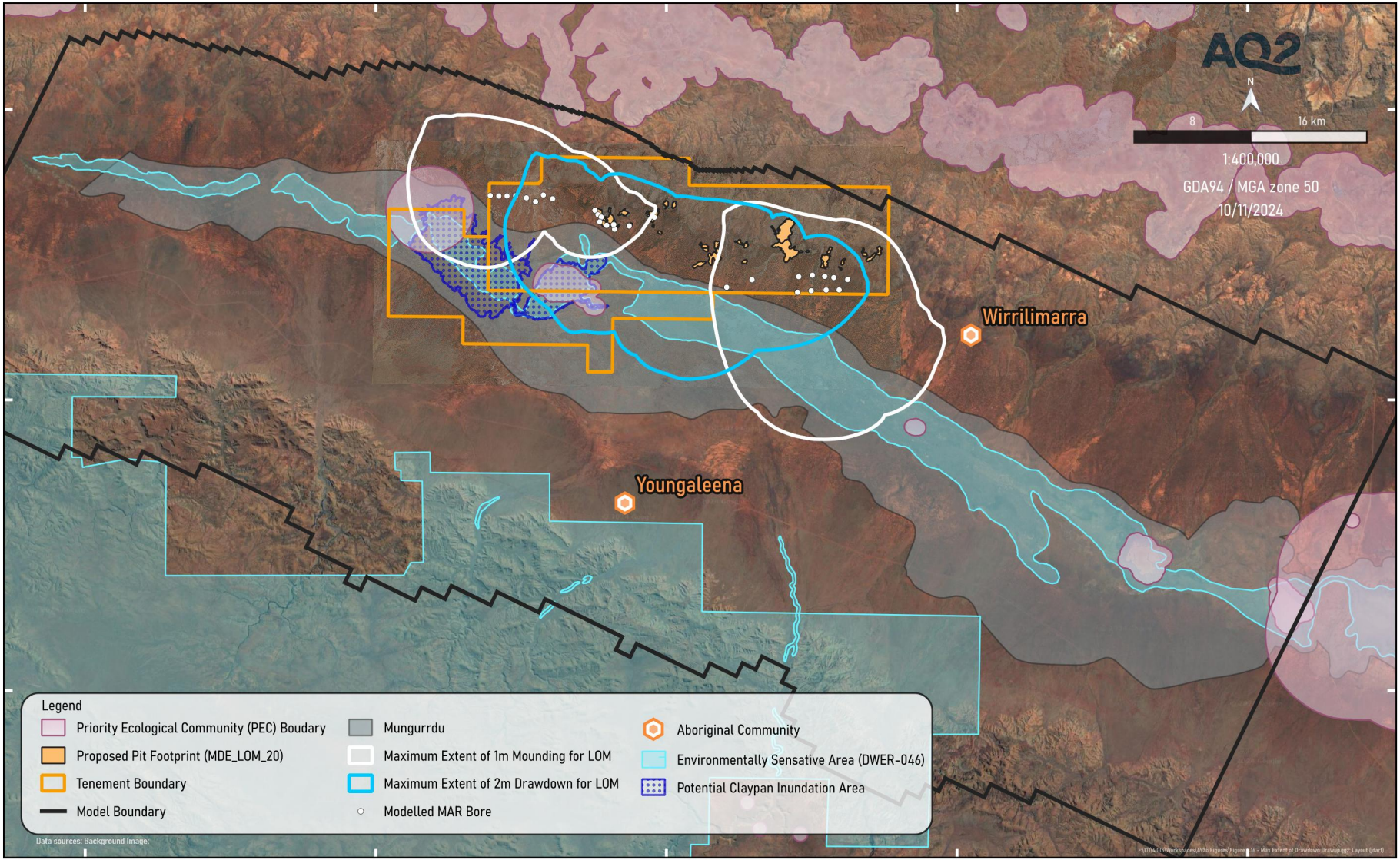
10/11/2024

F:\177\A.GIS\Workspaces\493a_Figures\Figure 5.13 - WL Changes Template.qgz

Legend

- Proposed Pit Footprint (MDE_LOM_20)
- Environmentally Sensitive Areas (DWER-046)
- Priority Ecological Community (PEC) Boundary
- Potential Claypan Inundation Area
- Simulated MAR Bore
- Model Boundary
- Drawdown (m)
- Mounding (m)
- Simulated Observation Points
- Mungurrdu

Figure 7-38: Maximum extent of predicted drawdown and mounding throughout LOM (AQ2 2024a)


620040E
640042E
660043E
680044E
700045E
7560491N
7540489N
7520488N
AQ2
N
8
16 km
1:400,000
GDA94 / MGA zone 50
10/11/2024
Wirrilimarra
Youngaleena
Legend
Priority Ecological Community (PEC) Boudary
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary
Model Boundary
Mungurrdu
Maximum Extent of 1m Mounding for LOM
Maximum Extent of 2m Drawdown for LOM
Modelled MAR Bore
Aboriginal Community
Environmentally Sensative Area (DWER-046)
Potential Claypan Inundation Area
Data sources: Background Image:

Changes to Groundwater Salinity

Groundwater across the Development Envelope and the surrounding area ranges from fresh (180 mg/L TDS) in the upper reaches of the groundwater system, to saline (18,000 mg/L TDS) across the valley area, with salinity profiling data confirming saline groundwater originating from the claypans and extending along the valley as well as beneath the orebodies closest to the claypans (although the mining of these orebodies is not part of the proposed mine plan).

The numerical model was used to simulate changes in groundwater salinity resulting from dewatering and MAR. The predicted TDS of the combined dewatering discharge for all dewatering bores over the LoM varies between 1,700 and 4,200 mg/L. This represents the TDS concentrations that were then assigned to all MAR bores over the LoM. It is assumed that there will be no increase in the salinity of the re-injected water resulting from evapoconcentration as, for the rates being considered, only limited storage (i.e., less than a week) would be feasible based on the required dewatering rates (AQ2 2024a).

7.5.2 Indirect impacts

7.5.2.1 Surface Water

Potential indirect impacts to surface water include changes to physical and chemical water quality through:

- Leaks or spills from mine operations including vehicles, stored fuels, chemicals and hydrocarbons;
- Acid mine drainage (AMD) leachate seepage from the WRD and to a lesser extent the RoM; and
- Saline water runoff (dust suppression), saline pipeline leaks/failure.

Modification of the chemical water quality (for example hydrocarbon pollution, seepage from WRDs) may result in contamination of local waterways and the Fortescue Valley.

Site drainage infrastructure will be designed to minimise or eliminate surface water runoff into areas where hydrocarbon contamination may occur.

Use of saline water for the suppression of dust during construction and operations of the mine can result in increased surface water salinity entering into the receiving environment (creeklines, claypans, pools and floodplain). There is also the potential for pipeline failure resulting in release of saline water into receiving environment, including vegetation.

7.5.2.2 Groundwater

Potential indirect impacts to groundwater include:

- Contamination through:
  - Spills and accidental discharges of stored materials (oils, fuels etc);
  - Leaching contaminants or acid mine drainage from WRDs or RoM and/or onsite landfill.
- Impacts on other groundwater users through reduction in quantity or quality of groundwater available.

Contamination of groundwater

During construction and operation, the Proposal has the potential to contaminate groundwater due to storage and handling of hazardous materials and hydrocarbons and WRDs may result in leaching on acidity or soluble metals or salts into groundwater.

Other Groundwater Users

Existing groundwater users in the vicinity of the Proposal include the Mulga Downs Station, Hooley Station and Mt Florance Station (for stock water). The key groundwater quality criterion for maintaining the current beneficial use is based on the drinking water requirements for livestock (beef cattle).

More regionally, other groundwater users in the vicinity of the Proposal include the Wirrilimarra and Youngaleena Aboriginal Communities.

From ecohydrological studies conducted to date in the vicinity of the claypans, the vegetation in that area is not considered to be groundwater dependent (AQ2 2025).

In addition, water is a key aspect to be considered in terms of traditional cultural heritage and assessment of impacts on social surroundings in **Section 14.**

7.5.2.3 Other Environmental Values

Impacts on inland waters from changes in hydrological and hydrological regimes and water quality can have indirect impacts on other environmental values including:

- Surface water dependent vegetation (i.e., sheetflow), riparian vegetation, and associated fauna habitat (**Section 9** and **10**), and
- Subterranean fauna: troglofauna and stygofauna (discussed in **Section 8**).

7.5.3 Cumulative Impacts

The Proposal and other projects in the region may have a cumulative impact on inland waters at a regional scale through:

- Changes in surface hydrological regimes.
- Change in groundwater regimes (associated with drawdown from abstraction and mounding from MAR).

Cumulative impacts are discussed in **Section 17**.

7.6 Mitigation

The hierarchy of impact management has been adopted and implemented for the Proposal by HPPL in relation to this environmental factor as outlined in **Table 7-11.**

Table 7-11: Mitigation Measures for Inland waters

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
Direct Impacts			
Modifications to the existing hydrological regime	Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal.	• The Water Management Plan will be implemented (**Appendix 6**) • Surface water management during construction, mining and closure will be designed to minimise adverse impacts on the natural function and environmental value of watercourses, water quality and sheet flow downstream of the mine area. • Adherence to permit requirements under the RiWI Act.	• Implement the monitoring as outlined in the Water Management Plan (**Appendix 6**) • Implement the approved Mine Closure Plan. Temporary infrastructure will be removed and natural flow paths, and catchments, reestablished in these areas.
Modification of surface water quality	Divert surface water flows away from mining areas to avoid the potential for contamination. Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal	• The Water Management Plan will be implemented (**Appendix 6**)	• Implement the monitoring as outlined in the Water Management Plan (**Appendix 6**) • Implement the approved Mine Closure Plan.
Changes to groundwater levels	Mining will be scheduled so that operational water demand can be supplied from mine dewatering; avoiding the need for a non-potable water supply borefield	• Implement the Water Management Plan (**Appendix 6**) • Pit optimisation and mine planning to reduce dewatering and MAR required. • Maximise use of abstracted water for mine processes prior to MAR. • Adherence to permit requirements under the RiWI Act.	• Monitoring of groundwater water levels in accordance with the Water Management Plan **(Appendix 6)** • Implement the approved Mine Closure Plan.

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
	Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal		
Changes in groundwater salinity	Complete avoidance is not possible for this Proposal with minimisation then being the key measure.	• The Water Management Plan will be implemented (**Appendix 6**)	• Monitoring of groundwater quality in accordance with the Water Management Plan **(Appendix 6)**
Indirect Impacts			
Contamination of surface water	Avoidance is not possible for this Proposal with minimisation then being the key measure.	• Storage of contaminating materials in Australian Standard (AS) compliant locations with bunding, spill controls and leak prevention. • Spills and leaks will be cleaned up in accordance with HPPL procedures. • The Water Management Plan will be implemented (**Appendix 6**) • If encountered during mining, encapsulate PAF materials within the larger WRL structures. • Construct WRD with appropriate seepage and leachate control structures. • Separate contaminated water runoff (from mine areas).	• Monitoring of surface water quality in accordance with the WMP. • Waste dumps and TSFs at closure will be rehabilitated to ensure they are stable, revegetated and non-polluting, in accordance with relevant approvals obtained under the EP Act Part V, Part IV, Mining Act and EPBC Act. • Remove infrastructure on closure.
Contamination of groundwater	Avoidance of mining the JER and NAM geological units which	• Implement management actions in accordance with the Water Management Plan **(Appendix 6)**.	• Monitoring of groundwater quality in accordance with the Water Management Plan.

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
	contain higher sulphur levels.	• Storage of contaminating materials in Australian Standard (AS) compliant locations with bunding, spill controls and leak prevention. • Spills and leaks will be cleaned up in accordance with HPPL procedures. • If encountered during mining, encapsulate PAF materials within the larger WRL structures. • Construct WRD with appropriate seepage and leachate control structures. • Storage, handling, and disposal of hazardous substances in accordance with internal procedures.	• Waste dumps and TSFs at closure will be rehabilitated to ensure they are stable and revegetated and non-polluting, in accordance with relevant approvals obtained under the EP Act Part V, Part IV, Mining Act and EPBC Act.'
Impacts on other groundwater users	Minimisation is considered to be the key measure to minimise impacts to other groundwater users.	• Implement management actions in accordance with the Water Management Plan **(Appendix 6)** • Ongoing consultation with other groundwater users.	Monitoring of groundwater levels and groundwater quality in accordance with the Water Management Plan **(Appendix 6)**

7.7 Assessment and Significance of Residual Impacts

An assessment of the significance of residual impacts to Inland Waters as a result of the Proposal is addressed in this section. The assessment of potential impacts from mining operations, dewatering and MAR on other factors is also addressed under the relevant factor, e.g. impacts on riparian vegetation in flora and vegetation (**Section 9**), impacts to social surroundings (**Section 14**) and impacts on subterranean fauna habitat (**Section 8**).

7.7.1 Direct Impacts

7.7.1.1 Surface Water

Modification of Existing Hydrological Regimes

The residual risks of the Proposal to the hydrological environment were assessed taking into account the proposed mitigation measures and the results of the flood modelling and claypan water balance modelling. The residual risks were generally considered to be low.:

A Water Management Plan (**Appendix 6**) has been prepared and provides additional information on the surface water management measures proposed, including proposed management infrastructure. The proposed management infrastructure and resulting surface water flow are shown in **Figure 7-34**.

The potential footprints of the Surface Water Containment Areas (covering the pits, waste rock dumps, ore handling plants, borrow pits, and stockpiles) extend across approximately 20 km^2 within the claypan catchments. To prevent the impact of potentially sediment laden runoff from these areas impacting the downstream environment, any rainfall across these footprints will be initially contained and be prevented from contributing flows to the downstream environment. These footprints represent approximately 10% of the assumed total catchment area estimated for the Gnalka Gnoona claypan and 2% of the combined Gnalka Gnoona and Koodjeepindarranna claypan catchment area (1,033 km^2 total catchment area (AQ2 2024a)). Water balance model predictions of the claypan water levels indicate that the potential reduction in claypan catchment areas result in only a negligible reduction on the hydroperiod (in the order of days) and water levels of the claypans (between nil to 0.022 m) (AQ2 2024a).

Although the surface water diversions aim to return the water back to the downstream surface water drainage line, the diversions do change the distribution of surface water flows in the Fortescue Valley, particularly in the area immediately to the south of Fridge pits, Murray's Hill and Horseshoe West pits. Difference mapping of Baseline and LoM maximum water depth model predictions are shown in AQ2 2024; Appendix D) for the design rainfall events. In terms of potential impact to vegetation communities, the changes to the more frequent event flood depths (such as the 63% and 50% AEP events) are more important than the changes to the 1% AEP event given the distribution of vegetation is correlated to the inundation patterns in smaller, more regular runoff events.

The 50% AEP flood difference map indicates that a reduction in maximum flood depths of up to 0.2 m is predicted to occur in the valley ponding areas which are located south of the Fridge pits, which is related to the diversion of a large catchment to the west of Fridge Hill Pit. The most extensive area of water level reduction is located to the south of Fridge West. Some larger reduction in flood depths is predicted in localised areas within the model which represent drainage lines that have had flow diverted around them due to the proposed mine

development. Conversely, the diversion of runoff around the disturbance footprints is predicted to cause an increase in water depths along the diversions and in the Fortescue Valley immediately downstream of the diversion. Water depth increases of up to 0.3 m are predicted in some areas of valley floor ponding. The most extensive area of increased ponding within the Fortescue Valley is caused by the diversion between Fridge Hill and Horseshoe West areas.

Water shadowing downstream of linear infrastructure (e.g. roads) is minimal due to the preliminary locations selected for the proposed culverts as captured in the model, which allow flows to continue downstream of the infrastructure. The modelling predicts only localised impacts on surface water inundation depths upstream and downstream of roads, with the largest impact at locations where culverts haven't been considered to date (AQ2 2024a). The predicted impacts to key environmental assets as identified in AQ2 as a result of changes to hydrological regimes is as follows:

- The claypan water balance quantified impacts to the claypans during a small, medium and a large inundation event. The impacts are considered negligible and are summarised as follows:
  - Reductions in claypan water level were predicted to range between nil to 0.022 m. Note that the water levels in the Koodjeepindarranna Claypan were only impacted if the water level in the Gnalka Gnoona Claypan exceeded the height of the divide between the two claypans (402.9 mRL)
  - Inundation duration was predicted to decrease in the order of days for large and medium events, with negligible change in inundation duration predicted for the small events.
  - Only a marginal change in TDS between the model scenarios.
  - The Ebathcalby claypan, as it is located about 9 km south of the eastern margin of R47/12. It is unlikely to be impacted by runoff from the Proposal, as its elevation is approximately 5 m higher than the base of the Fortescue Valley below the Development Envelope (AQ2 2024a).
- Millstream National Park is located more than 100 km west of the Development Envelope and will not be impacted.
- As shown in Figure 2.14, surface water flows from Karijini National Park are towards the Fortescue River so there is no mechanism or pathway for modified surface waters as a result of the Proposal to impact the National Park.

Modification of the Physical Water Quality

Surface water runoff in the region naturally has a high sediment load given the high velocity of runoff from intense storms or cyclonic activity. Disturbed material resulting from construction and/or mining activities and areas where vegetation cover has been removed may increase the volume of sediment available to be mobilised during these events. Where practicable, natural runoff will be diverted around operating areas, thereby limiting the volume of water required to be treated before being released to the natural environment. Where diversion of larger drainage channels is required, the design will aim to incorporate geomorphic design principles such that the natural sediment transport through the channel is maintained and the structure itself does not become a sediment source. Surface water management measures will be undertaken to capture and minimise sediment runoff to undisturbed areas and drainage lines where practicable, such as using bunding and other drainage features such as silt traps and sediment basins.

The residual risks to the physical quality of surface water have been rated Low AQ2 2024). The Water Management Plan (**Appendix 6**) outlines the management measures to manage sediment transport, with the key management measurements summarised in the preceding section of this report.

The surface water mitigation measures as outlined in the Water Management Plan (**Appendix 6**) are anticipated to reduce all of the surface water risks identified for the Proposal to Low (AQ2 2024a).

7.7.1.2 Groundwater

Change in Groundwater Levels

Without management practices in place, there is the potential for detrimental environmental impacts resulting from changes to groundwater levels and / or quality because of the mining activities (in particular dewatering and MAR). The overarching groundwater management strategy is therefore to:

- Minimise impact to the current beneficial use of the groundwater.
- Minimise the impact on other groundwater users and groundwater dependent ecosystems (i.e. subterranean fauna); this includes minimising the extent of groundwater level changes.
- Maintain groundwater levels such that there is no surface expression of groundwater or water logging of vegetation.

From the numerical modelling conducted to date, the groundwater drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along strike (i.e., in a northwest – southeast direction) is curtailed by MAR. Due to the progressive approach to the mining , the maximum extent of the 2 m drawdown occurs in different directions at different times. The maximum extent of the predicted 2 m drawdown contour, from the mining areas, extends ~6 km to the west, ~3.5 km to the east and ~8 km to the south across the majority of the valley's width; however, it is not predicted to reach the Hamersley Range or Karijini National Park.

The maximum extent of the predicted 1 m mounding contour associated with the Fridge / Horseshoe South MAR Borefield extends ~10 km to the south (across the valley) and ~5 km beyond the Mulga East tenement boundary, in a southeasterly direction. The maximum extent of the 1 m mounding contour associated with the Murray's West MAR Borefield is predicted to extend ~7 km to the northwest (along strike) and ~5 to 5.5 km to the south and southwest (across the valley), in the vicinity of the Koodjeepindarranna Claypan.

As ecohydrological studies to date have found that the vegetation is disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. A lowered water table would increase the thickness of unsaturated sediments, which may slightly reduce the responsiveness of the aquifer to recharge events. However, these sediments are not considered to be accessible to plant root systems.

Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl. If water levels rise above this threshold for prolonged periods, vegetation stress is predicted. Although the predicted depth to groundwater remains below 2.5 mbgl (i.e., below this threshold) in the immediate MAR areas throughout the LOM, areas to the south of both the Murray's Hill / Anticline Hill and Fridge / Horseshoe South MAR areas, at

the break of slope, have been identified as areas at risk of exposure to shallow groundwater levels for periods of time. Impacts to flora and vegetation are further discussed in **Section 9**. Upon the reduction / cessation of dewatering and MAR, groundwater level recovery will occur. Modelling indicates that he majority of groundwater level recovery occurs during the LoM, as the maximum depths of mining are reached prior to the end of mining. In particular, the western areas of Murray's Hill and Anticline Hill, which are mined (and dewatered) first and subsequently used for MAR have predicted water levels near to pre-mining water levels at the end of the LoM (i.e., at mine closure). The modelling indicates a rapid recovery of groundwater levels post-mining. Groundwater levels are predicted to recover to within 0.1 m of pre-mining level within 10 years after the cessation of mining, at all mining areas, MAR areas and regional simulated observation points (AQ2 2024a).

The groundwater modelling and assessment was subject to peer review in 2023. The review concluded that the modelling and assessment has been conducted competently and justifiably consistent with best practice methods (HydroGeoLogic 2023**; Appendix 7b**).

Groundwater drawdown and mounding will affect subterranean fauna and this is discussed further in **Section 7.**

Ongoing monitoring of groundwater levels will be undertaken as outlined in the Water Management Plan (**Appendix 6**).

Changes to Groundwater Quality

Groundwater salinity across the Development Envelope and surrounds ranges from fresh (180 mg/L as TDS) to saline (18,000 mg/L as TDS). Higher groundwater salinity is associated with groundwater beneath the claypans in the Fortescue Valley, while lower groundwater salinity is associated with the fractured rock aquifers on the Chichester Range, around the proposed mine pit areas. Groundwater salinity contours are also illustrated in the hydrogeological cross sections (**Figure 7-13** to **Figure 7-16**).

Groundwater salinity will change as a result of dewatering and MAR activities. The predicted TDS of the combined dewatering discharge for all dewatering bores over the LoM is varies between 1,700 and 4,200 mg/L. This represents the TDS concentrations that were then assigned to all simulated MAR bores over the LoM. It is assumed that there will be no increase in the salinity of the re-injected water resulting from evapoconcentration, as for the rates being considered, only limited storage (i.e., less than a week) would be feasible based on the required dewatering rates.

The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be fairly localised (i.e., <2 km in extent). This is demonstrated by both the simulated groundwater flow paths for the LoM and predicted salinity changes at the simulated observation points. Model predictions indicate that the key driver for groundwater salinity change is the proposed dewatering at Murray's Hill. This is predicted to result in increases to the dewatering discharge salinity as more saline water is drawn in from the valley areas. The subsequent re-injection of this more saline dewatering discharge into the Murray's West and Fridge / Horseshoe South MAR Borefields results in localised areas of increased groundwater salinity as well as subsequent increases to the combined dewatering discharge, as the re-injected water in the east is recirculated towards the Fridge West and Fridge Hill mining areas later in the LoM.

Taking into account the uncertainty associated with aquifer porosity, the greatest changes in salinity outside of the mining areas are predicted in three areas:

- In the Murray's West MAR Borefield area, the TDS is predicted to increase from ~1,200 mg/L to between ~3,600 and 4,700 mg/L (for high and low porosity scenarios), recovering to between ~2,700 and 3,500 mg/L, upon the cessation of MAR in this area and the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area.
- Down-slope from the Murray's Hill mining / MAR area, the TDS is predicted to increase from ~3,600 mg/L to between 4,400 and 5,600 mg/L (for high and low porosity scenarios), potentially exceeding the tolerance limit for cattle (i.e., 5000 mg/L). However, when the Murray's Hill / Anticline area is used for MAR, the TDS is predicted to reduce, reaching between ~3,300 and 4,300 mg/L by the end of mining.
- Down-slope from the Fridge / Horseshoe South MAR Borefield, the TDS is predicted to increase from ~2,300 mg/L to between 2,400 and 3,900 mg/L (for high and low porosity scenarios), with TDS at the end of mining predicted to range between 2,300 and 3,700 mg/L.Predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LoM.

The excavation and exposure of PAF materials in the pit walls is not anticipated and groundwater contamination from other potential sources such as waste rock dumps or spills is anticipated to be low risk, being managed by on-going monitoring and adaptive management. Furthermore, the risk of re-injection water becoming acidic or contaminated is low as this water will be sourced predominantly from ex-pit dewatering bores on the southern, down-dip side of the pits, rather than in-pit sump pumping.

HPPL will back fill the pit voids to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided which eliminates any post-mining increases in groundwater salinity caused by evaporation from the pit lake surfaces. No modelling of post-mining groundwater quality has been conducted to date; however, it is anticipated that the return of the groundwater salinity distribution to pre-mining conditions will take considerably longer (i.e., geological times scales) to achieve than the recovery of groundwater levels (AQ2 2024a).

Surveys and assessments undertaken to identify the subterranean fauna values across the Proposal (Bennelongia, 2024) indicate stygofauna are present in areas of both fresh and saline groundwater (up to ~18,000 µS/cm EC). **Section 8** provides further information on the predicted salinity ranges and tolerances of subterranean fauna taxa found within the Development Envelope.

7.7.2 Indirect Impacts

7.7.2.1 Surface Water

Contamination of surface water

During construction and operation, the Proposal has the potential to contaminate surface water due to storage and handling of hazardous materials, hydrocarbons, and waste. Site drainage infrastructure will be designed to minimise or eliminate surface water runoff into areas where hydrocarbon contamination may occur. Hydrocarbon storage facilities will be appropriately constructed and bunded in accordance with Australian Standards. Facility inspection, maintenance and spill management procedures are expected to effectively mitigate the risk of contamination from these sources.

To mitigate the risk of AMD impacts to soil, surface water and groundwater, HPPL has purposely designed the mining pits to exclude basal Nammuldi Member subunits and Roy Hill Shale. Waste material characterisation

conducted to date shows elevated sulfur material at depth within these units, posing the highest AMD generation risk. Excluding these material types notably lowers the risk of AMD from waste rock dumps, in-pit backfill, exposed mine pit walls, ore on RoM pads and low-grade ore stockpiles.

The majority of waste material 95% is classified as non acid forming (NAF) with less than 1% being classified as potentially acid forming (PAF) by a very conservative measure. Any probability that significantly acid generating material will occur in waste material stored in landforms or backfilled below water table has been almost completely avoided. Waste management of any PAF encountered during mining will consider the placement of the material into discrete cells that can be isolated within waste rock to limit acid generation. These facilities will be constructed such that they are stable, non-polluting landforms and the risk of impacts to the environment is low. This is an established approach to effectively manage PAF and prevent acid mine drainage. Leachate pH is a primary control on contaminant solubility. Under the neutral pH conditions expected for most of the waste rock, leaching is expected be limited and the risk of metalliferous drainage is low.

Pipelines transferring saline water will be routinely inspected for operability and maintenance. Saline pipelines will also be bunded or equipped with telemetry or pressure sensors to identify leaks or pipeline failures to allow for immediate response. Indirect impacts can be managed by application of the Water Management Plan (**Appendix 6**) and through conditions of the Mining Proposal under the *Mining Act 1978*.

7.7.2.2 Groundwater

Contamination of groundwater

Groundwater contamination from potential sources such as the WRD landforms or spills will be considered and managed. HPPL has purposely designed the mining pits to exclude basal Nammuldi Member subunits and Roy Hill Shale. Waste material characterisation conducted to date shows elevated sulfur material at depth within these units, posing the highest AMD generation risk. Excluding these material types notably lowers the risk of AMD from waste rock dumps, in-pit backfill, exposed mine pit walls, ore on RoM pads and low-grade ore stockpiles.

Waste rock generated by the Proposal will be stored in waste dumps and used to backfill pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process. From the studies undertaken, PAF classed material was found to be a very low proportion - approximately 1% of the waste material to be managed. If PAF is encountered during mining, waste management will consider the placement of PAF material into discrete PAF cells that can be isolated within waste rock to limit acid generation. This will allow for the control of acid mobilisation and solute release from these materials into groundwater (SRK 2024).

Mitigation of potential groundwater related impacts are proposed through the Water Management Plan (**Appendix 6**), which includes trigger and threshold levels.

Upstream and downstream groundwater quality triggers and thresholds have been proposed to assess impacts to groundwater attributed to the proposed WRD landforms. These facilities will be constructed such that they are stable, non-polluting landforms in accordance with relevant approvals obtained under the EP Act, Mining Act and EPBC Act.

Hydrocarbon storage facilities will be appropriately constructed and bunded in accordance with Australian Standards. Facility inspection, maintenance and spill management procedures are expected to effectively mitigate any associated risk of contamination.

Impacts on other groundwater users

Other groundwater users in the vicinity of the Proposal include pastoral stations as well as the Wirrilimarra and Youngaleena Communities.

The potable water supply bores for the Wirrilimarra and Youngaleena Communities are located outside of the predicted maximum extent of the 1 m draw-up and 2 m drawdown contours and the predicted injection zones. It is therefore not anticipated that either the quantity or quality of the Community water supplies will be affected by the proposed dewatering and MAR activities (AQ2 2024a). However, should the water supplies be unduly impacted, an alternative supply will be provided.

Throughout the planning of the Proposal HPPL have been actively engaged in stakeholder consultation. As part of engagement the draft Water Management Plan has been provided to the Native Title holders as part of the referral package for review. The Water Management Plan has been developed to management any potential impacts and ensure no significant impacts to sites of cultural significance (**Appendix 6**).

