

## CONTENTS

<b>EXECUTIVE SUMMARY</b>	<b>ES-1</b>
ES1.1 Description of the Project	ES-1
ES1.2 The Environmental Impact Assessment process	ES-6
ES1.3 Background and need for the Project	ES-7
ES.1.3.1 Strategic planning	ES-7
ES.1.3.2 Demand studies	ES-8
ES.1.3.3 Consequences of not proceeding with the Project	ES-9
ES1.4 Alternatives considered	ES-9
ES.1.4.1 Within-Project alternatives	ES-10
ES1.5 Existing environment, potential impacts and mitigation measures	ES-14
ES.1.5.1 Climate and natural disasters	ES-14
ES.1.5.2 Topography and geomorphology	ES-14
ES.1.5.2 Landscape character and visual amenity	ES-14
ES.1.5.3 Geology and soils	ES-15
ES.1.5.4 Land use and infrastructure	ES-15
ES.1.5.6 Land contamination	ES-16
ES.1.5.7 Sensitive environmental areas	ES-17
ES.1.5.8 Terrestrial flora	ES-17
ES.1.5.9 Terrestrial fauna	ES-19
ES.1.5.10 Aquatic flora	ES-21
ES.1.5.11 Aquatic fauna	ES-22
ES.1.5.12 Surface water	ES-23
ES.1.5.13 Groundwater	ES-26
ES.1.5.14 Surface water quality	ES-27
ES.1.5.15 Air quality	ES-27
ES.1.5.16 Greenhouse gas	ES-27
ES.1.5.17 Noise and vibration	ES-28
ES.1.5.18 Waste	ES-28
ES.1.5.19 Transport	ES-28
ES.1.5.20 Indigenous cultural heritage	ES-29
ES.1.5.21 Non-indigenous cultural heritage	ES-30
ES.1.5.22 Social environment	ES-31
ES.1.5.23 Economic environment	ES-33
ES.1.5.24 Hazard and risk	ES-33
ES.1.5.25 Cumulative impacts	ES-34
ES.1.5.26 Matters of National Environmental Significance (MNES)	ES-35
ES1.6 Stakeholder consultation	ES-36
ES1.7 Approach to environmental management	ES-37
ES1.8 Recommendations	ES-37

1.	INTRODUCTION	1-1
1.1.	Project proponent	1-1
1.2.	Project description	1-1
1.3.	Need for the Project	1-5
1.3.1.	Strategic planning for water supply needs	1-5
1.3.2.	Recent water demand studies	1-12
1.3.3.	Summary of demand and need	1-13
1.4.	Relationship to other projects	1-14
1.4.1.	Water infrastructure projects	1-14
1.4.2.	Coal seam gas projects	1-14
1.4.3.	Coal mining projects	1-15
1.4.4.	Consequential impacts	1-18
1.5.	Cumulative impacts	1-20
1.6.	Socio-economic cost and benefits of the Project	1-21
1.6.1.	Economic costs and benefits	1-21
1.6.2.	Direct socio-economic costs and benefits	1-21
1.6.3.	Flow-on economic and social costs and benefits	1-22
1.6.4.	Demand for natural resources	1-22
1.7.	Alternatives to the Project	1-22
1.7.1.	Recycling, system management and water use efficiency	1-23
1.7.2.	Groundwater	1-24
1.7.3.	Coal seam gas water	1-24
1.7.4.	Desalination	1-26
1.7.5.	Surface water supplies	1-27
1.7.6.	Combinations of alternatives	1-27
1.7.7.	'Do nothing' option	1-28
1.7.8.	Within-Project alternatives	1-29
1.8.	Co-location opportunities	1-33
1.9.	The Environmental Impact Assessment process	1-34
1.9.1.	Methodology of the EIS	1-34
1.9.2.	Objective of the EIS	1-36
1.9.3.	Risk assessment and management methodology	1-39
1.9.4.	Submissions on the EIS	1-41
1.10.	Public consultation process	1-42
1.10.1.	Stakeholder identification	1-42
1.10.2.	Scope of community consultation	1-42
1.10.3.	Consultation phases and activities	1-43
1.10.4.	Summary of outcomes from the consultation process	1-46
1.11.	Project approvals	1-46
1.11.1.	Relevant legislation	1-47
1.11.2.	Planning process and standards	1-59
1.11.3.	Accredited process for controlled actions under Commonwealth legislation	1-65

<b>2.</b>	<b>DESCRIPTION OF PROJECT</b>	<b>2-1</b>
2.1.	Project overview	2-1
2.2.	Location	2-7
2.2.1.	Water storage area	2-7
2.2.2.	Pipeline	2-10
2.2.3.	Associated infrastructure	2-14
2.3.	Design	2-25
2.3.1.	Water storage	2-25
2.3.2.	Pipeline	2-42
2.3.3.	Associated infrastructure	2-45
2.4.	Construction	2-50
2.4.1.	Pre-construction activities	2-50
2.4.2.	Water storage	2-57
2.4.3.	Pipeline	2-68
2.4.4.	Associated infrastructure	2-74
2.4.5.	Demobilisation and rehabilitation	2-75
2.4.6.	Workforce and accommodation	2-78
2.4.7.	Commissioning	2-82
2.4.8.	Environmentally Relevant Activities	2-83
2.5.	Operation	2-83
2.5.1.	Water storage infrastructure	2-83
2.5.2.	Water distribution	2-87
2.5.3.	Associated infrastructure	2-90
2.6.	Decommissioning	2-90
2.6.1.	Water storage	2-90
2.6.2.	Water distribution pipeline	2-91
<b>3.</b>	<b>CLIMATE AND NATURAL DISASTERS</b>	<b>3-1</b>
3.1.	Climate	3-1
3.1.1.	Temperature and humidity	3-3
3.1.2.	Rainfall	3-3
3.1.3.	Evaporation	3-3
3.1.4.	Wind	3-4
3.2.	Natural disasters	3-5
3.2.1.	Bushfires	3-6
3.2.2.	Flooding	3-6
3.2.3.	Drought	3-6
3.2.4.	Earthquakes	3-6
3.2.5.	Climatic extremes	3-9
3.3.	Climate change	3-9
3.3.1.	Methodology	3-9
3.3.2.	Potential impacts and mitigation measures	3-10
3.4.	Summary	3-11

<b>4.</b>	<b>TOPOGRAPHY AND GEOMORPHOLOGY</b>	<b>4-1</b>
4.1.	Methodology	4-1
4.2.	Description of environmental values	4-1
4.2.1.	Dam and surrounds	4-1
4.2.2.	Pipeline	4-4
4.2.3.	Associated infrastructure	4-4
4.3.	Potential impacts and mitigation measures	4-7
4.3.1.	Dam and surrounds	4-7
4.3.2.	Pipeline	4-8
4.3.3.	Associated infrastructure	4-9
4.3.4.	Impact assessment and residual risks	4-9
4.4.	Summary	4-11
<b>5.</b>	<b>LANDSCAPE CHARACTER AND VISUAL AMENITY</b>	<b>5-1</b>
5.1.	Methodology	5-1
5.2.	Landscape character	5-2
5.3.	Description of environmental values	5-6
5.3.1.	Dam and surrounds	5-6
5.3.2.	Pipeline	5-16
5.3.3.	Associated infrastructure	5-22
5.4.	Potential impacts and mitigation measures	5-23
5.4.1.	Dam and surrounds	5-23
5.4.2.	Pipeline	5-26
5.4.3.	Associated infrastructure	5-28
5.4.4.	Impact assessment and residual risks	5-29
5.4.5.	Cumulative risk	5-32
5.5.	Summary	5-32
<b>6.</b>	<b>GEOLOGY AND SOILS</b>	<b>6-1</b>
6.1.	Description of environmental values	6-1
6.1.1.	Regulatory framework	6-1
6.1.2.	Methodology	6-1
6.1.3.	Nathan Dam catchment	6-2
6.1.4.	Dam site and surrounds	6-5
6.1.5.	Pipeline	6-18
6.1.6.	Associated infrastructure	6-32
6.2.	Potential impacts and mitigation measures	6-32
6.2.1.	Dam site and storage area	6-32
6.2.2.	Pipeline	6-38
6.2.3.	Associated infrastructure	6-41
6.2.4.	Impact assessment and residual risks	6-42
6.3.	Summary	6-46

<b>7.</b>	<b>LAND USE AND INFRASTRUCTURE</b>	<b>7-1</b>
7.1.	Description of environmental values	7-1
7.1.1.	Methodology	7-1
7.1.2.	Dam and surrounds	7-2
7.1.3.	Pipeline	7-30
7.1.4.	Associated infrastructure	7-70
7.2.	Potential impacts and mitigation measures	7-70
7.2.1.	Dam and surrounds	7-71
7.2.2.	Pipeline	7-80
7.2.3.	Associated infrastructure	7-83
7.2.4.	Impact assessment and residual risks	7-85
7.2.5.	Cumulative risks	7-89
7.3.	Summary	7-89
<b>8.</b>	<b>LAND CONTAMINATION</b>	<b>8-1</b>
8.1.	Description of environmental situation	8-1
8.1.1.	Regulatory framework	8-1
8.1.2.	Methodology	8-2
8.1.3.	Dam and surrounds	8-3
8.1.4.	Pipeline	8-7
8.2.	Potential impacts and mitigation measures	8-11
8.2.1.	Impacts	8-11
8.2.2.	Mitigation measures	8-14
8.2.3.	Unforeseen contamination and prevention of contamination	8-14
8.2.4.	Impact assessment and residual risks	8-16
8.3.	Summary	8-21
<b>9.</b>	<b>SENSITIVE ENVIRONMENTAL AREAS</b>	<b>9-1</b>
9.1.	Methodology	9-1
9.2.	Terrestrial environments	9-1
9.2.1.	Protected areas	9-1
9.2.2.	Significant regional ecosystems	9-5
9.2.3.	Threatened ecological communities	9-6
9.2.4.	Important habitats for threatened flora	9-7
9.2.5.	Biodiversity planning assessment	9-10
9.2.6.	Important habitats for threatened fauna	9-10
9.3.	Aquatic environments	9-14
9.3.1.	Freshwater ecosystems	9-14
9.3.2.	Declared fish habitat areas	9-14
9.3.3.	Wetlands of national significance	9-14
9.3.4.	Wetlands of international significance (Ramsar wetlands)	9-14
9.3.5.	World heritage areas	9-14
9.3.6.	Important habitats for threatened aquatic species	9-15

9.4.	Cultural environments	9-19
9.4.1.	Indigenous Heritage	9-19
9.4.2.	Non-indigenous heritage	9-19
9.5.	Implications of climate change for nature conservation values	9-21
9.5.1.	Overview of vulnerability of biodiversity to climate change	9-21
9.5.2.	Species/ecosystems at risk in the Project area	9-22
9.5.3.	Implications for nature conservation values in the Project area	9-23
<b>10.</b>	<b>TERRESTRIAL FLORA</b>	<b>10-1</b>
10.1.	Description of environmental values	10-1
10.1.1.	Regulatory framework	10-1
10.1.2.	Methodology	10-4
10.1.3.	Dam study area	10-14
10.1.4.	Pipeline	10-43
10.1.5.	Associated infrastructure	10-65
10.2.	Potential impacts and mitigation measures	10-67
10.2.1.	Dam and surrounds	10-67
10.2.2.	Pipeline	10-79
10.2.3.	Associated infrastructure	10-84
10.3.	Impact assessment and residual risks	10-86
10.4.	Environmental offsets strategy	10-94
10.4.1.	Vegetation offsets	10-95
10.4.2.	Biodiversity offsets	10-96
10.5.	Cumulative impacts	10-97
10.6.	Summary	10-97
<b>11.</b>	<b>TERRESTRIAL FAUNA</b>	<b>11-1</b>
11.1.	Description of environmental values	11-1
11.1.1.	Regulatory framework	11-1
11.1.2.	Methodology	11-2
11.1.3.	Dam and surrounds	11-17
11.1.4.	Pipeline	11-47
11.1.5.	Associated Infrastructure	11-60
11.2.	Potential impacts and mitigation measures	11-60
11.2.1.	Dam and surrounds	11-60
11.2.2.	Pipeline	11-78
11.2.3.	Associated infrastructure	11-82
11.2.4.	Impact assessment and residual risk	11-83
11.3.	Cumulative impacts	11-91
11.4.	Summary	11-91

