

Table of Contents

1	Introduction	1-1
1.1	Overview of document	1-1
1.1.1	Proposal Title	1-1
1.1.2	Proponent	1-1
1.1.3	Project Objectives	1-1
1.1.4	Background to the Project	1-4
1.2	Environmental Management Framework	1-4
1.2.1	Approval Process	1-4
1.2.3	Key Legislation and Policies	1-15
1.2.4	BHP Billiton Sustainable Development Framework	1-16
1.2.5	Applicable Guidelines and Standards.....	1-17
1.2.6	Principles of Environmental Protection	1-17
Tables		
	Table 1.1 – Terms of Ref.....	1-8
	Table 1.1 – Terms of Ref.....	1-9
	Table 1.1 – Terms of Ref.....	1-10
	Table 1.1 – Terms of Ref.....	1-11
	Table 1.1 – Terms of Ref.....	1-12
	Table 1.1 – Terms of Ref.....	1-13
	Table 1.1 – Terms of Ref.....	1-14
	Table 1.2 – Key Western Australian and Commonwealth Legislation	1-15
	Table 1.3 – Bilateral Agreements and International Conventions	1-16
	Table 1.4 – Applicable Guidelines and Standards	1-18
Figures		
	Figure 1.1 – Port Hedland Existing Operations.....	1-2
	Figure 1.2 – Outer Harbour Development General Arrangement.....	1-3
	Figure 1.3 – Coordinated Environmental Assessment Process and Indicative Timeframes Table 1.1 – Terms of Ref	1-6
	Figure 1.4 – BHP Billiton Group’s Project Evaluation and Investment Process.....	1-17
2	Project Description	2-1
2.1	The Project	2-1
2.4	Landside Infrastructure	2-3
2.4.1	Railway Route.....	2-3
2.4.2	Stockyards at Boodarie.....	2-4
2.4.3	Infrastructure Corridor from the Stockyards to the Jetty.....	2-5
2.4.4	Construction of the Landside Infrastructure	2-5
2.5	Marine Infrastructure	2-8
2.5.1	New Dredged Channel, Wharf and Jetty.....	2-8
2.5.2	Construction of the Marine Infrastructure.....	2-13
2.5.3	Dredging and Spoil Disposal Program	2-18

2.6	Support Services and Utilities	2-20
2.6.1	Overview.....	2-20
2.6.2	Temporary Construction Facilities.....	2-20
2.6.3	Borrow Areas.....	2-20
2.6.4	Roads	2-20
2.6.5	Buildings.....	2-24
2.6.6	Power Supply and Demand	2-24
2.6.7	Water Supply and Demand	2-24
2.6.8	Stormwater Management.....	2-26
2.6.9	Wastewater Management.....	2-26
2.6.10	Workforce	2-26
2.7	Operations	2-26

Tables

Table 2.1 – Project Key Characteristics.....	2-2
Table 2.2 – Land Tenure and Ownership	2-3
Table 2.3 – Marine Construction Equipment	2-13
Table 2.4 – Construction Vessel Movements	2-17
Table 2.5 – Summary of Estimated Dredging by Project Stage.....	2-19
Table 2.6 – Indicative Cumulative Power Demand – BHP Billiton Iron Ore’s Existing Port Hedland Operations and Proposed Projects.....	2-24
Table 2.7 – Indicative Water Supply Demand for Port Hedland Operations	2-25
Table 2.8 – Proposed Water Supply Strategy for BHP Billiton Iron Ore Port Operations	2-25

Figures

Figure 2.1 – Proposed Landside Infrastructure Layout.....	2-9
Figure 2.2 – Proposed Stockyards, Rail Loop and Infrastructure Corridor	2-10
Figure 2.3 – Proposed Layout for Crossing, Conveyors and Transfer Station	2-11
Figure 2.4 – Proposed Marine Infrastructure Layout.....	2-14
Figure 2.5 – Proposed Construction Staging of Wharfs and Berths	2-15
Figure 2.6 – Proposed Extent of Dredging	2-21
Figure 2.7 – Proposed Spoil Grounds.....	2-22
Figure 2.8 – Areas of Highest Construction Vessel Movement.....	2-23

Plates

Plate 2.1 – Stockyards at Boodarie.....	2-4
Plate 2.2 – Indicative Cross Section of the Infrastructure Corridor.....	2-6
Plate 2.3 – Indicative Cross Section of the West Creek Causeway.....	2-6
Plate 2.4 – Proposed Western Spur and Rail Loops.....	2-7
Plate 2.5 – Jetty/Wharf Structure.....	2-8
Plate 2.6 – Jetty Structure.....	2-8
Plate 2.7 – Wharf and Transfer Deck	2-12
Plate 2.8 – Stratigraphy Offshore of Port Hedland.....	2-19

3	Development Justification and Alternatives	3-1
3.1	Project Justification	3-1
3.2	Project Benefits.....	3-1
3.3	Evaluation of Alternatives	3-1
3.3.1	No Action Alternative.....	3-1
3.3.2	Concept Phase – Port Site Selection	3-2
3.3.3	Selection Phase	3-6
3.4	Definition, Execution and Operational Modifications	3-14

Tables

Table 3.1 – Alternative Port Locations Options Assessment	3-3
Table 3.2 – Selection Phase Studies Options Evaluation Assessment Outcome	3-6
Table 3.3 – Summary of Definition Design, Construction and Operational Modifications and Resultant Benefits	3-16
Table 3.3 – Summary of Definition Design, Construction and Operational Modifications and Resultant Benefits (continued).....	3-17

Figures

Figure 3.1 – Alternative Port Locations.....	3-5
Figure 3.2 – Shipping Channel Alignment Options	3-9
Figure 3.3 – Preliminary and Proposed Spoil Ground Locations	3-12
Figure 3.4 – Rail Options.....	3-15