The potential for indirect impacts to groundwater in use by the pastoral stations of Mt Florance, Hooley and Mulga Downs for stock drinking water has been considered. The groundwater within the predicted area of impact is only used for stock water and the key groundwater quality criterion for maintaining the current beneficial use is based on the drinking water requirements for livestock (cattle). Drinking water guidelines for beef cattle indicate a tolerance limit of 5,000 mg/L TDS (ANZECC, 2000), therefore where shallow groundwater is currently within this limit, the intent is to minimise the impact on this zone. The groundwater quality in the vicinity of the pastoral bores will be monitored and basic groundwater will be measured against the ANZEEC & ARMCANZ (2000) Livestock Drinking Water Guidelines (**Appendix 6**). Should the livestock water supplies be unduly impacted by changes to groundwater quality and / or groundwater levels, an alternative supply will be provided.

A detailed discussion of the proposed management measures is provided in the Water Management Plan (**Appendix 6**), with key management measures summarised below:

- Surplus water managed via MAR (i.e. via re-injection bores, repurposed dewatering bores and / or in-pit infiltration) to:
  - Limit the extent of drawdown from the immediate mining area (accepting recirculation of groundwater).
  - Limit the potential for the saline interface to rise as a result of hydrostatic changes in the broader cone of depression.
- Comprehensive baseline and operational monitoring of groundwater levels and groundwater quality to monitor impacts relating to dewatering and MAR; inclusive of on-going monitoring outside of the area of impact to provide further baseline data, thereby allowing differentiation between seasonal and mining-related changes.

- Operation of multiple MAR areas to allow flexibility of injection and periods of recovery (i.e., reduced injection in one area and increased in another) if required due to groundwater level or groundwater quality triggers being observed.
- Review of dewatering if groundwater level or groundwater quality triggers are observed and cannot be managed by modifying the distribution of MAR.
- Backfilling of the pits at closure to allow groundwater levels to return to near pre-development conditions and eliminate further changes to groundwater salinity resulting from evaporation from pit lakes.

In addition to the above management measures, monitoring data will be regularly compared to model predictions and, as necessary, the numerical model can be re-calibrated to recorded responses and used to re-assess integrated groundwater management and mining scenarios.

7.8 Significant Residual Impact

The residual impacts of the Proposal to Inland Waters are not considered significant. HPPL therefore considers the Proposal can be managed to meet the EPA's objective to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

7.9 Environmental Outcomes

Based on the studies and investigations undertaken to date, the potential direct, indirect and cumulative impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objective (**Section 7.1**) and guidance (**Section 7.2**) for inland waters as outlined in **Table 7-12.**

Table 7-12: Environmental Outcomes for Inland Waters

Potential impact	Environmental Outcome
Direct impacts	
Modifications to hydrological processes	• Water depth increases of up to 0.3 m are predicted in some areas of valley floor ponding. Water depth reductions of up to 0.2 m are predicted in some areas of valley floor ponding. • No significant impacts to key environmental assets (including the claypans) are predicted. • No impacts to terrestrial groundwater dependent ecosystems. • Groundwater drawdown and catchment area modifications are not predicted to materially impact on the key ecohydrological receptors. • The potential indirect impacts on claypans within the vicinity of the Development Envelope are not considered significant.
Changes to surface water quality	• The residual risks to the physical quality of surface water have been rated Low. • Potential changes to surface water quality will be managed in accordance with the Water Management Plan.
Change to groundwater levels	• Potential changes to groundwater levels will be managed to ensure that mounding is maintained beneath root zones of vegetation. • Managed in accordance with the Water Management Plan.
Changes to groundwater salinity	• Changes (and extent of changes) to groundwater salinity resulting from dewatering and MAR are predicted to be minor with respect to beneficial use.
Indirect impacts	
Contamination of surface water	• Potential contamination of surface water will be managed in accordance with the MCP and Water Management Plan.
Contamination of groundwater	• Potential contamination of groundwater will be managed in accordance with the Mine Closure Plan and Water Management Plan.

8 Subterranean Fauna

8.1 EPA Objective

The EPA's objective for the environmental factor Subterranean Fauna is:

> "To protect subterranean fauna so that biological diversity and ecological integrity are maintained" (EPA 2016a).

Subterranean fauna are fauna which live in underground environments. This includes fauna which inhabit the terrestrial realm (hypogean) and are referred to as troglofauna, and fauna which inhabit the groundwater and are referred to as stygofauna. The subterranean communities are composite and encompass species which are at different stages adapted to underground environments. They can be classified as stygoxene or trogloxenes (temporary inhabitants), stygophile or troglophile (strong hypogean affinities) or stygobites and troglobite (obligatory hypogean) (Gibert and Deharveng 2002).

For the purposes of EIA, subterranean fauna is defined as fauna that live their entire lives (obligate) below the surface of the earth (EPA 2016; 2021a).

8.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to the key environmental factor Subterranean Fauna which have informed the planning for the Proposal are listed in **Table 8-1**.

HPPL has specifically considered these guidance documents in the following ways:

- Surveys and analyses undertaken to describe the receiving environment and its significance;
- Identification of activities which may lead to impacts to Subterranean Fauna; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 8-1: Subterranean Fauna Policy and Guidance

Reference	Title	How Policy and Guidance have been considered
EPA 2016a	Environmental Factor Guideline: Subterranean Fauna	Documents were applied when planning and undertaking the subterranean fauna surveys for this Proposal. This document also provided guidance on the identification of activities which may lead to impacts to subterranean fauna.
EPA 2021g	Technical Guidance – Subterranean Fauna Surveys for Environmental Impact Assessment	
EPA 2012	A review of subterranean fauna assessment in Western Australia. Discussion Paper.	This document provides guidance on the current state of knowledge on subterranean fauna for the purpose of EIA. It presents different approaches and direction for future assessment.
Government of Western Australia (GoWA) 2011	WA Environmental Offsets Policy	The offset policy and guidelines have been considered in relation to the definition of significant residual impacts and the proposed offset strategy.
GoWA 2014	WA Environmental Offsets Guidelines	

Specific additional work required for assessment of the Proposal, relating to Subterranean Fauna, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this section.

8.3 Receiving environment

The following sections describe the key features of the receiving environment in relation to Subterranean Fauna, including details of the surveys and studies undertaken to support the Proposal.

8.3.1 Relevant Studies

A summary of the subterranean fauna studies undertaken for the Proposal and surrounding area is provided in (**Table 8-2**). The assessment of potential impacts on subterranean fauna resulting from implementation of the Proposal draws on the information from these studies.

Table 8-2: Subterranean fauna studies undertaken to inform the Proposal

Reference	Title	Survey/Study Type and Area	Guidance
Strategen-JBS&G 2021	Subterranean Fauna – Preliminary Impact Assessment.	Preliminary Impact Assessment to demonstrate the limited impact of the MEIOP on subterranean fauna. Unpublished report to Roy Hill Iron Ore Pty Ltd, 25th June 2021	Environmental Factor Guideline: Subterranean fauna (EPA 2016c) Technical Guidance – Sampling methods for subterranean fauna (EPA 2007)
Bennelongia (BEC) 2019 **Appendix 8a**	Mulga East Subterranean Fauna Desktop	Desktop study on the subterranean fauna data for the Mulga East Iron Ore Project. Incorporates the findings of previous surveys: ecologia 2011. Murray Hill Troglofauna Survey Phoenix 2013. Subterranean fauna survey of the Mulga Downs Project Bennelongia 2014. Mulga Downs Project Troglofauna Assessment – Letter	Technical Guidance – Sampling methods for subterranean fauna (EPA 2007) Technical Guidance – Subterranean Fauna Surveys (EPA 2013)
Bennelongia (BEC) 2021 **Appendix 8b**	Mulga East Subterranean Fauna Baseline Survey	Report detailing the results of the baseline survey completed in 2019 and 2020.	Environmental Factor Guideline: Subterranean fauna (EPA 2016c) Technical Guidance – Sampling methods for subterranean fauna (EPA 2007) Technical Guidance – Subterranean Fauna Surveys (EPA 2013)
AQ2 2024b **Appendix 9**	Mulga Downs Iron Ore Mine: Troglofauna habitat assessment. Memo 171Y_505b.	Troglofauna Habitat assessment and model development using 3D Leapfrog modelling software. This study incorporates an initial assessment of potential troglofauna habitat compiled from drill hole logs (Strategen-JBS&G 2021).	Technical Guidance –Subterranean fauna surveys for environmental impact assessment (EPA 2021)

Reference	Title	Survey/Study Type and Area	Guidance
	Mulga Downs Iron Ore Mine: Stygofauna habitat assessment. Memo 171Y_508c	Stygofauna Habitat assessment and model development using 3D Leapfrog modelling software. This study incorporates stygofauna sampling data competed for the mine.	
Bennelongia (BEC) 2024b **Appendix 22**	Memo 675: Salinity tolerance of stygofauna at Mulga Downs Iron Ore Mine	Information on the likely upper salinity tolerances of a selection of restricted stygofauna which occur in MDIOM.	Environmental Factor Guideline: Subterranean fauna (EPA 2016c) Technical Guidance –Subterranean fauna surveys for environmental impact assessment (EPA 2021)
Bennelongia (BEC) 2024a **Appendix 26**	Mulga Downs Iron Ore Mine: Subterranean Fauna Survey 2019-2024	Detailed (2019-2022) and targeted (2023-2024) survey. Report compiles and assesses all the data to date. Molecular analyses undertaken on up to 188 specimens.	
		Targeted subterranean fauna survey November 2023 to January 2024. Intense 3 months survey targeting restricted taxa and increased sampling of regional areas (reference sites).	

In addition to the subterranean fauna surveys, the following items were identified in the ESD:

- Item 3 - detailed habitat characterisation and ecological requirements of relevant subterranean fauna.
- Item 4 – the preparation of an objective based monitoring and management plan to mitigate the impacts to subterranean fauna during the operational activities of the mine.

To address the ESD item 3, subterranean fauna habitat assessments were completed for both troglofauna and stygofauna using Leapfrog 3D modelling software (AQ2 2024b) (**Appendix 9**).

The objectives of the assessments were to:

- Identify the extent and continuity of geological units potentially habitable to troglofauna and assess the volume of habitat which may be impacted as a result of implementation of the Proposal; and
- Identify the extent and continuity of geological units potentially habitable to stygofauna and assess the volume of habitat which may be impacted by groundwater level drawdown from mine dewatering.

This assessment defined the likely troglofauna and stygofauna habitat stratigraphy and the amount of potential habitat lost from implementation of the Proposal. The assessment also defined the extent and continuity of the habitats which have been identified as potential subterranean fauna habitat within the area modelled. The likelihood of this habitat extending beyond the area of impact is addressed in Section 8.6 of this document.

This approach aligns with other Proposals which have been assessed under the EP Act and follows the steps outlined by the EPA in the *Technical Guidance – Subterranean Fauna Surveys for Environmental Impact Assessment* (EPA 2021g).

In addition to the above habitat assessments, the inferred salinity tolerances for stygofauna was assessed in Mulga Downs – memo 675 (BEC 2024b; Appendix 22). The groundwater chemistry has also been investigated

(CBEC, 2024) based on extensive hydrogeological investigations undertaken for the Proposal and detailed in Section 7 (AQ2 2024a; 2025; **Appendix 4** and **Appendix 5**). This information supports item 3 of the ESD and provides further information on the likely ecological requirements of the stygofauna in particular salinity ranges and the groundwater type that forms the baseline data used to establish triggers and thresholds for effective management of impacts to the subterranean fauna from implementation of this Proposal (Item 4).

To address the ESD item 4, a Subterranean Fauna Monitoring and Management Plan (SFMMP) has been prepared (**Appendix 29**) and draws information from the Water Management Plan (**Appendix 6**). Specifically, the Water Management Plan defines preliminary trigger and threshold criteria relating to groundwater. It also outlines the methodology and inputs which will be used to refine these criteria specific to each site upon completion of further works and collection of baseline data from finalised groundwater infrastructure.

The approach for the assessment of this key environmental factor aligns with the process outlined in Figure 1 of the EPA (2021g). Each progressive step was implemented following review of the outcomes of each survey and against the scale and nature of the impacts from the Proposal. The primary aspect driving each survey was the lack of taxonomic resolution of the species, which is a persistent issue with this key environmental factor and many of the taxa collected in Western Australia continue to remain unresolved. As such, the assessment included detailed subterranean fauna surveys, a targeted survey, the use of DNA and the inclusion of habitat connectivity following extensive sampling.

8.3.2 Subterranean Fauna (Data)

The subterranean fauna surveys completed for the Proposal were undertaken in accordance with EPA (2021g) and (EPA 2016a). Surveys implemented prior to 2021 aligned with the relevant earlier versions. The assessment guidance for this factor is provided in **Table 8-1**. The individual survey reports describe how each of the surveys align with relevant guidance. The desktop assessment (BEC 2019), baseline survey (BEC 2021) and detailed and targeted survey report (BEC 2024a) are provided in **Appendix 8a, Appendix 8b**, and **Appendix 26** respectively).

Surveys were designed based on the requirements of the different stages of the assessment and ranged from reconnaissance (basic) to detailed and targeted surveys within and in the vicinity of the Proposal. Targeted surveys were developed based on the likely scale and nature of potential impacts from the Proposal. This aligns with the process for determining the required level of survey as outlined in EPA (2021g). Changes to the extent of the Proposal, based on refinement of the mine design and ongoing mitigation of potential impacts, also steered the targeted surveys which is described in greater detail in **Section 8.3.1**.

8.3.2.1 Survey Area

Unlike the other key environmental factors of Terrestrial Fauna and Flora and Vegetation, the extent of potential impacts to subterranean fauna may extend beyond the Development Envelope. The survey design for subterranean fauna is to take this into consideration (as defined in EPA (2021g)) and adequate sampling is to be undertaken within the area of impacts and beyond. This section defines these areas.

Changes in the groundwater levels and groundwater physio-chemistry as a result of MAR and mine pit dewatering may affect the physiology and persistence of stygofauna and troglofauna and are therefore considered within this impact assessment. These have been considered in the supporting reports when identifying potentially restricted taxa and defining habitats (refer to **Appendix 8**).

Potential impacts to troglofauna are defined as:

- Areas required for the excavation of the mine pits; and
- Extent of predicted mounding associated with MAR (shown as 1 m mounding contours in all figures).

Potential impacts to stygofauna are defined as:

- Areas below the groundwater table which will be excavated (i.e. the pits);
- Extent of groundwater drawdown from abstraction (shown as 2 m drawdown contour in all figures); and
- Areas where reinjection of excess mine dewater via MAR potentially altering groundwater salinity.

The extent of subterranean fauna surveys undertaken for this assessment are presented in **Figure 8-1**.

8.3.2.2 Survey Effort

Surveys have been undertaken for the Proposal since 2009. A detailed survey was undertaken by Bennelongia between 2019-2022 over five phases. Up to 292 samples were collected from previously sampled sites with repeat sampling where required.

Based on the outcomes of the 2019 – 2022 sampling, an additional targeted survey was undertaken from November 2023 to January 2024 targeting areas which had a higher number of restricted taxa for both stygofauna and troglofauna and areas outside of the expected impact areas. The targeted survey included three rounds of intense sampling over three consecutive months (November 2023 through January 2024). The outcome of the detailed and targeted surveys is presented in **Appendix 26**(BEC 2024a).

The survey effort for 2009 to 2014 and 2019 to 2024 are summarised in **Table 8-3** and **Table 8-4** respectively.

Collectively, 1,208 samples were collected from 664 sites between 2009 to 2024. This included 636 troglofauna samples, of which 292 were traps, and 572 samples for stygofauna, 555 of which were phreatic net hauls.

Specific details of survey methods used for each respective survey are provided in **Appendix 8**.

Table 8-3: Survey Effort Subterranean Fauna 2009-2014

Target fauna and method	Method	2009 – 2010 ecologia	2011-2012 Phoenix	2014 Bennelongia	Total
Stygofauna	Net - Phreatic	-	106	37	151
	Karaman-Chappuis	-	8	-	
Troglofauna	Scrape	68	122	119	315 (scrape+traps)
	Single Trap	-	120	77	
	Double Trap	97	-	24	
	Banana Trap	-	4	-	

Table 8-4: Subterranean Fauna Survey Effort -Detailed and Targeted Surveys (2019-2024)

Target fauna	Method	2019	2020	2022			2023		2024	Total
		Aug	Jan	Mar	Jul	Nov	Nov	Dec	Jan	
Stygofauna	Net - Phreatic	40	79	71	71	31	37	53	30	421
	Bou Rouche	-	9	-	-	-	-	-	-	
Troglofauna	Scrape	60	60	25	25	19	136	-	-	321 (scrape+traps)
	Trap1	58	55	25	-	18	136	-	-	
	Trap2	1	-	-		2	8	-	-	

Early subterranean fauna surveys were designed to characterise the subterranean community present within and surrounding the Development Envelope. The detailed surveys from 2019-2022 and the targeted survey from 2023 to 2024 were designed to understand the potential impacts to subterranean fauna that may result from the Proposal, incorporating the outcomes of modelling of predicted groundwater changes from mine dewatering and reinjection of surplus water through MAR (AQ2 2025).

The survey effort for impact and reference sites is skewed towards impact areas primarily as a result of access to, and the availability of, sample boreholes outside of the Development Envelope. Therefore, an assessment of habitat connectivity has also been undertaken to address the potential impacts to any restricted taxa that cannot be resolved at this time.

As with many subterranean fauna surveys for the purpose of environmental impact assessment there was a greater number of sample sites for troglofauna in the area of impact. From 2019-2022, 327 sites were sampled for troglofauna and included scrapes and traps. The targeted survey involved the sampled of 48 holes (traps and scrapes) for troglofauna. **Figure 8-2** shows the extent of the detailed and the targeted surveys with sampling occurring in the proposed pit areas and outside the area of impact.

With respect to stygofauna, 421 samples were collected from 356 sample sites (drill and bore holes, including pastoral) within the expected area of impact and in areas which will not be impacted (**Figure 8-3**). Of these 412 were using a phreatic haul net.

The data collected between 2019 and 2024 is considered the most current. Given the changes in the taxonomy in the past 20 yrs this data will be the focus of the assessment. To align with recommendations in Framenau et al. (2021) this survey data was also considered the most reliable as all required sampling information was consistent. The currency of the data from 2009 to 2014 was considered in the context of this assessment. The earlier surveys lacked sufficient field data and while the information collected is relevant as baseline, many of the specimens were not identified past higher order and cannot be retrieved for validation or comparison, including DNA. Molecular analyses were undertaken on the specimens collected from the pre-2019 surveys. Where successful, this information has been considered in this assessment to determine which taxa are at most risk from implementation of the Proposal. The same sites sampled pre 2019 were resampled from 2019 to 2024. This limitation has been considered in the survey report (BEC 2024a).

Overall, the sampling effort for this Proposal is considered extensive and the sampling effort for the detailed and targeted survey can be described as intensive. The survey effort for the subterranean fauna for this Proposal is considered to be adequate for assessment of impacts from implementation of the Proposal.

8.3.2.3 Habitat Assessment

An assessment of suitable troglofauna habitat was undertaken by AQ2 (2024d) and is discussed further in **Section 8.3.2.1**.

Groundwater salinity profiles (measured in situ) were used to identify the range of salinities within the groundwater profile which are known to support stygofauna habitat. The assessment on the impacts to groundwater and surface water by AQ2 (2025) (**Appendix 5**) addresses the potential changes in groundwater following drawdown and mounding.

This information has been used to develop baseline thresholds and trigger values for inclusion in the Subterranean Fauna Management and Monitoring Plan (SFMMP) (**Appendix 29**).

The information collected from the groundwater profiles will be applied to developing baseline triggers and threshold values for inclusion in the Subterranean Fauna Management and Monitoring Plan (SFMMP) (**Appendix 29**).

8.3.2.4 Habitat Connectivity

Where adequate sampling has been completed, and the data shows records where taxa still appear to be restricted to impact areas, the EPA considers the interpretation of habitat connectivity as appropriate in assessing whether a Proposal will meet the EPA's objective for Subterranean Fauna (EPA 2012; EPA 2021g). This is a method which is now considered standard for the purpose of environmental impact assessments on subterranean fauna. Both physical and biological connectivity were investigated for this assessment to determine if the taxa recorded within the Proposal impact zones were truly restricted (that is displaying true short-range endemism, or whether they are classed as restricted because of poor taxonomic resolution. The latter is characteristic for subterranean fauna in Western Australia and has been investigated in numerous studies (refer to Framenau et al.2021).

Habitat connectivity for subterranean fauna within the Development Envelope was considered based on physical, biological, ecological, and where possible, genetic data collected to support the Proposal.

8.3.2.5 Ecological criteria

There are a number of physicochemical factors which influence biotic distributions in groundwater. However, it is generally accepted that salinity is one of the more important measures to assess distribution (i.e. presence) (Strayer 1994; Williams 2000). Basic groundwater measurements were collected in situ during each of the subterranean fauna field surveys. The limitations with this approach are stated below in **Section 8.3.7** - constraints and limitations.

Salinity was chosen as an ecological criterion for the stygofauna. Modelling has predicted changes to the salinity profile within the aquifer as a result of MAR. As such, salinity was considered as a suitable parameter for use in the assessment of impacts to the stygofauna. Other parameters are being collected which will also be included

in establishing the ecological criteria for the stygofauna. The dominance of certain groups is to be considered when establishing criteria. An in depth assessment of groundwater quality has been undertaken by AQ2 (2024a). Groundwater water quality data is being collected as part of the on-going sampling program for the Proposal (refer to the Water Management Plan). The sampling bores have been constructed according to the requirements for sampling stygofauna, with water quality collected at intervals. The SFMMP will be supported by the Water Management Plan.

8.3.2.6 Delineation of taxa

Morphological identifications

All subterranean animals collected were initially identified morphologically under dissecting microscopes or, after dissection, under compound microscopes, with differential interference contrast lighting. Identifications were made using published, unpublished, and informal taxonomic keys, as well as species descriptions in the scientific literature. In the identification process, most animals were identified to undescribed species. These undescribed species were assigned voucher code names. Selected representative animals of most voucher code species were lodged with the Western Australian Museum. In some cases, the life stage, sex, or condition of specimens did not allow for identification to the species level and identification was to a higher taxonomic level. The lowest taxonomic unit (LTU) is applied to these taxa.

Genetics

Molecular sequencing has been adopted across all fields to solve the issue of cryptic species. Subterranean fauna, in general, are a problematic group taxonomically and this issue is recognised in extensive literature (refer to Framenau et al 2021) and EPA (2012; 2021g). To assist in the delineation of cryptic taxa, DNA barcoding has proven to be an acceptable tool (EPA 2021g).. In the absence of a central data depository for subterranean taxa, the use of DNA barcoding and the uploading into public databanks (such as GenBank) allows for a greater understanding of the area of occupancy (distribution) for stygofauna and troglofauna and subsequently their conservation status.

For this Proposal DNA sequencing was used to assign a name for juvenile or damaged animals, confirm morphological identifications, and for comparison with available DNA barcodes. The species records from each survey were reviewed and their names were updated to the most current iteration. BEC (2024a) outlines these analyses (**Appendix 26**). The outcome of the genetic analyses is presented in Appendix 2 of BEC (2024a) and discussed further in **Section 8.3.4** .

To further mitigate impacts to the subterranean fauna at Mulga Downs agreements are in progress between other companies to share data, including encouraging the uploading into GenBank.

8.3.2.7 Constraints and Limitations

There is much uncertainty regarding subterranean fauna, in particular with respect to taxonomy as taxonomic frameworks are in development. This places limitations on the interpretation of results in particular when historical data is combined with recent data. Historical data for the purpose of this assessment was used to define the significance of the area to subterranean fauna. The supporting documents have also applied this information in the survey reports. The assessment of impacts to subterranean fauna is based on the results from

the 2019 to 2024 surveys as they are considered the most reliable in terms of identifications and consistency in methods. This was considered when assessing the subterranean fauna found to be limited to the areas of impact and therefore at higher risk from implementation of the Proposal. The ranking of the risk to the subterranean fauna from low to high and the rationale for this ranking is outlined in Section 8.3.2.8.

Limitations to these 2019 to 2024 surveys included:

- Extent of sampling – this was limited to the availability of suitable bores across all habitats. Access due to tenure was limited to Hancock tenure or pastoral stations. Suitable hole for troglofauna were skewed toward the impact area as this had the highest concentration of suitable drill holes. This is standard for subterranean surveys. All efforts were made to locate sufficient holes outside the area of impact. With the reduction in the Proposal extent from 20 Mtpa capacity to 12 Mtpa many sampled holes could be classified as reference sites.
- Groundwater physicochemical measurements were collected using a bailer. This limits the understanding of the groundwater salinity at the time of sampling to the first meter of the groundwater column and do not reflect the conditions of the wider aquifer.
- Weather – heavy rainfall interrupted the scheduled sampling and collection of traps on occasions and prevented access to many sites. However, seasonality was captured with multiphase surveys.
- Taxonomy and genetics – specimen identifications were assessed by a combination of morphology and genetic analyses wherever possible. While it is expected, best practice was followed in the field and laboratory to ensure genetic success rates; given the extreme conditions in the Pilbara and distance to Perth, some sequencing failure was unavoidable. This is addressed in the supporting reports.
- Incorporation of previous results - many taxa/ morphospecies recorded from previous surveys could not be compared to the operational taxonomic units (OUT) from the 2019-2024 survey data as specimens or DNA was unavailable. There have been updates to the taxonomic frameworks between pre 2019 and current (2019-2024) surveys. This has been addressed in this assessment with the focus on the 2019-2024 data. However, the supporting reports have included historical data in their interpretations and this information remains in their data lists.

8.3.2.8 Assessment of data

As stated in Section 8.3.2.7, the incorporation of previous results has limitations. As such, the assessment of impacts to subterranean fauna in this ERD is focussed on the data from the 2019 to 2024 surveys presented in Bennelongia (2024a). The level of risk from the Proposal to the subterranean fauna was ranked as Low, Moderate or High. The rationale for this ranking is outlined below. This ranking is applied for the stygofauna and troglofauna taxa considered to be restricted to areas considered to be directly impacted by the Proposal activities. These are excavation of habitat (mine pits/borrow pits), mounding caused by MAR (1 m contour areas), drawdown of the water table from dewatering activities (2 m contours) and changes in salinity (measured in the 1 m mounding contour).

The assessment of the data collected for this Proposal is ongoing and adapts to change in the state of knowledge and currency of information. To ensue best practice, the data is being peer reviewed and will be compared to available dataset from other projects. The information resulting from all reviews will inform the management of potential impacts to subterranean fauna in the SFMMP.

Risk ranking

The level of risk to "restricted" troglofauna and stygofauna identified in Bennelongia (2024a) were ranked as either Low Risk, Moderate Risk or High Risk:

Low Risk: Implementation of the Proposal will not impact the biological diversity of subterranean fauna within the MDIOM and ecological integrity, that is the composition, structure, function and processes which make up the subterranean environment supporting the troglofauna and stygofauna, can be maintained. The EPA's objective for this factor can be met, and if required, standard management conditions may be applied, with the natural variation taken into consideration.

Moderate Risk: The EPA's objective for Subterranean Fauna may be met, however there are one or two aspects which may require further consideration (in the assessment of significant residual impacts). A further level of consideration is required to provide confidence that the residual impact will not be significant and can be mitigated with the information presented at the time of assessment.

High Risk: Following consideration of the information provided at the time of assessment, implementation of the Proposal, without further mitigation, will result in a significant residual impact. Additional information will be required to mitigate impacts (including conditions for compliance).

The assessment of risks to the 41 troglofauna taxa which were considered as being "restricted" to areas with direct impacts (pit and mounding) are considered in **Table 8-6**. The 13 stygofauna taxa identified as restricted in Bennelongia (2024a) are presented in **Table 8-7**.

Taxa which were identified as having Moderate or High risks (from the direct impacts) were considered further in Section 8.4.1. Those identified as low risk were not considered further. **Table 8-10** and **Table 8-13** present the outcome of that further assessment. The rationale for the rankings is outlined below.

Rationale

The risk ranking for the restricted troglofauna and stygofauna taxa is based on the EPA's objective for all biota that biological diversity and ecological integrity are to be maintained. In terms of subterranean fauna, the high number of cryptic taxa is problematic when assessing diversity. As such, the area of occupancy for many of the unnamed species cannot be easily defined.

Restricted taxa (those with limited rangers) are at greater risk from direct impacts. The distribution of taxa, especially outside of these areas of impact, is essential in mitigating any impacts. Singletons (specimens which are only found once in one sampling location) are common in subterranean fauna surveys and this is well documented (refer to Eberhard et al, 2009; EPA 2012; Framenau et al, 2021). To mitigate impacts, evidence of habitat connectivity (both biological and physical) is required. This also includes identifying any barriers.

The following information was included in the assessment for the MDIOM:

- The extent of the direct impact (pit and/or mounding for troglofauna; drawdown and salinity for stygofauna);
- The extent of supporting/suitable habitat (from the habitat assessment);
- The presence of barriers which may restrict the movement of subterranean fauna;
- The linear extent of taxa;

- The reliability of identifications (in the absence of resolved taxonomy – that is the species has a recognised name) or a DNA barcode has been applied which can be used to identify this specimen (either a LTU – lowest taxonomic unit or an OTU – operation taxonomic unit). This naming unit can be cross checked on a publicly available database or, if there is an agreement in place, sharing of data between companies. Where taxa were clearly identified as new species from successful DNA analyses; and
- Currency and reliability of data (as defined by EPA (2021) Technical Guidance – Subterranean fauna surveys for environmental impact assessment and strongly advised in Data should be comparable – this includes information which is collected in situ.