<b>12. AQUATIC FLORA</b>	<b>12-1</b>
12.1. Description of environmental values	12-1
12.1.1. Regulatory framework	12-1
12.1.2. Methodology	12-3
12.1.3. Dam and surrounds	12-5
12.1.4. Pipeline	12-17
12.1.5. Associated infrastructure	12-20
12.2. Potential impacts and mitigation measures	12-20
12.2.1. Dam and surrounds	12-20
12.2.2. Pipeline	12-27
12.2.3. Associated infrastructure	12-29
12.3. Impact assessment and residual risks	12-29
12.4. Cumulative impacts	12-34
12.5. Summary	12-34
<b>13. AQUATIC FAUNA</b>	<b>13-1</b>
13.1. Description of environmental values	13-1
13.1.1. Legislative framework	13-1
13.1.2. Methodology	13-3
13.1.3. Dam and surrounds	13-6
13.1.4. Pipeline	13-33
13.1.5. Associated infrastructure	13-39
13.1.6. Estuarine and marine	13-39
13.2. Potential impacts and mitigation measures	13-42
13.2.1. Dam and surrounds	13-42
13.2.2. Pipeline	13-58
13.2.3. Associated infrastructure	13-59
13.2.4. Impact assessment and residual risks	13-60
13.3. Cumulative impacts	13-65
13.4. Summary	13-67
<b>14. SURFACE WATER</b>	<b>14-1</b>
14.1. Description of environmental values – hydrology	14-1
14.1.1. Regulatory framework	14-1
14.1.2. Assessment methodology	14-3
14.1.3. Catchment description	14-6
14.1.4. Surface water flow patterns	14-9
14.1.5. Flooding	14-20
14.1.6. Current water resource development	14-29
14.1.7. Pipeline	14-37
14.2. Potential impacts and mitigation measures - hydrology	14-38
14.2.1. Construction	14-38
14.2.2. Surface water flow under operations	14-41
14.2.3. Flooding	14-72
14.3. Cumulative risk	14-81

14.3.2.	Impact assessment and residual risks	14-87
14.4.	Summary - hydrology	14-92
14.5.	Description of environmental values – fluvial geomorphology	14-92
14.5.1.	Methodology	14-92
14.5.2.	Dam and surrounds	14-95
14.5.3.	Pipeline	14-113
14.5.4.	Associated infrastructure	14-114
14.6.	Potential impacts and mitigation measures – fluvial geomorphology	14-115
14.6.1.	Methodology	14-115
14.6.2.	Dam and surrounds	14-115
14.6.3.	Pipeline	14-121
14.6.4.	Associated infrastructure	14-123
14.6.5.	Impact assessment and residual risks	14-123
14.7.	Cumulative risks	14-134
14.8.	Summary – fluvial geomorphology	14-134
<b>15.</b>	<b>GROUNDWATER</b>	<b>15-1</b>
15.1.	Description of environmental values	15-1
15.1.1.	Regulatory framework	15-1
15.1.2.	Methodology	15-3
15.1.3.	Dam and surrounds	15-4
15.1.4.	Pipeline	15-28
15.1.5.	Associated infrastructure	15-29
15.2.	Potential impacts and mitigation measures	15-29
15.2.1.	Water Resource (GAB) Plan and GAB ROP	15-29
15.2.2.	Nathan Dam groundwater model	15-30
15.2.3.	Dam and surrounds	15-32
15.2.4.	Pipeline	15-43
15.2.5.	Impact assessment and residual risks	15-44
15.2.6.	Groundwater monitoring	15-52
15.2.7.	Groundwater extraction bores and decommissioning of temporary groundwater bores	15-53
15.3.	Summary	15-53
<b>16.</b>	<b>SURFACE WATER QUALITY</b>	<b>16-1</b>
16.1.	Description of environmental values	16-1
16.1.1.	Regulatory framework	16-1
16.1.2.	Defining environmental values	16-4
16.1.3.	Methodology	16-8
16.1.4.	Dam and surrounds	16-11
16.1.5.	Pipeline	16-37
16.1.6.	Associated infrastructure	16-39
16.2.	Potential impacts and mitigation measures	16-39
16.2.1.	Dam and surrounds	16-39
16.2.2.	Pipeline	16-45
16.2.3.	Associated infrastructure	16-47
16.2.4.	Impact assessment and residual risks	16-47



16.3.	Cumulative risks	16-53
16.4.	Summary	16-54
<b>17.</b>	<b>AIR QUALITY</b>	<b>17-1</b>
17.1.	Description of environmental values	17-1
17.1.1.	Regulatory framework	17-1
17.1.2.	Methodology	17-2
17.1.3.	Water storage dam and surrounds	17-2
17.1.4.	Pipeline	17-9
17.1.5.	Associated infrastructure	17-10
17.2.	Potential impacts and mitigation measures	17-10
17.2.1.	Dam and surrounds	17-10
17.2.2.	Pipeline construction	17-19
17.2.3.	Associated infrastructure	17-23
17.2.4.	Other air quality impacts	17-30
17.2.5.	Operations phase impacts	17-30
17.3.	Cumulative impacts	17-30
17.3.1.	Mitigation measures	17-31
17.3.2.	Residual risk	17-31
17.4.	Summary	17-34
<b>18.</b>	<b>GREENHOUSE GAS EMISSIONS</b>	<b>18-1</b>
18.1.	Regulatory framework	18-1
18.2.	Methodology	18-1
18.2.1.	Emissions classification	18-1
18.2.2.	Emission factors	18-2
18.3.	Potential impacts	18-3
18.3.1.	Dam and surrounds	18-3
18.3.2.	Pipeline	18-4
18.3.3.	Operational emissions	18-4
18.3.4.	Upstream emissions	18-4
18.4.	Mitigation measures	18-5
18.4.1.	Construction	18-5
18.4.2.	Operation	18-5
18.5.	Summary	18-6
<b>19.</b>	<b>NOISE AND VIBRATION</b>	<b>19-1</b>
19.1.	Description of environmental values	19-1
19.1.1.	Regulatory framework	19-1
19.1.2.	Methodology	19-6
19.1.3.	Dam and surrounds	19-7
19.1.4.	Pipeline	19-11
19.1.5.	Associated infrastructure	19-12
19.1.6.	Project noise and vibration goals	19-12
19.2.	Potential impacts and mitigation measures	19-14
19.2.1.	Methodology	19-14

19.2.2.	Dam and surrounds – construction phase	19-14
19.2.3.	Dam and surrounds - operations phase impacts	19-20
19.2.4.	Pipeline - construction	19-21
19.2.5.	Pipeline - operation	19-23
19.2.6.	Associated infrastructure – road upgrades	19-26
19.2.7.	Associated infrastructure – extraction activities	19-29
19.2.8.	Impacts on terrestrial and aquatic fauna	19-31
19.2.9.	Mitigation measures	19-31
19.3.	Impact assessment and residual risks	19-32
19.4.	Cumulative impacts	19-36
19.5.	Summary	19-36
<b>20.</b>	<b>WASTE</b>	<b>20-1</b>
20.1.	Legislative framework	20-1
20.2.	Waste management strategy	20-1
20.2.1.	Waste management hierarchy	20-2
20.2.2.	Cleaner production	20-2
20.2.3.	Waste tracking	20-3
20.2.4.	Waste monitoring	20-3
20.3.	Construction phase	20-4
20.3.1.	Waste generation	20-4
20.3.2.	Waste management	20-7
20.4.	Operation phase	20-11
20.5.	Impact assessment and residual risks	20-11
20.6.	Cumulative impact risks	20-17
20.7.	Summary	20-17
<b>21.</b>	<b>TRANSPORT</b>	<b>21-1</b>
21.1.	Regulatory framework	21-1
21.1.1.	Transport Infrastructure Act 1994	21-1
21.1.2.	Guidelines for Assessment of Road Impacts of Development	21-1
21.2.	Methodology	21-3
21.2.1.	Assumptions and limitations	21-3
21.2.2.	Potential impacts	21-4
21.3.	Transport methods and routes	21-4
21.3.1.	Description of existing infrastructure	21-4
21.3.2.	Road network	21-4
21.3.3.	School bus services	21-19
21.3.4.	Rail and port facilities	21-19
21.3.5.	Police and emergency services	21-19
21.3.6.	Infrastructure and transport requirements	21-19
21.3.7.	Timing	21-19
21.3.8.	Construction phase	21-24
21.3.9.	Operational traffic	21-36
21.3.10.	Consideration of other projects impacting on the road networks	21-36

21.4.	Project impacts and mitigation measures	21-38
21.4.1.	Construction within or in proximity to a road reserve	21-40
21.4.2.	Construction within or in proximity to a railway corridor	21-40
21.5.	Impact assessment and residual risk	21-40
21.5.1.	Cumulative risks	21-43
21.6.	Summary	21-43
<b>22.</b>	<b>INDIGENOUS CULTURAL HERITAGE</b>	<b>22-1</b>
22.1.	Description of existing indigenous cultural heritage values	22-1
22.1.1.	Regulatory framework	22-1
22.1.2.	Methodology	22-1
22.1.3.	Cultural heritage database searches	22-6
22.1.4.	Previous cultural heritage investigations	22-6
22.1.5.	Cultural heritage investigations	22-7
22.1.6.	Consultation	22-9
22.2.	Management and mitigation of impacts on indigenous cultural heritage	22-11
22.2.1.	Cultural heritage engagement agreements	22-11
22.2.2.	Cultural heritage management plans	22-11
<b>23.</b>	<b>NON INDIGENOUS CULTURAL HERITAGE</b>	<b>23-1</b>
23.1.	Description of non-indigenous cultural heritage values	23-1
23.1.1.	Regulatory framework	23-1
23.1.2.	Methodology	23-3
23.1.3.	Contextual history	23-6
23.1.4.	Dam and surrounds	23-15
23.1.5.	Pipeline	23-18
23.1.6.	Associated infrastructure	23-21
23.2.	Potential Impacts and Mitigation Measures	23-21
23.2.1.	General mitigation measures	23-22
23.2.2.	Dam and surrounds	23-25
23.2.3.	Pipeline	23-31
23.2.4.	Associated infrastructure	23-36
23.3.	Impact assessment and residual risks	23-36
23.3.1.	Cumulative risk	23-39
23.4.	Summary	23-39
<b>24.</b>	<b>SOCIAL VALUES AND MANAGEMENT OF IMPACTS</b>	<b>24-1</b>
24.1.	Introduction and background	24-1
24.1.1.	Methodology	24-1
24.1.2.	Stakeholder consultation	24-1
24.1.3.	Social policy framework	24-2
24.2.	Description of the local community area	24-5
24.2.1.	Definition of the study area	24-5
24.2.2.	Townships	24-8
24.2.3.	Other relevant proposals and projects	24-10
24.2.4.	Features in the study area	24-12