4 Stakeholder Consultation..... 4-1

4.1 Introduction	4-1
4.2 Consultation and Engagement	4-1
4.3 Key Stakeholders	4-1
4.4 Community Consultation	4-3
4.4.1 Identifying and Managing Growth Issues.....	4-3
4.5 Consultation with Government and Industry	4-7
4.6 Ongoing Consultation.....	4-7

Tables

Table 4.1 – Key Stakeholders	4-2
Table 4.2 – Summary of Key Queries and Comments Raised During Consultation with State and Local Government Agencies, Non Government Organisations and Other Stakeholders.....	4-8

Figures

Figure 4.1 – Communications Matrix.....	4-4
Figure 4.2 – Community Dialogue Process Chart.....	4-5
Figure 4.3 – Town of Port Hedland Growth Impacts Relative Importance – Average Scores.....	4-6
Figure 4.4 – Town of Port Hedland Dialogue Café Critical Responses Proportion.....	4-6

5 Existing Terrestrial Environment 5-1

5.1 Overview.....	5-1
5.2 Climate.....	5-1
5.2.1 Temperature	5-1
5.2.2 Rainfall	5-3
5.2.3 Winds 5-3	
5.2.4 Tropical Cyclones	5-4
5.3 Landforms, Geology and soils	5-5
5.3.1 Land Systems and Landforms.....	5-5
5.3.2 Topography	5-5
5.3.3 Geology and Soils	5-5
5.3.4 Acid Sulphate Soils	5-8
5.3.5 Contaminated Sites.....	5-10
5.4 Catchment Hydrology and Groundwater	5-12
5.4.1 Surface Hydrology.....	5-12
5.4.2 Groundwater	5-14

5.5	Biological Environment	5-17
5.5.1	Biogeography	5-17
5.5.2	Biodiversity	5-20
5.5.3	Existing and Proposed Reserves and Conservation Areas	5-20
5.5.4	Flora and Vegetation.....	5-20
5.5.5	Vegetation of Conservation Significance.....	5-27
5.5.6	Flora of Conservation Significance.....	5-27
5.5.7	Introduced Flora Species	5-30
5.5.8	Vertebrate Fauna	5-30
5.5.9	Fauna Habitats of Conservation Significance.....	5-32
5.5.10	Fauna of Conservation Significance	5-32
5.5.11	Introduced Fauna.....	5-36
5.5.12	Short-Range Endemic Invertebrate Fauna	5-37
5.5.13	Subterranean Fauna	5-37
5.5.14	Matters of National Environmental Significance	5-38
5.6	Summary	5-39

Tables

Table 5.1	– Summary of Climatic Averages for Port Hedland (Station 4032) 1942 – 2008	5-1
Table 5.2	– Land Systems of the Terrestrial Disturbance Envelope	5-5
Table 5.3	– Superficial Geological Profile of the Terrestrial Disturbance Envelope	5-8
Table 5.4	– Potential for Acid Sulphate Soils at Proposed Infrastructure Areas	5-10
Table 5.5	– Vegetation Communities Recorded in the Survey Area.....	5-21
Table 5.6	– Priority Flora Species Potentially Occurring in the Study Area.....	5-28
Table 5.7	– Priority Flora Recorded in the Study Area.....	5-28
Table 5.8	– Fauna Habitats Recorded in the Terrestrial Study Area.....	5-31

Figures

Figure 5.1	– Location of the Project in the Pilbara Region	5-2
Figure 5.2	– Average Monthly Rainfall and Maximum and Minimum Temperatures for Port Hedland (Station 4032)	5-3
Figure 5.3	– Seasonal Wind Roses for Port Hedland Airport for the Year 2007	5-4
Figure 5.4	– Land Systems of the Terrestrial Study Area.....	5-6
Figure 5.5	– Topography of the Terrestrial Study Area	5-7
Figure 5.6	– Geology of the Terrestrial Study Area	5-9
Figure 5.7	– Acid Sulphate Soils Risk Map for the Terrestrial Study Area	5-11
Figure 5.8	– Surface Water Hydrology of the Project Area.....	5-13
Figure 5.9	– Design 1 in 50 Year ARI Flood Event	5-15
Figure 5.10	– Design 1 in 100 Year ARI Flood Event.....	5-16
Figure 5.11	– Department of Water WIN Database Listed Bores in the Port Hedland Area.....	5-18
Figure 5.12	– Hydrogeological Gradient for the Project Area	5-19
Figure 5.13	– Vegetation Communities Recorded in the Survey Area	5-25
Figure 5.14	– Flora of Conservation Significance Recorded in the Study Area.....	5-29
Figure 5.15	– Fauna Habitats Recorded in the Survey Area	5-33

6 Existing Marine Environment 6-1

6.1 Overview..... 6-1

6.2 Oceanography..... 6-1

6.2.1 Circulation

6.2.2 Tides and Currents

6.3	Coastal and seabed geomorphology	6-3
6.3.1	Coastal Geomorphology	6-3
6.3.2	Bathymetry and Seabed Geomorphology	6-3
6.3.3	Fate of Dredged Material.....	6-4
6.4.1	Turbidity.....	6-6
6.4.2	Water Temperature	6-7
6.4.3	Light Availability.....	6-8
6.4.4	Sedimentation Rate.....	6-8
6.4.5	Sediment Particle Size Distribution	6-8
6.5	Sediment Quality	6-9
6.5.1	Physical Characteristics	6-9
6.5.2	Chemical Characteristics	6-9
6.6	Biological Environment	6-12
6.6.1	Marine Habitats Overview	6-12
6.6.2	Benthic Primary Producer Habitat.....	6-15
6.2.1	Non-Benthic Primary Producers	6-32
6.6.4	Avifauna (Seabirds and Shorebirds).....	6-43
6.6.5	Marine Reptiles	6-47
6.6.6	Marine Mammals.....	6-55
6.6.7	Fish	6-57
6.6.8	Invasive Marine Species	6-70
6.6.9	Marine Fauna of Conservation Significance.....	6-70
6.6.10	Matters of National Environmental Significance	6-72
6.7.1	State and Commonwealth Marine Protected Areas	6-74
6.7.2	Pilbara Coastal Water Quality Consultation Outcomes	6-75
6.7.3	The North-West Marine Bioregional Plan	6-75
6.8	Historical dredging and disposal in the Port Hedland region	6-77
6.9	Summary	6-78