Based on the above, the rationale applied to rank (as high, moderate or low) restricted taxa is summarised below. A combination of all, or the majority of, the factors listed above (as a minimum) determined the risk ranking.

- **Low Risk:** Specimens collected prior to 2019, with little or no collection information, identification were based on morphology and usually the specimen was either incomplete, based on juveniles, or the final identification was on speculation/level of uncertainty, no molecular analyses was undertaken or sequencing failed, there was no repeat sampling at the same site. Evidence that the specimen was collected from an area which is now excluded from direct impact (avoidance applied); specimen is known to have a linear range which extends beyond direct impact.
- **Moderate Risk:** Specimens which were collected prior to 2019 and repeat sampling yielded a similar specimen; DNA sequencing was successful, and a barcode assigned; displays evidence of dispersal (though sampling was limited to area of impact).
- **High Risk:** Singletons; DNA successful and new species identified; found only in habitat which is not continuous.

Figure 8-1: Troglofauna survey extent - 2019-2024

610000 615000 620000 625000 630000 635000 640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000 695000

7585000 7580000 7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000 7525000 7520000

NANUTARRA RD

MUNJINA RD

GREAT NORTHERN HWY

MUNJINA-ROY HILL RD

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

Collection date

- 2019-2023 Detailed Survey
- 2023-2024 Targeted Survey
- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:260,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

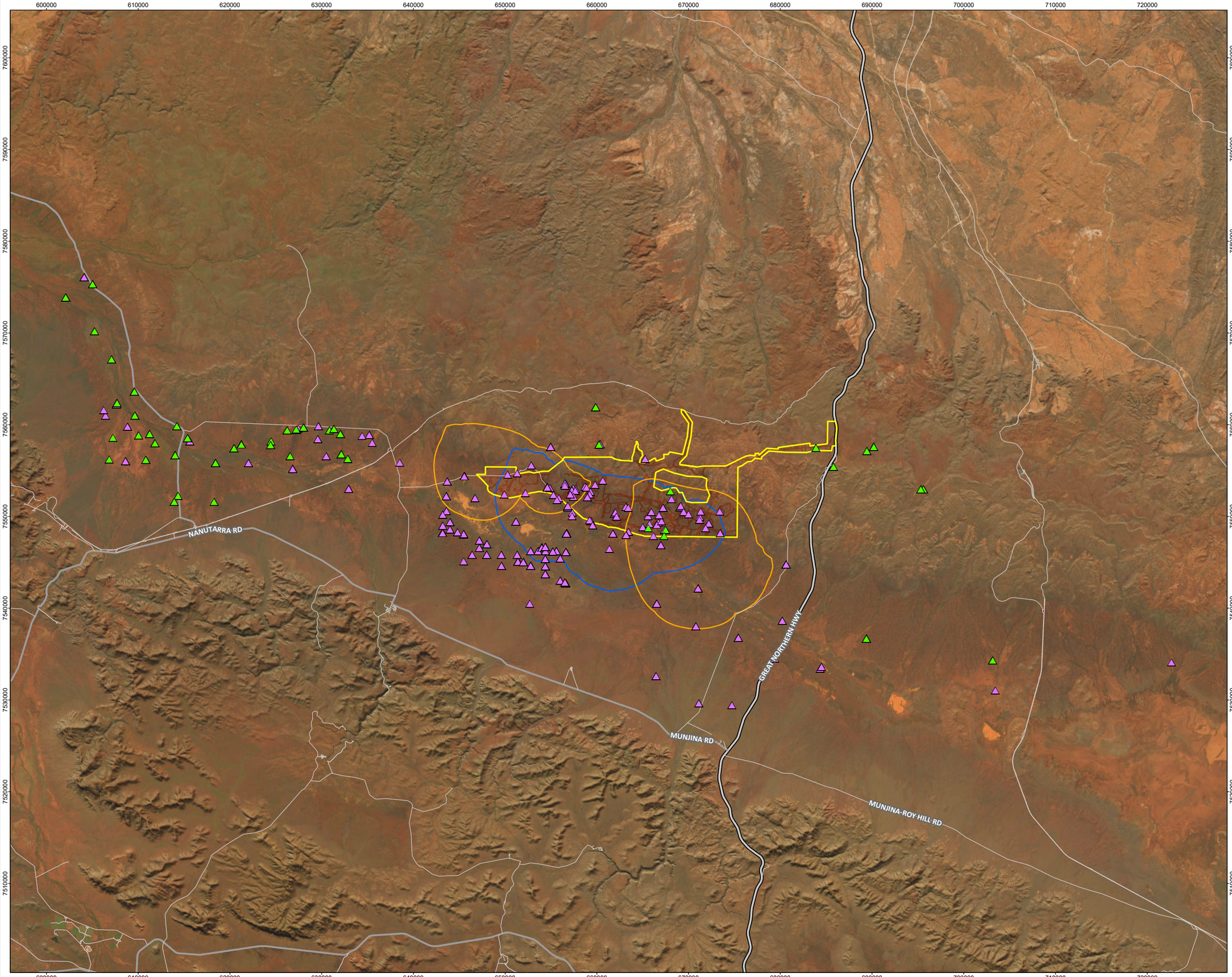
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA
SURVEY EXTENT - 2019-2024

FIGURE 8.1

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-2: Stygofauna survey extent 2019-2024



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown

Collection date

- 2019-2023 Detailed Survey
- 2023-2024 Targeted Survey
- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:380,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA
SURVEY EXTENT - 2019-2024

FIGURE 8.2

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-3: Troglofauna sampling effort with respect to mine pits and mounding) (2019-2024)

642000 644000 646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000 7538000

MUNJINA RD

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Survey effort (Troglofauna)

- 2019-2023
- 2023-2024

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:119,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SAMPLING EFFORT WITHIN AREA OF IMPACT (PITS AND MOUNDING) 2019-2024

FIGURE 8.3 Map 1 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

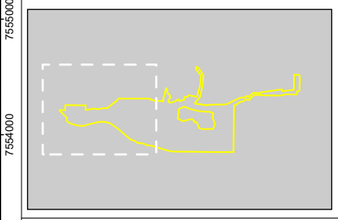
- Anticline Hill
- Fridge West
- Murray's Hill

Survey effort (Troglofauna)

- 2019-2023
- 2023-2024

Roads (LGATE-195)

- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

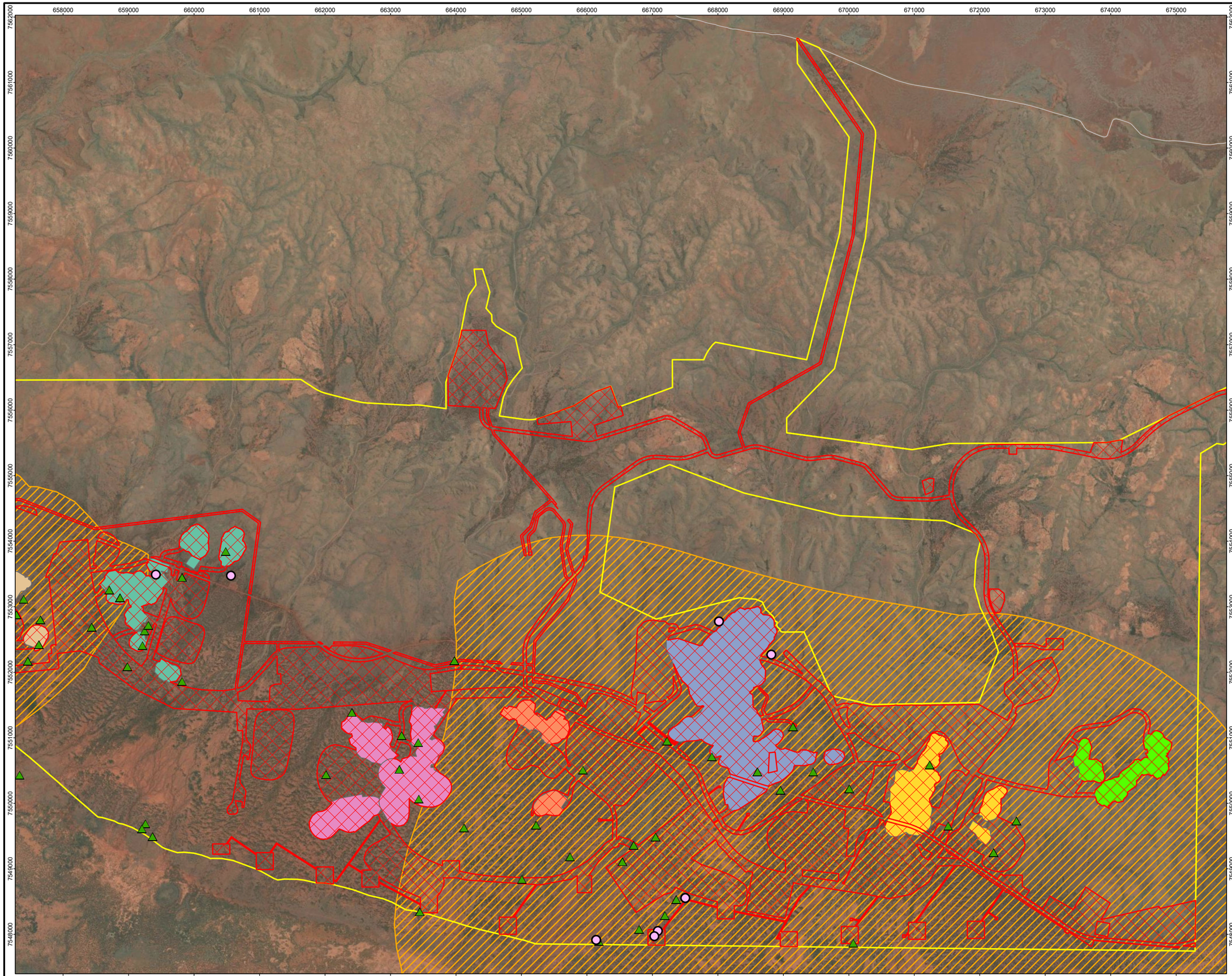
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SAMPLING EFFORT WITHIN AREA OF IMPACT (PITS AND MOUNDING) 2019-2024

FIGURE 8.3 Map 2 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Survey effort (Troglofauna)

- 2019-2023
- 2023-2024

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SAMPLING EFFORT WITHIN AREA OF IMPACT (PITS AND MOUNDING) 2019-2024

FIGURE 8.3 Map 3 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

671000 672000 673000 674000 675000 676000 677000 678000 679000 680000 681000 682000 683000 684000 685000 686000 687000 688000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

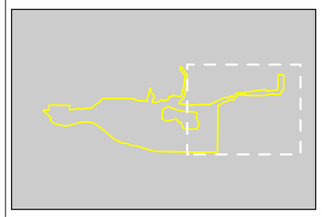
- Horseshoe Hill
- Horseshoe West

Survey effort (Troglofauna)

- 2019-2023

Roads (LGATE-195)

- Highway
- Minor Road



JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SAMPLING EFFORT WITHIN AREA OF IMPACT (PITS AND MOUNDING) 2019-2024

FIGURE 8.3 Map 4 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-4: Stygofauna sampling effort with respect to extent of drawdown and mounding (2019-2024).

642000 644000 646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000 7538000

MUNJINA RD

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown

Survey effort (Stygofauna)

- 2019-2022
- 2023-2024

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:119,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SAMPLE EFFORT WITHIN AREA OF IMPACT (DRAWDOWN AND MOUNDING) 2019-2024

FIGURE 8.4 Map 1 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown

Survey effort (Stygofauna)

- 2019-2022
- 2023-2024

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

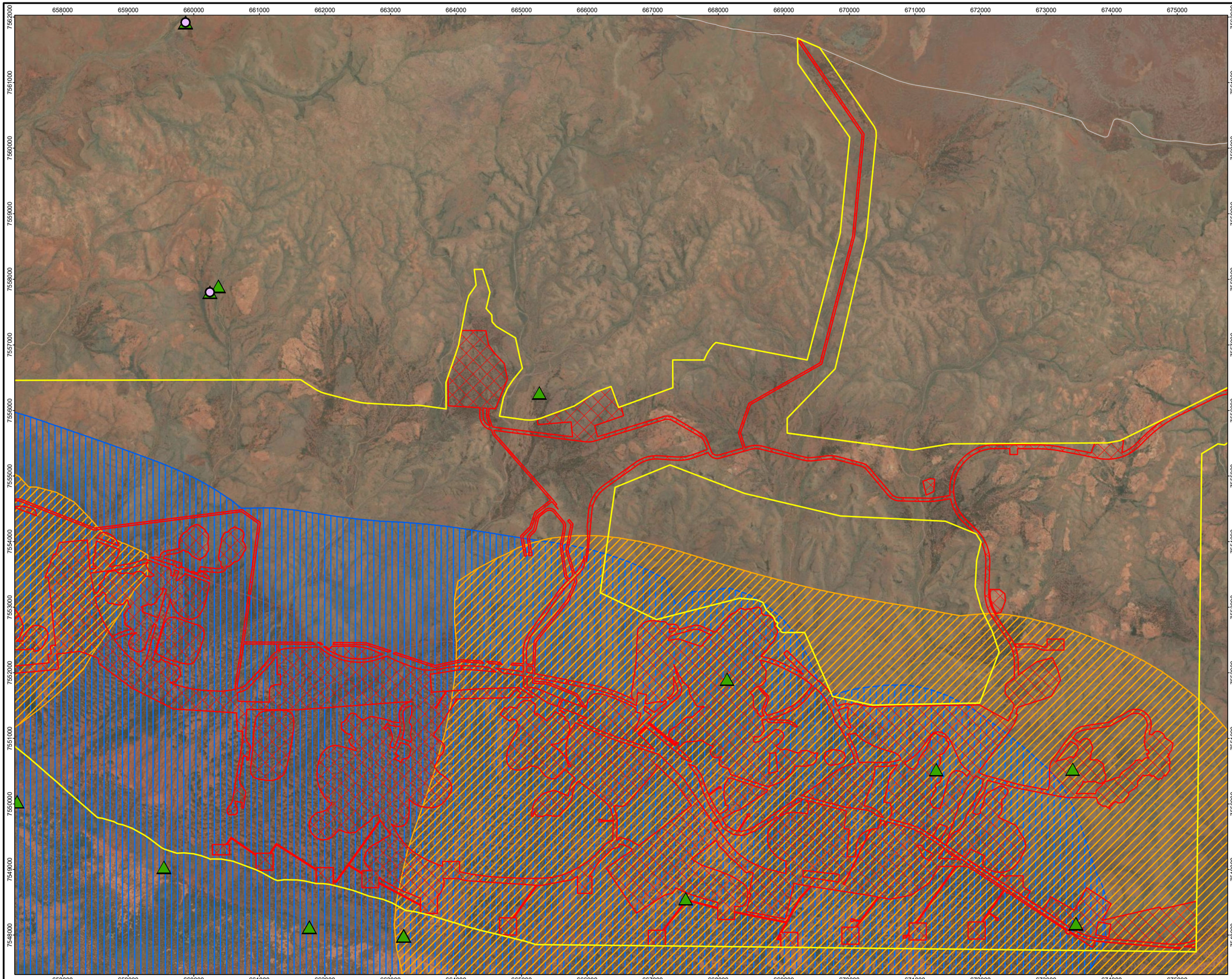
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SAMPLE EFFORT WITHIN AREA OF IMPACT (DRAWDOWN AND MOUNDING) 2019-2024

FIGURE 8.4 Map 2 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown

Survey effort (Stygofauna)

- 2019-2022
- 2023-2024

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

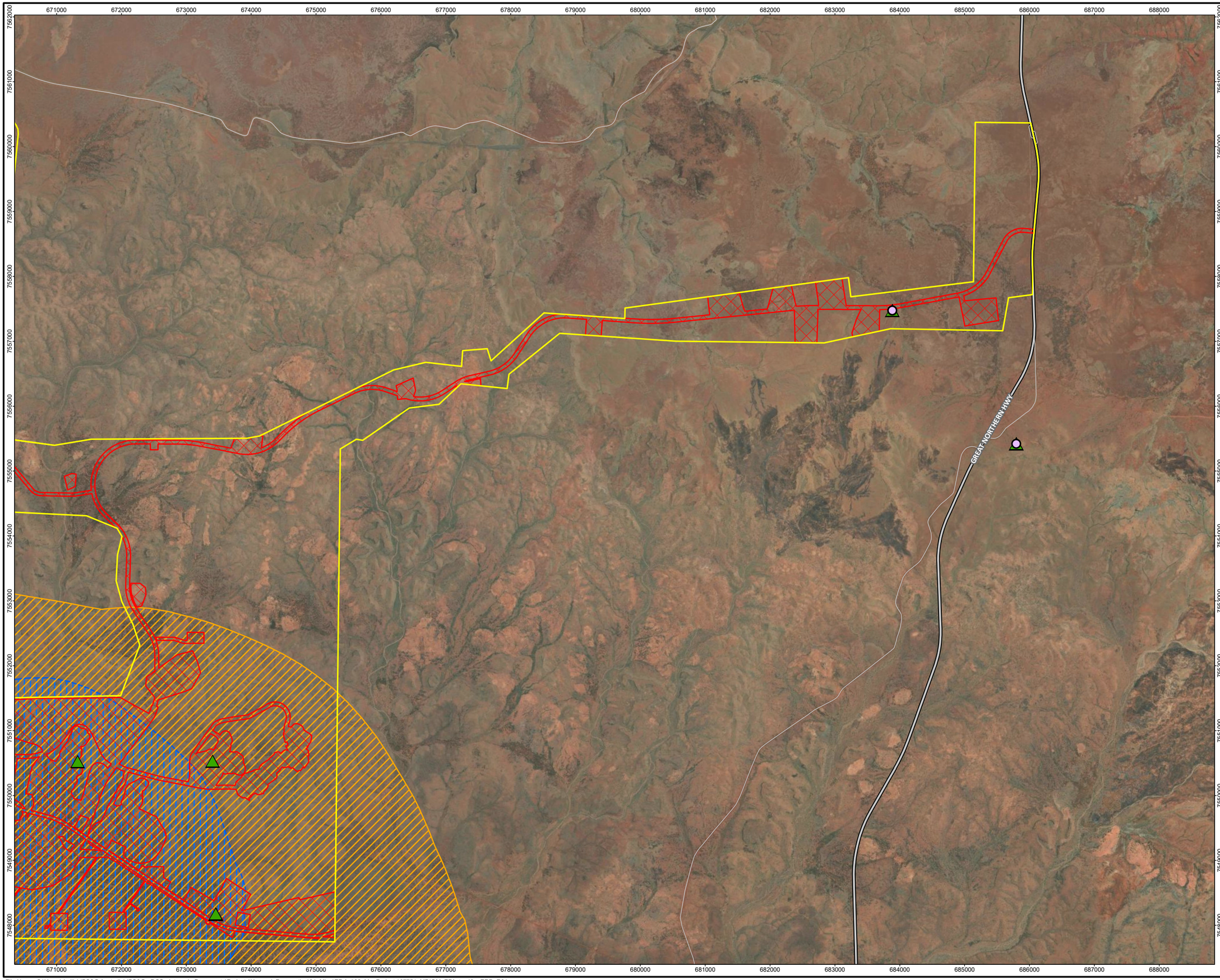
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SAMPLE EFFORT WITHIN AREA OF IMPACT (DRAWDOWN AND MOUNDING) 2019-2024

FIGURE 8.4 Map 3 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.



Legend

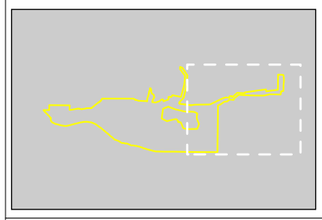
- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown

Survey effort (Stygofauna)

- 2019-2022
- 2023-2024

Roads (LGATE-195)

- Highway
- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SAMPLE EFFORT WITHIN AREA OF IMPACT (DRAWDOWN AND MOUNDING) 2019-2024

FIGURE 8.4 Map 4 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

8.3.3 Subterranean Fauna Habitat

The presence of subterranean fauna is strongly linked to the underlying geology and hydrology. Subterranean ecosystems are thought to have reduced habitat diversity compared to terrestrial ecosystems, primarily due to the absence of vegetation, however geology and hydrology drive habitat heterogeneity. Generally, subterranean environments which are highly transmissive have been found to support more substantial assemblages of subterranean fauna, both in terms of abundance and diversity (Gilbert et al, 1994).

8.3.3.1 Troglofauna habitat

A troglofauna habitat assessment model was developed by AQ2 using the Leapfrog Geo (3D) modelling software (AQ2 2024b; **Appendix 9**). The troglofauna habitat assessment was developed based on the ecological requirements and characteristics of troglofauna (AQ2, 2024b). A range of data sets were used in conjunction with data from AQ2's previous hydrogeological investigations, including topographic data, drillhole data, troglofauna survey data and groundwater data in two scenarios (with mine groundwater development and without mine groundwater development), as well as the conceptual pit shells to define zones of potential loss. The extent of the habitat model was defined laterally using all available lithological/geological data, and the base was defined by applying the maximum predicted groundwater level over the life of the mine.

Existing geological information indicates several prospective habitats for troglofauna (above water table) are likely to occur throughout the Development Envelope (**Table 8-5**) and into adjacent areas (AQ2, 2024b). The salient points from the habitat modelling include:

- The model indicates that the likely troglofauna habitats of Mineralised Marra Mamba and CID / Pisolite extend over much of the Chichester Range. The CID / Pisolite habitat is mostly continuous over the Proposal area and beyond, while Mineralised Marra Mamba occurs as discontinuous pods associated with the mineralisation.
- The likely habitat of Upper Calcrete is modelled to exist from the western side of proposed pits, and extend south, covering much of the Fortescue Valley, and west towards the Mulga West tenement. All troglofauna samples collected toward the valley centre were from drillholes within the Upper Calcrete unit. Where the Upper Calcrete occurs below the water table (i.e. within the Fortescue Valley), troglofauna species are not expected to occur as they do not inhabit aquatic systems.
- The possible troglofauna habitat of Undifferentiated Tertiary extends across the extent of the Development Envelope along the slopes of the Chichester Range and is continuous in nature.

The units of Upper Calcrete and CID/Pisolite which support troglofauna habitat occur across the Development Envelope and beyond and are mostly continuous. The unit Mineralised Marra Mamba occurs as discontinuous pods where they are associated with the mineralisation. Cross sections of troglofaunal habitat are presented in **Figure 8-6** to **Figure 8-8**. The extent of the potential impacts to troglofauna habitat is shown in **Figure 8-5** and the position of each of the lithological cross sections.

8.3.3.2 Stygofauna habitat

Stygofauna habitat is discussed in terms of suitable aquifers (in prospective lithologies, distance from surface) and groundwater quality (varying types of groundwater driving the community structure).

Palaeovalleys, such as the Fortescue Valley, are often synonymous with the presence of stygofauna because they represent old drainage lines. This indicates the presence of extensive groundwaters, usually with high

hydraulic connectivity and fed by drainage lines (also habitat and means of dispersal for many subterranean fauna).

Groundwater levels across the Proposal range from 385 m AHD to 420 m AHD and groundwater flows from the topographically higher areas into the Fortescue Valley, and then in a north westerly direction along the Fortescue Valley. A detailed assessment of groundwater with respect to the Proposal is provided in Inland Waters – (**Section 7**).

The hydrogeological conceptualisation of the Proposal and immediately beyond, indicates the Quaternary / Tertiary aquifer and fractured rock / bedrock aquifers are generally in hydraulic connection, while there are local areas of hydraulic disconnection between aquifers due to the presence of localised low permeable sediments such as clay, shales and saprolitic clay (AQ2 2025). A discussion on the aquifers is presented in the Inland Waters **Section 7**.

Key points regarding the assessment of the lithological units as potential stygofauna habitats are as follows:

- Likely habitats comprise the Upper Calcrete and Channel Iron Deposits (CID) / Pisolite units of the Tertiary sequence and mineralised / hydrated Marra Mamba bedrock, inclusive of the hardcap which can be very vuggy.
- Between the Upper Calcrete and CID / Pisolite is a unit of Undifferentiated Tertiary which is considered a possible habitat in areas where the clay content is lower.
- The lowermost Tertiary unit (the Basal Crete) is also considered a possible habitat. It is variable in both composition and nature but can be brecciated, weathered and / or vuggy.
- The shaley, unmineralised Marra Mamba is considered an unlikely habitat. Although there is the potential for vugs / voids in the oxidised zone, the same habitat potential as has been adopted for the previous troglofauna habitat assessments, in consultation with BEC (on 21/3/23), has been assigned to this unit. Given the shaley nature of the West Angela Formation, the potential for mineralisation or vugs / voids in the oxidised zones this unit has also been identified as an unlikely habitat.
- The Jeerinah Formation is considered a non-habitat as it is dominated by low porosity shale.
- Other bedrocks units are not impacted by the predicted drawdown.

The following are salient points with respect to the extent and continuity of the stygofauna habitat units:

- The Upper Calcrete is a continuous unit that occurs to the south of the proposed mining area and extends both across the Fortescue Valley and along the strike of the valley.
- The model indicates that the Mineralised Marra Mamba and CID / Pisolite extend over much of the Chichester Range, with the CID / Pisolite continuous (over the extent over the Proposal area and beyond) and Mineralised Marra Mamba occurring as discontinuous pods associated with the mineralisation.
- The Undifferentiated Tertiary unit is both continuous and extensive, covering both the lower slopes of the Chichester Range and extending across the Fortescue Valley.
- The unit Basal Crete is continuous across the Fortescue Valley area, although generally occurs at depths in excess of 30 m below the water table.

For the stygofauna habitat assessment, the top of the habitat was defined by the minimum predicted groundwater level, assuming no mine development (i.e., no dewatering or MAR) over the life of the mine period (AQ2 2024d).

The lithologies identified as suitable habitat for subterranean fauna are summarised in **Table 8-5**. Cross sections of stygofauna habitat are presented in **Figure 8-10** to **Figure 8-13**. The extent of the potential impact to stygofauna habitat is presented in **Figure 8-9.** The location for each of the lithological cross sections are also shown.

The Quaternary / Tertiary sediments (Tertiary Detritals refer to **Table 8-5**) form an unconfined, unconsolidated sedimentary aquifer. The alluvium is up to approximately 4 m thick and extends across most of the Fortescue Valley. The alluvium and colluvium are generally unsaturated and therefore were not investigated for aquifer properties or the stygofauna habitat assessment. The Tertiary sediments form a highly transmissive and continuous aquifer) within the Fortescue Valley to the south of the Development Envelope. These sediments are up to 60 m thick in the central part of the Valley.

The hydrogeological conceptualisation for the Proposal and beyond indicates the Quaternary / Tertiary aquifer and fractured rock / bedrock aquifers are generally in hydraulic connection. There are also local areas of hydraulic disconnection between aquifers due to the presence of localised low permeable sediments such as clay, shales and saprolitic clay (AQ2 2025).

Stygofauna sampling was undertaken by BEC by means of net hauls (BEC 2024a). The method involves a phreatic net being hauled from the base of the sampled drillholes / bores, with collection throughout the entire water column. As such, the depth that the stygofauna occupied at the time of collection is unknown. Unless a bore is screened over a certain interval, assumptions regarding the depth of the collected stygofauna are made based on subterranean ecology. Below a certain depth (~30 m to 40 m below the water table), low carbon and nutrient inputs are expected to severely limit the occurrence of subterranean fauna (Halse et al., 2014). As such, groundwater in the upper 30 m of the defined habitat is considered to provide 'preferential conditions' to stygofauna (Halse et al. 2014).

Groundwater as habitat

Groundwater salinity (as investigated for the extent of the subterranean fauna surveys) ranges from fresh (hyposaline) (180 mg/L as TDS) to saline (18,000 mg/L as TDS). Groundwater where the salinity is in the lower ranges is generally in the upper areas of the Chichester Range. Groundwater associated with the Fortescue Valley generally is of the higher salinity ranges, particularly around the claypans (refer to **Section 7.3.6**).

Groundwater quality in the Fortescue Valley area is generally of sodium chloride type, while groundwater over most of the Proposal has no dominant cations or anions, indicative of the mixing of different groundwater types or the ion exchange / dissolution processes during recharge or aquifer residency (AQ2 2025).

Basic water quality was measured with each stygofauna sample collected. Groundwater is primarily collected using a bailer. This limits the information to only the surface of the groundwater (standard bailer is 1 m in length). The data indicates that salinity in the first metre below the water table ranges from 60 mg/L to approximately 10,800 mg/L (TDS).

During the surveys, groundwater was found to be the most saline in the valley with a mound of saline groundwater originating from the overlying claypans and fresher groundwater occurring on the valley sides (presumably from rainwater infiltration). As such, on the edges of the saline mound, there is a halocline, usually at a depth between 40 mbgl and 80 mbgl, with salinities usually being 20,000 mg/L -30,000 mg/L at 120 mbgl (BEC 2024a).