24.3.	Profile of the local community	24-24
24.3.1.	Population size and growth	24-24
24.3.2.	Age profile	24-26
24.3.3.	Population mobility	24-27
24.3.4.	Households and families	24-27
24.3.5.	Cultural diversity	24-28
24.3.6.	Education	24-29
24.3.7.	Housing and accommodation	24-30
24.3.8.	Community capacity	24-33
24.3.9.	Community health and safety	24-35
24.3.10.	Local community values, vitality and lifestyles	24-37
24.4.	Profile of the local business community	24-39
24.4.1.	Directly affected properties and families	24-39
24.4.2.	Employment and income	24-40
24.4.3.	Agriculture, forestry and fishing	24-44
24.4.4.	Mining and industry	24-44
24.4.5.	Tourism	24-44
24.4.6.	Recreation	24-45
24.5.	Potential impacts and mitigation measures	24-45
24.5.1.	Property impacts	24-45
24.5.2.	Employment and education	24-48
24.5.3.	Local business and industry	24-53
24.5.4.	Population and demography	24-56
24.5.5.	Housing and accommodation	24-59
24.5.6.	Community services and social infrastructure	24-61
24.5.7.	Access and connectivity	24-66
24.5.8.	Community health and safety	24-68
24.5.9.	Community values and amenity	24-70
24.5.10.	Project workforce	24-73
24.6.	Cumulative impacts	24-73
24.6.1.	Potential cumulative social impacts	24-74
24.6.2.	Existing initiatives and potential alignment	24-76
24.7.	Social responsibility initiatives	24-78
24.8.	Impact assessment and residual risk	24-79
24.9.	Social impact management plan	24-88
24.9.1.	Background	24-88
24.9.2.	Methodology and schedule for SIMP development	24-88
24.9.3.	SIMP framework	24-89
24.10.	Summary	24-99
<b>25.</b>	<b>ECONOMIC ENVIRONMENT AND MANAGEMENT OF IMPACTS</b>	<b>25-1</b>
25.1.	Methodology	25-1
25.2.	Description of affected local and regional economies	25-5
25.2.1.	Gross regional product	25-5
25.2.2.	Population	25-6

25.2.3.	Labour force statistics	25-9
25.2.4.	Infrastructure	25-12
25.2.5.	Key industries and contribution	25-13
25.2.6.	Resource endowment, competitive advantage and future growth	25-19
25.2.7.	Key regional markets relevant to the Project	25-19
25.2.8.	Regional key industries and factor prices	25-22
25.3.	Potential impacts and mitigation measures	25-26
25.3.1.	Project timelines	25-26
25.3.2.	Economic Impacts	25-27
25.3.3.	Indirect economic impacts	25-34
25.4.	Cumulative impacts	25-38
25.4.1.	Climate change risk	25-39
25.4.2.	Strategies to mitigate disruption and increase local economic benefits	25-40
25.4.3.	Strategies for local participation	25-41
25.4.4.	Impact upon property management	25-44
25.5.	Sustainable development	25-45
25.6.	Summary	25-46
<b>26.</b>	<b>HAZARD AND RISK</b>	<b>26-1</b>
26.1.	Regulatory framework	26-1
26.1.1.	Queensland legislative framework for dam safety	26-2
26.1.2.	Dam safety guidelines	26-3
26.1.3.	Risk assessment and risk analysis	26-3
26.1.4.	Unmitigated and mitigated risk details	26-9
26.1.5.	Project Controls and Mitigation Measures	26-27
26.2.	Hazardous chemicals	26-32
26.2.1.	Risk assessment	26-33
26.2.2.	Mitigation measures	26-34
26.3.	Emergency management	26-36
26.3.1.	Emergency action plan	26-37
26.3.2.	Emergency response	26-38
26.4.	Decommissioning phase	26-39
26.5.	Summary	26-39
<b>27.</b>	<b>CUMULATIVE IMPACTS</b>	<b>27-1</b>
27.1.	Introduction	27-1
27.1.1.	Cumulative effects of development	27-1
27.1.2.	Cumulative impact assessment in Australia and overseas	27-2
27.2.	CIA methodology	27-3
27.2.1.	Scoping	27-3
27.2.2.	Establish baseline conditions	27-10
27.2.3.	Screening	27-11
27.2.4.	Evaluating and mitigation	27-16
27.3.	CIA results	27-17
27.3.1.	Cause and effect analysis (network diagrams)	27-17
27.3.2.	Potential cumulative impacts (matrix and spatial analysis)	27-21

27.3.3.	Evaluation of potential risk and opportunities (risk and opportunities tables)	27-26
27.4.	Conclusion	27-40
<b>28.</b>	<b>MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE</b>	<b>28-4</b>
28.1.	Introduction	28-4
28.2.	Description of the proposed action	28-5
28.2.1.	Location	28-8
28.2.2.	Design	28-11
28.2.3.	Pre-construction activities	28-14
28.2.4.	Construction of the dam	28-16
28.2.5.	Pipeline construction	28-19
28.2.6.	Operation	28-22
28.2.7.	Consequential actions and cumulative impacts	28-23
28.3.	Description of the affected environment	28-26
28.3.1.	World Heritage properties	28-26
28.3.2.	National Heritage places	28-28
28.3.3.	Wetlands of International Importance	28-30
28.3.4.	Threatened species and ecological communities	28-31
28.3.5.	Migratory species	28-86
28.3.6.	Marine species	28-88
28.4.	Impacts and mitigation measures	28-90
28.4.1.	World Heritage properties, National Heritage places and Wetlands of International Importance	28-91
28.4.2.	Threatened species and ecological communities	28-101
28.4.3.	Migratory species	28-126
28.4.4.	Offsets	28-129
28.5.	Environmental flows – an MNES context	28-134
28.5.1.	Flows as they relate to MNES	28-134
28.5.2.	Understanding environmental flow statistics	28-140
28.5.3.	Existing flow conditions in the Dawson River	28-149
28.5.4.	Flow regime change	28-151
28.5.5.	Cumulative	28-171
28.5.6.	Summary	28-177
28.6.	Cumulative impacts	28-178
28.7.	Environmental management plan outline	28-179
28.7.1.	Overview	28-179
28.7.2.	Draft construction environmental management plan outline	28-179
28.7.3.	Draft operation environmental management plan outline	28-180
28.8.	Environmental record of proponent	28-181
28.9.	Conclusions	28-182
28.9.1.	World Heritage properties and National Heritage places	28-182
28.9.2.	Wetlands of International Importance	28-182
28.9.3.	Threatened species and ecological communities	28-182
28.9.4.	Migratory species	28-184
28.10.	Linkages to EIS	28-185

29.	<b>ENVIRONMENTAL MANAGEMENT PLAN</b>	29-1
29.1.	Environmental management	29-1
29.2.	Purpose	29-1
29.2.1.	Environmental requirements and obligations	29-1
29.2.2.	Objectives and principles	29-3
29.3.	Responsibilities and implementation	29-4
29.3.1.	Management structure	29-4
29.3.2.	Overall responsibilities	29-5
29.3.3.	Environmental responsibilities	29-6
29.4.	Documentation, communication and complaints	29-6
29.4.1.	Documentation and environmental records	29-6
29.4.2.	Internal communication	29-7
29.4.3.	External communication	29-8
29.4.4.	Complaints and responses	29-8
29.5.	Monitoring, auditing and reporting strategies	29-9
29.5.1.	Monitoring	29-9
29.5.2.	Auditing	29-9
29.5.3.	Reporting	29-10
29.5.4.	Non-compliance and corrective actions	29-10
29.6.	Competence, training and awareness	29-10
29.7.	Decommissioning program	29-11
29.8.	Overview of draft environmental management plan outline	29-11
29.9.	Draft construction environmental management plan outline	29-11
29.9.1.	Overview	29-11
29.9.2.	Implementation	29-12
29.9.3.	Landscape character and visual amenity	29-14
29.9.4.	Geology and soils	29-14
29.9.5.	Land contamination	29-16
29.9.6.	Surface water hydrology	29-18
29.9.7.	Groundwater	29-19
29.9.8.	Surface water quality	29-20
29.9.9.	Terrestrial flora (not including weeds)	29-21
29.9.10.	Terrestrial fauna (not including pest species)	29-23
29.9.11.	Animal pests	29-25
29.9.12.	Aquatic flora and fauna	29-26
29.9.13.	Weeds	29-28
29.9.14.	Air quality and greenhouse gas	29-29
29.9.15.	Noise and vibration	29-31
29.9.16.	Waste	29-34
29.9.17.	Hazard and risk	29-36
29.9.18.	Transport and roads	29-39
29.9.19.	Indigenous and non-indigenous cultural heritage	29-41
29.9.20.	Social and economic	29-42
29.10.	Draft operation environmental management plan outline	29-43

29.10.1.	Overview	29-43
29.10.2.	Management of water storage and pipeline	29-44
29.10.3.	Dam safety	29-45
29.10.4.	Geology and soils	29-46
29.10.5.	Groundwater	29-47
29.10.6.	Surface water quality	29-48
29.10.7.	Greenhouse gas	29-50
29.10.8.	Hazardous substances	29-50
29.10.9.	Ecological rehabilitation, restoration and monitoring	29-51
29.10.10.	Social and economic	29-52
<b>30.</b>	<b>CONCLUSIONS AND RECOMMENDATIONS</b>	<b>30-1</b>
30.1.	Conclusions	30-1
30.2.	Recommendations	30-3
<b>31.</b>	<b>REFERENCES</b>	<b>31-1</b>



## APPENDICES

- 1A-1 TERMS OF REFERENCE
- 1A-2 TERMS OF REFERENCE CROSS-REFERENCE TABLE
- 1B CONSEQUENCE TABLES
- 1C CONSULTATION REPORT
- 1D APPROVALS MATRIX
- 1E STUDY TEAM
- 2A AFFECTED PROPERTIES TABLE - DAM
- 2B AFFECTED PROPERTIES TABLE - PIPELINE
- 2C AFFECTED PROPERTIES TABLE - ASSOCIATED INFRASTRUCTURE
- 6A ADDITIONAL SOILS INFORMATION
- 8A POTENTIALLY CONTAMINATED SITES WITHIN AND OUTSIDE FSL
- 8B POTENTIALLY CONTAMINATED SITES WITHIN AND ADJACENT TO PIPELINE ROUTE
- 10A PIPELINE REGIONAL ECOSYSTEM MAPPING
- 10B FLORA BASELINE STUDY SUPPORTING INFORMATION
- 10C BIOREGIONAL EXTENT AND REPRESENTATION OF SIGNIFICANT RES IN PROTECTED AREAS
- 11A DETAILED FAUNA METHODOLOGY AND RESULTS
- 11B BAAM BOGGOMOSS SNAIL REPORT (2008)
- 11C SKM BOGGOMOSS SNAIL REPORT (2009)
- 11D JKR ECOLOGICAL BOGGOMOSS SNAIL REPORT (2010)
- 11E BOGGOMOSS SNAIL TRANSLOCATION PLAN (BAAM, 2010)
- 12A PRE-WET SEASON SURVEY (FRC ENVIRONMENTAL)
- 12B POST-WET SEASON SURVEY (ECOWISE)
- 12C PRE-WET SEASON FIELD SURVEY: TURTLES AND WATER QUALITY (ECOWISE)
- 12D PIPELINE FLORA & FAUNA (FRC ENVIRONMENTAL)
- 13A ECOLOGY OF THE FISH THAT MAY BE AFFECTED BY NATHAN DAM
- 13B FITZROY RIVER TURTLE DISTRIBUTION, REPRODUCTIVE CONDITION AND NESTING SURVEY (FRC ENVIRONMENTAL, 2010)
- 14A CLIMATE CHANGE MODELLING INPUTS (DERM, 2009)
- 15A INTERPRETED EXTENT AND THICKNESS OF THE MAJOR FORMATIONS AT THE DAM SITE AND SURROUNDS
- 15B SUMMARY OF DETAILS FOR WATER BORES REGISTERED WITH DERM FOR REGION AROUND NATHAN DAM
- 15C GROUNDWATER LEVEL DATA FROM DERM DATABASE
- 15D SUMMARY OF GROUNDWATER AUTHORISATIONS FROM THE DERM WATER ENTITLEMENT SYSTEM
- 15E NATHAN DAM GROUNDWATER MODEL DEVELOPMENT