Tables

Table 6.1	– Water Quality Monitoring Sites	6-7
Table 6.2	– Descriptive Statistics for Turbidity (NTU) at the Six Monitoring Sites during the Dry and Wet Seasons	6-7
Table 6.3	– Descriptive Statistics for Light (moles/m ² /d) at the Six Monitoring Sites during the Dry and Wet Seasons	6-8
Table 6.4	– Descriptive Statistics for Mean Gross Daily Sedimentation Rate (mg/cm ² /d) at the Six Monitoring Sites during the Dry and Wet Seasons	6-9
Table 6.5	– Mangrove Species in the Port Hedland Harbour	6-17
Table 6.6	– Marine Investigations within the Marine Study Area providing Benthic Habitat Data.....	6-24
Table 6.7	– Summary of Marine Habitats within the Marine Study Area	6-29
Table 6.8	– Hard Coral Cover as Recorded by Field Observations in Marine Study Area	6-42
Table 6.9	– Sponge and Soft Coral Cover in the Study Area.....	6-47
Table 6.10	– Seabird Species Recorded within the Study Area.....	6-50
Table 6.11	– Shorebird Species Recorded within the Study Area.....	6-50
Table 6.12	– Seabird and Shorebird Species Expected in the Study Area	6-51
Table 6.13	– Number of Birds Recorded during Shorebird Counts in the Port Hedland Region with inclusion of Eighty Mile Beach Data for Comparative Purposes.....	6-54
Table 6.14	– Behavioural Stages of North-West Shelf Turtles and Respective Habitat.....	6-55
Table 6.15	– Main Commercial Fisheries in the Port Hedland Area.....	6-72
Table 6.16	– Known Introduced Marine Species in Port Hedland Inner Harbour	6-75

Table 6.17 – Marine Fauna of Conservation Significance Potentially Occurring with the Project Area 6-76
 Table 6.18 – Migratory Shorebirds and Seabirds present or likely to be present within the Study Area 6-79
 Table 6.19 – Environmental Values and Environmental Quality Objectives of the Port Hedland Area6-80
 Table 6.20 – Volumes of Material Previously Dredged and Disposed in the Offshore Port Hedland Environment.....6-80

Figures

Figure 6.2 – Spoil Ground J Showing Historical Disposal..... 6-5
 Figure 6.4 – Water Quality and Coral Health Baseline Monitoring Sites and Zoning 6-10
 Figure 6.5 – Location of Sediment Sampling Sites and Spoil Grounds 6-13
 Figure 6.6 – Location of Subtidal Investigations 6-16
 Figure 6.7 – Distribution of Mangrove Vegetation Associations..... 6-19
 Figure 6.8 – Intertidal Habitat on Finucane Island Platform6-22
 Figure 6.9 – Mixed Assemblages Distribution – Intertidal Zone6-23
 Figure 6.10 – Location of Subtidal Investigations6-25
 Figure 6.11 – Regional Subtidal Features and Survey Areas6-33
 Figure 6.12 – Subtidal Habitat Map of the Study Area6-35
 Figure 6.13 – Habitat Mapping Illustrating the Reduction in Spoil Ground 3 to Exclude Sensitive Habitat 6-37
 Figure 6.14 – Macroalgal Distribution in the Study Area6-39
 Figure 6.15 – Seagrass Distribution in the Study Area6-41
 Figure 6.16 – Hard Coral Distribution in the Study Area6-45
 Figure 6.17 – Turtle Habitats and Light Monitoring Locations6-58
 Figure 6.18 – Internesting Movements of Four Flatback Turtles Tracked from Cemetery Beach, Port Hedland6-59
 Figure 6.19 – Internesting Locations for Flatback Turtles 2008/09 to 2010/116-61
 Figure 6.20 – Internesting Locations for Flatback Turtles 2008/09 to 2010/11 in Proximity to the Proposed Project.....6-63
 Figure 6.21 – Post Nesting Migrations of all Turtles Headed South from Port Hedland in 2008/09 and 2009/10B6-64
 Figure 6.22 – Post-nesting Migrations of all Turtles Headed North from Port Hedland in 2008/09 and 2009/10.....6-65
 Figure 6.23 – In-Water Marine Turtle Sightings Offshore from Port Hedland (Summer 2008 Aerial Survey).....6-66
 Figure 6.24 – In-Water Marine Turtle Sightings Offshore from Port Hedland (Summer 2010 Aerial Survey).....6-67

7 Existing Social Environment..... 7-7-1
7.1 Regional Context7-7-1
7.2 Town of Port Hedland Plans7-7-1
7.3 BHP Billiton Iron Ore’s Community Development strategy.....7-7-2
7.4 Economic profile7-7-3
7.5 Regional Infrastructure and Social Services 7-7-4
 7.5.1 Health 7-7-6
 7.5.2 Education..... 7-7-6
 7.5.3 Recreation and Tourism7-7-7
 7.5.4 Infrastructure and Housing 7-7-8
7.6 Fisheries..... 7-7-9
 7.6.1 Commercial Fisheries 7-7-9
 7.6.2 Recreational Fisheries 7-7-10

7.7	Heritage	7-7-11
7.7.1	Native Title.....	7-7-11
7.7.2	Indigenous Heritage	7-7-11
7.7.4	Register of National Estate.....	7-7-13
7.8	Visual Amenity	7-7-15