Table 8-5: Lithological Groupings with respect to Potential Subterranean Fauna Habitats (from AQ2 2024b)

Habitat Stratigraphy	Lithology / Member	Stratigraphy	Habitat Probability		Reasoning
			Stygofauna	Troglofauna	
Alluvium	Alluvium	Recent Alluvium / Colluvium	Unlikely	Unlikely	This unit typically has a clay dominant matrix with low potential for porosity. Where drill data is available it predominantly occurs above the water table
Calcrete	Upper Calcrete	Tertiary Detritals	**Likely**	**Likely**	This unit typically has a high primary porosity.
Undifferentiated Sediments/Tertiary	Undifferentiated Sediments		Possible	Possible	Areas of lower clay content have the potential for high porosity.
CID / Pisolite	CID / Pisolites		**Likely**	**Likely**	CID unit is often vuggy, while pisolitic units typically have high primary porosity.
Basal Crete	Basal Crete (Calcrete / Silcrete)		Possible	None	Unit always encountered below water table within project area.
Jeerinah	Jeerinah Shale	Jeerinah Formation	None	None	Unit is dominated by shales with a low primary porosity.
Mineralised Marra Mamba	Mineralised / Hydrated BIF	Marra Mamba Formation	**Likely**	**Likely**	Units likely to have enhanced secondary porosity due to weathering/mineralisation processes.
Shaley / Unmineralised Marra Mamba	Undifferentiated	Marra Mamba Formation	Unlikely	Unlikely	Vugs/voids possible down to base of oxidation but unlikely due to shale content and more localised zones enhanced porosity.
	Nammuldi Member				
	MacLeod Member				
	Mt Newman Member				
West Angela Member	West Angela Member	Wittenoom Formation	Unlikely	Unlikely	Vugs/voids possible down to base of oxidation.
-	Paraburdoo Member		None	None	Units dominated by dolomite and dolomitic shales- low porosity even after weathering. Unit is not impacted by drawdown.
-	Bee Gorge Member				

Figure 8-5: Predicted Areal Extent of Impact to Troglofauna Habitat

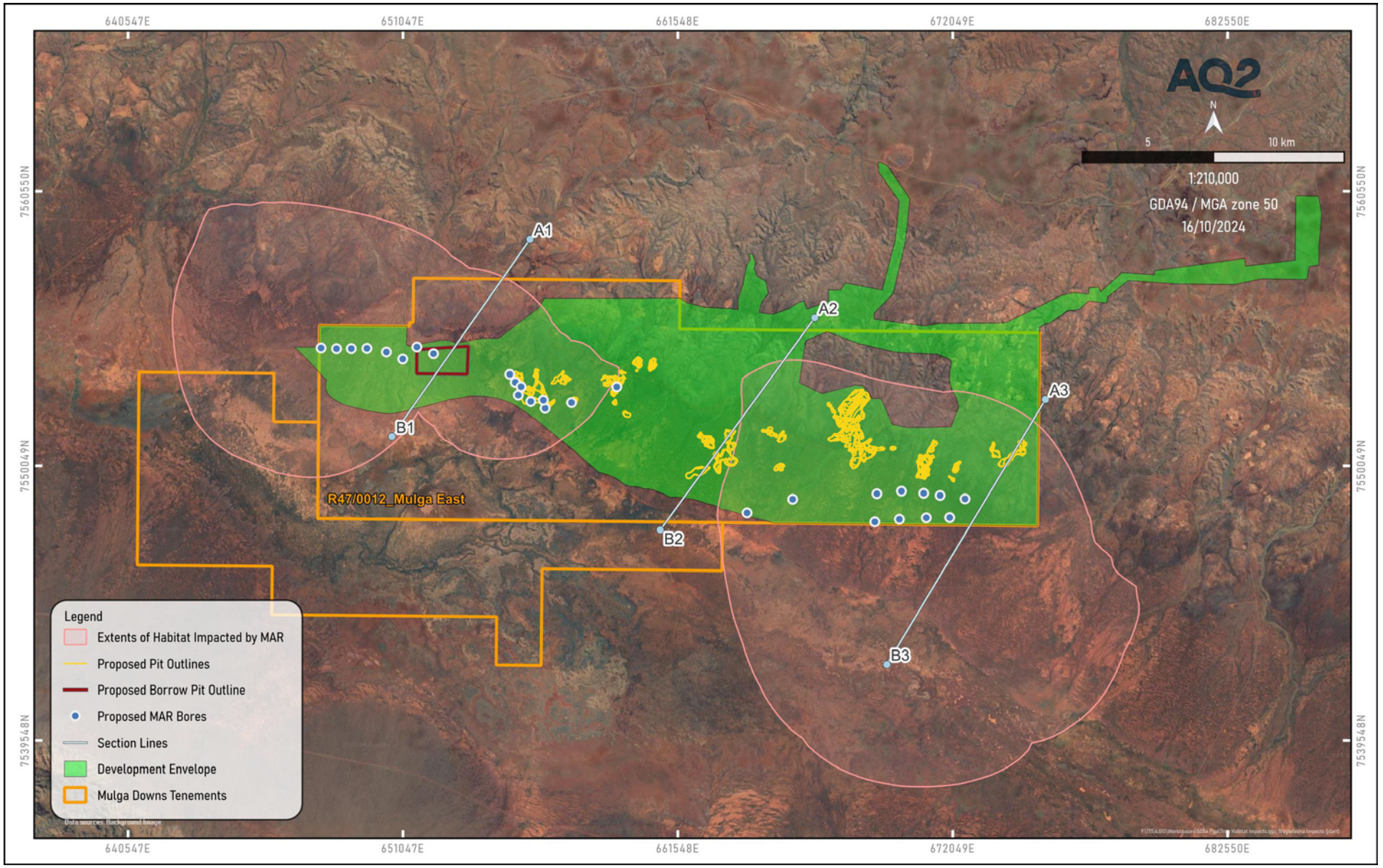
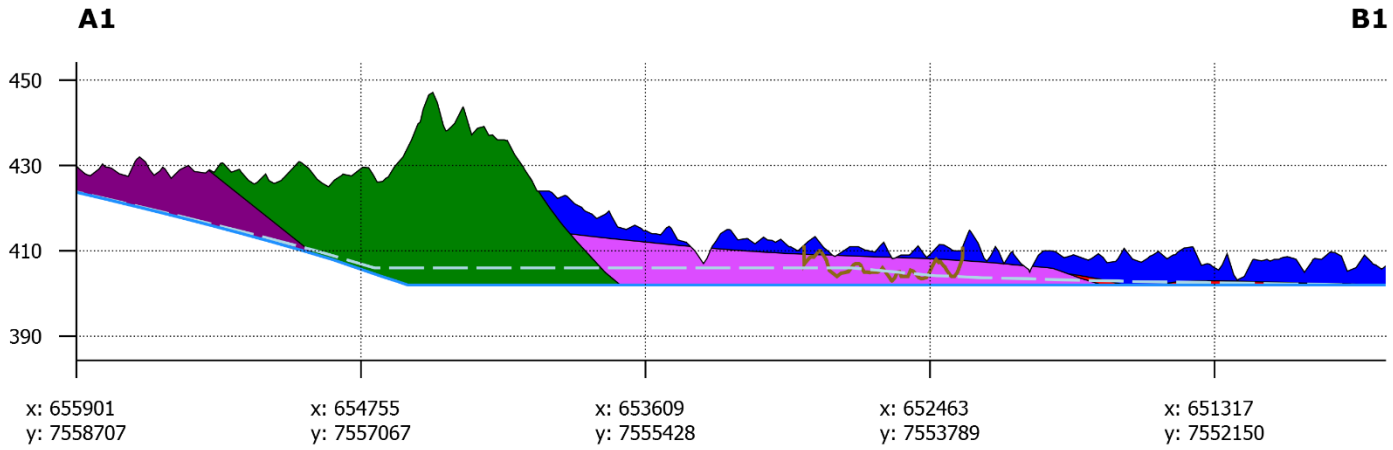


Figure 8.5 Predicted Areal Extent of Impact to Potential Troglofauna Habitat

Figure 8-6: Geological cross section of modelled troglofauna habitat (Section 1)



Legend

Troglofauna Habitat Volumes

- Alluvium (Unlikely Habitat)
- CID / Pisolite (Likely Habitat)
- Calcrete (Likely Habitat)
- Undifferentiated Tertiary (Possible Habitat)
- Jeerinah (Non-Habitat)
- Shaley / Unmineralised Marra Mamba (Unlikely Habitat)

Surfaces

- Proposed Borrow Pit Outline
- Modelled 'Maximum' Water Level (With Mine Development)
- Modelled 'Maximum' Water Level (No Mine Development)

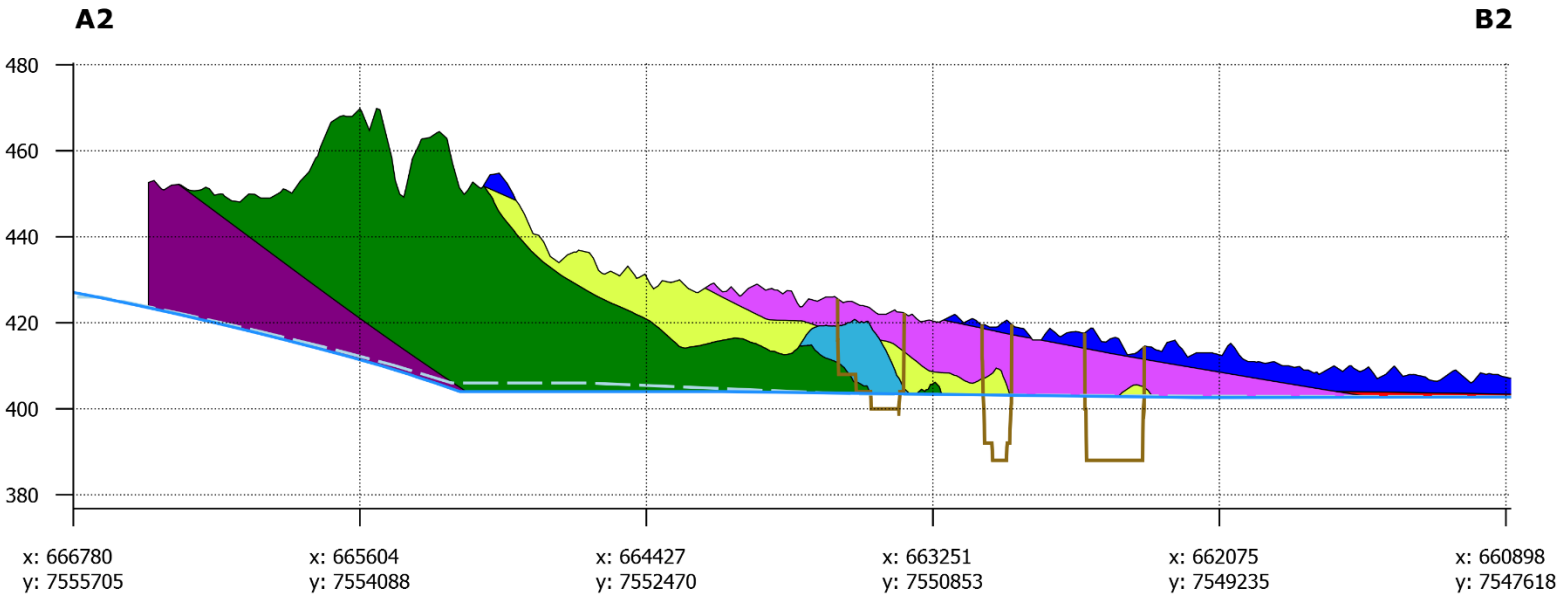
Location

A1: 655901, 7558707
B1: 650626, 7551162

Scale: 1:41,000
Vertical exaggeration: 30x
0m 1000m

Figure 8.6 Cross Section 1

Figure 8-7: Geological cross section of modelled troglofauna habitat (Section 2)



Legend

Troglofauna Habitat Volumes

- Alluvium (Unlikely Habitat)
- CID / Pisolite (Likely Habitat)
- Calcrete (Likely Habitat)
- Undifferentiated Tertiary (Possible Habitat)
- Mineralised Marra Mamba (Likely Habitat)
- Shaley / Unmineralised Marra Mamba (Unlikely Habitat)
- Jeerinah (Non-Habitat)

Surfaces

- Proposed Pit Outline
- Modelled 'Maximum' Water Level (With Mine Development)
- Modelled 'Maximum' Water Level (No Mine Development)

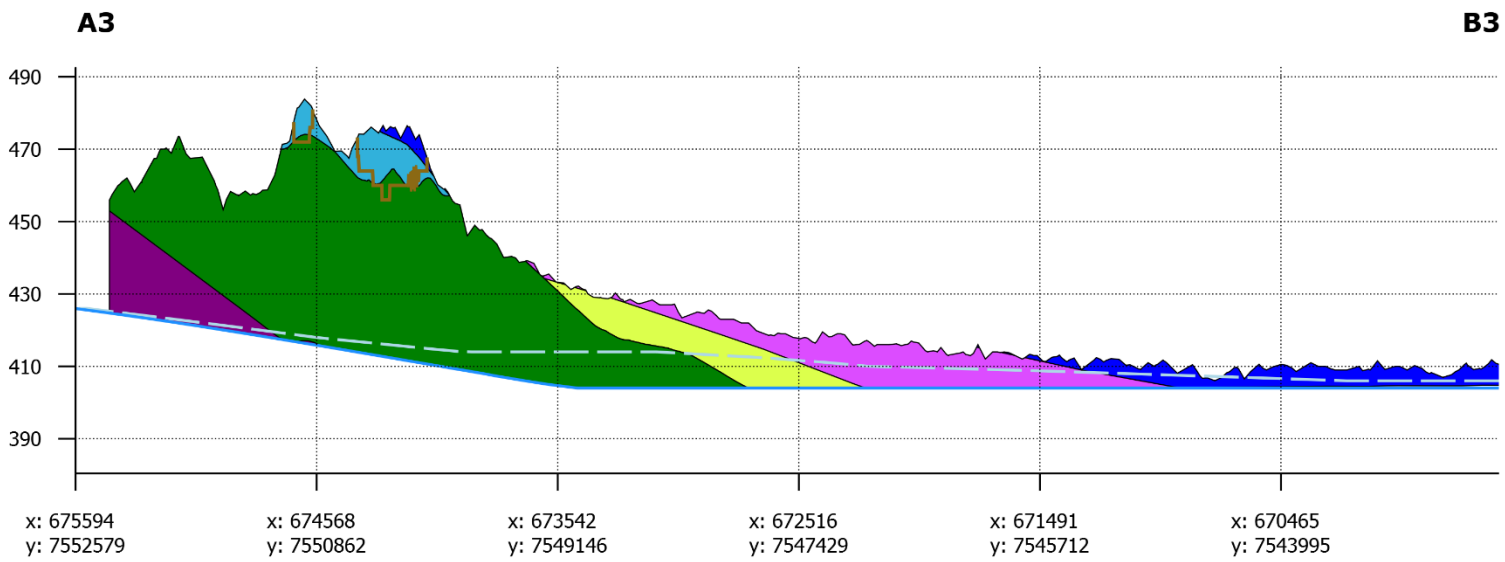
Location

A2: 666780, 7555705
B2: 660876, 7547588

Scale: 1:41,000
Vertical exaggeration: 30x
0m 1000m

Figure 8.7 Cross Section 2

Figure 8-8: Geological cross section of modelled troglofauna habitat (Section 3)



Legend

Troglofauna Habitat Volumes

- Alluvium (Unlikely Habitat)
- Undifferentiated Tertiary (Possible Habitat)
- CID / Pisolite (Likely Habitat)
- Mineralised Marra Mamba (Likely Habitat)
- Shaley / Unmineralised Marra Mamba (Unlikely Habitat)
- Jeerinah (Non-Habitat)

Surfaces

- Proposed Pit Outline
- Modelled 'Maximum' Water Level (With Mine Development)
- Modelled 'Maximum' Water Level (No Mine Development)

Location

A3: 675594, 7552579
B3: 669537, 7542442

Scale: 1:48,000
Vertical exaggeration: 30x
0m 1000m

Figure 8.8 Cross Section 3

Figure 8-9: Predicted Areal Extent of Impact to Potential Stygofauna Habitat

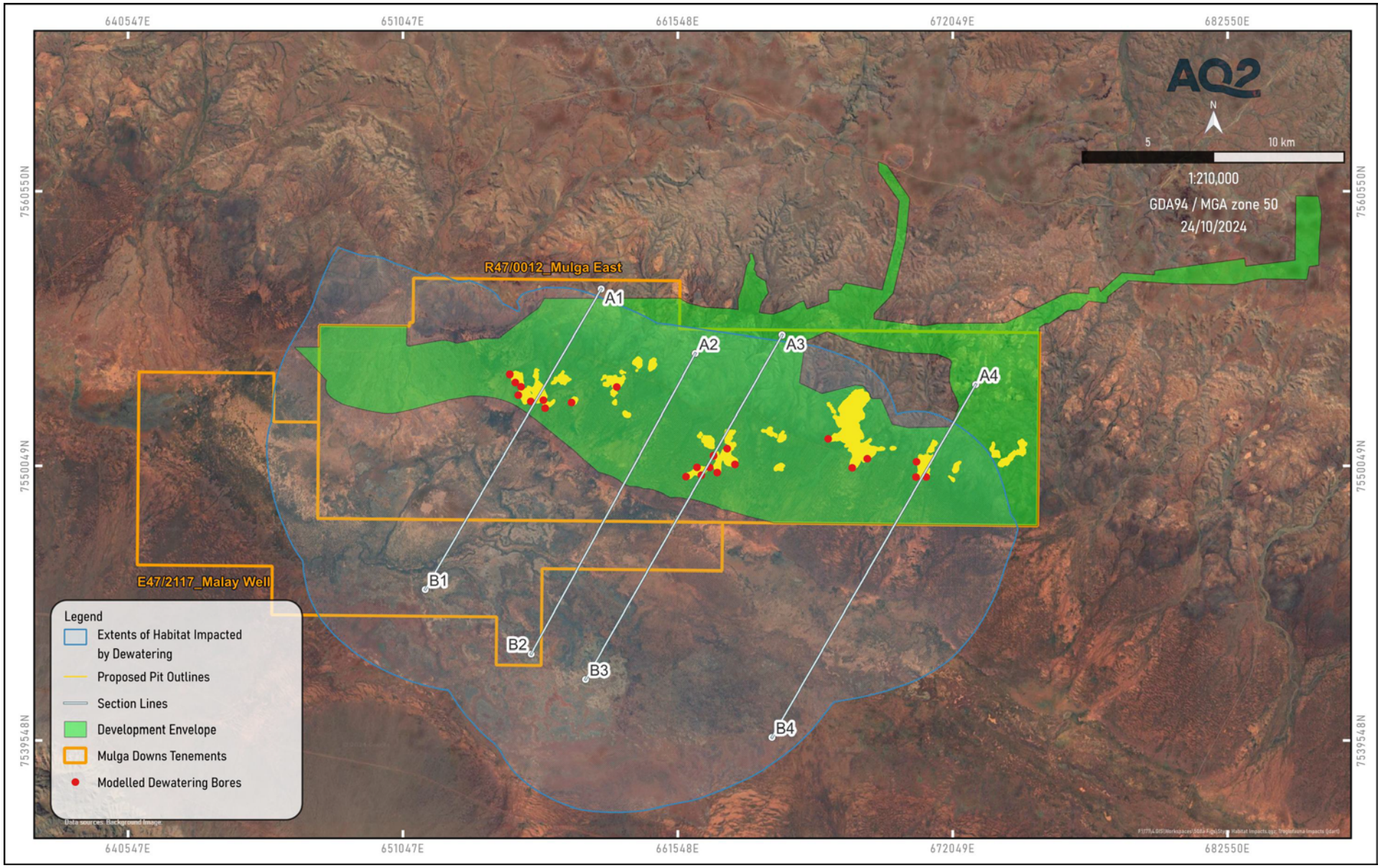


Figure 8.9 Predicted Areal Extent of Impact to Potential Stygofauna Habitat

Figure 8-10: Geological cross section of modelled stygofauna habitat (cross section 1)

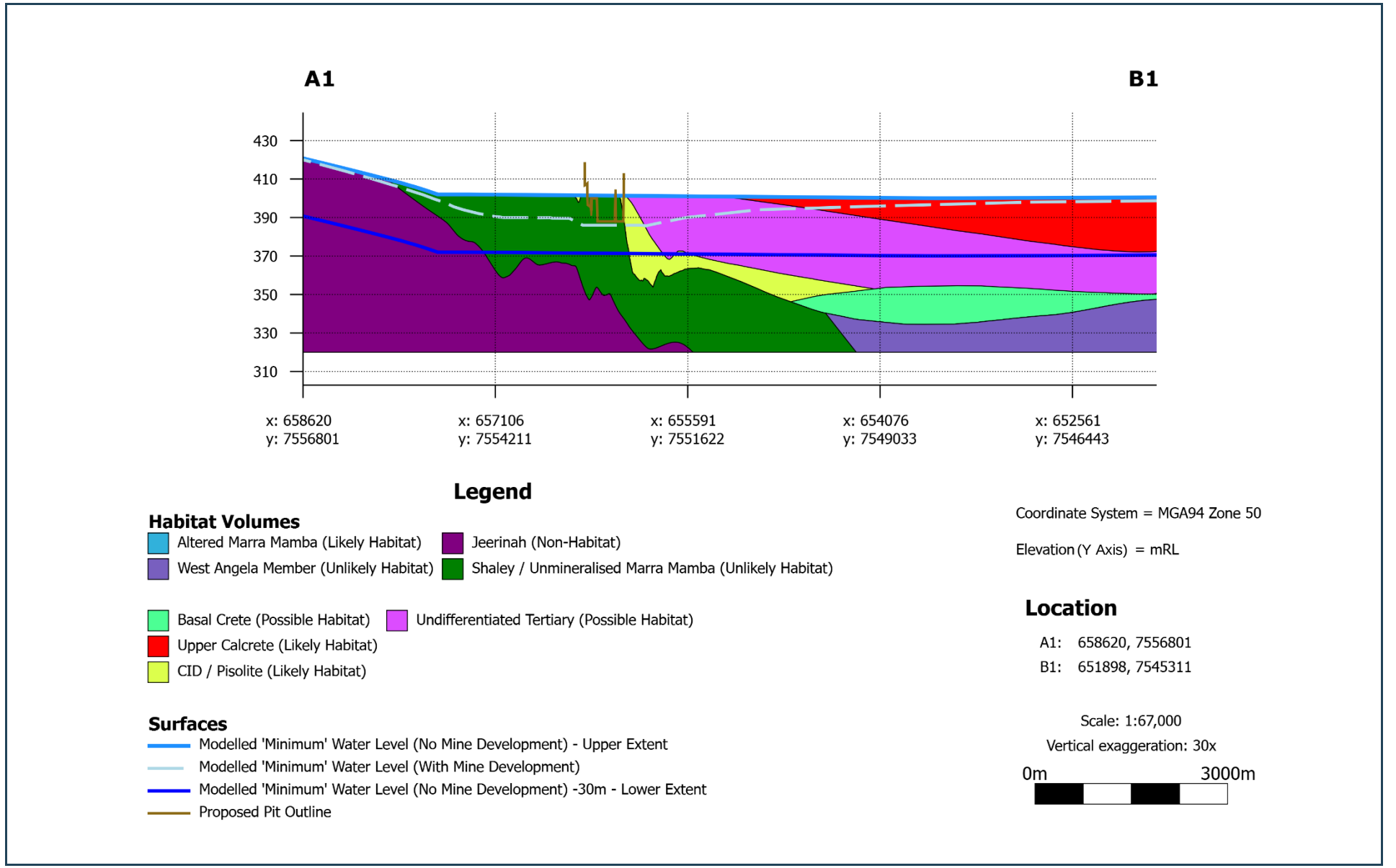
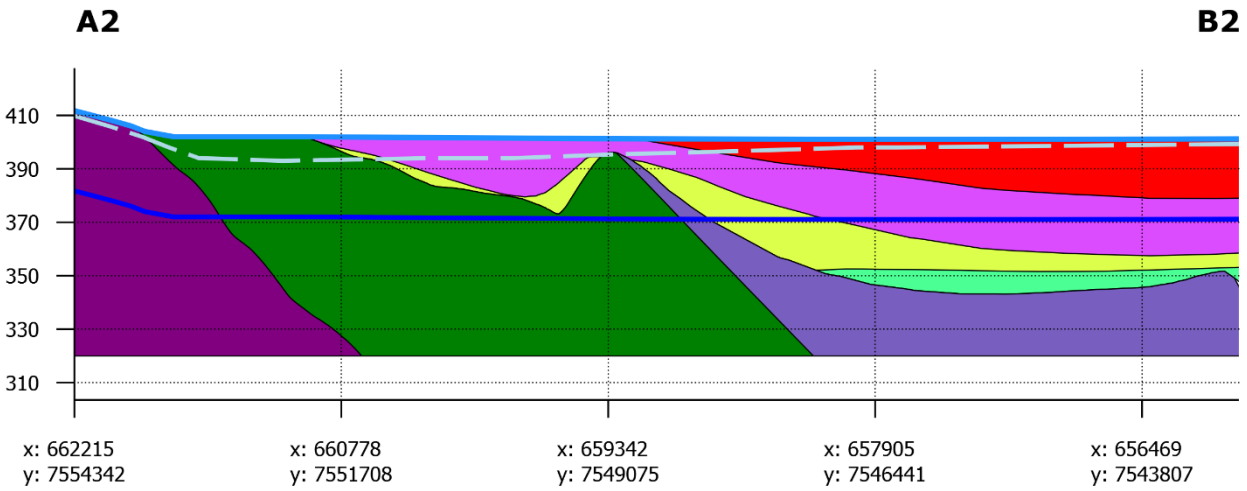


Figure 8.10 Cross Section 1

Figure 8-11: Geological cross section of modelled stygofauna habitat (cross section 2)



Legend

Habitat Volumes

- West Angela Member (Unlikely Habitat)
- Shaley / Unmineralised Marra Mamba (Unlikely Habitat)
- Jeerinah (Non-Habitat)
- Basal Crete (Possible Habitat)
- Undifferentiated Tertiary (Possible Habitat)
- Upper Calcrete (Likely Habitat)
- CID / Pisolite (Likely Habitat)

Surfaces

- Modelled 'Minimum' Water Level (No Mine Development) - Upper Extent
- Modelled 'Minimum' Water Level (With Mine Development)
- Modelled 'Minimum' Water Level (No Mine Development) -30m - Lower Extent

Coordinate System = MGA94 Zone 50

Elevation (Y Axis) = mRL

Location

A2: 662215, 7554342

B2: 655947, 7542850

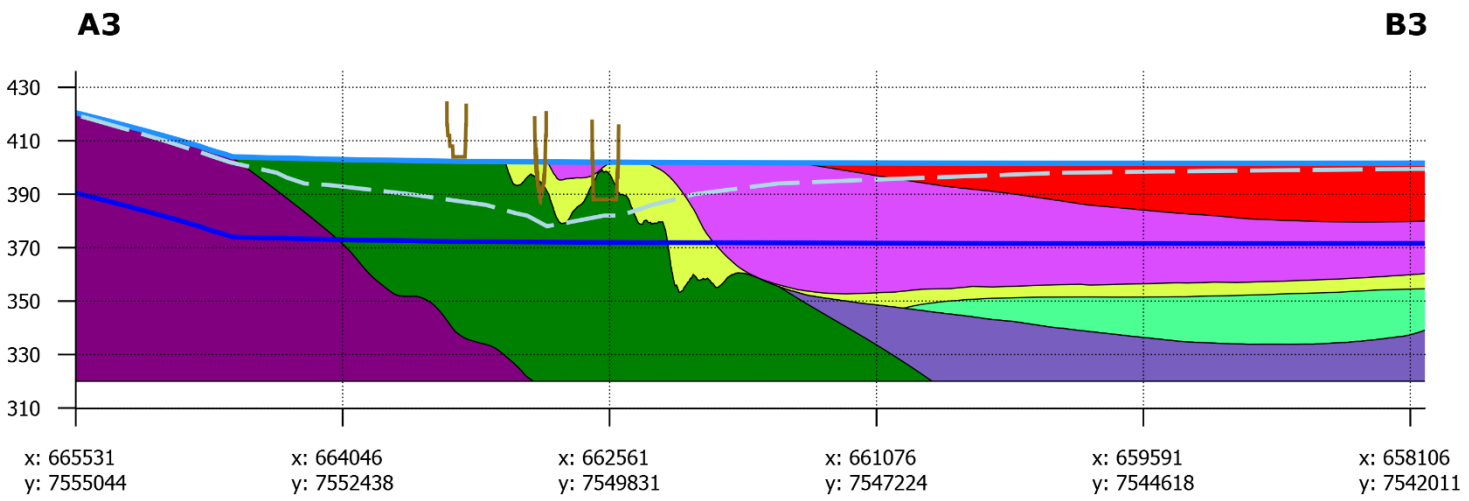
Scale: 1:67,000

Vertical exaggeration: 30x

0m 3000m

Figure 8.11 Cross Section 2

Figure 8-12: Geological cross section of modelled stygofauna habitat (cross section 3)



Legend

Habitat Volumes

- West Angela Member (Unlikely Habitat)
- Shaley / Unmineralised Marra Mamba (Unlikely Habitat)
- Jeerinah (Non-Habitat)
- Basal Crete (Possible Habitat)
- Undifferentiated Tertiary (Possible Habitat)
- Upper Calcrete (Likely Habitat)
- CID / Pisolite (Likely Habitat)