- 15F IMPACT OF DAM CONSTRUCTION AND OPERATION ON BOGGOMOSS SPRINGS
- 15G IMPACT OF DAM CONSTRUCTION AND OPERATION ON EXISTING GROUNDWATER USERS
- 15H MODELLED CHANGES TO GROUNDWATER ELEVATIONS ASSOCIATED WITH DAM INUNDATION
- 16A DERM WATER QUALITY MONITORING RESULTS (DAWSON)
- 16B SUNWATE WATER QUALITY MONITORING RESULTS (GLEBE)
- 23A HISTORIC HERITAGE MANAGEMENT PLAN (CONVERGE, 2008)
- 30A TABLE OF PROJECT COMMITMENTS

## TABLES

Table 1-1 Estimated water supply shortfalls by sector (Dawson-Callide and Upper Dawson sub-regions)	1-10
Table 1-2 Summary of projected new high priority demand for water from Nathan Dam	1-13
Table 1-3 Likelihood table	1-39
Table 1-4 Example consequence table (terrestrial flora)	1-40
Table 1-5 Risk matrix	1-40
Table 1-6 Community and stakeholder engagement - Consultation phases and activities	1-44
Table 2-1 Bounding location points delineate the dam wall and water storage area	2-8
Table 2-2 Summary of tenure of land within water storage area at FSL	2-8
Table 2-3 Tenure of land within pipeline (permanent) easement	2-14
Table 2-4 Lot and plan number and calculated area (ha) for clay area's 1-9	2-24
Table 2-5 Estimated flood routing results for a range of AEPs	2-27
Table 2-6 Reservoir area and storage capacity for Nathan Dam under a range of flood conditions	2-28
Table 2-7 Key parameters of the water storage	2-32
Table 2-8 Summary of engineering details of the conceptual design for main spillway	2-34
Table 2-9 Engineering summary E&R dam	2-36
Table 2-10 Engineering summary of saddle dam	2-39
Table 2-11 Description of outlet elements	2-40
Table 2-12 Indicative quantities of material required for dam construction	2-61
Table 2-13 Indicative quantities of imported pavement material for roads and hardstands required for dam construction (including associated infrastructure).	2-62
Table 2-14 Anticipated potential plant requirements	2-62
Table 2-15 Indicative quantities of water required for dam construction (including associated infrastructure)	2-65
Table 2-16 Waste volumes	2-67
Table 2-17 Indicative quantities of raw materials required to construct the pipeline	2-71
Table 2-18 Indicative quantities of imported pavement material for roads and hardstands required for pipeline construction	2-71
Table 2-19 Anticipated potential pipeline plant requirements	2-72
Table 2-20 Indicative quantities of water required for pipeline construction	2-74
Table 3-1 Climatic summary of Taroom Post Office and Dalby Airport	3-1
Table 3-2 Maximum Daily Rainfalls by Month, Taroom Post Office	3-9
Table 3-3 Potential change in climate for the Project area, relative to 1990 for medium and high emissions scenarios	3-10
Table 3-4 Potential impact of climate change and proposed mitigation measures	3-11
Table 4-1 Risk assessment results	4-10
Table 5-1 Landscape character units – sensitivity to change	5-3
Table 5-2 Landscape character units – dam and surrounds	5-9
Table 5-3 Landscape character units – pipeline	5-17
Table 5-4 Risk assessment results	5-30
Table 6-1 Geological units occurring in the Nathan Dam Catchment	6-4

Table 6-2 Geological units occurring in the vicinity of Nathan Dam	6-8
Table 6-3 Soil mapping units of the Nathan Dam area (after Shields, 1997)	6-12
Table 6-4 Geological units along the Nathan Dam to Dalby pipeline that only occur outside the Nathan Dam catchment	6-18
Table 6-5 Land Resource Areas occurring in the vicinity of the pipeline from Nathan Dam to the Great Dividing Range (after Forster, 1985)	6-22
Table 6-6 Land resource areas occurring in the vicinity of the pipeline from the Great Dividing Range to just west of Warra (after Maher, 1995; Maher, 1996)	6-23
Table 6-7 Land resource areas occurring in the vicinity of the pipeline from just west of Warra to Dalby (after Harris <i>et al.</i> , 1999; Maher 1998)	6-24
Table 6-8 Risk assessment results	6-43
Table 7-1 SPP1/03 Outcomes	7-3
Table 7-2 RGMF regional policies and outcomes	7-7
Table 7-3 Taroom Shire Planning Scheme – desired environmental outcomes	7-10
Table 7-4 Taroom Shire Planning Scheme – zones	7-12
Table 7-5 Reserves affected by the dam	7-17
Table 7-6 Taroom Shire Planning Scheme – desired environmental outcomes	7-31
Table 7-7 Murilla Shire Planning Scheme – DEOs	7-32
Table 7-8 Murilla Shire Planning Scheme – zones	7-33
Table 7-9 Chinchilla Shire Planning Scheme – DEOs	7-37
Table 7-10 Chinchilla Shire Planning Scheme – zones	7-38
Table 7-11 Dalby Town Planning Scheme – DEOs	7-39
Table 7-12 Dalby Town Planning Scheme – precincts	7-41
Table 7-13 Wambo Shire Planning Scheme – DEOs	7-42
Table 7-14 Wambo Shire Planning Scheme – zones	7-43
Table 7-15 Properties most affected by the water storage	7-72
Table 7-16 Impact assessment and residual risks	7-86
Table 8-1 Summary of current and historical review for the dam and surrounds	8-4
Table 8-2 DERM information relating to EMR listed sites	8-7
Table 8-3 Summary of historical review for the pipeline	8-8
Table 8-4 Risk assessment results - construction	8-17
Table 8-5 Risk assessment results - operations	8-19
Table 9-1 Protected areas located in the vicinity of the Project area	9-2
Table 9-2 Significant regional ecosystems	9-5
Table 9-3 Important habitats for threatened flora recorded in the study area	9-7
Table 9-4 Important habitats for threatened fauna recorded in the Project area	9-11
Table 9-5 Important habitat for threatened aquatic species	9-15
Table 9-6 Heritage/historic sites identified in the dam study area	9-19
Table 9-7 Heritage/historic sites identified within 5 km of the pipeline route	9-20

Table 9-8 Life history traits which influence vulnerability to climate change	9-22
Table 9-9 Species and systems within the Project area vulnerable to climate change	9-22
Table 9-10 Likely impacts of climate change on sensitive species within the Project area	9-23
Table 10-1 Condition assessment	10-13
Table 10-2 Regional Ecosystems within the dam study area (Queensland Herbarium, 2009)	10-14
Table 10-3 Threatened species identified in the database search results	10-22
Table 10-4 Regional ecosystems as mapped at a 1:10,000 scale within the dam study area	10-26
Table 10-5 GAB spring communities recorded within the dam study area	10-32
Table 10-6 Likelihood of occurrence of significant flora in the dam impact area	10-37
Table 10-7 Plants of cultural significance recorded in the dam study area	10-40
Table 10-8 Species declared under the LP Act recorded in the dam study area	10-41
Table 10-9 Extent of remnant and non-remnant vegetation in the water storage	10-41
Table 10-10 Timber volume estimates for the dam and surrounds	10-42
Table 10-11 Regional Ecosystems within the pipeline corridor (DERM, 2009b)	10-43
Table 10-12 Threatened species identified in the database search results	10-46
Table 10-13 Regional ecosystems within the pipeline corridor	10-53
Table 10-14 Extent of remnant and non-remnant vegetation within the pipeline corridor	10-54
Table 10-15 Likelihood of occurrence of threatened flora in the pipeline corridor	10-56
Table 10-16 Species of cultural significance within the pipeline corridor	10-60
Table 10-17 Declared weeds recorded within the pipeline corridor	10-63
Table 10-18 Timber volume estimates for the pipeline corridor	10-64
Table 10-19 Remnant regional ecosystems mapped at a scale of 1:10,000 within road upgrades	10-65
Table 10-20 Timber volume estimates for the road upgrades	10-66
Table 10-21 Areas of Regional Ecosystems impacted by the dam	10-68
Table 10-22 GAB springs affected by temporary drawdown during dam construction	10-71
Table 10-23 GAB springs affected by increased groundwater pressure and flow	10-72
Table 10-24 Potential impacts on threatened flora in the dam impact area	10-75
Table 10-25 Areas of regional ecosystems impacted by the pipeline easement	10-80
Table 10-26 Area of EPBC listed communities impacted by the pipeline easement	10-82
Table 10-27 Potential impacts on threatened flora by the pipeline	10-83
Table 10-28 Area of vegetation impacted by the associated infrastructure (road upgrades)	10-85
Table 10-29 Risk assessment – terrestrial flora – dam and surrounds	10-88
Table 10-30 Risk assessment - terrestrial flora - pipeline	10-91
Table 11-1 Location and habitat type of fauna survey sites	11-8
Table 11-2 Habitat types occurring along the pipeline corridor	11-13
Table 11-3 Threatened fauna potentially present in the Taroom region	11-18
Table 11-4 Vertebrate fauna species richness by survey site	11-25
Table 11-5 Mean species richness by fauna group and broad habitat types ranked from highest to lowest	11-26

Table 11-6 Boggomoss Snail population estimates	11-29
Table 11-7 Likelihood of occurrence of threatened fauna within the dam impact area	11-37
Table 11-8 Likelihood of occurrence of significant fauna (non-EVR priority taxa (Old EPA) and near-threatened (Action Plan for Australian Birds)) in the dam impact area	11-41
Table 11-9 Likelihood of occurrence of migratory species in the dam impact area	11-43
Table 11-10 Pest animals in the dam study area	11-45
Table 11-11 Potential for significant plant pests in the region	11-45
Table 11-12 Representativeness of fauna habitats within the water storage	11-46
Table 11-13 Additional threatened fauna that may occur on the pipeline corridor	11-50
Table 11-14 Likelihood of occurrence of threatened fauna within the pipeline corridor	11-52
Table 11-15 Likelihood of occurrence of significant fauna within the pipeline corridor	11-57
Table 11-16 Likelihood of occurrence of migratory species within the pipeline corridor	11-58
Table 11-17 Area of remnant habitat impacted within the dam and surrounds	11-63
Table 11-18 Impacts on threatened fauna in the dam and surrounds	11-68
Table 11-19 Impacts and mitigation on the Boggomoss Snail	11-73
Table 11-20 Impacts of the dam and surrounds on migratory fauna	11-75
Table 11-21 Area of remnant habitat impacted by the pipeline	11-78
Table 11-22 Area of remnant habitat impacted by the associated infrastructure (roads)	11-82
Table 11-23 Terrestrial fauna risk assessment, dam and surrounds	11-85
Table 11-24 Terrestrial fauna risk assessment, pipeline	11-87
Table 12-1 Dam and surrounds sites surveyed for aquatic flora during baseline surveys	12-3
Table 12-2 Macrophyte species recorded in the dam and surrounds study area during baseline surveys <sup>1</sup>	12-9
Table 12-3 Primary and secondary habitat preferences of the species recorded during the present study	12-14
Table 12-4 Macrophyte genera recorded at sites within the pipeline survey area	12-18
Table 12-5 Exotic plant species recorded within the pipeline study area	12-19
Table 12-6 Risk assessment – dam and surrounds - construction	12-31
Table 12-7 Risk assessment – dam and surrounds - operation	12-32
Table 12-8 Risk Assessment – Pipeline	12-33
Table 13-1 State and Commonwealth conservation status of conservationally significant species that may occur within and immediately downstream (within the Dawson River) of the Project area (DEWHA, 2008; Limpus <i>et al.</i> , 2007)	13-2
Table 13-2 State and Commonwealth conservation status of conservationally significant species that may occur downstream (Fitzroy River and Estuary / Marine environment) of the Project area (DEWHA, 2008; Limpus <i>et al.</i> , 2007)	13-2
Table 13-3 Sites surveyed for aquatic fauna during the 2007 / 2008 pre-wet and post-wet season surveys	13-4
Table 13-4 Number of taxa recorded by the DNRW at long term monitoring sites within the Dawson sub-catchment (adapted from data provided by DNRW, 2008)	13-14
Table 13-5 Number of taxa recorded within the dam and surrounds study area (adapted from data provided by Ecowise 2008a and 2008b)	13-14
Table 13-6 Most abundant taxa within the dam and surrounds study area	13-15