Tables

Table 7.1 – DIA Sites Potentially Impacted	7-7-11
Table 7.2 – Details for Shipwrecks Known to occur in the Port Hedland Area	7-7-13
Table 7.3 – Existing Views from Receptor Locations in the Port Hedland Area.....	7-7-17

Figures

Figure 7.1 – Western Australian Major Commodities by Value	7-7-3
Figure 7.2 – The Pilbara Themes	7-7-5
Figure 7.3 – European Heritage Sites in the Port Hedland Area.....	7-7-14
Figure 7.4 – Receptor Locations and Photomontage Locations in the Port Hedland Area	7-7-16

8	Emissions, Discharges and Wastes	8-1
8.1	Overview	8-1
8.2	Emissions	8-1
8.2.1	Greenhouse Gases Emissions	8-1
8.2.2	Atmospheric Emissions (Excluding Greenhouse Gas).....	8-2
8.2.3	Light 8-9	
8.2.4	Noise 8-10	
8.3	Marine Discharges	8-17
8.3.1	Overview.....	8-17
8.3.2	De-watering	8-17
8.3.3	Stormwater	8-17
8.3.4	Ballast Water.....	8-17
8.3.5	Sewage	8-17
8.4	General Waste	8-17
8.4.1	Overview.....	8-17
8.4.2	Types and Volumes of Waste Generated.....	8-17
8.5	Accidental Releases (spills and leaks)	8-20

Tables

Table 8.1 – Predicted TSP Ground Level Hospital Concentrations from the proposed Outer Harbour Development ($\mu\text{g}/\text{m}^3$)	8-7
Table 8.2 – Predicted PM_{10} Ground Level Hospital Concentrations from the proposed Outer Harbour Development ($\mu\text{g}/\text{m}^3$)	8-7
Table 8.3 – Summary of Assigned and Maximum Permissible Noise Levels at Port Hedland (L_{A10} dB (A)) Relative to Measured Background Levels.....	8-12
Table 8.4 – Outdoor Noise Criteria for Noise Sensitive Land Uses Next to New Roads or Railways*	8-12
Table 8.5 – Approximate Temporal Distribution of Modelled Meteorological Scenarios	8-13
Table 8.6 – Noise Levels (L_{A10} dB(A)) Generated by Pile Driving associated with the Outer Harbour Development in Isolation.....	8-13
Table 8.8 – Predicted LAeq Values (dB (A)) for Western Spur Railway in Isolation	8-14
Table 8.9 – Indicative Inventory of Construction Solid and Liquid Waste Types for the Outer Harbour Development.....	8-18
Table 8.10 – Indicative Inventory of Operational Solid and Liquid Waste Types for the Outer Harbour Development.....	8-19

Figures

Figure 8.1 – Receptor Locations for Dust and Noise Monitoring in the Port Hedland Area	8-3
Figure 8.2 – Ambient PM ₁₀ Concentrations in Port Hedland (BoM – Port Hedland Airport)	8-4
Figure 8.3 – Statistics of Predicted 24 hour TSP Ground Level Concentrations from the Proposed Outer Harbour Development (standalone with no background)	8-6
Figure 8.4 – Maximum Predicted 24 hour TSP Ground Level Concentrations from the Proposed Outer Harbour Development (no background)	8-6
Figure 8.5 – Statistics of Predicted 24-hour PM ₁₀ Ground Level Concentrations from the Proposed Outer Harbour Development (standalone with no background)	8-8
Figure 8.6 – Maximum Predicted 24-hour PM ₁₀ Ground Level Concentrations from the Proposed Outer Harbour Development (no background)	8-8
Figure 8.7 – Ambient Noise Levels Recorded at the Hospital Site, Port Hedland 22 February to 5 March 2008	8-11
Figure 8.8 – Modelled Noise Levels for the Outer Harbour Development to Stage 5, in Isolation.....	8-14

9	Terrestrial Impacts and Management	9-1
9.1	Key Factor – Terrestrial Flora and Vegetation.....	9-2
9.1.1	Management Objective	9-2
9.1.2	Description of Factor.....	9-2
9.1.3	Assessment Guidance	9-2
9.1.4	Potential Impacts.....	9-3
9.1.5	Matters of National Environmental Significance	9-5
9.1.6	Management Measures	9-5
9.1.7	Significance of Residual Impact.....	9-5
9.1.8	Predicted Environmental Outcome	9-6
9.2	Key Factor – Terrestrial Fauna.....	9-10
9.2.1	Management Objective	9-10
9.2.2	Description of Factor.....	9-10
9.2.3	Assessment Guidance	9-11
9.2.4	Potential Impacts.....	9-11
9.2.5	Matters of National Environmental Significance	9-13
9.2.6	Management Measures	9-14
9.2.7	Significance of Residual Impact.....	9-14
9.2.8	Predicted Environmental Outcome	9-15
9.3	Key Factor – Geology, Soils and Landforms	9-19
9.3.1	Management Objective	9-19
9.3.2	Description of Factor.....	9-19
9.3.3	Assessment Guidance	9-19
9.3.4	Potential Impacts.....	9-19
9.3.5	Matters of National Environmental Significance	9-21
9.3.6	Management Measures	9-21
9.3.7	Significance of Residual Impact.....	9-21
9.3.8	Predicted Environmental Outcome	9-21
9.4	Relevant Factor – Short-Range Endemic Fauna	9-24
9.4.1	Management Objective	9-24
9.4.2	Description of Factor.....	9-24
9.4.3	Assessment Guidance	9-24
9.4.4	Potential Impacts.....	9-24
9.4.5	Matters of National Environmental Significance	9-25
9.4.6	Management Measures	9-25
9.4.7	Significance of Residual Impact.....	9-25
9.4.8	Predicted Environmental Outcome	9-25