Surfaces

- Modelled 'Minimum' Water Level (No Mine Development) - Upper Extent
- Modelled 'Minimum' Water Level (With Mine Development)
- Modelled 'Minimum' Water Level (No Mine Development) -30m - Lower Extent
- Proposed Pit Outline

Coordinate System = MGA94 Zone 50

Elevation (Y Axis) = mRL

Location

A3: 665531, 7555044

B3: 658023, 7541866

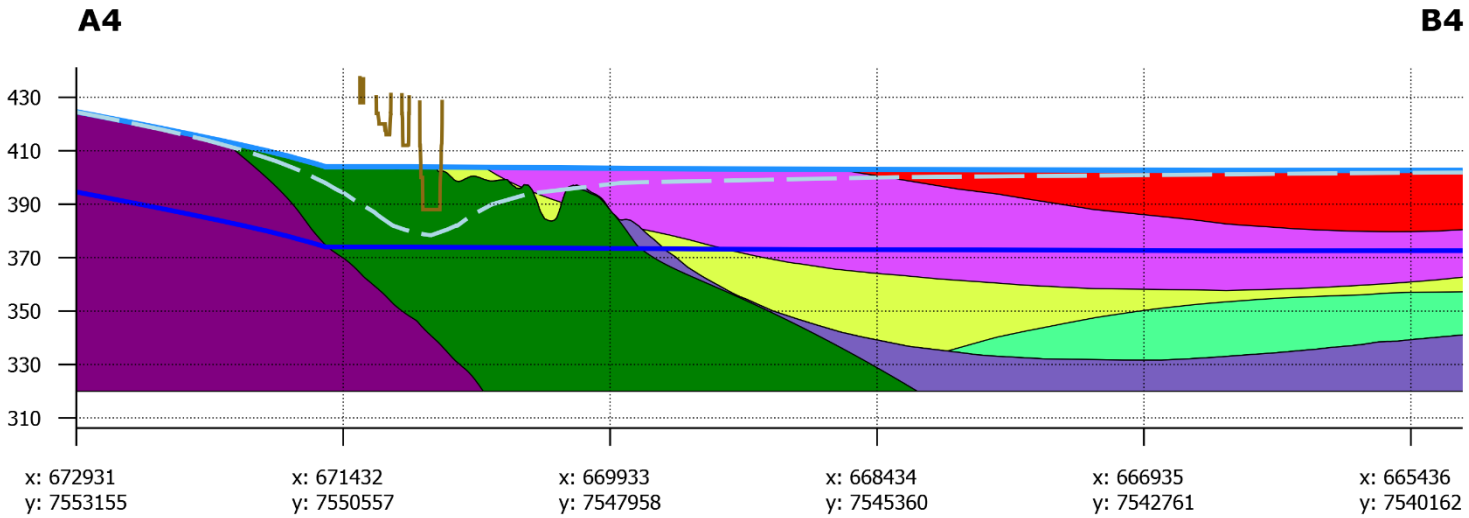
Scale: 1:67,000

Vertical exaggeration: 30x

0m 3000m

Figure 8.12 Cross Section 3

Figure 8-13: Geological cross section of modelled stygofauna habitat (cross section 4)



Legend

Habitat Volumes

- Altered Marra Mamba (Likely Habitat)
- Jeerinah (Non-Habitat)
- West Angela Member (Unlikely Habitat)
- Shaley / Unmineralised Marra Mamba (Unlikely Habitat)
- Alluvium
- CID / Pisolite (Likely Habitat)
- Basal Crete (Possible Habitat)
- Undifferentiated Tertiary (Possible Habitat)
- Upper Calcrete (Likely Habitat)

Surfaces

- Modelled 'Minimum' Water Level (No Mine Development) - Upper Extent
- Modelled 'Minimum' Water Level (With Mine Development)
- Modelled 'Minimum' Water Level (No Mine Development) -30m - Lower Extent
- Proposed Pit Outline

Coordinate System = MGA94 Zone 50

Elevation (Y Axis) = mRL

Location

A4: 672931, 7553155

B4: 665145, 7539659

Scale: 1:67,000

Vertical exaggeration: 30x

0m 3000m

Figure 8.13 Cross Section 4

8.3.4 Subterranean Fauna Assemblages

8.3.4.1 Troglofauna

In total, 1,743 specimens (including higher order identifications) belonging to 86 troglofauna species have been collected from within the Development Envelope and beyond the extent of impact areas (BEC 2024a). The subterranean fauna surveys span nearly 50 kms east to west and follow the Fortescue Valley (refer to **Figure 8-1**).

The groups represented in the troglofauna surveys include diplurans, isopods, beetles, pauropods, pseudoscorpions, silverfish, true bugs, schizomids, centipedes, palpigrads, cockroaches, spiders, symphylans, millipedes and flies.

The most frequently collected troglofaunal species was the cosmopolitan millipede, *Lophoturus madecassus*, which was collected 91 times (966 specimens). This species dominated the samples collected from within and beyond the areas of impact. This species is known to be a troglophile and is common throughout the Pilbara often collected from surface samples (Clark et al. 2021). The second most collected species was the isopod, *Troglarmadillo* sp. B54, which was represented by 209 specimens from 10 drill holes. This species was also collected beyond the extent of impacts and has a known linear range of approximately 16.5 km.

An overview of the troglofauna assemblages is presented in BEC (2024a) and is summarised in Table 5 of BEC (2024a). Known linear ranges for these taxa are presented in Table 5 of BEC (2024a) and includes the outcomes of the molecular analyses. This report is provided as **Appendix 26.**

Based on historical and recent data collected during the subterranean fauna surveys, Bennelongia have identified up to 42 troglofauna taxa as having linear ranges which identified them as potentially restricted. Up to 16 of these taxa may be duplicate names rather than distinct species. Another eight species will have wider distributions than the defined areas of impact if there is conspecificity. However, at present this cannot be resolved because of the typical constraints of this field of study (a taxonomic framework that is still being developed, a high number of cryptic taxa, and the artefacts of sampling subterranean environments). Bennelongia concluded that the number of troglofauna species known only from the areas of impact being the mine pits/areas of excavation and the extent of the groundwater mounding, is somewhere between 30 and 42 (BEC 2024a).

Table 8-6 summarises the 41 troglofauna which Bennelongia (2024a) identified as having limited linear distribution and were only found in areas impacted by the Proposal. This data includes historical data which dates to 2008. Given the level of uncertainty when comparing historical data with recent collections, these 41 taxa were reviewed and ranked based on the level of risk. The risk ranking and the rationale for this ranking is outlined in Section 8.3.2.8. Ranking is defined as low risk, moderate risk or high risk from the Proposal. A further assessment on the risk of the Proposal to taxa which have moderate to high risk is provided in **Section 8.6.1** (**Table 8-8**).

Based on the present information on the subterranean fauna assemblages, the average known linear range of 'restricted' species with multiple records is 8 km. In relation to the size of mine pits, this is comparatively large. The extent of the groundwater mounding, is approximately 12 km. There are two areas of mounding as is shown

in **Figure 8-1** to **Figure 8-21**. The impact of these areas in terms of troglofauna habitat loss is presented in **Section 8.6.1**.

The distribution of troglofauna which are considered to have true linear restrictions (that is potentially short range endemics) and therefore at greater risk are presented in **Figure 8-14** to **Figure 8-17**.

None of the troglofauna taxa and their associated communities which have been identified from the Development Envelope are listed or recognised as having conservation significance under the BC Act or are listed by the DBCA.

There are a number of taxa which have been identified as potential new species based on successful molecular analyses. These taxa considered to be of conservation significance for the purpose of EIA.

As part of continual mitigation, data sharing is underway with other companies. DNA sequences completed for Mulga Downs is in the process of being compared with the DNA sequences from other projects once data sharing is agreed. This information is expected in the following months.

Table 8-6: Troglofauna identified as having linear ranges only within the area impact ("restricted") at MDIOM.

Taxon (Lowest Taxonomic Unit (LTU))	Taxonomic factors	Impact type	Distribution	Risk Rankingl
Austrochthonius `BPS257`	ID on morphology only by Dr Danillo Harms (subject matter exoert in field)	Pit and mounding	Collected in 2020 at MD3207 by scrape	High. Considered a new species
Buddelundia sp. B57	ID on morphology only	Pit and mounding	Has a linear range of 4.5 km within the Development Envelope. Specimens collected in 2020 (from traps) at MD3028 and in 2023 from scrapes at MDRC2104. Other two specimens were collected in 2014 from MD3771 and MD3087	Moderate. Specimen has a small linear range; shows capacity to disperse
Campodeidae `BDP216`	Final ID is based on molecular analyses. Closest genetic match is Campodeidae p. B04 which is 18.4% divergent	Pit	Singleton. Collected in 2019 from MD3980	High. Singleton from in pit
Coleoptera 'BCO207'	Final ID is based on molecular analyses. Genetic match with Coleoptera `BCO207` which is 0-0.5% divergent	Pit and mounding	Linear range estimated at 3 km Collected in 2019 to 2020 surveys from MD1545, MD1796, MD1813, MD3809	Moderate. Small linear range, capacity to disperse indicated
Cryptops 'MH1' (=DNA05)	Molecular sequencing completed. May be *Cryptops* sp. B42 Genetically identified from *Cryptos* sp. to C. MH1 (1.1% divergence in COI)	Mounding	Linear range 12 km; Collected in 2012 from MD0525 and and 2020 from MD4821	Moderate. Based on collection in 2020 and sequencing
Cryptops sp. B42	Molecular analyses unsuccessful	Mounding	Singleton collected in 2014 MD0298	Low
Cryptops sp. B41	Molecular analyses unsuccessful	Mounding	Singleton Collected in 2014 MD0974	Low
Cryptorhynchinae sp. B18	ID on morphology only. Specimens prior to 2019-2024;	Mounding	Linear range 8 km. Sampling in MD0225 and MD3094	Low
Draculoides `BSC028`	Molecular analyses	Mounding	Singleton. Site now located in the Fauna Habitat Exclusion Zone (FHEZ) (MD3683)	Low

Taxon (Lowest Taxonomic Unit (LTU))	Taxonomic factors	Impact type	Distribution	Risk Rankingl
Draculoides `MH2`	ID on morphology only	Mounding	Singleton Collected in 2012 (Hole ID MD0525)	Low
Draculoides `SCH084-DNA`	Collected in 2019 and 2011, DNA confirmed	Mounding	Collected in 2019 and 2011 at MD6444	Moderate
Gnaphosidae sp. B03	Singleton not a full specimen, ID on morphology	Pit and mounding	Collected in 2014 from MD2889	Low
Gracilanillus `BCO176`	ID on morphology only	Mounding	Linear range 3 km, located in FHEZ, Hole ID MD3027 and MD6444	Low
Hanseniella `MH1`	ID on morphology only. May be same as Hanseniella `BSYM117`	Mounding	Linear range 3 km. Collected in 2011 and 2012 from md_kar6, MD0393, MD0397. *Hansiella* BYM117 not restricted	Low
Japygidae `BDP213`	Closest match is from the Bennelongia database, Japygidae `MH1` which is 12.15% different May be Japygidae 'MH1' or 'MH2' (not restricted)	Mounding	Linear range 6.2 km. Collected from MD7642 and MD9401 in 2022	Low
Japygidae `MH1`	ID on morphology	Pit and mounding	Linear range 13.5 km. Collected from MD0266 and MD0486 in 2011 and 2012	Low
Linnaeolpium `BPS502`	Identified from juvenile, probably *Linnaeolpium* sp. B03	Mounding	Singleton. Collected in 2019 MD4757. *Linnaeolpium* B03 is considered to typically have a greater linear range	Low
Nocticola 'BLA008'	Very juvenile specimen. No close matches, closest is Noticola sp. McP from Genbank which is 13.2% different (accession code OP242126)	Pit and mounding	Linear range 15.5 km. Collected from MD0398 (2019), MD0882 (2014). Potentially same species at Brockman Syncline	Moderate. Large linear range
nr *Andricophiloscia* sp. B18	ID on morphology of juvenile	Mounding	Singleton. Collected from MD4542 in 2014	Low

Taxon (Lowest Taxonomic Unit (LTU))	Taxonomic factors	Impact type	Distribution	Risk Rankingl
Palpigradi `BPAL053`	Very poor condition. Moelcular completed, no genetic matches. may be Palpigradi `MH2`	Mounding	Singleton. Collected from MD0401 in 2014	Moderate
Palpigradi `MH2`	ID on morphology	Mounding	Singleton. Collected from MD0398 in 2011. Noted as not being restricted in range	Low
Palpigradi sp. MH1	Genetically from Palpigradi sp. to MH1 (0.3% divergence in COI from 2014 specimen, only face was in sample	Pit and mounding	Linear range 0.3 km. Collected from MD0467 (2012) and MD2038 (2020)	HIgh
Palpigradi sp. B18	May be Palpigradi 'MH1'. Difficlut to know if DNA completed	Pit and mounding	Linear range 4 km. Collected from MD0716 and MD1284 (2014)	Moderate
Parajapygidae sp. B30	Probably Parajapygidae 'MH1'. Molecular analyses failed	Pit and mounding	Singleton. Collected from MD2094 in 2014	Moderate
Parajapyx `BDP217`	ID on morphology	Pit and mounding	Singleton. Collected from MD3207 in 2020	High
Pauropodidae `MH1`	ID on morphology	Pit and mounding	Singleton. Collected from MD0487 in 2011	Moderate
Pauropodidae `MH2`	Pauropodidae 'MH1' and 'MH2' are distinct species but how related to Pauropodidae 'BPU089' and 'BPU090' is unclear	Pit and mounding	Linear range18 km. Collected from MD0396, MD0415, and MDH0143	Moderate
Pauropodidae 'MH3'	ID on morphology	Pit and mounding	Linear range 15 km colected in 2011 MD0467, MD2038	Low
Phaconeura 'BHE036'	Did not match P. sp. B04, 15% different in general. Genetic match on Genbank with Meenoplidae sp. WAM-PHAC001/H-HEM003 (accession code MZ427776) which is 9.5% different. Potential new species	Mounding	Singleton collected in 2020 from MD3805	High

Taxon (Lowest Taxonomic Unit (LTU))	Taxonomic factors	Impact type	Distribution	Risk Rankingl
Phaconeura sp. WAM `PHAC002`	Not *Phaconeura* B04, 15% different in general. Genetic match with *Phaconeura* sp. WAM PHAC002 (accession code MW021247) which is 1.5% differen	Pit and mounding	Linear range 14 km. Collected from MD0398 and MD2936 2019 and 2020.	Moderate
Projapygidae `BDP182`	ID on morphology. Specimen in poor condition. may be P. 'MH1' and/ or P. sp. B18	Pit and mounding	Singleton. Collected from MD2936 in 2019	Moderate
Projapygidae 'MH1'	ID on morphology.May by synonoumous with Projapygidae `BDP182`	Pit and mounding	Linear range 3.2 km. Collected from MD0259, MD0397 and MD0467 in 2019	Moderate
Symphylella sp. B20	DNA not succesful	Pit and mounding	Linear range of 10 km. Collected from MD2926, MD6163 and MDRC2367	Moderate
Trinemura `BZY102`	Genetic match between two sampes. Closest match is *Trinemura* sp. B28 from Mulga East which is 11.1% different	Pit	Linear range of 4.5 km. Colected from MD0790, MD2453 in 2014	Low
Trochanteriidae sp. B01	ID on morphology. Not definite troglofaunaa	Mounding	Singleton collected from MD0635 in 2014	Low
Troglarmadillo 'BIS392'	14.1% divergent to *Troglarmadillo* sp. B03. Different species	Mounding	Singleton. Collected from MD0350 in 2020	Moderate
Troglarmadillo 'BIS562'	Very juveile individuals. Closest matches are *Troglarmadillo* BIS345 and *Buddelundia* sp. Biologic-ISOP006 (17.7 and 17.6% similarity).	Mounding	Only collected from one site - MDRC1351 in 2023	Moderate
Troglarmadillo 'MH1'	Probably *Troglarmadillo* sp. B54 or sp. B55 (no restricted)	Pit and mounding	Collected from MD0467 in 2012	Low
Troglarmadillo sp. B04	2008 collection specimen no longer avaiable	Mounding	Singleton. Collected from WF0138	Low
Troglarmadillo sp. B05	2008 collection specimen no longer avaiable	Mounding	Singleton. Collected from WF0138	Low

Taxon (Lowest Taxonomic Unit (LTU))	Taxonomic factors	Impact type	Distribution	Risk Rankingl
Tyrannochthonius `BPS229`	Nearest match is *Tyrannochthonius* aff. Basme H-PC050 (accession code MZ425011) which is 18% divergent. New species	Mounding	Linear range 11 km. Collected from MD1556 and MD4821 in 2019 and 2020	High
Tyrannochthonius sp. B35	This specimen is synonomous with *Tyrannochthonius* B36 (outside impact areas).	Pit and mounding	Linear range 11 km MD0884 and MD3661 in 2014	Low

8.3.4.2 Troglofauna Distribution and Habitat Connectivity

Physical Connectivity

The lithological units of Upper Calcrete and CID/Pisolite which support troglofauna habitat occur across the Development Envelope and beyond and are mostly continuous. The unit Mineralised Marra Mamba occurs as discontinuous pods where they are associated with the mineralisation (AQ2 2024b).

While the likely troglofauna habitats have been proposed, the occupancy by troglofauna within each unit is assumed. It is understood that troglofauna tend to migrate within the open drill hole, meaning trap depths are not necessarily representative of the habitat location of the sampled troglofauna. Troglofauna have been identified from traps and scrape samples collected from drillholes both within the proposed pit footprints and outside of the pits across the Development Envelope.

Many of the troglofauna identified as restricted (having limited liner ranges) were from drillholes located within the CID/Pisolite habitat and the Mineralised Marra Mamba lithologies (**Figure 8-6**). This is to be expected as this was the focus of the intense sampling effort. Not all these taxa were confined to the proposed pits. **Table 8-6** identifies the type of impact they are in. The distribution of the troglofauna which have limited ranges based on the outcomes of the surveys are shown in Appendix 6 of the Bennelongia (2024a).

The location of selected troglofauna (primarily those with very limited ranges considered to be at the most risk from the Proposal) have been mapped over the lithologies as identified in the 3D habitat assessment (AQ2 2024b). Additionally, the distribution of these restricted troglofauna within mapped habitat is presented in **Figure 8-18**.

Biological Connectivity

Habitat characterisation suggests that most of the troglofauna species known only from the mine pits or areas of groundwater mounding are likely to have limited ranges. Troglofauna located within the Mineralised Marra Mamba and the Upper Calcrete habitats are considered as having a more limited distribution as these two habitat types are discontinuous above the water table. **Figure 8-18** shows the location of restricted troglofauna within mapped habitat. Congeneric taxa (belonging to the same genus) are also shown in **Figure 8-18** demonstrating potential biological connectivity.

A review of the survey data indicates that dispersal across the habitats is likely, however the Mineralised Marra Mamba forms discontinuous pods which can fragment the troglofauna. Many taxa following targeted surveys and further taxonomic resolution were found to have greater linear ranges than initially concluded.

Biological connectivity requires further examination and review of the community structure within each sample site. Community structure has not been considered at this stage and rarely is for the purpose of EIA as the focus is on species to determine biological diversity. Which for subterranean fauna is confounded.

Figure 8-14: Distribution of troglofauna identified as restricted (Class Chilopoda, Diplopoda, Entognatha and Symphyla)

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

MD0525
MD2926
MD2936
MD3980
MD0298
MD3207
MD6138
MD4821

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

Chilopoda
- Cryptops `MH1` (=DNA05); Cryptops sp. B42

Entognatha
- Campodeidae `BDP216`
- Parajapyx `BDP217`
- Projapygidae `BDP182`

Symphyla
- Symphylella sp. B20

Roads (LGATE-195)
- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA - CLASS CHILOPDA, DIPLOPODA, ENTOGNATHA, SYMPHYLA

FIGURE 8.14

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-15: Distribution of troglofauna identified as restricted (Class Arachnida).

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

MD1284
MD2038
MD0716
MD1556
MD0467
MD3207
MD0401
MD4821

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Arachnida

- Austrochthonius `BPS257`
- Palpigradi `BPAL053`
- Palpigradi `MH1`; Palpigradi sp. B18/Palpigradi `MH1`
- Tyrannochthonius `BPS229`

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 18-Dec-2024

Drawn By: dmills | Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

RESTRICTED TROGLOFAUNA (CLASS ARACHNIDA) WITHIN THE MDIOM

FIGURE 8.15

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-16: Distribution of troglofauna identified as restricted (Class Insecta).

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

MD1796
MD0882
MD2936
MD1813
MD3805
MD1545
MD3809
MD3027
MD6444
MD0398

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Insecta

- Coleoptera `BCO207`
- Gracilanillus `BCO176`
- Nocticola `BLA008`
- Phaconeura `BHE036`
- Phaconeura sp. WAM `PHAC002`

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

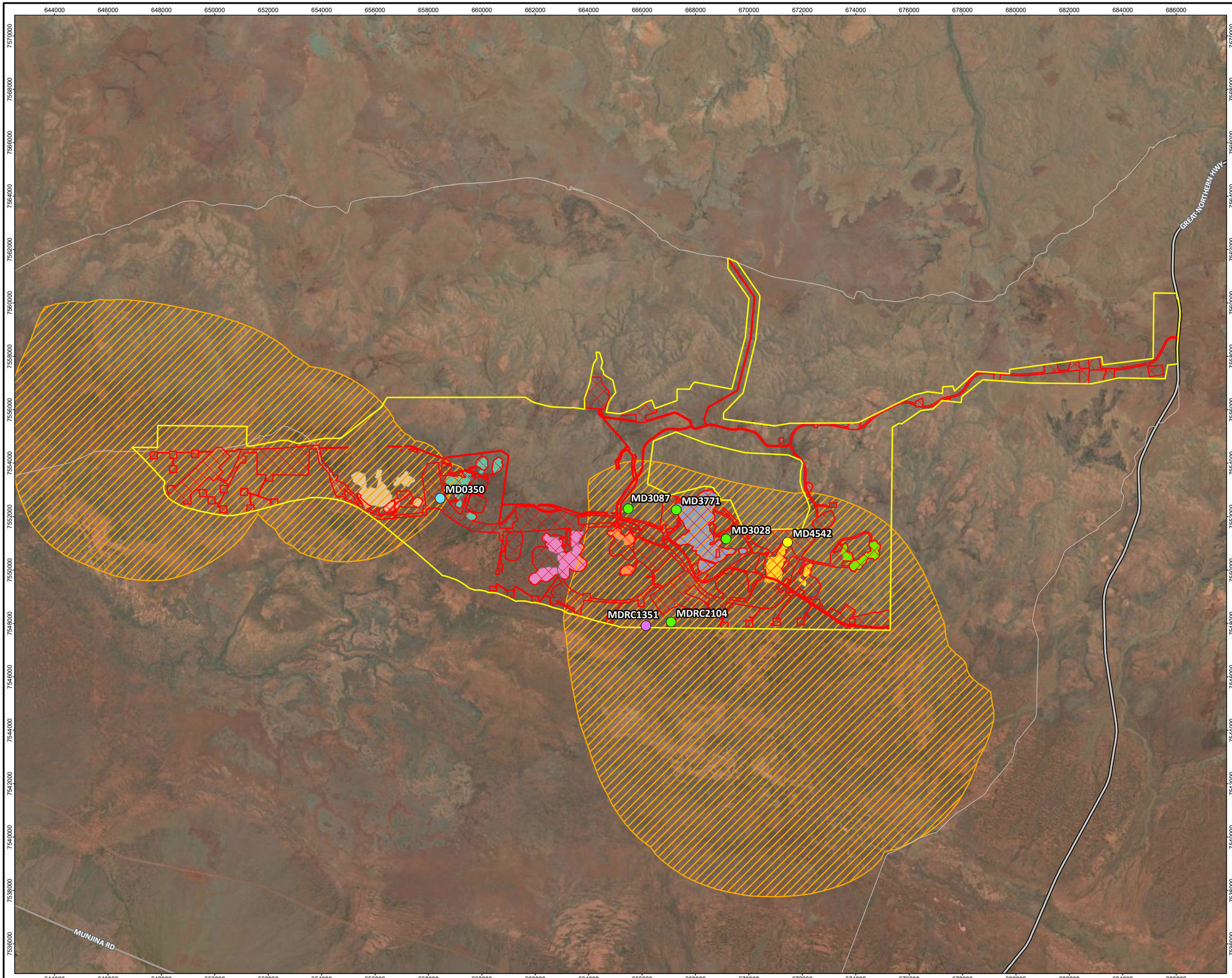
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

RESTRICTED TROGLOFAUNA (CLASS INSECTA) WITHIN THE MDIOM

FIGURE 8.16

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-17: Distribution of troglofauna identified as restricted (Class Malacostraca).



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Malacostraca

- Buddelundia sp. B57
- Troglarmadillo `BIS392`
- Troglarmadillo `BIS562`
- nr Andricophiloscia sp. B18

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:130,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

RESTRICTED TROGLOFAUNA - (CLASS MALACOSTRACA) WITHIN THE MDIOM

FIGURE 8.17

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-18: Linear extent of "restricted" troglofauna across suitable subterranean habitat. Congeneric taxa are included.

LTU*

- Austrochthonius `BPS257` (R)
- Buddelundia sp. B57 (R)
- Campodeidae `BDP216` (R)
- Coleoptera `BCO207` (R)
- Coleoptera sp. B07
- Nocticola `BBL043`(quartermainei gp)
- Nocticola `BLA008`
- Nocticola `MH1` (=B34)
- Nocticola `OES11`
- Nocticola sp.
- Palpigradi `BPAL053`
- Palpigradi `MH1` (R)
- Parajapyx `BDP217` (R)
- Phaconeura `BHE035`
- Phaconeura `BHE036`
- Phaconeura sp. WAM `PHAC002`
- Projapygidae `BDP182`
- Projapygidae `BDP215`
- Symphylella sp.
- Symphylella sp. B20
- Troglarmadillo `BIS392`
- Troglarmadillo `BIS562`
- Troglarmadillo sp.
- Troglarmadillo sp. B54
- Tyrannochthonius `BPS229`
- Tyrannochthonius sp.

Legend

- Development Envelope
- Indicative Footprint

Troglofauna habitat

- CID / Pisolite
- Shaley / Unmineralised Marra Mamba
- Undifferentiated Sediments
- Upper Calcrete
- Mineralised (Altered) Marra Mamba

*Restricted troglofauna are denoted with (R) and presented as a red symbol

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: jcrute	Checked By: VC

Scale 1:148,000 at A3

0 1 2
Kilometers

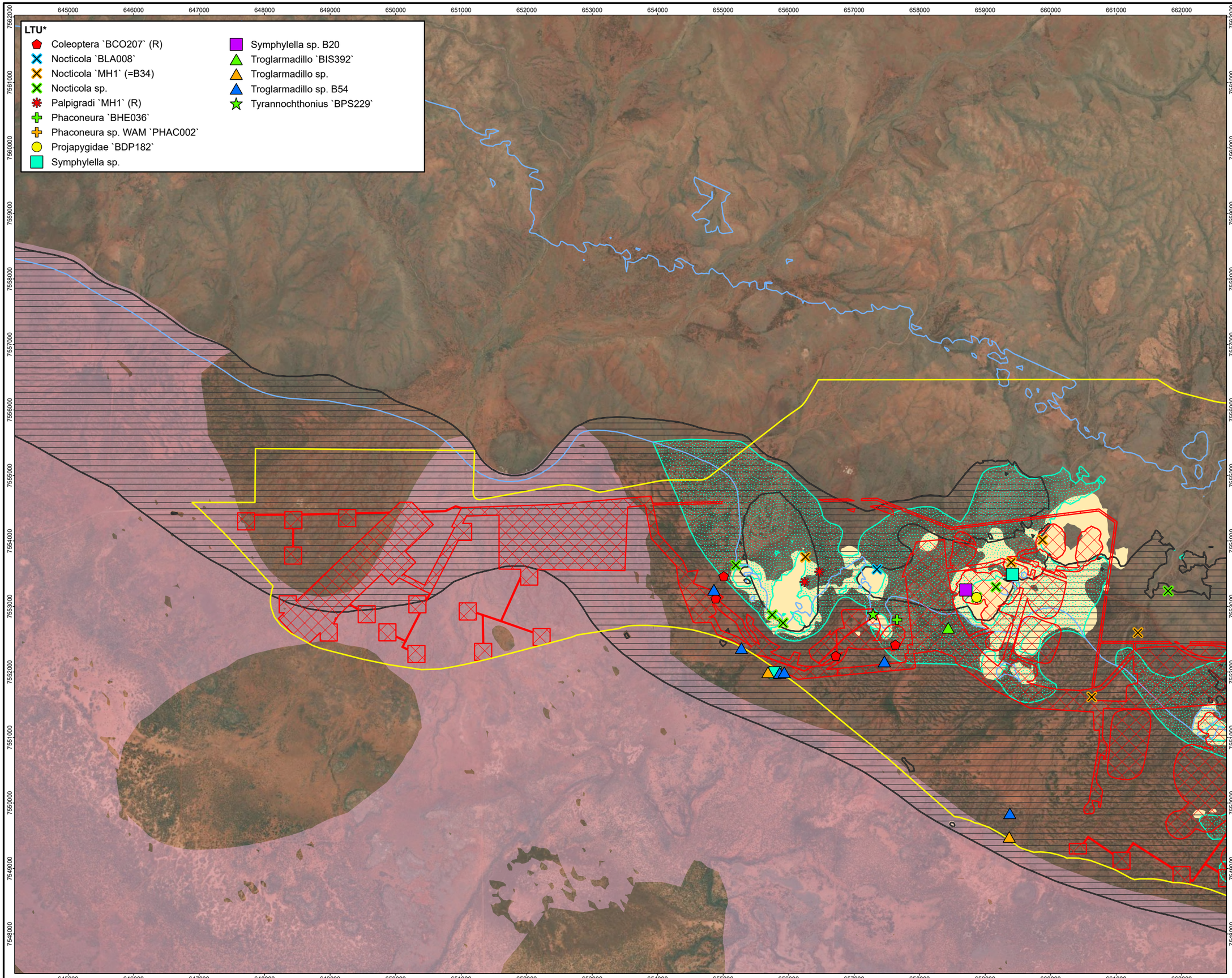
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LINEAR EXTENT OF "RESTRICTED" TROGLOFAUNA ACROSS SUITABLE SUBTERRANEAN HABITAT, CONGENERIC TAXA ARE INCLUDED

FIGURE 8.18 Map 1 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01_StygoTroglo.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.