Table 13-7 Common freshwater macroinvertebrate taxa that show a preference for particular habitat types (as indicated by presence and / or high abundance) in the catchment	13-17
Table 13-8 Fish species recorded in the study area, Dawson sub-catchment, Mackenzie sub-catchment and Fitzroy sub-catchment	13-19
Table 13-9 Presence of macrocrustaceans in the study area	13-22
Table 13-10 Total abundance of freshwater turtle species (pre-wet season EIS baseline survey)	13-25
Table 13-11 Total abundance of freshwater turtle species (targeted Fitzroy River turtle Survey – 2010)	13-25
Table 13-12 Total abundance of freshwater turtle species (targeted Fitzroy River turtle Survey – 2011)	13-25
Table 13-13 Fish recorded in the pipeline study area	13-37
Table 13-14 Catch and fishing data of the various fisheries in the Fitzroy River estuary area (commercial catch grids R29 and R30) in 2005 (DPI & F, 2007a)	13-40
Table 13-15 Risk assessment – construction	13-61
Table 13-16 Risk assessment – operation	13-63
Table 14-1 Streamflow reporting sites	14-3
Table 14-2 Catchments draining into the Nathan Dam water storage	14-9
Table 14-3 Fitzroy catchment gauge flow statistics	14-12
Table 14-4 Fitzroy catchment modelled flow statistics	14-13
Table 14-5 Colour code for model results	14-18
Table 14-6 Non-mandatory seasonal base flow results for the Full Entitlement scenario	14-19
Table 14-7 Mandatory first post-winter flow event performance indicators for the Full Entitlement scenario	14-19
Table 14-8 Mandatory and non-mandatory medium to high flow event objectives for Dawson River for the Full Entitlement scenario	14-20
Table 14-9 Mandatory and non-mandatory medium to high flow event objectives for Fitzroy River for the Full Entitlement scenario	14-20
Table 14-10 Historic flood depth (gauge height) in the Fitzroy Basin (m) (BoM, 2010)	14-27
Table 14-11 Recorded peak flood gauge heights and flows in the Dawson River (DERM, 2010)	14-28
Table 14-12 Dawson River flood frequency analyses (SunWater, 2008)	14-28
Table 14-13 Design flow estimates – Nathan Dam site (pre-dam) (SunWater, 2010c)	14-29
Table 14-14 Existing water storages in the Fitzroy Basin	14-30
Table 14-15 Fitzroy Basin supplemented water supply schemes (DNRW, 2008 & 2009)	14-31
Table 14-16 Existing and projected town water use in the Dawson River catchment	14-33
Table 14-17 Mandatory medium and high priority WASOs for the Full Entitlement scenario	14-36
Table 14-18 Mandatory unsupplemented WASO: days of water harvesting opportunity (Lower Fitzroy) for the Full Entitlement scenario	14-36
Table 14-19 Unsupplemented irrigator groups - mean annual diversions for the Full Entitlement scenario	14-37
Table 14-20 Gauge flow statistics: creeks crossed by the pipeline	14-38
Table 14-21 Fitzroy catchment modelled mean annual flow statistics	14-45
Table 14-22 Fitzroy catchment modelled median annual flow statistics	14-45

Table 14-23 Non-mandatory seasonal base flow results for the Full Entitlement and 'With Dam' scenarios	14-51
Table 14-24 Mandatory first post-winter flow event performance indicators for the Full Entitlement and 'With Dam' scenarios for Dawson River (Node 5, Node 4 and Node 2)	14-51
Table 14-25 Mandatory first post-winter flow event performance indicators for the Full Entitlement and 'With Dam' scenarios for Fitzroy River (Node 1 and Node 0)	14-52
Table 14-26 Mandatory and non-mandatory medium to high flow event objectives for Node 2 (Dawson River at Beckers)	14-52
Table 14-27 Mandatory and non-mandatory medium to high flow event objectives for Node 0 (Fitzroy River at Barrage)	14-53
Table 14-28 Mandatory medium and high priority WASOs	14-54
Table 14-29 Medium priority irrigation (Dawson River) – mean annual diversions	14-55
Table 14-30 Mandatory unsupplemented WASO: days of waterharvesting opportunity (Lower Fitzroy)	14-55
Table 14-31 Unsupplemented irrigators (Dawson River) – mean annual diversions	14-56
Table 14-32 "With dam" scenario – mean and median annual flow for the WRP simulation period (1900-1995) and the extended simulation period (1900-2008)	14-57
Table 14-33 Nathan Dam - probability of reaching key storage volumes	14-61
Table 14-34 General Circulation Models used for the Fitzroy Basin assessment (DERM, 2009)	14-63
Table 14-35 Mean annual flow in the Dawson River catchment - under projected 2050 climate change impacts (with dam scenario)	14-64
Table 14-36 Median annual flow in the Dawson River catchment - under projected 2050 climate change impacts (with dam scenario)	14-64
Table 14-37 LOS assessment results for current climate scenario	14-69
Table 14-38 LOS assessment results for the 10 <sup>th</sup> percentile climate change scenario	14-70
Table 14-39 LOS assessment results for the 50 <sup>th</sup> percentile climate change scenario	14-70
Table 14-40 LOS assessment results for the 90 <sup>th</sup> percentile climate change scenario	14-71
Table 14-41 Peak flows at Nathan Dam site	14-73
Table 14-42 Reservoir area and storage capacity for Nathan Dam at FSL, 1 in 100 AEP and 1 in 1000 AEP (SunWater, 2010)	14-73
Table 14-43 Peak flood levels for the 1 in 100 AEP – pre and post dam (SunWater, 2010)	14-76
Table 14-44 Peak flood levels at the Leichardt Highway Bridge at Taroom – pre and post dam	14-77
Table 14-45 Estimated flood routing results for a range of AEPs (SunWater, 2010b)	14-78
Table 14-46 Peak flood levels at Theodore – pre and post dam (SunWater, 2010b)	14-79
Table 14-47 Non-mandatory seasonal base flow results for the Full Entitlement and Cumulative Impacts scenarios	14-82
Table 14-48 Mandatory first post-winter flow event performance indicators for the Full Entitlement and Cumulative Impacts scenarios	14-83
Table 14-49 Mandatory and non-mandatory medium to high flow event objectives for Node 9 (Isaac River at Yatton)	14-83
Table 14-50 Mandatory and non-mandatory medium to high flow event objectives for Node 8 (Mackenzie River at Tartrus)	14-84
Table 14-51 Mandatory and non-mandatory medium to high flow event objectives for Node 0 (Fitzroy River at Barrage)	14-84
Table 14-52 Mandatory medium and high priority WASOs - Full Entitlement and Cumulative Impacts scenarios	14-85
Table 14-53 Mandatory unsupplemented WASO: days of waterharvesting opportunity (Nogoa Mackenzie)	14-86



Table 14-54 Mandatory unsupplemented WASO: days of waterharvesting opportunity (Lower Fitzroy) – Full Entitlement and Cumulative Impacts scenarios	14-86
Table 14-55 Unsupplemented irrigator groups: mean annual diversions - Full Entitlement and Cumulative Impacts scenarios	14-87
Table 14-56 Surface Water Risk Register	14-88
Table 14-57 Sites visited near dam site and surrounds	14-95
Table 14-58 Condition assessment of reach environments of the Dawson River	14-102
Table 14-59 Stability assessments for the monitoring study sites	14-103
Table 14-60 Fluvial geomorphology risk register	14-125
Table 15-1 Summary of the artesian / subartesian status of bores	15-8
Table 15-2 Summary of preliminary hydrogeological data at site of Nathan Dam (modified after PB, 2008)	15-10
Table 15-3 Summary details of reported individual bore yields	15-16
Table 15-4 Summary statistics for groundwater electrical conductivity ( $\mu\text{S}/\text{cm}$ )	15-16
Table 15-5 Summary statistics for groundwater pH	15-17
Table 15-6 Summary of details for groundwater analyses undertaken for Nathan Dam project (modified after DNR, 1996)	15-20
Table 15-7 Groundwater entitlements by sector	15-21
Table 15-8 Groundwater entitlements by aquifer	15-21
Table 15-9 Model predicted groundwater drawdown at affected Boggomoss springs as a result of dewatering activities	15-33
Table 15-10 Boggomoss springs inundated at full supply level	15-40
Table 15-11 Risk register	15-45
Table 16-1 Applicable water quality guidelines for the Project area	16-3
Table 16-2 Applicable water quality guidelines for metals in the Project area	16-3
Table 16-3 Environmental values for the Dawson River	16-5
Table 16-4 Environmental values as described in QWQG (2009)	16-5
Table 16-5 Key WQOs for the protection of aquatic ecosystem for proposed dam storage and surrounds	16-6
Table 16-6 Key WQOs for the protection of drinking water supply	16-7
Table 16-7 Summary of data-sets	16-9
Table 16-8 Comparison of water quality between Tartus Weir, Eden Bann Weir and Glebe Weir	16-14
Table 16-9 Summary of median water quality data collected at DERM monitoring stations (DERM, 2010)	16-16
Table 16-10 Summary of median water quality data associated with SunWater monitoring program of Glebe Weir 2001-2008 (SunWater, 2010)	16-17
Table 16-11 Summary of in-situ water quality results associated with Nathan Dam EIS pre wet-season baseline survey 2007 (adapted from FRC, 2008)	16-19
Table 16-12 Summary of in-situ water quality results associated with Nathan Dam EIS post-wet season baseline survey 2008 (adapted from Ecowise, 2008a)	16-19
Table 16-13 Summary of in-situ water quality results associated with Nathan Dam EIS pre wet-season baseline survey 2008 (adapted from Ecowise, 2008b)	16-20
Table 16-14 Summary of median water quality data downstream of the proposed Nathan Dam wall (DERM, 2010)	16-33
Table 16-15 Summary of water quality in small storages situated on the Dawson River (SunWater, 2010)	16-34