9.5	Relevant Factor – Subterranean Fauna	9-27
9.5.1	Management Objective	9-27
9.5.2	Description of Factor	9-27
9.5.3	Assessment Guidance	9-27
9.5.4	Potential Impacts.....	9-27
9.5.5	Matters of National Environmental Significance	9-28
9.5.6	Management Measures	9-28
9.6.7	Significance of Residual Impact.....	9-28
9.5.8	Predicted Environmental Outcome	9-28
9.6	Relevant Factor – Surface Water	9-30
9.6.1	Management Objective	9-30
9.6.2	Description of Factor	9-30
9.6.3	Assessment Guidance	9-30
9.6.4	Potential Impacts.....	9-30
9.6.5	Matters of National Environmental Significance	9-31
9.6.6	Management Measures	9-31
9.6.7	Significance of Residual Impact.....	9-31
9.6.8	Predicted Environmental Outcome	9-31
9.7	Relevant Factor – Groundwater	9-34
9.7.1	Management Objective	9-34
9.7.2	Description of Factor	9-34
9.7.3	Assessment Guidance	9-34
9.7.4	Potential Impacts.....	9-34
9.7.5	Matters of National Environmental Significance	9-35
9.7.6	Management Measures	9-35
9.7.7	Significance of Residual Impact.....	9-35
9.7.8	Predicted Environmental Outcome	9-36
9.8	Summary	9-36

Tables

Table 9.1 – Terrestrial Environmental Factors and Aspects	9-1
Table 9.2 – Guidance Specific to Terrestrial Flora and Vegetation	9-3
Table 9.3 – Summary of Potential Impacts and Management Measures associated with Terrestrial Flora and Vegetation	9-7
Table 9.4 – Legislation and Guidance Documents Specific to Terrestrial Fauna.....	9-10
Table 9.5 – Summary of Potential Impacts and Management Measures Associated with Terrestrial Fauna	9-16
Table 9.6 – Guidance Specific to Management of Acid Sulphate Soils	9-19
Table 9.7 – Summary of Potential Impacts and Management Measures Associated with Geology, Soils and Landforms	9-22
Table 9.8 – Guidance Specific to the Management of Short-Range Endemic Fauna	9-24
Table 9.9 – Summary of Potential Impacts and Management Measures Associated with Short-Range Endemic Fauna	9-26
Table 9.10 – Guidance Specific to the Management of Subterranean Fauna.....	9-27
Table 9.11 – Summary of Potential Impacts and Management Measures Associated with Subterranean Fauna	9-29
Table 9.12 – Guidance Specific to the Management of Surface Water	9-30
Table 9.13 – Summary of Potential Impacts and Management Measures Associated with Surface Water.....	9-32
Table 9.14 – Guidance Specific to the Management of Groundwater	9-34
Table 9.15 – Summary of Potential Impacts Associated with Groundwater	9-37

10	Marine Impact Assessment and Management	10-1
10.1	Introduction	10-1
10.2	Key Factor – Marine Water and Sediment Quality	10-2
10.2.1	Management Objectives	10-2
10.2.2	Description of Factor	10-2
10.2.3	Assessment Guidance	10-2
10.2.4	Potential Impacts.....	10-5
10.2.5	Management Measures	10-23
10.2.6	Significance of Residual Impact.....	10-24
10.2.7	Predicted Environmental Outcomes	10-24
10.3	Key Factor – Marine Habitat	10-24
10.3.1	Management Objectives	10-24
10.3.2	Description of Factor	10-24
10.3.3	Assessment Guidance	10-31
10.3.4	Potential Impacts.....	10-32
10.3.5	Management Measures	10-58
10.3.6	Significance of Residual Impact.....	10-62
10.3.7	Predicted Environmental Outcomes	10-63
10.4	Key Factor – Marine Fauna.....	10-67
10.4.1	Management Objective	10-67
10.4.2	Description of Factor	10-67
10.4.3	Assessment Guidance	10-67
10.4.4	Potential Impacts.....	10-69
10.4.5	Management Measures	10-77
10.4.6	Significance of Residual Impact.....	10-78
10.4.7	Predicted Environmental Outcomes	10-79
10.5	Key Factor – Geomorphology and Coastal Processes	10-84
10.5.1	Management Objectives	10-84
10.5.2	Description of Factor	10-84
10.5.3	Assessment Guidance	10-84
10.5.4	Potential Impacts.....	10-84
10.5.5	Management Measures	10-86
10.5.6	Significance of Residual Impact.....	10-86
10.5.7	Predicted Environmental Outcomes	10-86
10.6	Relevant Factor – Avifauna	10-88
10.6.1	Management Objectives	10-88
10.6.2	Description of Factor	10-88
10.6.3	Assessment Guidance	10-88
10.6.4	Potential Impacts.....	10-88
10.6.5	Management Measures	10-89
10.6.6	Significance of Residual Impact.....	10-89
10.6.7	Predicted Environmental Outcomes	10-90
10.7	Matters of National Environmental Significance.....	10-90
10.8	Summary.....	10-92