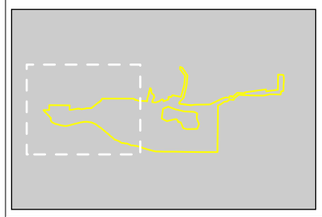
Legend

- Development Envelope
- Indicative Footprint

Troglofauna habitat

- CID / Pisolite
- Shaley / Unmineralised Marra Mamba
- Undifferentiated Sediments
- Upper Calcrete
- Mineralised (Altered) Marra Mamba

*Restricted troglofauna are denoted with (R) and presented as a red symbol



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: jcrute	Checked By: VC
Scale 1:53,000 at A3	

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LINEAR EXTENT OF "RESTRICTED" TROGLOFAUNA ACROSS SUITABLE SUBTERRANEAN HABITAT, CONGENERIC TAXA ARE INCLUDED

FIGURE 8.18 Map 2 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01_StygoTroglo.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

LTU*

- Austrochthonius `BPS257` (R)
- Buddelundia sp. B57 (R)
- Campodeidae `BDP216` (R)
- Coleoptera `BCO207` (R)
- Coleoptera sp. B07
- Nocticola `BLA008`
- Nocticola `MH1` (=B34)
- Nocticola sp.
- Palpigradi `BPAL053`
- Parajapyx `BDP217` (R)
- Phaconeura `BHE035`
- Phaconeura `BHE036`
- Phaconeura sp. WAM `PHAC002`
- Projapygidae `BDP182`
- Symphylella sp.
- Symphylella sp. B20
- Troglarmadillo `BIS392`
- Troglarmadillo `BIS562`
- Troglarmadillo sp.
- Troglarmadillo sp. B54
- Tyrannochthonius `BPS229`

Legend

- Development Envelope
- Indicative Footprint

Troglofauna habitat

- CID / Pisolite
- Shaley / Unmineralised Marra Mamba
- Undifferentiated Sediments
- Upper Calcrete
- Mineralised (Altered) Marra Mamba

*Restricted troglofauna are denoted with (R) and presented as a red symbol

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 27-Mar-2025

Drawn By: jcrute | Checked By: VC

Scale 1:53,000 at A3

0 1 2 Kilometers

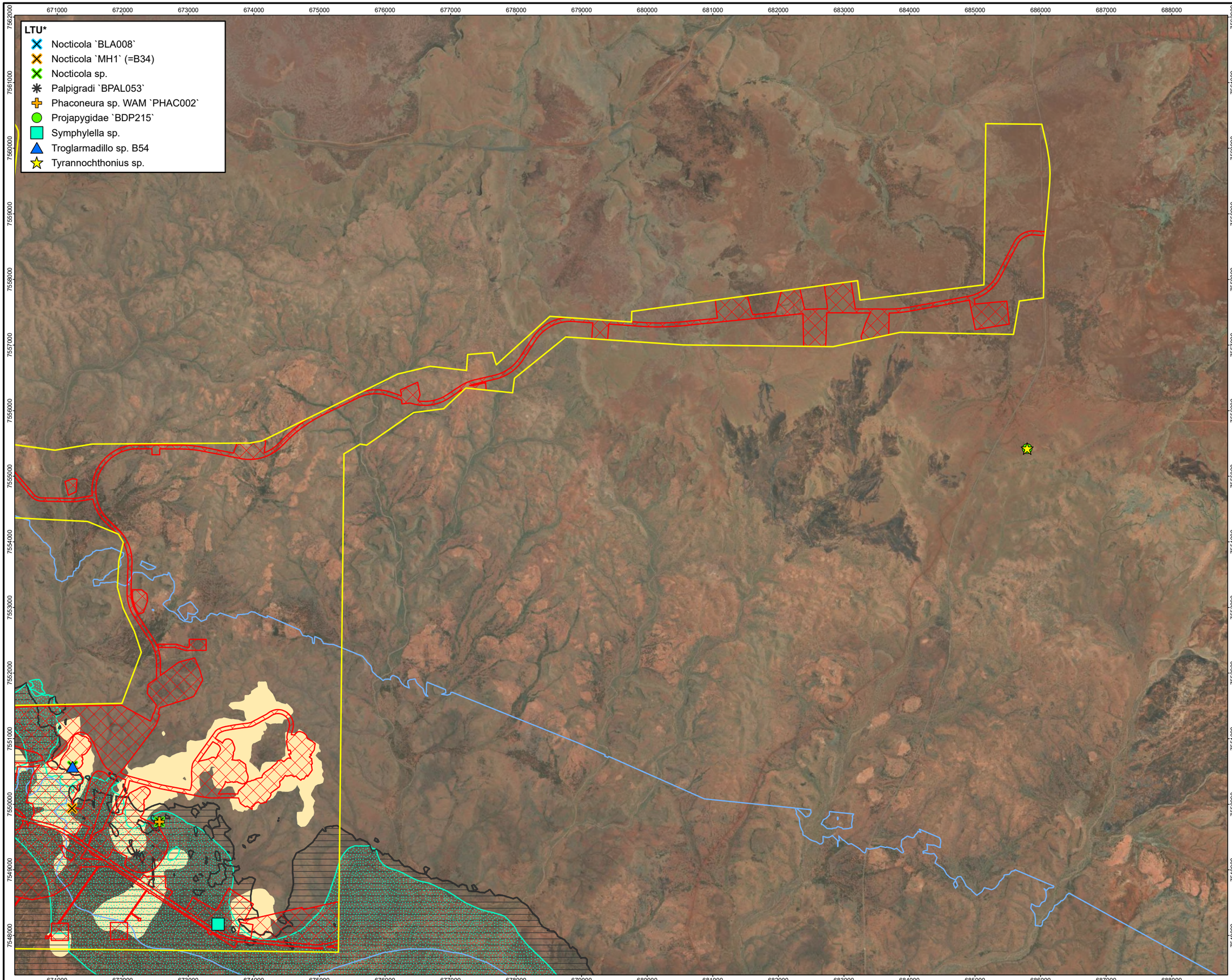
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LINEAR EXTENT OF "RESTRICTED" TROGLOFAUNA ACROSS SUITABLE SUBTERRANEAN HABITAT, CONGENERIC TAXA ARE INCLUDED

FIGURE 8.18 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01_StygoTroglo.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.



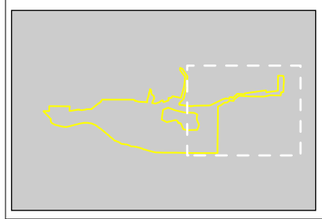
Legend

- Development Envelope
- Indicative Footprint

Troglofauna habitat

- CID / Pisolite
- Shaley / Unmineralised Marra Mamba
- Undifferentiated Sediments
- Mineralised (Altered) Marra Mamba

*Restricted troglofauna are denoted with (R) and presented as a red symbol



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: jcrute	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LINEAR EXTENT OF "RESTRICTED" TROGLOFAUNA ACROSS SUITABLE SUBTERRANEAN HABITAT, CONGENERIC TAXA ARE INCLUDED

FIGURE 8.18 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01_StygoTroglo.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

8.3.4.3 Stygofauna

In total, 12,045 specimens of at least 150 stygofauna species have been collected from the MDIOM. Up to six species may be duplicate names and at least two worm species, may comprise multiple species. Invertebrate groups represented at the MDIOM include copepods, ostracods, amphipods, annelid worms, syncarids, rotifers, isopods, mites, spelaeogriphacids, flatworms and nematode worms (treated as a single species but together with flatworms and rotifers not assessed in environmental impact assessments; EPA 2016).

The most frequently collected species was *Diacyclops humphreysi* s.l., which was collected 127 times (1,691 animals). The type locality of *Diacyclops humphreysi* is at Cape Range (Pesce and de Laurentiis 1996) and genetic analysis by Bennelongia and others indicates *Diacyclops humphreysi* s.l. comprises several locally widespread, cryptic species but the taxonomy of the lineage and distributions of the constituent species remain to be formalised and defined.

Thirteen stygofauna species were identified as having limited ranges and considered restricted by Bennelongia (2024a). *Achaeta* sp. Is considered amphibious and therefore is not included in the number. There are no potential duplicate species in the list however there is still some uncertainty regarding the final identifications of some of the taxa (**Table 8-7**). The rationale behind how the troglofauna were further defined was also applied to the stygofauna and the factors which determine whether they are at low to high risk is outlined in **Table 8-7**.

Ranges of stygofauna species within the MDIOM are very variable, even when known stygophiles (with potential for surface dispersal) are excluded. Bennelongia concluded that when stygophiles are included, nearly half of the species recorded at MDIOM have linear ranges >70 km. While the known ranges of most species expand as the amount of sampling increases, it would still be expected and the theoretical considerations put forward in Eberhard et al. (2009) and Halse et al. (2014) that most species known only from single sites at the MDIOM have linear ranges of <30 km. Fifty-seven per cent of stygofauna species known only from areas of groundwater disturbance were collected from single holes on one or more dates, compared with 18% of all stygofauna species. Thus, a substantial proportion of the species known only from areas of groundwater disturbance are likely to have relatively small ranges.

These taxa were also collected from more than one sampling location. While still considered within a limited linear range and within the areas of proposed impact, this demonstrates dispersal. Many of the syncarids in the Pilbara are known to disperse along drainage lines within the same catchment. However, in more complex hydrological settings where there is discontinuity, dispersal is limited (Perina et al, 2024). The hydrological setting at Mulga Downs is continuous.

On review of the data, the majority of the taxa listed as restricted were collected from sites with a high diversity of other stygofauna, including species from the same taxonomic group. This is to be considered when assessing dispersal capability of stygofauna, particularly in environments where the is connectivity. While these 13 taxa have been categorised as restricted, their capacity to disperse is considered in this assessment.

None of the stygofauna taxa, nor the communities recorded in the Development Envelope, are listed or recognised as having conservation significance under the BC Act or DBCA listings.

Table 8-7: Stygofauna identified as having linear ranges only within the area impact (restricted) at MDIOM. Risk Ranking identified.

Taxon (LTU)	Taxonomic factors	Impact type	Distribution	Risk Ranking
Areacandona `BOS1381`	Taxonomy was based on morphology. One specimen was collected in 2011 and was integrated male. 2019 identifications on valves only. Specimen was noted as potentially being *A. clementia.* No molecular analyses completed.	Drawdown and Mounding	Known Linear range of 7 km. Collected from Robinson Well and MD0462. Salinity (measured as electrical conductivity) ranges (in situ collection from first 1 m of water column) 3,130 µS/ cm to 3,990 µS/ cm at this site. Specimen collected at 3,990 µS/ cm.	Moderate. All other ostracods collected had a greater range.
Atopobathynella sp. B09 (Parabathynellidae `MH1`)	Taxonomy on morphology. Two specimens from 2012 collected using a Karaman-Chappuis. Specimens collected using net included 3 juveniles. No molecular analyses completed.	Drawdown and Mounding	Known linear range of 3 km. Karaman-Chappuis used at md_kar7 no details on depth to SWL or end of hole (EoH). Other specimens were from MD0429 collected in 2012. No field data collected.	Low. Collected in 2012, no field data and absence of information on taxonomy.
Billibathynella `BSY244`	Closest match from BLAST search was with Parabathynellidae sp. Biologic-PBAT003. DNA may be uncertain as definite morphological feature present on one male specimen	Drawdown	Ony collected from one site – MDWB0037 2022.	Moderate. To be considered in terms of habitat
*Brevisomabathynell*a `BSY233`	Specimen was small with very long antenna signifying stygofauna. Molecular analyses identified nearest match is *Brevisomabathynella pilbaraensis* which is 23.7% divergent. Considered a new species	Drawdown	Singleton.	High. New species.
Dussartstenocaris `BHA335`	Collected in 2022.Initial examination showed very long furca. Molecular analyses found nearest match was *Laophonte longicaudata*, which is 19.1%. Considered a separate species	Drawdown	Singleton. Collected from MDWB0038 in 2022. May be synonymous with *Dussartstenocaris* sp. B01 (65 specimens collected) which has a distribution range of 53 km	Moderate.

Taxon (LTU)	Taxonomic factors	Impact type	Distribution	Risk Ranking
Guineaxonopsis sp. B03 (S01 group)	Identification on morphology, specimen was dead on collection	Drawdown and Mounding	Has a linear range of 20 km.	Low. Sample was dead on collection and has large linear range
Maarrka `BAM182`	Molecular sequencing found 19.9% and 14.5% divergent from specimens at site Unknown 5 and *Maarrka* sp. 1 TLF-2008. New species	Drawdown	Collected only from one site twice in 2020 and 2022 - MDWB0038 (site renamed from MDCMB09). Shallow SWL of 5 m for EoH at 28 m.	Moderate to high. Single site and a new species
nr *Billibathynella* `MH2` (Parabathynellidae `MH2`)	No comments on this specimen and ID only on morphology	Drawdown and Mounding	Known linear range of 18 km. Collected in 2012 from md_kar6 using Karaman-Chappuis and sites MD0369, MD0509' MD0533' MD0562 using net.	Low. Large linear range, samples collected in 2012, no field data and absence of information on taxonomy
Parabathynellidae `MH3`	ID on morphology and no notes for this taxon	Drawdown and Mounding	Singleton. Collected in 2012 at MD0525	Low. Collected in 2012, no field data and absence of information on taxonomy
Pilbaranella `MH1`	ID on morphology only. Specimen has DNA barcode. *Pilbaranella* `BSY380` was matched to *Pilbaranella* `MH1` with 15.6% divergence	Drawdown and Mounding	Linear range of 16 km. All collected in 2012 from md_kar 6, MDO499, MD0577, MD0462, MD0974	Low. Collected in 2012, no field data and absence of information on taxonomy
Pilbaranella `MH2`	ID on morphology only	Drawdown and Mounding	Singleton only collected at MD0462 in 2012.	Low. Collected in 2012, no field data and absence of information on taxonomy
Pilbaranella sp. B18	ID on morphology only	Drawdown and Mounding	Singleton only collected at MD0974 in 2014	Low
Schizopera `BHA277`	ID on morphology only	Drawdown	Singleton collected from MDPZ7458C in 2019	Moderate. Few copepods are restricted

8.3.4.4 Stygofauna Distribution and Habitat Connectivity

There has been extensive sampling for stygofauna undertaken within the Development Envelope and surrounding areas since 1997. Intensive sampling for the Proposal commenced in 2019, however sample locations have been primarily restricted to impact areas, particularly within the extent of the predicted drawdown and MAR contours (refer to **Figure 7-4**). Limitations to sampling undertaken to date are detailed in the reports provided in **Appendix 8**. As with most subterranean surveys, the taxonomic resolution of this group remains poor. The uptake of molecular sequencing has provided some insight into groupings; however, they are still a poorly studied group with much of the data collected considered a competitive advantage. For this reason, there are many unnamed taxa which places them in the category of 'restricted" and at greater risk from potential impacts.

Many of the samples collected using phreatic haul nets yield a highly diverse catch and many well-known taxa which have known ranges across Western Australia. Other taxa still showed limited distribution, again, mostly because of the lack of information. The high yield of specimens, especially in respect to the ostracods provided the material needed to identify the shrimp.

The distribution of restricted stygofauna is shown in **Figure 8-19** and **Figure 8-20**.

Biological Connectivity

The distribution of the stygofauna within the MDIOM areas and beyond the area of impact is presented in Bennelongia 2024a. The area has a highly diverse and abundant stygofauna community. The records show distribution of taxonomic groups across the different hydrogeologies/aquifers.

Stygofauna found to have limited ranges from the survey data is presented in **Figure 8-19** to **Figure 8-21**. These taxa have been mapped across the subterranean habitats as defined by AQ2 (2024b). The distribution is based on areal extent. Given there is a connection between each of the aquifers it is highly likely that the stygofauna exist in more than one aquifer. To demonstrate biological connectivity, congeneric taxa are also shown in **Figure 8-21**. The distribution of these taxa demonstrates the extend of movement for many of the same taxonomic groups, the *Areacandona* are an example.

Records of stygofauna beyond the scope of the 3D habitat mapping, are primarily in drainage lines. This is expected as most sampling is undertaken in production or monitoring bores. To demonstrate biological connectivity two groups were chosen – the ostracod *Areacandona* `BOS1381` and the copepods (*Schizopera* spp. and *Dussartstenocaris* spp.). These three taxa were considered "restricted" because of few yields in samples and their limited range. While they had limited ranges, based in the locations of other ostracod and copepod records at MDIOM it is unlikely these three are restricted and true SREs. *Areacandona* `BOS1381` was collected form two boreholes, while both in areas of impact, demonstrates dispersal (**Figure 8-21).**

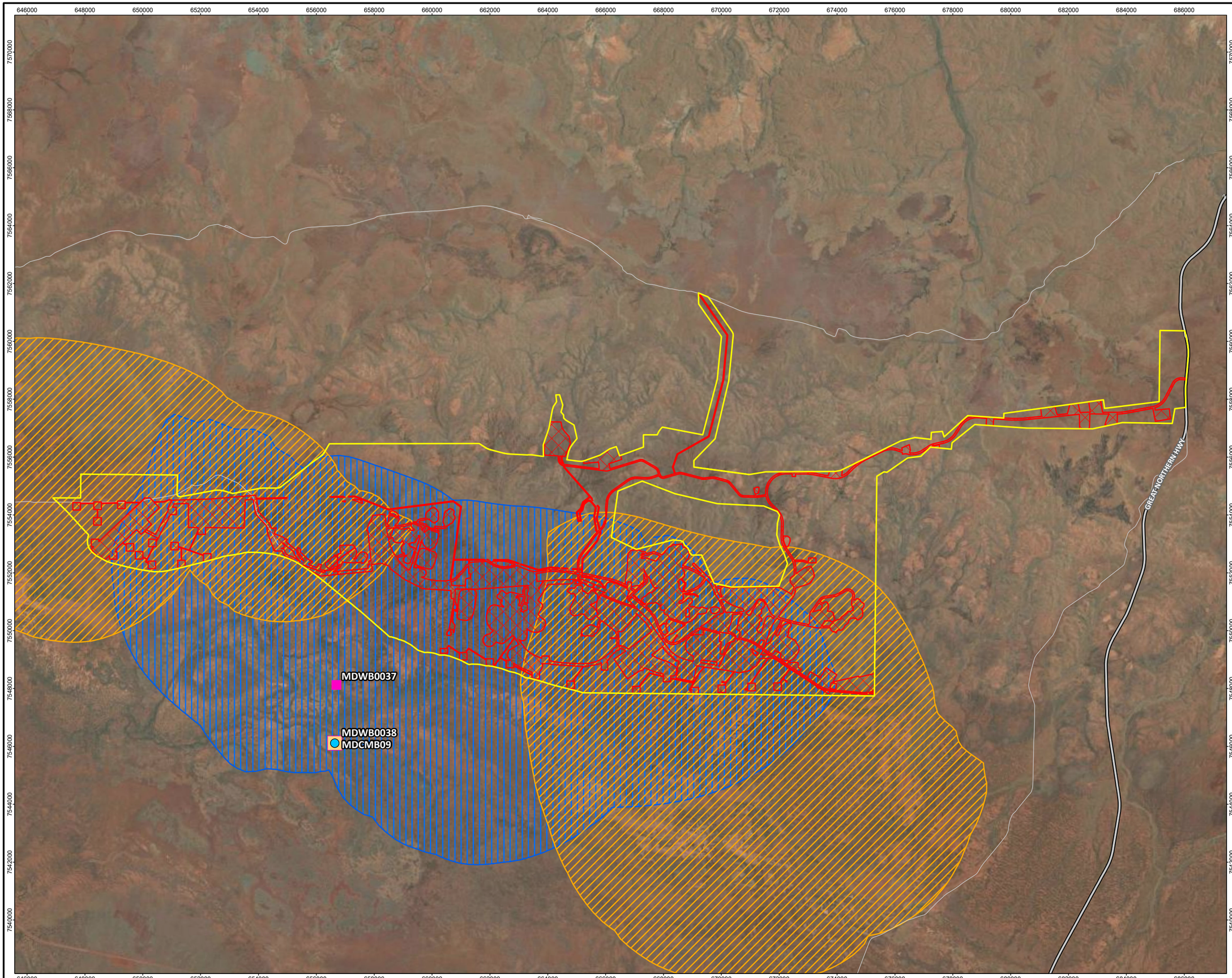
The ostracods are one of the dominant taxa in the Pilbara groundwater. In the Fortescue system they can be classified into three main categories with the taxa recorded at the Proposal aligning with the "lowland group" made up of *Areacandona* and *Humphreyscandona.* The distribution of the ostracods indicates connection with some taxa co-existing in the same bore hole. Their distribution along drainage lines and near the claypans in the calcrete area demonstrates their ecology (they readily disperse within a catchment along drainage lines (Reeves at al 2007)). They are often within calcrete areas because of their need to build their valves (OES 2009).

The dispersal pattern displayed by this group supports habitat connectivity as mitigating impacts to taxa which cannot be resolved. It is considered unlikely that the majority of the stygofauna will be restricted to impact areas within the Tertiary aquifer.

Similar pattern is displayed in the copepods. The copepods *Schizopera* spp. and *Dussartstenocaris* spp are shown to occur within the habitats of the Fortescue Valley palaeovalley. Records of the congeneric taxa are shown from east to west within this system.

Stygofauna records from the MDIOM show distribution of all taxonomic groups across all the habitat types and along mapped drainage lines. Many of the taxa occur in both the east and west sections showing the capacity for dispersal and biological connectivity. As with the majority of the subterranean studies in the Pilbara, dispersal is restricted to catchments and it is expected that the extent of many of the cryptic taxa will be within the greater Fortescue Valley Catchment – bounded by Goodaidarrie Hills and Millstream.

Figure 8-19: Distribution of stygofauna considered restricted (Class Malacostraca).



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown

Malacostraca

- Billibathynella `BSY244`
- Brevisomabathynella `BSY233`
- Maarrka `BAM182`

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

RESTRICTED STYGOFAUNA - (CLASS MALACOSTRACA) WITHIN THE MDIOM

FIGURE 8.19

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-20: Distribution of stygofauna identified as restricted (Class Maxillopoda and Ostracoda).

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

MD0462

ROBINSONS WELL

MDWB0038
MDPZ7458C

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown

Maxillopoda

- Dussartstenocaris `BHA335`
- Schizopera `BHA277`

Ostracoda

- Areacandona `BOS1381`

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

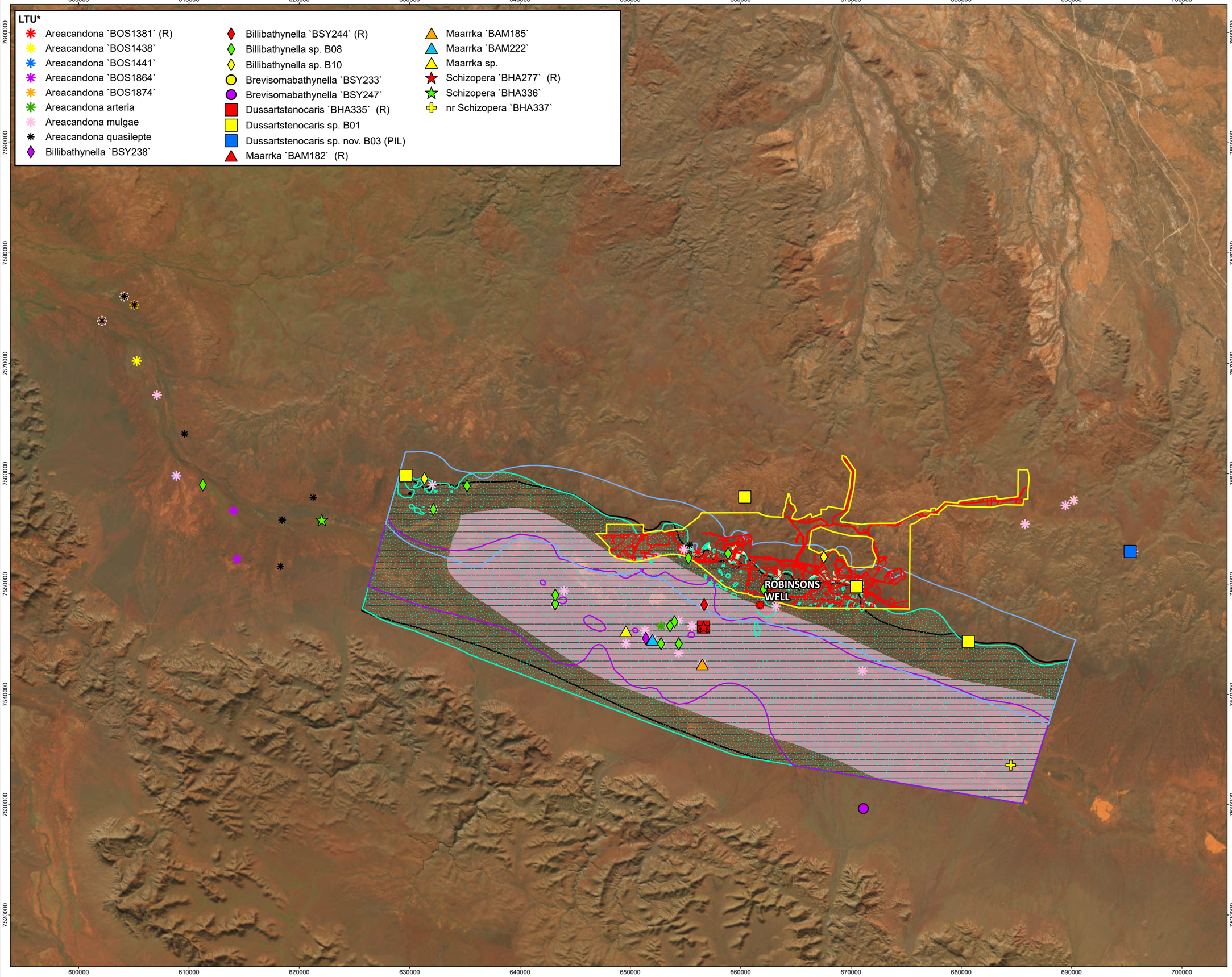
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

DISTRIBUTION OF STYGOFAUNA OF THE CLASSES MAXILLOPODA AND OSTRACODA WITHIN SUITABLE HABITATS

FIGURE 8.20

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-21: Linear extent of “restricted” stygofauna across suitable subterranean habitat. Congeneric taxa are included.