Table 16-16 Nathan Dam EIS pipeline route baseline monitoring – in-situ parameters (frc, 2009)	16-38
Table 16-17 Guidelines for blue green algae for primary contact recreation (QWQG, 2009)	16-43
Table 16-18 Risk assessment results – construction	16-49
Table 16-19 Risk assessment results - operation	16-51
Table 17-1 Air quality goals	17-2
Table 17-2 Deposited dust sampling locations details	17-7
Table 17-3 Deposited dust levels at the three locations	17-9
Table 17-4 Dust emission factors from site establishment	17-11
Table 17-5 TSP and PM <sub>10</sub> emission rates from site establishment	17-11
Table 17-6 24 hour averaged PM <sub>10</sub> impacts and 1-year averaged TSP impacts from site establishment activities	17-12
Table 17-7 Dust emission factors from Dam construction	17-13
Table 17-8 TSP and PM <sub>10</sub> emission rates from Dam construction	17-13
Table 17-9 Dust emission factors from exposed areas	17-18
Table 17-10 PM <sub>10</sub> and TSP Emission rates from exposed areas	17-18
Table 17-11 24 hour averaged PM <sub>10</sub> impacts and 1-year averaged TSP impacts from exposed areas	17-19
Table 17-12 Dust emission factors from pipeline construction	17-19
Table 17-13 PM <sub>10</sub> and TSP emission rates from pipeline construction	17-20
Table 17-14 Assumed plant list for clay borrow activities	17-23
Table 17-15 Dust emission factors from clay borrow area No. 8	17-23
Table 17-16 PM <sub>10</sub> and TSP emission rates from clay borrow area No. 8	17-24
Table 17-17 Dust emission factors from road construction or upgrade activities	17-27
Table 17-18 PM <sub>10</sub> and TSP emission rates from road construction and upgrade	17-27
Table 17-19 Risk assessment	17-33
Table 18-1 Project emissions classification	18-2
Table 18-2 Greenhouse emission factors used for emission estimation for construction and operation	18-2
Table 18-3 GHG emissions (tonnes CO <sub>2</sub> -e) resulting during construction.	18-3
Table 18-4 GHG emissions (tonnes CO <sub>2</sub> -e) resulting from inundation	18-3
Table 18-5 GHG emissions (tonnes CO <sub>2</sub> -e) resulting from pipeline construction	18-4
Table 18-6 Annual GHG emissions (tonnes CO <sub>2</sub> -e) resulting from pump stations	18-4
Table 18-7 GHG emissions associated with the embodied energy of major construction materials	18-5
Table 19-1 Schedule 1 Acoustic quality objectives	19-2
Table 19-2 Recommended outdoor background noise planning levels	19-4
Table 19-3 Residences represented by each noise logger location	19-7
Table 19-4 Noise sensitive receivers surrounding the Nathan Dam site and the relevant noise generating construction activities	19-8
Table 19-5 Noise logging results used as representative noise values at NSRs (free field), dB(A)	19-10
Table 19-6 Rated Background Levels (RBL) for each noise logging location	19-10
Table 19-7 Estimated average background sound pressure levels (L <sub>A90,T</sub> ) for areas containing residences in Australia	19-11
Table 19-8 Recommended outdoor background noise planning levels for each noise sensitive receiver	19-13

Table 19-9 Adjustments to recommended RBL to prevent background creep from occurring	19-13
Table 19-10 Adjusted RBLs for the prevention of background creep	19-13
Table 19-11 Applicable noise criteria for the operations of the Project	19-14
Table 19-12 Dam construction stages and associated noise sources	19-15
Table 19-13 Anticipated pipeline plant requirements	19-21
Table 19-14 Pump operation equipment and sound powers used in noise modelling	19-23
Table 19-15 Road upgrades noise levels at the closest NSRs	19-26
Table 19-16 Resource extraction equipment and sound powers used in noise modelling	19-29
Table 19-17 Impact assessment and residual risks - construction	19-33
Table 19-18 Impact assessment and residual risks - operations	19-35
Table 20-1 Waste streams, inventory and management	20-5
Table 20-2 Risk assessment results	20-13
Table 21-1 State controlled roads and multi-combination vehicle permits affected by the Project	21-7
Table 21-2 Roads implementation program for local and state controlled roads in the vicinity of the Project	21-9
Table 21-3 Local access roads in the Project area	21-11
Table 21-4 Traffic volumes for state controlled roads affected by the Project	21-17
Table 21-5 Potential dam raw materials sources, quantities and likely routes	21-28
Table 21-6 Estimated daily vehicle trips during dam construction	21-29
Table 21-7 Indicative Quantities of Raw Materials Required to Construct the Pipeline	21-30
Table 21-8 Estimated daily vehicle trips during pipeline construction	21-32
Table 21-9 Austroads level of service criteria	21-33
Table 21-10 Estimated levels of service for affected roads	21-34
Table 21-11 Existing projects, 2010	21-36
Table 21-12 Planned projects, 2010	21-37
Table 21-13 Project impacts and mitigation measures – construction phase	21-38
Table 21-14 Risk assessment	21-41
Table 22-1 Significant cultural heritage consultation activities for the Project	22-9
Table 23-1 Sites within dam and surrounds study area identified through heritage register searches	23-15
Table 23-2 Sites identified in the dam and surrounds study area	23-16
Table 23-3 Sites within 5 km of the pipeline identified through heritage register searches	23-18
Table 23-4 Sites identified within 5 km of pipeline alignment	23-19
Table 23-5 Criteria for impact assessment	23-21
Table 23-6 Impacts and mitigations - dam and surrounds	23-27
Table 23-7 Impacts and mitigations - pipeline	23-32
Table 23-8 Risk assessment results	23-38
Table 24-1 Central Queensland RFGM guiding principles	24-3
Table 24-2 Taroom Planning Scheme relevant desired environmental outcomes	24-4
Table 24-3 Chinchilla Shire Planning Scheme relevant desired environmental outcomes	24-4

Table 24-4 Dalby Town Planning Scheme relevant desired environmental outcomes	24-5
Table 24-5 Key demographic characteristics	24-9
Table 24-6 Existing projects, 2010	24-10
Table 24-7 Planned projects, 2010	24-11
Table 24-8 Childcare facilities and capacity in the study area	24-13
Table 24-9 Social infrastructure – dam and surrounds (Taroom)	24-15
Table 24-10 Social infrastructure – pipeline	24-18
Table 24-11 Population estimates – dam and pipeline area	24-24
Table 24-12 Change in estimated resident population, 2006-2009	24-25
Table 24-13 Projected estimated resident population, 2006-2031	24-25
Table 24-14 Age profile, 2006	24-26
Table 24-15 Population mobility, 2006 (%)	24-27
Table 24-16 Household type, 2006 (%)	24-27
Table 24-17 Family households, 2006 (%)	24-28
Table 24-18 Key demographic statistics for Indigenous people in the local community area, 2006	24-29
Table 24-19 Education institution attending, 2006 (%)	24-29
Table 24-20 Education levels, 2006 (%)	24-30
Table 24-21 Housing characteristics, 2006 (%)	24-31
Table 24-22 Landlord type, 2006 (%)	24-31
Table 24-23 Houses available for rent within the study area, December 2011	24-32
Table 24-24 Median house prices, November 2010 – October 2011*	24-32
Table 24-25 Housing affordability ratings, 2005 – 2010	24-33
Table 24-26 SEIFA indices for dam and pipeline communities, 2006	24-34
Table 24-27 Need for assistance, 2006	24-34
Table 24-28 Admissions to hospitals in Toowoomba and Darling Downs District, 2005/2006	24-35
Table 24-29 Crime statistics, reported offences 2008 - 2009	24-36
Table 24-30 Victim/offender relationship, 2008/2009	24-36
Table 24-31 Domestic and family violence orders by court, 2005-2006	24-37
Table 24-32 Business counts by employment size, 2006-2007	24-40
Table 24-33 Labour force participation, 2006 (%)	24-41
Table 24-34 Unemployment, December 2009-December 2010*	24-41
Table 24-35 Employment by industry	24-41
Table 24-36 Employment by occupation	24-42
Table 24-37 Agricultural enterprise in the Taroom SLA and WDRC, 2005-06	24-44
Table 24-38 Construction workforce, dam and surrounds	24-57
Table 24-39 Construction workforce, pipeline	24-58
Table 24-40 Potential alignment with existing cumulate impact initiatives	24-76
Table 24-41 Social risk assessment results – construction	24-80

Table 24-42 Social risk assessment results – operation	24-85
Table 24-43 Methodology for draft SIMP development	24-89
Table 24-44 Summary of key social impacts and benefits	24-90
Table 24-45 Employment and training action plan	24-92
Table 24-46 Local business development action plan	24-94
Table 24-47 Community services and infrastructure action plan	24-95
Table 24-48 Workforce housing and well-being action plan	24-96
Table 24-49 Stakeholder engagement and community well-being action plan	24-98
Table 25-1 Study area definitions	25-3
Table 25-2 Real gross regional product (\$m, 2005–06)	25-5
Table 25-3 Real gross regional product per capita (\$m, 2005–06)	25-6
Table 25-4 Estimated resident population for impacted local community area	25-7
Table 25-5 Non-resident workers in the Surat Basin	25-8
Table 25-6 Persons in full-time employment by industry and Local Government Area	25-9
Table 25-7 Full time equivalent population for the Surat Basin as at 30 June 2010	25-12
Table 25-8 Composition of industry gross value add, Fitzroy (%)	25-13
Table 25-9 Composition of industry gross value add, Darling Downs (%)	25-14
Table 25-10 Gross value of agricultural production	25-18
Table 25-11 Employment rates in study area	25-20
Table 25-12 Residential land valuation report, Western Downs Regional Council LGA (2010)	25-20
Table 25-13 Residential land valuation report, Banana Shire Council LGA (2010)	25-21
Table 25-14 Residential and non-residential building approvals, 12 months ending 31 March 2010 (\$,000)	25-21
Table 25-15 Fitzroy Basin supplemented water supply schemes	25-23
Table 25-16 Project development timing	25-26
Table 25-17 Estimated location of project capital expenditure	25-35
Table 25-18 Expenditure by location (\$)	25-36
Table 25-19 Proportion of employment and plant, materials and other expenses assumptions	25-36
Table 25-20 Estimated flow on jobs	25-37
Table 25-21 Estimated Contribution to Gross State Product (GSP)	25-38
Table 25-22 Mitigation measures	25-40
Table 26-1 Legislative compliance	26-1
Table 26-2 Consequence scale	26-4
Table 26-3 Likelihood Scale	26-4
Table 26-4 Risk matrix	26-4
Table 26-5 Risk assessment – construction and decommissioning	26-10
Table 26-6 Risk assessment – dam operation and maintenance	26-20
Table 26-7 Risk assessment – pipeline operation and maintenance	26-23
Table 26-8 Indicative list of dangerous goods and hazardous substances	26-32