Tables

Table 10.1 – Marine Environmental Factors and Aspects	10-2
Table 10.2 – Legislation and Guidance Documents Specific to Water and Sediment Quality	10-3
Table 10.4 – Levels of Ecological Protection linked to the EQO for ‘Maintenance of Ecosystem Integrity’	10-4
Table 10.3 – Environmental Values and Environmental Quality Objectives	10-4
Table 10.5 – Construction Dredging Activities, Indicative Timing and Associated Volumes.....	10-5
Table 10.6 – Volume of Dredge Spoil to be Disposed of at each Spoil Disposal Ground utilised for the Modelling.....	10-16
Table 10.7 – Concentrations of Contaminants of Potential Concern in Groundwater Samples Collected from Boreholes at the Boodarie Site.....	10-21
Table 10.8 – Physical Parameters Measured in the Groundwater Samples from Boodarie.....	10-21
Table 10.9 – Summary of Potential Impacts and Management Actions associated with Marine Water and Sediment Quality	10-25
Table 10.10 – Summary of Marine Habitats within the Proposed Outer Harbour Development Area	10-31
Table 10.11 – Legislation and Guidance Documents Specific to Marine Habitat	10-31
Table 10.12 – List of Terms Used to Define Impacts to Benthic Communities and Benthic Habitats (EPA 2010b) . 10-32	
Table 10.13 – Cumulative Changes in Extent of Mangrove Associations in 1963 and 2008.....	10-33
Table 10.14 – Estimated Loss of Mangrove Habitat Associations due to the Proposed Outer Harbour Development.....	10-33
Table 10.15 Historical and Cumulative Loss of Mangrove BPPH in Port Hedland Industrial LAU using Revised Estimates.....	10-34
Table 10.16 – Proposed Local Assessment Units and their Boundaries for the Impact Assessment of Coastal Intertidal BPPH	10-36
Table 10.17 – Historical Losses of Coastal Intertidal BPPH	10-37
Table 10.18 – Direct Losses of Coastal Intertidal BPPH due to the Proposed Marine Infrastructure Footprint.....	10-37
Table 10.19 – Total Cumulative Losses of Coastal Intertidal BPPH due to the Proposed Outer Harbour Development.....	10-37
Table 10.20 – Proposed Local Assessment Units and their Boundaries for the Impact Assessment of Subtidal BPPH.....	10-42
Table 10.21 – Decision Rules Used to Determine the Zones of Impact and their Boundaries	10-43
Table 10.22 – Historical Losses of Subtidal BPPH within State Waters.....	10-44
Table 10.23 – Direct Losses of Subtidal BPPH due to the Proposed Marine Infrastructure Footprint	10-47
Table 10.24 – Predicted Indirect Losses of Subtidal BPPH due to Dredge-Related Sedimentation.....	10-54
Table 10.25 –Total Cumulative Losses of Subtidal BPPH due to the Proposed Outer Harbour Development.....	10-54
Table 10.26 – BPP and Non BPP Categories Included in the Subtidal BPPH Loss Estimates for the Proposed Outer Harbour Development.....	10-54
Table 10.27 – Areas (ha) and Proportions (%) of Substrate Types Present within the Proposed Outer Harbour Development Spoil Grounds	10-57
Table 10.28 – Summary of Habitat Losses in State and Commonwealth Jurisdictions due to the Proposed Outer Harbour Development.....	10-61
Table 10.29 – Summary of Potential Impacts and Management Actions Associated with Marine Habitat..	10-64
Table 10.30 – Legislation and Assessment Guidance relating to Marine Fauna	10-68
Table 10.31 – Summary Table of Construction and Operational Vessel Movements.....	10-70
Table 10.32 – Summary of Estimated Impacts on Marine Fauna from Underwater Noise.....	10-76
Table 10.33 – Summary of Potential Impacts and Management Actions Associated with Marine Fauna	10-80
Table 10.34 – Legislation and Assessment Guidance specific to Geomorphology and Coastal Processes ...	10-84
Table 10.35 – Summary of Potential Impacts Associated with Geomorphology and Coastal Processes.....	10-87
Table 10.36 – Legislation and Guidance Documents Specific to Shorebirds and Seabirds	10-88
Table 10.37 – Summary of Potential Impacts and Management Actions Associated with Shorebirds and Seabirds	10-91

Figures

Figure 10.1 – Levels of Ecological Protection Identified within the Port Hedland Harbour and for the proposed Outer Harbour Development	10-6
Figure 10.2 – Sediment Plume Predictions as TSS Concentrations (in mg/L) at the Surface (top left), 0.5 m above the Seabed (top right) and a Benthic Profile (bottom)	10-9
Figure 10.3 – Stage 1 February to April (left) and October to December (right) of Year 1; 80 th Percentile TSS Concentrations (in mg/L)	10-9
Figure 10.4 – Stage 1 Dry Season (left) and Wet Season (right); 50 th Percentile TSS Concentrations (in mg/L)	10-11
Figure 10.5 – Stage 2 December to March of Year 4; 80 th Percentile TSS Concentrations (in mg/L).....	10-11
Figure 10.6 – Dry Season: Stage 3 September to November of Year 5; 80 th Percentile (left) and 50 th (right) TSS Concentrations (in mg/L)	10-11
Figure 10.7 – Wet Season: Stage 3 November to December of Year 5; 80 th Percentile (left) and 50 th (right) TSS Concentrations (in mg/L)	10-12
Figure 10.8 – Stage 1: 2 to 4 Months after Commencement (left) and 10 to 12 Months Later (right); 80 th Percentile Sedimentation Rates (in kg/m ²)	10-12
Figure 10.9 – Wet Season: Stage 1 December to January 80 th Percentile TSS Concentrations (in mg/L; left) and Sedimentation Rates (in kg/m ² ; right).....	10-12
Figure 10.10 – Wet to Dry Transition: Stage 1 April to June 80 th Percentile TSS Concentrations (in mg/L; left) and Sedimentation Rates (in kg/m ² ; right).....	10-13
Figure 10.11 – Stage 1 June to August (left) and Stage 2 February to April (right) 50 th Percentile Sedimentation Rates (in kg/m ²)	10-13
Figure 10.12 – Estimates of Highest TSS concentrations (in mg/L) and Highest Sedimentation (in g/m ²) from Disposal into Spoil Ground 3 in January (left) and May (right)	10-14
Figure 10.13 – Estimates of Highest TSS concentrations (in mg/L) and Highest Sedimentation (in g/m ²) from Disposal into Spoil Ground 7 in January (left) and May (right)	10-15
Figure 10.14 – Estimates of Highest TSS concentrations (in mg/L) and Highest Sedimentation (in g/m ²) from Disposal into Spoil Ground 9 in January (left) and May (right)	10-15
Figure 10.15 – Location of Sediment Sampling Sites and Spoil Grounds.....	10-19
Figure 10.16 – Location of Dewatering Discharge Point in Salmon Creek	10-22
Figure 10.17 – Location of Marine Habitat Categories within the Proposed Outer Harbour Development Area	10-30
Figure 10.18 – Estimated Loss of Mangrove BPPH from the Proposed Infrastructure Corridor	10-35
Figure 10.19 – LAU Boundaries for Assessment of Impacts to Coastal Intertidal BPPH for the Proposed Outer Harbour Development.....	10-38
Figure 10.20 – Historical Coastal Intertidal BPPH Loss	10-39
Figure 10.21 – Direct Losses of Coastal Intertidal BPPH due to the Proposed Outer Harbour Development Jetty Abutment.....	10-40
Figure 10.22 – Predicted Irreversible Losses of Coastal Intertidal BPPH due to Elevated Sedimentation Rates	10-41
Figure 10.23 – LAU Boundaries for Assessment of Impacts to Subtidal BPPH for the Proposed Outer Harbour Development	10-45
Figure 10.26 – Historical Subtidal BPPH Loss in State Waters	10-48
Figure 10.24 – Zones of Impact within State Waters for the Proposed Outer Harbour Development as Depicted by the Modelling.....	10-49
Figure 10.25 – Zones of Impact within State Waters for the Proposed Outer Harbour Development	10-51
Figure 10.27 – Direct Losses of Subtidal BPPH in State Waters due to the Proposed Outer Harbour Development Marine Infrastructure Footprint	10-53
Figure 10.28 – Predicted Irreversible Losses of Subtidal BPPH due to Elevated Sedimentation Rates	10-55
Figure 10.29 – Commonwealth Subtidal Habitats within the Proposed Outer Harbour Development Marine Infrastructure Footprint.....	10-59
Figure 10.30 – Area of Primary Vessel Movements with Respect to Turtle Density Observations.....	10-71