Legend

- Development Envelope
- Indicative Footprint

Stygofauna habitat

- Shaley / Unmineralised Marra Mamba
- Basal Crete
- CID / Pisolite
- Undifferentiated Sediments
- Upper Calcrete
- Mineralised (Altered) Marra Mamba

*Restricted stygofauna are denoted with (R) and presented as a red symbol

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: jcrute	Checked By: VC

Scale 1:316,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LINEAR EXTENT OF "RESTRICTED" STYGOFAUNA ACROSS SUITABLE SUBTERRANEAN HABITAT, CONGENERIC TAXA ARE INCLUDED

FIGURE 8.21 Map 1 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01_StygoTroglo.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

LTU*
- Areacandona `BOS1381` (R)
- Areacandona mulgae
- Areacandona quasilepte
- Billibathynella `BSY244` (R)
- Billibathynella sp. B08
- Dussartstenocaris sp. B01

Legend
- Development Envelope
- Indicative Footprint

Stygofauna habitat
- Shaley / Unmineralised Marra Mamba
- Basal Crete
- CID / Pisolite
- Undifferentiated Sediments
- Upper Calcrete
- Mineralised (Altered) Marra Mamba

*Restricted stygofauna are denoted with (R) and presented as a red symbol

ROBINSONS WELL

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: jcrute	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

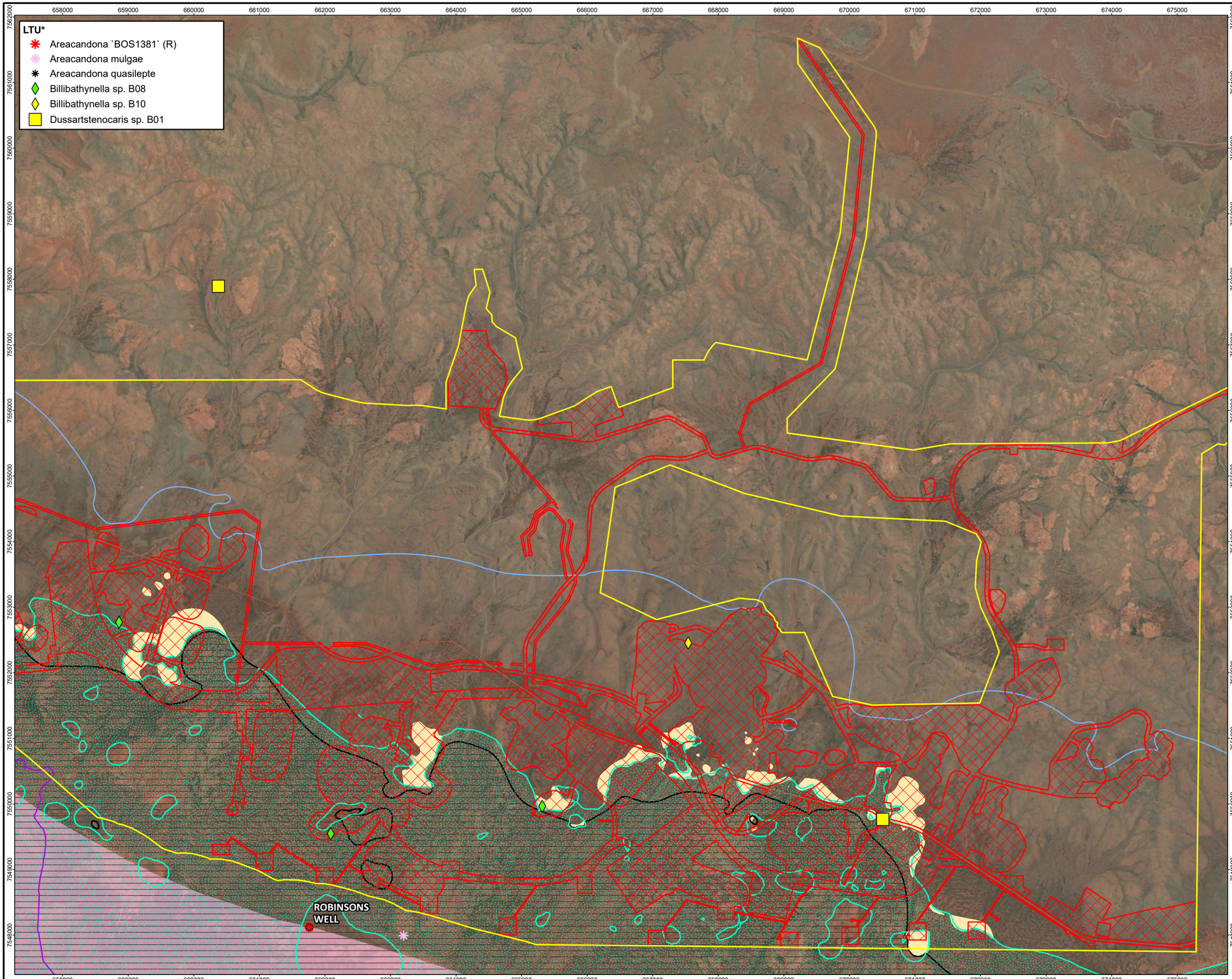
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LINEAR EXTENT OF "RESTRICTED" STYGOFAUNA ACROSS SUITABLE SUBTERRANEAN HABITAT, CONGENERIC TAXA ARE INCLUDED

FIGURE 8.21 Map 2 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01_StygoTroglo.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.



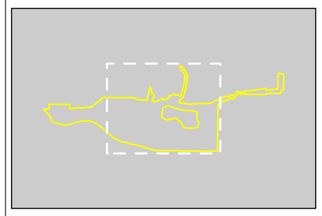
Legend

- Development Envelope
- Indicative Footprint

Stygofauna habitat

- Shaley / Unmineralised Marra Mamba
- Basal Crete
- CID / Pisolite
- Undifferentiated Sediments
- Upper Calcrete
- Mineralised (Altered) Marra Mamba

*Restricted stygofauna are denoted with (R) and presented as a red symbol



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: jcrute	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

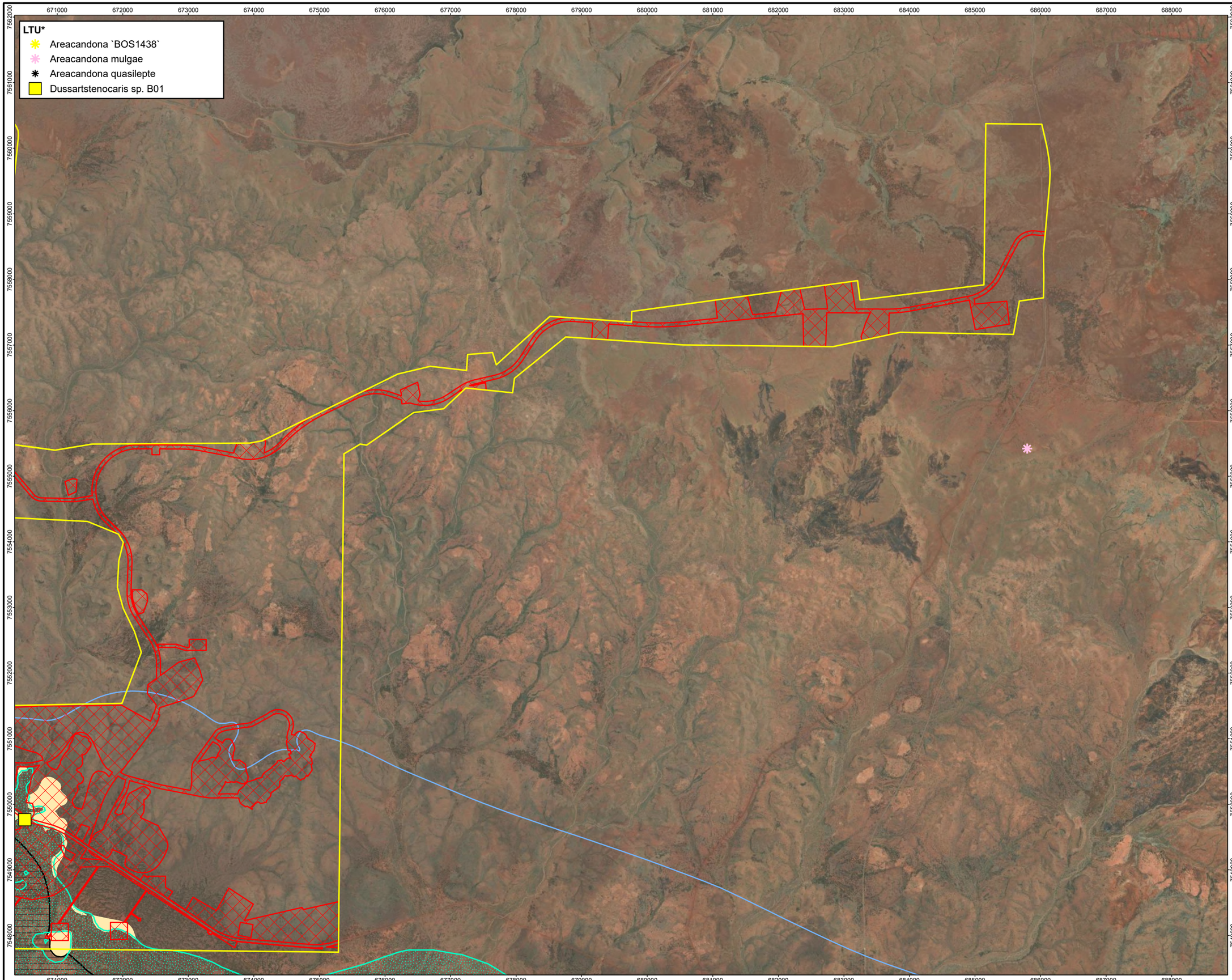
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LINEAR EXTENT OF "RESTRICTED" STYGOFAUNA ACROSS SUITABLE SUBTERRANEAN HABITAT, CONGENERIC TAXA ARE INCLUDED

FIGURE 8.21 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01_StygoTroglo.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.



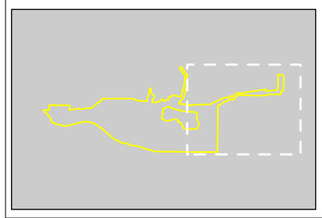
Legend

- Development Envelope
- Indicative Footprint

Stygofauna habitat

- Shaley / Unmineralised Marra Mamba
- CID / Pisolite
- Undifferentiated Sediments
- Mineralised (Altered) Marra Mamba

*Restricted stygofauna are denoted with (R) and presented as a red symbol



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: jcrute	Checked By: VC

Scale 1:53,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LINEAR EXTENT OF "RESTRICTED" STYGOFAUNA ACROSS SUITABLE SUBTERRANEAN HABITAT, CONGENERIC TAXA ARE INCLUDED

FIGURE 8.21 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01_StygoTroglo.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

Salinity ranges of stygofauna within the Development Envelope

The inferred upper salinity tolerances of eight potentially restricted stygofauna species were estimated using a formal methodology that is likely to be accurate for most species collected from a large number of sites (refer to BEC 2024b) (**Appendix 22**). However, the species in Table 2 (in **Appendix 22)** were collected from few sites (1-5) and in such circumstances the inferred upper salinity tolerance of species may be underestimated for some species. At the same time, in agreement with values in Table 2, there is broad-based information suggesting more than 80% of Pilbara stygofauna species have mean occurrence of < 1,800 mg/L.

An assessment of the likely upper salinity tolerances of selected 'restricted' stygofauna species that occur in groundwater mounding associated with MAR were developed from data collected by BEC (2024b). The mean, minimum and maximum salinity occurrence was extracted for all Pilbara stygofauna species in BEC's subterranean fauna database that have at least four records of occurrence accompanied by salinity measurements. Bennelongia has conducted extensive stygofauna sampling in the Pilbara since 2007. The likely salinity tolerances of 26 stygofauna which were considered to be 'restricted' were inferred from the broad pattern of salinity tolerances for different stygofauna groups in the Pilbara.

While there may be some error in inferred salinity tolerances of individual species, BEC (2024b) provides an informed assessment of the general salinity tolerance characteristics of the 'restricted' species. Of the 'restricted' species identified during surveys for the Proposal, four species appear likely to be found only in groundwater of <500 mg/L, four species appear likely to be found in groundwater of about 500 mg/L -1,000 mg/L, 11 species are likely to be found in water of about 1,000 mg/L-5,000 mg/L and seven species in water about 5,000 mg/L-10,000 mg/L. One species, for which salinity contours were used to derive its salinity record, has an inferred maximum salinity of 11,100 mg/L but is treated here as occurring in the 5,000 mg/L-10,000 mg/L group. It appears that very few species present will have salinity ranges extending to >10,000 mg/L TDS.

8.4 Potential Impacts

An impact assessment requires knowledge of the distribution of species within and beyond a development footprint, and therefore it is important to determine the range of each species and the availability of suitable habitat beyond the impact area. Limitations in the ability to survey subterranean fauna result in uncertainties in modelling their distribution patterns and are compounded by a lack of knowledge of habitat preferences and responses to impacts. In addition, the ecology of subterranean fauna also presents specific problems in delineating species (EPA 2012; Halse 2018; Framenau et al, 2021).

An assessment of the potential direct, indirect and cumulative impacts of the Proposal to troglofaunal and stygofauna values in consideration of the EPA objectives is provided below.

8.4.1 Direct impacts to Troglofauna

The direct impacts to troglofauna from implementation of the Proposal are from the excavation of the mine pits (including some proposed borrow pit areas) and MAR leading to mounding. These impacts have the potential to result in:

- Loss of troglofauna habitat; and
- Loss of troglofauna species.

8.4.1.1 Loss of Troglofauna habitat

Direct loss of habitat is typically considered the most significant impact to subterranean fauna. The excavation of the mine pits will result in permanent removal of troglofaunal habitat. Habitat may also be impact from groundwater mounding from MAR. These impacts have been presented as a volumetric area and percent of potential habitat loss are presented in in **Table 8-8.**

The geological units considered **Likely** habitat are the Upper Calcrete, Mineralised Marra Mamba and CID / Pisolite units (Tertiary Detritals).

In total an estimated 195,127,440 m^3 of Tertiary Detritals will be impacted across both mining and predicted MAR.

Of this:

- An estimated 66,731,740 m^3 will be permanently lost during excavation of ore and formation of pits. Of which, the greatest volume lost will be in the Mineralised Marra Mamba unit; and
- An estimated 128,395,700 m^3 of habitat will be altered because of mounding levels from MAR. There is the capacity for the groundwater to return to baseline conditions and therefore while a significant impact, it is not permanent. The greatest impacts are to the Upper Calcrete and CID/Pisolite units.

The Undifferentiated Tertiary unit in which troglofauna habitat is **Possible** will be reduced by an estimated 285,573,000 m^3. Of this:

- An estimated 25,833,000 m^3 will be permanently removed through mining; and
- An estimated 259,740,000 m^3 will be temporarily lost from MAR.

Table 8-8: Potential Troglofauna Habitat (volumetric) which will be impacted from excavation and/or mounding (MAR)

Troglofauna Habitat	Habitat Likelihood	Predicted Volume (m^3) Impacted (Excavation)	Predicted Volume (m^3) Impacted (Mounding)	Total Predicted Volume Impacted (m^3)
Upper Calcrete	Likely	374,740	71,185,000	195,127,440
CID / Pisolite		12,275,000	53,598,000	
Mineralised Marra Mamba		54,082,000	3,612,700	
Undifferentiated Tertiary	Possible	25,833,000	259,740,000	285,573,000
Alluvium	Unlikely	11,922,000	90,168,000	373,795,500
Shaley / Unaltered Marra Mamba		7,895,500	263,810,000	
Total		**112,382,240**	**742,113,700**	**854,495,940**

Table 8-9: Predicted Percentage of Habitat Lost within the Area of Impact (excavation and mounding)

Troglofauna Habitat	Habitat Likelihood	Total Habitat (m^3) Within Predicted Area of Impact (Pre-Mining)	Predicted Volume (m^3) Impacted (Excavation and Mounding)	Predicted Percentage of Habitat Lost Within Area of Impact
Upper Calcrete	Likely	193,130,000	71,559,740	37%
CID / Pisolite		255,490,000	65,873,000	26%
Mineralised Marra Mamba		82,491,000	57,694,700	70%
Undifferentiated Tertiary	Possible	1,036,600,000	285,573,000	28%
Alluvium	Unlikely	839,190,000	102,090,000	12%
Shaley / Unaltered Marra Mamba		2,178,600,000	271,705,500	12%
Total		**4,585,501,000**	**854,495,940,**	**19%**

8.4.1.2 Loss of Troglofauna species

The mining of the ore involves the excavation of material will results in the loss of troglofauna habitat. This has the potential to cause the loss of troglofauna species. The species which have been identified as having limited ranges and considered restricted, are the most at risk. Troglofauna typically have less dispersal capabilities compared to stygofauna and naturally shorter ranges. The troglofauna identified from Mulga Downs which occur within the Mineralised Marra Mamba are primarily either singletons or their ranges only extend 500 m outside of the pit. This habitat exists as discontinuous pods. Areas of Mineralised Marra Mamba occur outside of the pits which allows for a level of dispersion for these taxa.

At present, six of the troglofauna in **Table 8-10** are considered to have limited ranges and were recorded from within the Mineralised Marra Mamba Unit.

The majority of the taxa appear to be present within the Undifferentiated Tertiary Detritals. This unit lies between the Upper Calcrete and CID/Pisolite habitats. It was found to be continuous, extending across the Development Envelope along the slopes of the Chichester Range. There are several records of restricted troglofauna from holes which intersect this unit.

One of the defining characteristics of subterranean fauna globally is the high level of regional and short-range endemism (Eberhard et al. 2007). Troglofauna are less likely to have the dispersal extents that stygofauna have. Troglofauna have been found to live within working pits and to recolonise areas where mining has ceased (for example at Mesa A (EPA 2012).

Mining will result in a high level of risk to six troglofauna taxa only found within the Mineralised Marra Mamba habitat. However, with respect to the EPA's objective for this factor, if the taxa are found to have a greater extent of occurrence, then mitigation measures can be applied to work toward meeting the EPA's objective. The physical and biological connectivity observed in the data at MDIOM indicates that there is the ability for these taxa to disperse and therefore have greater ranges than is presented in BEC (2024a) in particular within the Undifferentiated Tertiary habitat. Over 99 % of this habitat will not be impacted by the Mine.

Table 8-10: Troglofauna identified as most at risk from implementation of

Taxon	Impact Type	Distribution within Likely Habitat	Risk from Proposal
Taxon potentially at risk			
Austrochthonius `BPS257`	Pit and mounding	These taxa were all collected from within the mine pits and the Mineraliised Marra Mamba habitat. Up to 65% of this habitat will be lost. Abutting these areas, small amounts of habitat remain. While the loss of habitat is considered high, these taxa are presently at risk based on linear ranges from samping effort being concentrated in these areas and the true extent of distribution unknown. *Buddelundi*a sp. 57 is presently only in impacted areas. However is under review and shows capacity for dispersal.	The risk to these taxa at present remains high as they are only located within habtats which are discontinous. Additional sampling may yield more locations. However this habitat appears to be the most suitable for these species given the repeated collections in the same habitat type A targeted survey has been scoped for 2025 to identify the gap in knowledge
Buddelundia sp. B57	Pit and mounding		
Campodeidae `BDP216`	Pit and mounding		
Coleoptera 'BCO207'	Pit and mounding		
Palpigradi sp. MH1	Pit and mounding	Linear range 0.3 km. Both records of this species were within the mine pits.	Palpigradi sp. MH1 is considered at risk from this Proposal as it has only been recorded from Mineralised Marra Mamba within a mine pit. A targeted survey has been scoped for 2025
Parajapyx `BDP217`	Pit and mounding	This species was recorded in mine pits of the Mineralised Marra Mamba habitat. Up to 65% of this habitat will be lost. Abutting these areas, small amounts of habitat remain. While the loss of habitat is considered high, these taxa are presently at risk based on linear ranges from samping effort being concentrated in these areas and the true extent of distribution unknown.	Parajapyx `BDP217` is considered at risk from this Proposal as it has only been recorded from Mineralised Marra Mamba within a mine pit. A targeted survey has been scoped for 2025
Taxon not considered at risk			
Nocticola 'BLA008'	Pit and mounding	Linear range 15.5 km. This species was collected from both the Mineralised Marra Mamba habitat and the Upper Calcrete Habitat. A record of this species is at Brockman Syncline. This taxon is not restricted.	*Nocticola* 'BLA008' is not considered at risk from this Proposal
Phaconeura 'BHE036'	Mounding	The Upper Calcrete / Calcrete Habitat supports a number of troglofauna. Over 99% of this habitat will remain. While mapped in Calcrete habitat which is discontinuous, the sample site smay also intersect the Undifferentiated Tertiary/Sediment habitat which is continuous.	*Phaconeura* 'BHE036' is not considered at risk from this Proposal

Taxon	Impact Type	Distribution within Likely Habitat	Risk from Proposal
Projapygidae `BDP182`	Pit and mounding	This taxon was colleced from within the Mineralised Marra Mamba Habitat. Up to 65% of this habitat will be lost. Abutting these areas, small amounts of habitat remain. While the loss of habita is considerd high, these taxa are presently at risk based on linear ranges from samping effort concentrated in these areas and the true extent of distribution unknown. It is also found in the The Upper Calcrete / Calcrete Habitat supports a number of troglofauna. Over 99 % of this habitat will remain. While discontinuous, it does lie over the Undifferentiated Tertiary/Sediment Habitat.	Projapygidae `BDP182` is not considered at risk from this Proposal
Projapygidae 'MH1'	Pit and mounding	The Upper Calcrete / Calcrete habitat supports a number of troglofauna. Over 99% of this habitat will remain. While discontinuous, it does lie over the Undifferentiated Tertiary /Sediment habitat.	Projapygidae 'MH1' is not considered at risk from this Proposal
Symphylella sp. B20	Pit and mounding	The species appears to inhabit the Undifferentiated Tertiary/Sediment habitat. Symphyllans are truely subterranan fauna. The connectivity of this habitat across the Chichester allows for dispersal. This unit also appears to be intersected by the various drainage lines from the Chichester. Catchments are usually the extent of occupancy for many subterranean fauna. The high diveristy at Mulga Downs may be influenced by the many subcatchments feeding into this area and providing dispersal for many taxa especially troglofauna.	*Symphylella* sp. B20 is not considered at risk from this Proposal
Troglarmadillo 'BIS392'	Mounding	Both *Troglarmadillo* taxa were recorded from bores which intersect the Upper Calcrete/Calcrete Habitat which supports a number of troglofauna. Over 99% of this habitat will remain. While discontinuous, it does lie over the Undifferentiated Tertiary/Sediment Habitat which is continous.	*Troglarmadillo* 'BIS562' and *Troglarmadillo* 'BIS392' are not considered at risk from this Proposal
Troglarmadillo 'BIS562'	Mounding		
Tyrannochthonius `BPS229`	Mounding	Drill holes MD4821 and MD1556 are located within the Undifferentiated Tertiary/Sediment Habitat. This unit is continuous, extending across the Development Envelope along the slopes of the Chichester Range. Other taxa colected from this hole include *Cryptos* MH1 (=DNA05) and Pauropodidae BPU089. Over 97% of this habitat will remain after mining. 28% of this habitat will be impacted by mounding and excavation, leaving over 70% of continuous habitat remaining and mitigating any risks from potential fragmentation.	*Tyrannochthonius* `BPS229` is not considered at risk from this Proposal.

8.4.2 Indirect Impacts to Troglofauna

Indirect impacts to troglofauna have been identified as:

- Clearing of vegetation and construction of infrastructure (i.e. WRD, RoM pads) – resulting in the loss of energy transfer to the subterranean environment);
- Contamination of subterranean environment from mine activities – such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste dumps, and use of saline mine water for dust suppression in mine area; and
- Changes to groundwater affecting humidity in vadose zone.

8.4.2.1 Clearing of vegetation and construction of infrastructure

The trophic paths for troglofaunal subterranean environments are not well studied, however it is understood that the source is the terrestrial environment. Removal of vegetation and construction of above ground infrastructure is likely to change the subsurface environment and reduce nutrient inputs, impacting on the subterranean habitat.

8.4.2.2 Contamination of subterranean environment from mine activities

There is the potential for contaminants to seep into the subterranean environment as a result of chemicals, hydrocarbons and waste used and/or produced during construction and operation of the Proposal. There is the risk of contamination from hydrocarbon spills and leaching from the waste rock.

The use of saline mine decant water within the mine area to suppress dust has the potential to increase salinity levels of surface water which may move through into subterranean fauna habitat.

8.4.2.3 Changes to groundwater affecting humidity in vadose zone (altered hydrology)

Troglofauna are relict species that are understood to have sought refuge from the transition to a more arid continent. They rely on moisture to breath in a low oxygen environment and are susceptible to dehydration. Changes to groundwater levels have been known to alter the humidity of the subterranean environment, reducing the quality of habitat for troglofauna. However, many of the taxa recorded within pits (troglobitic taxa) belong to groups which are known to migrate vertically and horizontally moving to moist areas (Villani et al 1999).

8.4.3 Direct Impacts to Stygofauna

The direct impact to stygofauna from implementation of the Proposal will be from the excavation of pits, groundwater drawdown and changes to groundwater salinity (quality) as a result of the dewatering and MAR. These impacts will result in:

- Loss of habitat from excavation of pits below the water table or changes in groundwater levels (≥ 1 m);
- Reduction in quality of habitat due to salinity changes; and
- Loss of stygofauna species (specifically restricted taxa).

8.4.3.1 Loss of Habitat

Loss of Habitat from Pit Excavation

There will be loss of stygofauna habitat where pit excavation occurs below the water table primarily with a reduction in the groundwater level of the Tertiary Aquifer. Stygofauna habitat has been confirmed within the aquifers underlying the proposed pit areas.

Loss of Habitat from Drawdown

Groundwater drawdown has the potential to reduce the amount and quality of stygofauna habitat. From the numerical modelling, the groundwater drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along strike (i.e. in a northwest – southeast direction) is curtailed by MAR Due to the progressive approach to the mining, the maximum extent of the 2 m drawdown occurs in different directions at different times. The maximum extent of the predicted 2 m drawdown contour extends ~6 km to the west, ~3.5 km to the east and ~7.5 km to the southwest across the majority of the valley's width; however, it is not predicted to reach the Hamersley Range or Karijini National Park.

The areal extent of dewatering drawdown is shown in **Figure 8-2** and **Figure 8-4** and is defined as a > 2 m drawdown.

The volume of habitat loss was calculated based on the top of the habitat reducing to the predicted minimum groundwater level surface over the LOM, taking into account groundwater level changes resulting from dewatering and MAR.

The loss of stygofauna habitat is presented in **Table 8-11**. For the Tertiary units (which have a defined base), the percentage of habitat lost within the predicted area of impact has been calculated and is presented in **Table 8-12**.

Table 8-11: Potential Stygofauna Habitat Loss During Mining (dewatering)

Stygofauna Habitat	Habitat Likelihood	Predicted Volume Impacted by Mining (m^3)	Predicted Volume (m^3) Impacted by Dewatering	Total Predicted Volume Impacted (m^3)
Upper Calcrete	Likely	0	556,380,00	671,449,100
CID / Pisolite		3,273,500	112,770,000	
Mineralised Marra Mamba		550,280	1,299,100	
Undifferentiated Tertiary /Sediment	Possible	1,415,200	482,930,000	482,930,000
Basal Crete		0	0	
Alluvium	Unlikely	0	3,776	533,134,266
West Angela Member		11,438	90,490	
Shaley / Unaltered Marra Mamba		13,937,000	533,040,000	
Total		**19,187,418**	**1,686,513,366**	**1,686,513,366**

Table 8-12: Predicted Percentage of Habitat Lost Within the Area of Impact

Stygofauna Habitat	Habitat Likelihood	Total Habitat (m^3) Within Predicted Area of Impact (Pre-Mining)	Predicted Volume (m^3) Impacted (Dewatering)	Predicted Percentage of Habitat Lost Within Area of Impact
Alluvium	Unlikely	3,776	3,776	100%
Upper Calcrete	Likely	3,554,200,000	556,380,000	16%
Undifferentiated Tertiary	Possible	7,687,100,000	482,930,000	6%
CID / Pisolite	Likely	2,978,200,000	112,770,000	4%
Basal Crete	Possible	2,151,5000,000	0	0%
Total		**16,371,003,776**	**1,152,083,776**	**10%**

The total pre-mining volume of Tertiary habitat within the predicted area of impact is 16,371,003,776 m^3. Of this 1,152,083,776 m^3 (10%) will be lost as a result of dewatering drawdown over the life of the mine.

Of this volume, the loss of likely habitat is predicted is estimated as:

- 556,380,000 m^3 of Upper Calcrete which equates to 16% of habitat which is likely to support stygofauna;
- 112,770,000 m^3 of the CID/Pisolite which equates to 4% of habitat which is likely to support stygofauna; and
- 482,930,000 m^3 of Undifferentiated Tertiary which equates to 6% of habitat which could support stygofauna.

Of the total volume of potential habitat that is predicted to be impacted (i.e., 1,686,509,590 m^3), 30% of the total predicted impact volume is within the lithological unit considered to be a likely habitat for stygofauna, 26% for possible habitat units and the remaining 44% for unlikely habitat units.

Groundwater levels are predicted to recover to 1 m below the pre-development level within 26 to 37 years after the end of mining and dewatering. The remainder of groundwater recovery to predevelopment levels is predicted to occur over a further 30 to 40 years. The loss of stygofauna habitat from drawdown is not expected to be critical given the extent of the aquifer which is unconsolidated.

Historical long-term hydrographs from the Proposal (AQ2 2025) indicate that seasonal responses to rainfall events have the potential to result in groundwater level variations of up to 1 m. As such, the predicted extent of the 1 m drawdown contour, throughout the life of the mine, has been used to define the extent of habitat impact. A more conservative extent of 2 m drawdown has been applied in respect to stygofauna survey design (BEC 2024a).

8.6.3.2 Reduction in quality of habitat due to salinity changes

Groundwater salinity will change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LoM is predicted to range between 1,700 and 4,200 mg/L,

taking into account the uncertainty associated with aquifer porosity, with this being the range of TDS concentrations that were then assigned to all MAR bores over the LOM (AQ2 2025).

The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be localised (i.e. <2 km in extent). This is demonstrated by both the simulated groundwater flow paths for the LoM and predicted salinity changes at the simulated observation points. Model predictions indicate that the key driver for groundwater salinity change is the proposed dewatering at Murray's Hill. This is predicted to result in increases to the dewatering discharge salinity as more saline water is drawn in from the valley areas. The subsequent re-injection of this more saline dewatering discharge into the Murray's West and Fridge / Horseshoe South MAR Borefields results in localised areas of increased groundwater salinity as well as subsequent increases to the combined dewatering discharge, as the re-injected water in the east is recirculated towards the Fridge West and Fridge Hill mining areas later in the LoM.