Table 26-9 Indicative list of dangerous goods and hazardous substances – construction	26-33
Table 26-10 Indicative list of dangerous goods and hazardous substances – operation	26-33
Table 27-1 Local and Regional Scale Definition	27-4
Table 27-2 Existing projects, 2010	27-12
Table 27-3 Planned projects, 2010	27-14
Table 27-4 Example cumulative impacts - risks and opportunities table	27-17
Table 27-5 Potential cumulative impacts: dam	27-22
Table 27-6 Potential cumulative impacts: pipeline	27-24
Table 27-7 Cumulative impacts - risks and opportunities	27-28
Table 27-8 Potential alignment with existing cumulate impact initiatives	27-39
Table 28-1 Key parameters of the water storage	28-10
Table 28-2 Engineering summary for the earth and rockfill Dam	28-11
Table 28-3 Summary of engineering details of the conceptual design for main spillway	28-12
Table 28-4 Engineering summary of saddle dam	28-12
Table 28-5 Description of outlet elements	28-13
Table 28-6 World Heritage criteria for the Great Barrier Reef	28-26
Table 28-7 GAB spring wetlands recorded within the dam study area	28-60
Table 28-8 Likelihood of occurrence of threatened flora species in the Project area	28-61
Table 28-9 Likelihood of occurrence of threatened fauna species within the Project area	28-68
Table 28-10 Boggomoss Snail population estimates based on patch specific densities	28-79
Table 28-11 Likelihood of occurrence of migratory species in the Project area	28-87
Table 28-12 Listed marine species potentially occurring in the Fitzroy River estuary and/or Great Barrier Reef Marine Park	28-88
Table 28-13 Assessment of impacts on World Heritage values	28-95
Table 28-14 Assessment of impacts on National Heritage values	28-97
Table 28-15 Assessment of impacts on Ramsar wetland values	28-99
Table 28-16 Summary of mitigation measures relevant to World Heritage values, National Heritage places and Wetlands of International Importance	28-100
Table 28-17 Brigalow EC impacted by the Project	28-101
Table 28-18 EPBC Act impact assessment on the Brigalow EC	28-102
Table 28-19 GAB springs impacted by the Project	28-104
Table 28-20 EPBC Act assessment of significance on Hairy-joint Grass	28-107
Table 28-21 EPBC Act Assessment of Significance on Curly-bark Wattle and Chinchilla Wattle	28-108
Table 28-22 EPBC Act Impact Assessment on the Boggomoss Snail	28-110
Table 28-23 EPBC Act Impact Assessment on Brigalow Scaly-foot	28-112
Table 28-24 EPBC Act Impact Assessment on the Squatter Pigeon	28-114
Table 28-25 EPBC Act Impact Assessment on the Australian Painted Snipe	28-116
Table 28-26 Assessment of impacts on Fitzroy River Turtle	28-123
Table 28-27 EPBC Act assessment of significance on migratory species known from the Project area	28-127

Table 28-28 EPBC Act assessment of significance on migratory species likely to occur	28-128
Table 28-29 Assessment against the EPBC Act Offset Policy	28-133
Table 28-30 Adopted flows for GBR	28-135
Table 28-31 Adopted flows for Boggomoss Snail	28-137
Table 28-32 Adopted flows for Fitzroy River turtle	28-140
Table 28-33 Spells analysis (10 cm flows)	28-146
Table 28-34 Spells analysis (30 cm flows)	28-146
Table 28-35 MNES flow statistics and WRP EFO comparison	28-148
Table 28-36 Estuary flushing flows (2yr ARI) spells analysis	28-157
Table 28-37 Isla Delusion half bank spells analysis	28-159
Table 28-38 Isla Delusion bankfull spells analysis	28-160
Table 28-39 Southend half bank spells analysis	28-162
Table 28-40 Soundend Bankfull flow Spells Analysis	28-163
Table 28-41 Isla Delusion 10 cm or greater spells analysis	28-165
Table 28-42 Isla Delusion 30 cm or greater spells analysis	28-166
Table 28-43 Isla Delusion flushing flows or greater spells analysis	28-167
Table 28-44 Southend 10 cm or greater spells analysis	28-169
Table 28-45 Southend 30 cm or greater spells analysis	28-170
Table 28-46 Southend Flushing flows or greater Spells Analysis	28-170
Table 28-47 Estuary Flushing Flows (2yr ARI or greater) spells analysis	28-174
Table 28-48 Wattlebank 10 cm or greater Spells analysis	28-175
Table 28-49 Wattlebank 30 cm or greater spells analysis.	28-176
Table 28-50 Wattlebank flushing flows 1,926 ML/day or greater spells analysis	28-177
Table 28-51 Linkages with the EIS	28-185
Table 29-1 Project responsibilities - construction	29-5
Table 29-2 Project responsibilities - operation	29-6
Table 29-3 Outline of Draft EMP subplan tables	29-13

## FIGURES

Figure ES-1 Locality plan	ES-2
Figure ES-2 Water storage area	ES-3
Figure ES-3 Pipeline route	ES-12
Figure 1-1 Location of the Project	1-3
Figure 1-2 Extent of water storage	1-4
Figure 1-3 Approximate break-up of water use by sector (NRW, 2006a)	1-9
Figure 1-4 Coal seam gas projects in the Bowen and Surat Basins	1-16
Figure 1-5 Coal resources, mines, advanced projects and rail infrastructure in south-east Queensland	1-17
Figure 1-6 Pipeline alignment options	1-32
Figure 1-7 Key steps in EIS preparation	1-35
Figure 2-1 Catchment area	2-3
Figure 2-2 Water storage area	2-5
Figure 2-3 Downstream areas and potential benefited areas	2-6
Figure 2-4 Affected properties	2-9
Figure 2-5 Pipeline alignment	2-11
Figure 2-6 Infrastructure plan	2-16
Figure 2-7 External roadworks	2-17
Figure 2-8 Potential resource extraction areas	2-19
Figure 2-9 Potential clay borrow areas	2-23
Figure 2-10 Recreational areas	2-26
Figure 2-11 Relationship between headwater and tailwater	2-28
Figure 2-12 Storage curve	2-29
Figure 2-13 1 in 100 AEP flood level	2-30
Figure 2-14 Depth of the water storage at full supply level	2-31
Figure 2-15 Dam operations area	2-33
Figure 2-16 Typical spillway sections	2-35
Figure 2-17 General arrangement	2-37
Figure 2-18 Typical dam sections	2-38
Figure 2-19 Fishway concept	2-41
Figure 2-20 Balancing Storage and Pump Station	2-44
Figure 2-21 Control valve	2-44
Figure 2-22 Surge tank	2-44
Figure 2-23 Scour outlet	2-44
Figure 2-24 Typical swab insertion and removal station	2-45
Figure 2-25 Dam construction footprint	2-58
Figure 2-26 Anticipated dam construction workforce	2-79
Figure 3-1 BoM Weather Stations	3-2



Figure 3-2 Average monthly rainfall at the reference sites	3-3
Figure 3-3 Average monthly evaporation at the Brigalow and Dalby reference sites	3-4
Figure 3-4 Seasonal wind roses for Taroom by season	3-5
Figure 3-5 Bushfire hazard rating in the Nathan Dam catchment and along the pipeline route (Rural Fire Service, 2008)	3-7
Figure 3-6 Recorded earthquakes in the vicinity of the proposed dam and the pipeline (Geoscience Australia, 2008)	3-8
Figure 4-1 Fitzroy Basin showing major streams and topographic features	4-2
Figure 4-2 Topography and significant landscape features in the vicinity of dam	4-3
Figure 4-3 Topography and significant landscape features in the vicinity of pipeline between Nathan Dam and Miles	4-5
Figure 4-4 Topography and significant landscape features in the vicinity of pipeline between Miles and Dalby	4-6
Figure 5-1 Topographic features and visual catchment of dam and surrounds	5-8
Figure 5-2 Landscape character units	5-10
Figure 5-3 LCU1 – View of flat agricultural land north of Glebe Weir	5-12
Figure 5-4 LCU1 – View of flat agricultural land along Glebe Road	5-12
Figure 5-5 LCU2 – View of undulating agricultural land north of the Dawson River	5-13
Figure 5-6 LCU3 – View of remaining vegetation along banks of Dawson River at Glebe Weir	5-14
Figure 5-7 LCU3 – View of remaining vegetation along banks of Dawson River at Bundulla Road	5-15
Figure 5-8 LCU4 – View of main street in Taroom Township	5-15
Figure 5-9 LCU1 – Flat agricultural land adjacent to the Warrego Highway, east of Chinchilla	5-19
Figure 5-10 LCU2 – Undulating agricultural land south of the Dawson River	5-19
Figure 5-11 LCU3 – Remaining vegetation south of Wandoan	5-20
Figure 5-12 LCU4 – Brigalow Township	5-20
Figure 5-13 LCU5 – View of Chinchilla business centre	5-21
Figure 5-14 LCU5 – View of Warrego Highway through Dalby	5-22
Figure 5-15 Sensitive receivers with potential views of the water storage area	5-24
Figure 6-1 Geology of the Nathan Dam Catchment	6-3
Figure 6-2 Geology of the proposed dam and surrounds	6-7
Figure 6-3 Recorded earthquakes in the vicinity of the proposed dam and the pipeline (Geoscience Australia, 2008)	6-10
Figure 6-4 Dominant soils in the vicinity of water storage area	6-15
Figure 6-5 GOAL in the water storage	6-17
Figure 6-6 Geology along the pipeline from Nathan Dam to Dalby	6-20
Figure 6-7 Location of Chinchilla Sand Local Fossil Fauna Site in relation to pipeline	6-21
Figure 6-8 Land resource areas in the vicinity of the pipeline from the Great Dividing Range (after Forster, 1985)	6-26
Figure 6-9 Land resource areas in the vicinity of the pipeline from the Great Dividing Range to Warra (after Maher, 1998)	6-27
Figure 6-10 Land resource areas in the vicinity of the pipeline from Warra to Dalby (from Maher, 1998)	6-28
Figure 6-11 GOAL in the vicinity of the pipeline from Nathan Dam to the Great Dividing Range	6-29
Figure 6-12 GOAL in the vicinity of the pipeline from the Great Dividing Range to Warra	6-30
Figure 6-13 GOAL in the vicinity of the pipeline from Warra to Dalby	6-31
Figure 7-1 Regional and local government boundaries	7-6

Figure 7-2 Zoning – dam and surrounds	7-13
Figure 7-3 Land use – dam and surrounds	7-15
Figure 7-4 Irrigated agriculture in the vicinity of Glebe Weir	7-16
Figure 7-5 Recreation areas at Taroom	7-16
Figure 7-6 Land tenure – dam and surrounds	7-18
Figure 7-7 Mining tenements – dam and surrounds	7-21
Figure 7-8 Petroleum and gas tenements – dam and surrounds	7-22
Figure 7-9 Protected areas – dam and surrounds	7-25
Figure 7-10 Glebe Weir	7-26
Figure 7-11 Infrastructure – dam and surrounds	7-27
Figure 7-12 Glebe Weir Camping Reserve	7-28
Figure 7-13 Existing telecommunications infrastructure	7-28
Figure 7-14A Zoning – pipeline	7-34
Figure 7-15A Land use – pipeline	7-45
Figure 7-16 Industrial land use near the end of the pipeline in Dalby	7-48
Figure 7-17 Low density residential land use in Brigalow	7-48
Figure 7-18 Grain silos and low residential land use in Brigalow	7-49
Figure 7-19A Land tenure – pipeline	7-51
Figure 7-20 Mining leases – pipeline	7-55
Figure 7-21A Mining tenements – pipeline	7-56
Figure 7-22 Petroleum leases – pipeline	7-59
Figure 7-23A Petroleum and gas tenements – pipeline	7-60
Figure 7-24 Western rail system and Warrego Highway	7-64
Figure 7-25A Infrastructure – pipeline	7-65
Figure 7-26 High voltage powerlines to the west of Chinchilla	7-68
Figure 7-27 Powerlines in the vicinity of the pipeline	7-69
Figure 7-28 Powerlines and lateral connections in the vicinity of the pipeline	7-69
Figure 8-1 Location of identified potentially contaminated sites within the dam and surrounds area	8-6
Figure 8-2A Location of identified potentially contaminated sites along the pipeline	8-9
Figure 9-1 Protected areas in the vicinity of the dam study area	9-3
Figure 9-2 Protected areas in the vicinity of the pipeline corridor	9-4
Figure 9-3 Potential habitat for threatened flora in the dam study area	9-9
Figure 9-4 Potential habitat for threatened fauna	9-13
Figure 9-5 Declared fish habitat area	9-16
Figure 9-6 Wetlands of significance	9-17
Figure 9-7 World heritage properties	9-18
Figure 10-1 Field survey sites for the dam study area	10-7
Figure 10-2 Field survey sites for the pipeline corridor	10-8