11	Social Impacts and Management	11-1
11.1	Introduction	11-1
11.2	Key factor - Community Services	11-1
11.2.1	Management Objective	11-1
11.2.2	Description of Factor	11-1
11.2.3	Assessment Guidance	11-2
11.2.4	Potential Impacts.....	11-2
11.2.5	Matters of National Environmental Significance	11-6
11.2.6	Management Measures	11-6
11.2.7	Significance of Residual Impact.....	11-6
11.2.8	Predicted Environmental Outcomes	11-8
11.3	Key Factor – Indigenous Heritage	11-8
11.3.1	Management Objective	11-8
11.3.2	Description of Factor	11-8
11.3.3	Assessment Guidance	11-8
11.3.4	Potential Impacts.....	11-8
11.3.5	Matters of National Environmental Significance	11-8
11.3.6	Management Measures	11-9
11.3.7	Significance of Residual Impact.....	11-10
11.3.8	Predicted Environmental Outcomes	11-10
11.4	Key Factor – Public Amenity	11-10
11.4.1	Management Objective	11-10
11.4.2	Description of Factor	11-10
11.4.3	Assessment Guidance	11-11
11.4.4	Potential Impacts.....	11-11
11.4.5	Matters of National Environmental Significance	11-16
11.4.6	Management Measures	11-16
11.4.7	Significance of Residual Impact.....	11-18
11.4.8	Predicted Environmental Outcomes	11-18
11.5	Key Factor - Visual Amenity	11-20
11.5.1	Management Objective	11-20
11.5.2	Description of Factor	11-20
11.5.3	Assessment Guidance	11-20
11.5.4	Potential Impacts.....	11-20
11.5.5	Matters of National Environmental Significance	11-27
11.5.6	Management Measures	11-27
11.5.7	Significance of Residual Impact.....	11-27
11.6	Relevant Factor – Public Health	11-29
11.6.1	Management Objective	11-29
11.6.2	Description of Factor	11-29
11.6.3	Assessment Guidance	11-30
11.6.4	Potential Impacts	11-30
11.6.7	Significance of Residual Impact	11-34
11.6.8	Predicted Environmental Outcomes.....	11-34

11.7	Relevant Factor - European Heritage	11-36
11.7.1	Management Objective	11-36
11.7.2	Description of Factor	11-36
11.7.3	Assessment Guidance	11-36
11.7.5	Matters of National Environmental Significance	11-37
11.7.6	Management Measures	11-37
11.7.7	Significance of Residual Impact.....	11-37
11.7.8	Predicted Environmental Outcomes	11-37
11.8	Relevant Factor – Recreation	11-37
11.8.1	Management Objective	11-37
11.8.2	Description of Factor.....	11-38
11.8.3	Assessment Guidance	11-38
11.8.4	Potential Impacts.....	11-38
11.8.5	Matters of National Environmental Significance	11-39
11.8.6	Management Measures	11-39
11.8.7	Significance of Residual Impact.....	11-40
11.8.8	Predicted Environmental Outcomes	11-40
11.9	Relevant Factor - Commercial Fisheries	11-40
11.9.1	Management Objective	11-40
11.9.2	Description of Factor.....	11-40
11.9.3	Assessment Guidance	11-41
11.9.5	Matters of National Environmental Significance	11-41
11.9.6	Management Measures	11-42
11.9.7	Significance of Residual Impact.....	11-42
11.9.8	Predicted Environmental Outcomes	11-42
11.10	Relevant Factor – Climate Change	11-43
11.10.1	Management Objective	11-43
11.10.2	Description of Factor.....	11-43
11.10.3	Assessment Guidance	11-43
11.10.7	Significance of Residual Impact.....	11-44
11.10.8	Predicted Environmental Outcomes	11-44