Taking into account the uncertainty associated with aquifer porosity, the greatest changes in salinity outside of the mining areas are predicted in three areas:

- In the Murray's West MAR Borefield area, the TDS is predicted to increase from approximately 1,200 mg/L to between 3,600 and 4,700 mg/L (for high and low porosity scenarios), recovering to between 2,700 and 3,500 mg/L, upon the cessation of MAR in this area and the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area.
- Down-slope from the Murray's Hill mining / MAR area, the TDS is predicted to increase from 3,600 mg/L to between 4,400 and 5,600 mg/L (for high and low porosity scenarios). However, when the Murray's Hill / Anticline area is used for MAR, the TDS is predicted to reduce, reaching between 3,300 and 4,300 mg/L by the end of mining.
- Down-slope from the Fridge / Horseshoe South MAR Borefield, the TDS is predicted to increase from approximately 2,300 mg/L to between 2,400 and 3,900 mg/L (for high and low porosity scenarios), with TDS at the end of mining predicted to range between 2,300 and 3,700 mg/L.

8.4.3.2 Loss of species

Up to 13 stygofauna were identified as being restricted based on their location within the areas of impact (BEC 2024a). For the purpose of EIA, restricted taxa are considered the most at risk from impacts to their habitat (EPA 2021). Of these 13 taxa, seven were from pre 2019 surveys and could only be identified to high order. It is unknown if these taxa were truly stygobitic. Data from pre 2019 surveys were not available and their stygofauna status could not be confirmed. These taxa were identified by BEC (2024a) as only known from areas with predicted groundwater drawdown from dewatering of ≥2 m and/or ≥1 m groundwater mounding from MAR (BEC 2024a). These taxa were collected from sample sites which intersect geological units assessed as being continuous. Records of stygofauna from the MDIOM show similar groups, including congeneric taxa (taxa belonging to the same genus), across and beyond the area of impact. The capacity for many of the stygofauna to disperse across the aquifer is demonstrated in Figure 8.21. As such, it is understood that biological and physical connectivity exists from within the area of impact and extending beyond, and stygofauna taxa are not restricted to sample location.

With respect to loss of taxa due to impacts to habitat (loss and changes to groundwater quality) the aquifer found to be likely to support stygofauna is considered extensive and continues along the Fortescue Valley. Many of the taxa identified have a greater distribution outside the Development Envelope (Figure 8.21). For example,

dispersal of stygal ostracods is known to occur within each catchment and not between catchments in the Pilbara. Dispersal has been found to occur along the extent of uninterrupted aquifers (Reeves et al., 2007) and the dispersal of stygofauna within the Development Envelope was evident with a number of taxa from different orders collected from several locations. A number of the singletons were also collected with stygal taxa which were found in several other locations in the Development Envelope (and area of impact extent) as well as beyond the extent of the impact.

Based on an assessment of the habitat connectivity and the volumes which will be lost from dewatering, the impacts to the six remaining at risk stygofauna taxa was found to be low. As outlined in **Table 8-13**, none of the remaining stygofauna taxa will be at risk from implementation of the Proposal.

Table 8-13: Stygofauna identified as most at risk from implementation of Proposal

Taxon (LTU)	Impact type	Distribution within Likely Habitat	Risk level from Proposal
Areacandona `BOS1381`	Drawdown and Mounding	Known Linear range of 7 km. Collected from Robinson Well and MD0462. Robinson Well lies within the area shown in cross sections 2 to 3. These cross sections show the modelled likely habitat of the Upper Calcrete / Calcrete. The changes resulting from mine development appear to have limited effect on the remaining aviable habitat. This was calculated as a potential loss of 16% of this habitat. This taxon was also collected from MD0462 which lies just out of the CID/Pisolite Habitat and in the Mineralised Mara Mamba Habitat. Only 4% of the CID/Pisolite is expected to be impacted from drawdown. These habitats are also continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive. Dispersal appears possible with numerous records of ostracods across these lithologies and the associated aquifers. Groundwater flow is in an east to west direction This taxon while only found at two locations, will not be at risk from the Proposal as it has more than 80 % of likely habitat remaining. *Areacandona* `BOS1381` also lies within an area which will be impact by MAR which for stygofauna can indicate a change is salinity. *Areacandona* `BOS1381` was collected from bore with an EC of 3,990 µS/cm. The changes to salinity and the impact on subterranean fauna will be managed through the Water Management Plan and the SFMMP.	*Areacandona* `BOS1381` is not considered at risk from implementation of this Proposal
Billibathynella `BSY244`	Drawdown	Only collected from one site – MDWB0037 in 2022. This bore is located within the Upper Calcrete / Calcrete aquifer and the cross section 2 and 3 indicate the changes which are predicted from drawdown. The Upper Calcrete /Calcrete habitat is continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive and it is expected that only 16% will be lost.	*Billibathynella* `BSY244` is not at risk from implementation of this Proposal
Brevisomabathynella `BSY233`	Drawdown	Both taxa were singleton collected at MDWB0038. This bore is located within the Upper Calcrete / Calcrete aquifer and the cross section 2 and 3 indicate the changes which are predicted from drawdown. The Upper Calcrete/Calcrete habitat is continuous across the valley within the predicted	*Brevisomabathynella* `BSY233` is not at risk from implementation of this Proposal

Taxon (LTU)	Impact type	Distribution within Likely Habitat	Risk level from Proposal
Maarrka `BAM182`	Drawdown	area of impact and beyond. The extent of drawdown is not laterally extensive and it is expected that only 16% will be lost. Both are new species and at higher risk of impacts from changes to their environment in particular as there were only found in one location.	*Maarrka* `BAM182` is not at risk from implementation of this Proposal
Dussartstenocaris `BHA335`	Drawdown	Singleton. Collected from MDWB0038 in 2022. This bore is located within the Upper Calcrete/Calcrete. Cross sections 2 and 3 indicate that the impacts from drawdown will be minimal. Like *Areacandona* `BOS1381`this species is capable of dispersing across this aquifer. The Upper Calcrete/Calcrete habitat is continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive and it is expected that only 16% will be lost.	*Dussartstenocaris* `BHA335` is not at risk from implementation of this Proposal
Schizopera `BHA277`	Drawdown	Singleton collected from MDPZ7458C in 2019. This bore is located within the Upper Calcrete in close proximity to MDWB0038. Cross sections 2 and 3 indicate that the impacts form drawdown will be minimal. This taxon is of the same Class as *Dussartstenocaris* `BHA335` and is also capable of dispersing across this aquifer. The CID/Pisolite habitat is continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive and it is expected that only 4% will be lost.	*Schizopera* `BHA277` is not at risk from implementation of this Proposal

8.4.4 Indirect Impacts to Stygofauna

The indirect impact which has the potential to effect stygofauna as a result of the Proposal is the contamination of subterranean environment from mine activities such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste rock.

There is the potential for contaminants to seep into the subterranean environment and be transported across the aquifer. There is the risk of contamination from hydrocarbon spills and leaching from the waste rock. The use of saline water within the mine area to suppress dust has the potential to increase salinity levels of surface water which move through into subterranean fauna habitat. These potential impacts may reduce the suitability of subterranean habitat.

8.4.5 Cumulative Impacts

The Proposal and other projects in the region may have a cumulative impact on inland waters at a regional scale through:

- Changes in surface hydrological regimes.
- Change in groundwater regimes (associated with drawdown from abstraction and mounding from MAR).
- Clearing, construction and operation of the Proposal.

The Murrays Hill Mine did not consider mining below groundwater and therefore there are no cumulative impact to stygofauna.

The Mulga Downs Hub and Rail Spur will not cumulatively add to subterranean fauna impacts as no substantial excavations are proposed or substantial groundwater abstraction.

The cumulative impacts associated with the construction and operation of the Proposal and other projects are discussed in more detail in the Cumulative Impact Assessment in **Section 17**.

8.5 Mitigation

HPPL has applied the mitigation hierarchy (avoid, minimise and rehabilitate) during Proposal design to reduce the potential impacts to subterranean fauna. The design of the Proposal has been planned to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope where possible since its referral in 2021. Three applications to amend the Proposal (under s43A of the EP Act) have been submitted by HPPL, each change resulting in a reduction in the potential environmental impacts of the Proposal on flora and vegetation. Overall, there has been a total reduction in the Development Envelope, Indicative Footprint and dewatering/MAR.

A summary of mitigation measures applied to address the key potential impacts on subterranean fauna are provided in **Table 8-14**.

The approach recommended by the EPA (EPA 2021g) has been applied in assessing the impact to subterranean fauna from the Proposal. The area is known to support a diverse subterranean community. The lack of taxonomic resolution remains the largest constraint in assessing the true range of all the restricted taxa. An extensive sampling program was applied for this Proposal. The low success rate of molecular analyses is another limitation. A detailed assessment of the habitats confirmed that the subterranean environments are connected and extend beyond the area of impact. The mapping of subterranean fauna records shows capacity for dispersal. Similar taxonomic groups were found across both impact and reference areas indicating biological connectivity.

The impacts to the habitat have been quantified and found that 19% of troglofaunal habitat will be lost from both excavation and mounding. It is to be considered that mounding is not a permanent impact.

The amount of habitat which will be lost for stygofauna is predicted to be 10%.

The changes to habitat with respect to salinity is predicted to vary between 1,800 mg/L and 3,000 mg/L for the LoM. These may be beyond many of the species' tolerance, however the changes to the groundwater salinity are progressive, though longer lasting than changes to depth.

The Subterranean Fauna Monitoring and Management Plan (SFMMP) (**Appendix 29**) has been designed based on the Water Management Plan with triggers and threshold being developed to manage the risks to the stygofauna. This management plan has been prepared in conjunction with the Water Management Plan (**Appendix 6**). The SFMMP also details a monitoring program to manage impacts to the troglofauna.

A targeted survey has been scheduled for 2025 to collect further information on the six restricted troglofauna taxa. This survey will gather information on the connection of sample sites within the Mineralised Marra Mamba habitat (particularly in pit) to the other habitats. This is to better understanding the connectivity of these areas

At present, agreements to share data with other mining companies is in progress. The data collected is under peer review, including the molecular sequences. This process is to ensure a clean dataset for effective management of the impacts. It will also allow for a better understanding of the conservation status of these taxa. The final sequences will be uploaded into GenBank for public access.

Table 8-14: Mitigation Measures for Subterranean Fauna

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
Direct Impacts – Troglofauna			
Loss of troglofauna habitat from excavation of mine pits and mounding.	Excavation of troglofaunal habitat is contained in seven mine pits. The number of pits has been reduced and mining output has been reduced from20 Mtpa to 12 Mtpa avoiding troglofaunal habitat.	• Excavate no more than 66,731.74 m^3 of Tertiary Detritals identified as likely troglofauna habitat. • Limit the reduction of habitat to 274,648,900 m3 of troglofauna habitat primarily in the CID/Pisolite. • Undertake pit construction in stages to manage dewatering and MAR requirements – optimise the West to East mining scenario as outlined in Water Management Plan. • Maintain the current beneficial use of groundwater as per the Water Management Plan, to limit the extent of groundwater extraction (and associated drawdown and MAR). • Maintain groundwater levels such that there is no surface expression of groundwater (as a result of MAR) limiting troglofauna habitat. • Implement management actions as defined in the Water Management Plan. • Implement the management actions as defined in the SFMMP.	• Develop and implement a MCP as approved by DEMIRS (as per the requirements of the Mining Act and DEMIRS Guidelines for Preparing Mine Closure Plan, March 2020). • Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act. • Implement the SFMMP. • Monitoring program targeting troglofauna which have the highest level of endemism.
Impact to troglofauna taxa (specifically restricted taxa). The number of restricted taxa may be up to 6 taxa.	Not applicable, with minimisation then being the key measure.	• Apply the developed habitat assessment model to updated species list.	• Implement monitoring as detailed in the Water Management Plan Implement the SFMMP.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
Direct Impacts - Stygofauna			
Loss of stygofauna habitat from excavation of pits below the water table or changes in groundwater levels (≥ 1 m).	Complete avoidance is not possible for this Proposal; however the Proposal has been designed so that excavation is contained to seven designate mine pits as per mining schedule.	• Loss of no more than 370,648,900 m3 of stygofauna habitat from extraction of mine pits for LoM. • Implement mine schedule of staged pit excavation (optimise West to East mining scenario as per WMP). • Limit dewatering profile to that which is necessary for mining. • Implement the management actions in the Water Management Plan. • Implement the management actions in the SFMMP.	• Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act. • Implement monitoring as detailed in the Water Management Plan and SFMMP. • Implement the SFMMP.
Reduction in quality of habitat due to salinity changes.	Not applicable, with minimisation then being the key measure.	• Limit MAR profile to that which is necessary for mining.	• Implement monitoring as detail in the Water Management Plan and SFMMP. • Implement the SFMMP.
Loss of stygofauna species (specifically restricted taxa). No stygofauna are expected to be lost.	Further work needs to be undertaken to determine if avoidance is possible.	• Limit dewatering profile to that which is necessary for mining. • Implement the Water Management Plan. • Implement SFMMP.	• Implement monitoring as detailed in the Water Management Plan • Implement the SFMMP.
Indirect Impact - Troglofauna			
Clearing of vegetation and construction of infrastructure (i.e. WRD, RoM pads) resulting in the loss of energy transfer to the subterranean environment).	Not applicable, with minimisation then being the key measure.	• Backfilling of pits to reduce ex-pit WRDs. • Minimise the clearing of vegetation required where possible.	• Progressive rehabilitation to be undertaken in accordance with a Mine Closure Plan assessed and approved by DEMIRS, as per requirements under the Mining Act.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
			• Backfilling of pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process.
Contamination of subterranean environment from mine activities such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste rock, and use of saline water for dust suppression in mine area.	Not applicable, with minimisation then being the key measure.	• Design of potential contaminating facilities (landfill, WRD) to prevent seepage to surface water and/or groundwater. • Adhere to works approval and licence conditions under Part V of the EP Act. • Storage of contaminating materials in Australian Standard compliant locations with bunding, spill controls and leak prevention. • Saline water (> 5000 mg/L TDS) shall not be used for dust suppression unless approved by the Environmental Manager and where approved, dribble bars shall be used to control overspray onto adjacent vegetation. • WRD to be designed in accordance with the Mine Closure Plan. • Design and construction of WRD with appropriate seepage and leachate control structures. • Management of chemical and hydrocarbons, appropriate types and quantities of spill response equipment will be maintained. • Manage any spills including any contaminated material, in accordance with	• Implement monitoring as detail in the Water Management Plan and SFMP. • Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. • Conduct periodic inspections of chemical and hydrocarbon storage areas to confirm compliance with Licence conditions and applicable Australian Standards.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
		the internal procedures; and investigate and report incidents in accordance with internal procedures, to prevent the recurrence of incidents of the same or similar nature.	
Changes to groundwater affecting humidity in vadose zone (altered hydrology).	Not applicable, with minimisation then being the key measure.	• Limit dewatering profile to that which is necessary for mining. • Limit mounding to that which is necessary for mining. • Implement the management actions in the Water Management Plan.	Ongoing groundwater monitoring and modelling will be undertaken for the mine and borefields throughout the mine in accordance with the Water Management Plan Implement the SFMMP.
Indirect Impact - Stygofauna			
Contamination of subterranean environment from mine activities such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste dumps.	Not applicable, with minimisation then being the key measure.	• WRD to be designed in accordance with the MCP. • Design of potential contaminating facilities (e.g. landfill, WRD) to prevent seepage to surface water and/or groundwater. • Storage of contaminating materials in AS compliant locations with bunding, spill controls and leak prevention. • Design and construction of WRD with appropriate seepage and leachate control structures. • Management of chemical and hydrocarbons, appropriate types and quantities of spill response equipment will be maintained. • Manage any spills including any contaminated material, in accordance with the internal procedures; and investigate and	Implement monitoring as detail in the Water Management Plan and SFMMP. • Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. • Conduct periodic inspections of chemical and hydrocarbon storage areas to confirm compliance with Licence conditions and applicable Australian Standards.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
		report incidents in accordance with internal procedures, to prevent the recurrence of incidents of the same or similar nature.	

8.6 Assessment and Significance of Residual Impacts

8.6.1 Direct Impacts - Troglofauna

8.6.1.1 Loss of Troglofauna habitat

The excavation of the mine pits and areas of habitat lost as a result of groundwater mounding are considered to be a direct impact to troglofauna. The loss of habitat as a result of both activities can be presented as a volumetric area.

The geological units considered **Likely** habitat are the Tertiary Detritals which includes the Upper Calcrete, CID/Pisolite and Mineralised Marra Mamba units. In total 195,127,440 m^3 of Tertiary/Detritals will be impacted across both mining and predicted mounding from MAR. Of this:

- An estimated 66,731,740 m^3 will be permanently lost during excavation of ore and formation of pits. The greatest volume lost will be in the Mineralised Marra Mamba.
- An estimated 128,396,700 m^3 of habitat will be altered as a result of changes to the groundwater levels from MAR reinjection. The greatest impact is to the Upper Calcrete and CID/Pisolite. There is the capacity for the groundwater to return to baseline conditions and therefore while a significant impact it is not permanent.
- The Undifferentiated Tertiary geology will be reduced by 285,573,000 m^3. This habitat has been found to support troglofauna at Mulga Downs. Of this:
  - 25,833,000 m^3 will be permanently removed through mining.
  - 259,740,000 m^3 will be temporarily lost from MAR.
- The overall anticipated percentage of troglofauna habitat which may may be impacted is 19%.

The Undifferentiated Tertiary habitat is mostly continuous over the Proposal area and beyond, while Mineralised Marra Mamba occurs as discontinuous pods associated with the mineralisation.

Precedence exists with the EPA that the direct impacts to the troglofauna can be mitigated based on the capacity for dispersal (EPA Report 1402 (EPA, 2011)).

8.6.1.2 Loss of Troglofauna species

At least six troglofauna species are currently known only from the Mineralised Marra Mamba habitat. This is the area of greatest impact as this is where the pits lie. These species are also identified as being potentially locally restricted.

Widespread species are considered to be less vulnerable to extinction following changes to their habitat than locally restricted species (EPA 2016b; Ponder and Coglan 2002). Investigation of the troglofauna taxa at Mulga Downs has shown that there is the capacity for dispersal.

8.6.2 Indirect Impacts – Troglofauna

The indirect impacts to the troglofauna fauna include:

- Contamination of troglofauna habitat from mining activities;
- Clearing of vegetation and construction of infrastructure resulting in the loss of energy transfer to subterranean environment;
- Changes to humidity from altered hydrology (changes in groundwater level).

8.6.2.1 Contamination of Troglofauna habitat from mining activities

As outlined in **Section 7.7.2.2**, groundwater contamination from potential sources such as the Waste Rock, hydrocarbon spills, will be considered and managed as stated in the Water Management Plan.

Waste rock generated by the Proposal will be stored in waste dumps and used to backfill pits to ensure backfill is above the water table after settlement avoiding the creation of pit lakes. This will be further informed by future infield study work as part of the closure planning process. From the studies undertaken, Potential Acid Forming (PAF) classed material was found to be a very low proportion (approximately 4%) of the waste material to be managed. If PAF is encountered during mining, waste management will consider the placement of PAF material into discrete PAF cells that can be isolated within waste rock to limit acid generation. This will allow for the control of acid mobilisation and solute release from these materials into groundwater (SRK 2023c).

Mitigation of impacts are proposed through the Water Management Plan, which includes trigger and threshold levels.

Hydrocarbon storage facilities will be appropriately constructed and bunded in accordance with Australian Standards. Facility inspection, maintenance and spill management procedures are expected to effectively mitigate the risk of contamination.

8.6.2.2 Clearing of vegetation and construction of infrastructure

Implementation of the Proposal will result in the clearing of up to 4,339.16 ha of native vegetation. While this is considered a potential indirect impact to troglofauna there is little information which has measured trophic energy pathways to hypogean environments. These environments are energy poor and there is a lack of basal trophic level which increases opportunism (Gibert and Deharveng 2002). Clearing of vegetation is not considered to affect the troglofauna.

8.6.2.3 Changes to humidity from altered hydrology (changes in groundwater level)

Surveys for troglofauna for this Proposal have been extensive and the area has been characterised in respect to significance as subterranean habitat. The likely habitat for troglofauna has been assessed and potential for connectivity and capacity for dispersal identified.

As discussed in **Sections 7.6 and 8.5**, the overarching groundwater management strategy is to:

- Maintain the current beneficial use of the groundwater.
- Minimise the impact on other groundwater users and groundwater dependent ecosystems (i.e. subterranean fauna); this includes minimising the extent of groundwater level changes.

- Maintain groundwater levels such that there is no surface expression of groundwater or water logging of vegetation.

A Water Management Plan (**Appendix 6**) has been developed which outlines HPPL's approach to monitoring and managing groundwater in response to potential impacts associated with construction and operation of the Proposal. In particular, the impacts associated with mine dewatering and the management of excess mine dewater via MAR. The Water Management Plan defines preliminary trigger and threshold criteria relating to groundwater. It also outlines the methodology and inputs which will be used to refine these criteria specific to each site upon completion of further works and collection of baseline data from finalised groundwater infrastructure. This information will inform the SFMMP.

8.6.3 Direct Impacts - Stygofauna

8.6.3.1 Loss of habitat

Implementation of the Proposal will result in the loss of 1,152,083,776 m^3 of stygofauna habitat as a result of dewatering. This equates to 10% of the volume of groundwater reduced by dewatering.

Of this volume, the loss of likely habitat is predicted as:

- 556,380,000 m^3 of Upper Calcrete which equates to 16% of habitat which is likely to support stygofauna;
- 112,770,000 m^3 of the CID/Pisolite which equates to 4% of habitat which is likely to support stygofauna; and
- 482,930,000 m^3 of the Undifferentiated Tertiary which equates to 6% of habitat which could support stygofauna.

In respect to loss of taxa due to changes in habitat (loss of habitat and changes to groundwater quality), the stygofauna habitat along the Fortescue Valley is extensive and uninterrupted for the majority of the aquifer. This allows for dispersal and mitigates impacts to stygofauna as a result of decreased habitat quality from the Proposal.

Many of the taxa identified have a greater distribution outside the Development Envelope. For example, dispersal of stygal ostracods is known to occur within each catchment and not between catchments in the Pilbara. Dispersal has been found to occur along the extent of uninterrupted aquifers (Reeves et al., 2007). Dispersal of stygofauna within the Development Envelope was evident with a number of taxa from different orders collected from several locations. Singletons were also collected with stygal taxa which were found in several other locations in the Development Envelope and surrounds.

Habitat for stygofauna has been found to be continuous and extensive within and outside of the Development Envelope. This also includes beyond the extent of the impacts.

8.6.3.2 Reduction in quality of habitat due to salinity changes

Characteristically, stygofauna diversity decreases with depth, the highest closer to the surface level of the groundwater. Reinjection at depths will decrease the likelihood of impacts to the stygofauna in the shallower

aquifers with the highest diversity. These are primarily in the upper section of the aquifer Upper Calcrete and Undifferentiated Tertiary aquifers.

Changes to groundwater quality is considered to be a direct impact to stygofauna. Based on the stygofauna taxa presented in BEC (2024b), of the 26 species defined as being 'restricted', four species were only recorded from groundwater with salinity < 500 mg/L; four species appear likely to be found in groundwater of about 500-1,000 mg/L; 11 species are likely to be found in water of about 1,000-5,000 mg/L and seven species in water about 5,000-10,000 mg/L. One species, for which salinity contours were used to derive its salinity record, has an inferred maximum salinity of 11,100 mg/L but is treated here as occurring in the 5,000-10,000 mg/L group. It appears that very few species in the MDIOM will have salinity ranges extending to >10,000 mg/L TDS.

Groundwater across the Development Envelope ranges from fresh (180 mg/L TDS) in the upper reaches of the groundwater system, to saline (18,000 mg/L TDS) across the valley area, with salinity profiling data confirming saline groundwater originating from the claypans and extending along the valley as well as beneath the proposed pit areas (AQ2 2024a).

Groundwater salinity will change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LoM is predicted to range between 2,500 and 6,200 mg/L, with this being the range of TDS concentrations that were then assigned to all MAR bores over the LoM.

Based on the BEC (2024a) data, potentially eight stygofauna may be at risk as their inferred upper tolerance limit was below 1000 mg/L. However, there continues to be constraints regarding resolution of species because of a lower success rate with molecular analyses and the continued issue of OTUs in lieu of identifications to the species level. This is characteristic of subterranean fauna and is recognised.

The Quaternary / Tertiary aquifer and fractured rock / bedrock aquifers are generally in hydraulic connection (AQ2 2024a) (refer to **Section 7.3.2**) and groundwater flow is east to west. The stygofauna habitats which extends across the Development Envelope continues beyond the areas of impact and are continuous as has been shown from the habitat assessments.

This reduces the potential risk from changes in salinity resulting from MAR can be identified and managed in the SFMMP.

8.6.3.3 Loss of stygofauna species

Up to 13 stygofauna taxa were identified as being restricted to areas within predicted groundwater drawdown of ≥2 m and/or ≥1 m groundwater mounding from reinjection (BEC 2024a). These taxa have been found in geological units which are continuous. An assessment of the risk to these taxa was undertaken and based on taxonomic factors and distribution within the identified likely habitats. Assessment based on their area of occurrence (being the likely habitat) as a factor found that no stygofauna collected, to date, were considered at risk from the effects of mining or drawdown.

8.6.4 Indirect Impacts – Stygofauna

The indirect impacts to the subterranean fauna may result from the contamination of stygofauna habitat from mining activities.

8.6.4.1 Contamination of stygofauna habitat from mining activities

As outlined in **Section 7.7.2.2**, groundwater contamination from potential sources such as the WRD landforms or spills will be considered and managed.

Waste rock generated by the Proposal will be stored in waste dumps and used to backfill pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process. From the studies undertaken, Potential Acid Forming (PAF) classed material was found to be a very low proportion (approximately 4% of the waste material to be managed. If PAF is encountered during mining, waste management will consider the placement of PAF material into discrete PAF cells that can be isolated within waste rock to limit acid generation. This will allow for the control of acid mobilisation and solute release from these materials into groundwater (SRK 2023).

Mitigation of impacts are proposed through the WMP, which includes trigger and threshold levels.

Hydrocarbon storage facilities will be appropriately constructed and bunded in accordance with Australian Standards. Facility inspection, maintenance and spill management procedures are expected to effectively mitigate the risk of contamination.

On the basis that the direct impact areas to stygofauna largely encompass the areas of indirect impacts, the significance of the indirect impacts is considered to be negligible.

8.7 Significant Residual Impact

The significant residual impact of the Proposal to Subterranean Fauna, after the application of the mitigation hierarchy, is:

- The loss of up to 96,048,900 m^3 of troglofauna habitat from the excavation of pits.
- A reduction of up to 274,648,900 m^3 of troglofauna habitat as a result of changes to the groundwater levels from MAR reinjection.
- Loss of up to 370,648,900 m^3 of stygofauna habitat from dewatering of mine pits for LoM.
- The loss of stygofauna habitat as a result of changes to groundwater salinity from MAR and dewatering drawdown.
- There is potential to impact up to six species of troglofauna which have not been found outside the mine pit and mounding areas.
- No stygofauna taxa will be lost. The data shows dispersal is possible from areas of impact to areas outside any impact from the Proposal. Up to 14 have been found to be restricted, however there is no evidence of isolated or fragmentated habitat where these taxa were found.

Surveys for both stygofauna and troglofauna for this Proposal have been extensive and the area has been characterised in respect to significance as subterranean habitat. The likely habitat for stygofauna and troglofauna has been assessed and found to be extensive and continuous, dispersal has been displayed by the subterranean fauna at MDIOM.

8.8 Environmental Outcome

Based on the studies and investigations undertaken to date, the outcomes of the assessment of potential impacts and proposed mitigation measures to protect environmental values associated with subterranean fauna, are aligning with the EPA's principles. As further information becomes available additional mitigation will be identified to ensure that the Proposal can achieve the EPA's objective for this factor. The predicted environmental outcomes for subterranean fauna summarised in **Table 8-15**.

Table 8-15: Environmental Outcomes of Subterranean Fauna

Potential Impact	Environmental Outcome
Direct Impacts	
Loss of subterranean fauna habitat	• Loss of no more than 66,731,740 m^3 of likely troglofauna habitat (mostly Mineralised Marra Mamba). • A reduction of up to 128,396,700 m^3 of troglofauna habitat altered as a result of changes in groundwater levels (mounding) from MAR during the LoM • A reduction of no greater than 16% Upper Calcrete stygofauna habitat from dewatering; • A reduction of no greater than 4% CID/Pisolite habitat which can support stygofauna. • A reduction of no more than 6% of undifferentiated tertiary habitat which can support stygofauna. • Loss of stygofauna habitat from changes in groundwater salinity as a result of MAR of up to 4,200 mg/L TDS above baseline
Impact on species	• Impact on up to six troglofauna taxa from excavation of mine pits. • Impact to stygofauna from changes in groundwater salinity. • No impact to stygofauna from changes in groundwater levels.
Indirect impacts	
Contamination of GW/subsurface habitat from mining activities	Not considered significant, will be managed under Part V of the EP Act.
Reduction in energy input (removal of vegetation)	Not considered significant, limited transfer of energy across epigean and hypogean environments
Reduction in humidity in vadose zone (altered hydrology)	Not considered significant