Tables

Table 11.1 – Social Factors and Aspects	11-1
Table 11.2 – Guidance Documents Specific to Community Services	11-2
Table 11.3 – Summary of Potential Impacts and Benefits and Management Actions associated with Community Services.....	11-7
Table 11.4 – Guidance Document Specific to Indigenous Heritage	11-8
Table 11.5 – Summary of Potential Impacts and Management Actions associated with Indigenous Heritage.....	11-9
Table 11.6 – Guidance Documents Specific to Public Amenity	11-11
Table 11.7 – Approved Dust Performance Targets (Ministerial Statement 740).....	11-12
Table 11.8 – Statistics for TSP Ground Level Concentrations at the Hospital ($\mu\text{g}/\text{m}^3$).....	11-14
Table 11.9 – Statistics for TSP Ground Level Concentrations at South Hedland and Wedgefield ($\mu\text{g}/\text{m}^3$) .	11-14
Table 11.10 – Assigned and Maximum Permissible Noise Levels at Port Hedland Receptors	11-15
Table 11.11 – Outdoor Noise Criteria for Noise Sensitive Land Uses Next to New Roads or Railways*	11-15
Table 11.12 –Noise Levels (L_{A10} dB (A)) Generated by the Operation of the Proposed Outer Harbour Development Cumulatively without Noise Control	11-16

Table 11.13 – Predicted Cumulative LAeq Values (dB (A))	11-16
Table 11.14 – Summary of Potential Impacts and Management Actions associated with Public Amenity	11-19
Table 11.15 – Guidance Documents Specific to Visual Amenity	11-20
Table 11.16 – Summary of Potential Impacts and Management Actions associated with Visual Amenity	11-28
Table 11.17 – Guidance Documents Specific to the Management of Public Health	11-29
Table 11.18 – Approved Dust Performance Targets (Ministerial Statement 740)	11-30
Table 11.19 – Statistics for Predicted PM ₁₀ Ground Level Concentrations at Hospital and Taplin Street (µg/m ³)	11-33
Table 11.20 – Statistics for Predicted PM ₁₀ Ground Level Concentrations at South Hedland and Wedgefield (µg/m ³)	11-34
Table 11.21 – Summary of Potential Impacts and Management Actions associated with Public Health	11-35
Table 11.22 – Guidance Documents Specific to European Heritage	11-35
Table 11.23 – Summary of Potential Impacts and Management Actions associated with European Heritage	11-37
Table 11.24 – Legislation and Guidance Documents Specific to Public Recreation	11-38
Table 11.25 – Summary of Potential Impacts and Management Actions associated with Recreation	11-40
Table 11.26 – Legislation and Guidance Documents Specific to Commercial Fisheries	11-41
Table 11.27 – Summary of Potential Impacts and Management Actions associated with Commercial Fisheries	11-42
Table 11.28 – Legislation and Guidance Documents Specific to Greenhouse Gas Emissions	11-43
Table 11.29 – Summary of Potential Impacts and Management Actions associated with Climate Change	11-45

Figures

Figure 11.1 – Cumulative Assessment - Statistics of predicted 24-hour TSP ground level concentrations	14
Figure 11.2 – Cumulative Assessment: Maximum predicted 24-hour TSP ground level concentrations (µg/m ³)	14
Figure 11.3 – Cumulative Assessment - Statistics of Predicted 24-hour PM10 Ground Level Concentrations	33
Figure 11.4 – Cumulative Assessment: Maximum predicted 24-hour PM10 Ground Level Concentrations (µg/m ³)	33

Plates

Plate 11.1 – Photomontage of the Expected View from Outside the All Seasons Hotel, Port Hedland East	22
Plate 11.2 – Photomontage of the Expected View from Sutherland Street, Port Hedland West	23
Plate 11.3 – Photomontage of the Expected View from Hamilton Road, South Hedland	24
Plate 11.4 – Photomontage of the Expected View from the Shoreline on the Northern Coast of Finucane Island	25
Plate 11.5 – Photomontage of the Expected View from the Gazebo at Laurentius Point	26
Plate 11.6 – Photomontage of the View from Ridley and Pinnacles Streets, Wedgefield	27

12 Environmental Management..... 12-1

12.1 BHP Billiton Environmental Management Overview	12-1
12.1.1 Health, Safety and Environmental Management System	12-1
12.1.2 Risk Assessment and Management System	12-1
12.2 Project Environmental Management Program.....	12-1
12.2.1 Outcome Based Conditions	12-1
12.2.2 Environmental Management – Construction	12-3
12.2.3 Environmental Management – Operation	12-13
12.2.4 Environmental Management – Decommissioning	12-14
12.2.5 Project Environmental Monitoring	12-14
12.2.6 Project Environmental and Heritage Review Process	12-15
12.2.7 Project Workforce Education	12-15

12.3 Key Environmental Management Commitments 12-15

Tables

Table 12.1 – Proposed Outcome Based Conditions..... 12-4
 Table 12.2 – Acid Sulphate Soils 12-5
 Table 12.3 – Terrestrial Flora, Vegetation and Fauna..... 12-5
 Table 12.4 – Dredging and Dredge Spoil Disposal..... 12-6
 Table 12.5 – Marine Fauna 12-6
 Table 12.6 – Public Amenity (Air Quality)..... 12-7
 Table 12.7 – Public Amenity (Noise) 12-7
 Table 12.8 – Environmental Management Programs
 and Supporting Environmental Management Plans – Construction 12-8
 Table 12.9 – Environmental Management Programs
 and Supporting Environmental Management Plans – Operation..... 12-13
 Table 12.10 – Environmental Management Commitments 12-16

Figures

Figure 12.1 – BHP Billiton’s Sustainable Development Policy 12-2
 Figure 12.2 – BHP Billiton Iron Ore Health, Safety, Environment
 and Community Management Standards 12-3

13 Glossary 13-2
13 References 13-5
13.1 Abbreviations 13-19