Figure 10-3a Regional ecosystems within the dam study area	10-17
Figure 10-4 DERM regrowth vegetation in the dam study area	10-20
Figure 10-5a Regional ecosystems mapped in the dam study area at a scale of 1:10,000	10-28
Figure 10-6 Spatial extent of 'Endangered' and 'Of Concern' regional ecosystems (VM Status) as mapped at a 1:10,000 scale within the dam study area	10-31
Figure 10-7 Brigalow ecological community as mapped at a 1:10,000 scale within the dam study area	10-33
Figure 10-8 Location of GAB spring communities within the dam study area	10-34
Figure 10-9 Location of threatened species in the dam study area	10-36
Figure 10-10 Location of threatened flora species in the pipeline corridor	10-62
Figure 10-11 GAB spring communities impacted by drawdown during construction of the dam wall	10-73
Figure 10-12 GAB spring communities impacted by increased groundwater pressure in the Precipice Sandstone	10-74
Figure 10-13 Location of threatened flora in the dam construction footprint	10-77
Figure 11-1 Location of survey sites – dam study area	11-7
Figure 11-2 Location of Boggomoss Snail survey sites	11-12
Figure 11-3 Pipeline survey sites	11-16
Figure 11-4 Wildlife corridors – dam study area	11-23
Figure 11-5 Threatened fauna locations – dam study area	11-24
Figure 11-6 Boggomoss Snail records	11-32
Figure 11-7 Wildlife corridors within the pipeline corridor	11-51
Figure 11-8 Remnant and non-remnant habitat impacted by dam construction footprint and water storage	11-62
Figure 12-1 Sites surveyed for aquatic flora during the baseline surveys	12-4
Figure 12-2 Variety of habitats on the Dawson River at the Bundulla Road crossing (rocks apparently placed in the stream as part of an abandoned crossing)	12-6
Figure 12-3 Waterbody type (percent) recorded at each site in the dam and surrounds study area in the pre-wet season (frc environmental, 2007)	12-6
Figure 12-4 Waterbody type (percent) recorded at each site in the dam and surrounds study area in the post-wet season (Ecowise, 2008)	12-7
Figure 12-5 Number of aquatic macrophyte species (richness) recorded at each site in the pre-wet and post-wet season surveys (adapted from frc environmental 2007 and Ecowise 2008)	12-10
Figure 12-6 Percent coverage of macrophytes recorded at each site in the dam and surrounds study area in pre-wet and post-wet season surveys (adapted from frc environmental 2007 and Ecowise 2008)	12-10
Figure 12-7 Emergent <i>Persicaria</i> spp. and sedges (family <i>Cyperaceae</i> and <i>Juncaceae</i> )	12-11
Figure 12-8 Floating <i>Azolla pinnata</i> and <i>Ludwigia peploides montevidensis</i>	12-11
Figure 12-9 Richness of each macrophyte growth form at each site surveyed within the pipeline survey area	12-18
Figure 12-10 Percent coverage of each macrophyte growth form at each site surveyed within the pipeline survey area	12-19
Figure 12-11 Storage level trace plot based on modelled flow data from 1940-45 (normal conditions)	12-24
Figure 12-12 Storage level trace plot based on modelled flow data from 1954-59 (wet conditions)	12-24
Figure 12-13 Storage Level Trace Plot based on modelled flow data from 1918-23 (dry conditions)	12-25

Figure 13-1 Location of sites surveyed for aquatic fauna during the 2007/2008 baseline surveys (source: Ecowise, 2008)	13-5
Figure 13-2 Daily flow at Nathan Gorge during period of typical climatic conditions – full entitlement only (1930-1940)	13-7
Figure 13-3 The Fitzroy Basin, showing the location of dams and weirs	13-8
Figure 13-4 Percent coverage of large woody debris habitat (A), percent bank coverage of tree root habitat (B), percent bank coverage of overhanging vegetation (C) and substrate type coverage (D) recorded at each site	13-10
Figure 13-5 Glebe Weir at very low water levels, showing the channel bar plain on the Dawson River upstream of the weir (site 4); Cockatoo Creek to the left	13-11
Figure 13-6 Wetlands in the vicinity of the proposed Nathan Dam site	13-13
Figure 13-7 Macroinvertebrate taxonomic richness (A) and abundance (B) (mean $\pm$ SE) in the dam and surrounds study area during the pre- and post-wet season baseline surveys	13-16
Figure 13-8 Recorded presence of the Fitzroy River turtle ( <i>Rheodytes leukops</i> ) in the Fitzroy Basin (adapted from Limpus <i>et al.</i> , 2007; frc environmental 2009; DERM, 2011)	13-27
Figure 13-9 Recorded presence of the white throated snapping turtle ( <i>Elseya albagula</i> ) in the Fitzroy Basin (adapted from Limpus <i>et al.</i> , 2007; frc environmental 2009; DERM, 2011)	13-28
Figure 13-10 Mean taxonomic richness ( $\pm$ SE) (A) and mean abundance ( $\pm$ SE) (B) of macroinvertebrates in the four habitat types present at sites to be crossed by the pipeline	13-36
Figure 14-1 Fitzroy Basin drainage characteristics	14-7
Figure 14-2 Area of inundation and Boggomoss sites	14-8
Figure 14-3 Gauged daily flow at Nathan Gorge (GS 130320)	14-11
Figure 14-4 Gauged annual flow at Glebe (GS 130303)	14-11
Figure 14-5 Dawson River at Nathan Gorge daily flow duration curve	14-14
Figure 14-6 Dawson River D/S Theodore daily flow duration curve	14-15
Figure 14-7 Dawson River at Beckers daily flow duration curve	14-15
Figure 14-8 End of Dawson River flow duration curve	14-16
Figure 14-9 Fitzroy River inflow to Eden Bann Weir daily flow duration curve	14-16
Figure 14-10 Fitzroy River inflow to Barrage daily flow duration curve	14-17
Figure 14-11 Fitzroy River at end of system daily flow duration curve	14-17
Figure 14-12 Annual flood peaks – Fitzroy River at Rockhampton (BoM, 2010)	14-22
Figure 14-13 Annual flood peaks – Dawson River at Taroom Gauge (GS 130302)	14-23
Figure 14-14 Annual flood peaks – Dawson River at Theodore Gauge (GS 130305)	14-23
Figure 14-15 Annual flood Peaks - Dawson River at Beckers Gauge (GS 130322)	14-24
Figure 14-16 January 2010 flood hydrograph – Dawson River at Taroom (BoM, 2010b)	14-25
Figure 14-17 January 2010 flood hydrograph – Dawson River at Woodleigh (BoM, 2010b)	14-25
Figure 14-18 January 2010 flood hydrograph – Dawson River at Beckers (BoM, 2010b)	14-25
Figure 14-19 January 2010 flood hydrograph - Dawson River at Newlands (BoM, 2010b)	14-26
Figure 14-20 Fitzroy Basin supplemented water supply schemes	14-32
Figure 14-21 Banana, Baralaba, Moura and Theodore demand projections (PB, 2008)	14-34
Figure 14-22 Dawson River at Nathan Gorge daily flow duration curve (with dam)	14-46

Figure 14-23 Dawson River D/S Theodore daily flow duration curve (with dam)	14-47
Figure 14-24 Dawson River at Beckers daily flow duration curve (with dam)	14-47
Figure 14-25 End of Dawson River daily flow duration curve (with dam)	14-48
Figure 14-26 Fitzroy River inflow to Eden Bann Weir daily flow duration curve (with dam)	14-48
Figure 14-27 Fitzroy River inflow to Barrage daily flow duration curve (with dam)	14-49
Figure 14-28 Fitzroy River at end of system daily flow duration curve (with dam)	14-49
Figure 14-29 Nathan Dam modelled storage trace – WRP simulation period and extended simulation period (1900-2008)	14-58
Figure 14-30 Nathan Dam modelled storage trace – WRP simulation period and extended simulation period (1960-2008)	14-58
Figure 14-31 Nathan Dam modelled storage exceedance curve – WRP simulation period (1900-1995) and extended simulation period (1900-2008)	14-59
Figure 14-32 Nathan Gorge daily flow duration curve - WRP simulation period (1900-1995) and extended simulation period (1900-2008)	14-60
Figure 14-33 Nathan Dam time to fill analysis	14-61
Figure 14-34 Daily flow exceedance curve - Dawson River at Nathan Gorge	14-65
Figure 14-35 Daily flow exceedance curve - Dawson River at Theodore	14-66
Figure 14-36 Daily flow exceedance curve - Dawson River at Beckers	14-66
Figure 14-37 Daily flow exceedance curve - End of Dawson River	14-67
Figure 14-38 Nathan Dam modelled storage trace – current climate and potential climate change scenarios	14-71
Figure 14-39 Nathan Dam – inundation extent at FSL and the 1 in 100 AEP	14-75
Figure 14-40 Flooding at the Leichardt Highway Bridge at Taroom (March, 2010)	14-77
Figure 14-41 Flood hydrograph at Theodore for the 1 in 10 AEP	14-79
Figure 14-42 Flood extent at Theodore for the 1 in 100 AEP (pre and post dam)	14-80
Figure 14-43 Proforma used to assess overall channel stability (Simon <i>et al.</i> 2007)	14-94
Figure 14-44 Geomorphic assessment site locations	14-96
Figure 14-45 The macro-channel and channels that flow within it (Rountree <i>et al.</i> , 1999)	14-98
Figure 14-46 Estimated sediment contribution to coast for the Fitzroy River basin (from Dougall <i>et al.</i> (2006))	14-101
Figure 14-47 Geomorphic features of Juandah Creek	14-104
Figure 14-48 Geomorphic features of Palm Tree Creek	14-105
Figure 14-49 Geomorphic features of Dawson River at Bundulla Road and Cockatoo Creek	14-106
Figure 14-50 Geomorphic features of Dawson River downstream of Glebe Weir	14-107
Figure 14-51 Geomorphic features of Dawson River, immediately downstream of dam site	14-108
Figure 14-52 Geomorphic features of Price Creek, immediately downstream of dam site	14-109
Figure 14-53 Typical Geomorphic features of Precipice Creek	14-110
Figure 14-54 Impacts of landuse change	14-112
Figure 14-55 Impacts of landuse change	14-114
Figure 15-1 Cross section through the Project area – Nathan Gorge to Taroom	15-7
Figure 15-2 Water table depth for dam and surrounds	15-13
Figure 15-3 Potentiometric surface map of the Precipice Sandstone	15-14

Figure 15-4 Potentiometric surface map of the Hutton Sandstone	15-15
Figure 15-5 Authorisation to take groundwater (DERM Water Entitlement System, 26 July 2010)	15-22
Figure 15-6 Location of Boggomoss spring sites and artesian extent of the Precipice Sandstone aquifer	15-26
Figure 15-7 Histogram of model predicted groundwater drawdown at affected Boggomoss springs as a result of dewatering activities	15-34
Figure 15-8 Modelled groundwater drawdown as a result of dewatering activities	15-36
Figure 15-9 Schematic cross section showing the impact of dam inundation	15-38
Figure 16-1 Map displaying relative site locations associated with Nathan Dam EIS baseline surveys	16-18
Figure 16-2 Temperature profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-21
Figure 16-3 Temperature at sites sampled during the 2008 pre wet-season baseline survey (as presented in Ecowise, 2008b)	16-21
Figure 16-4 Diurnal temperature profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-22
Figure 16-5 Conductivity profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-23
Figure 16-6 Conductivity at sites sampled during the 2008 pre wet-season baseline survey (as presented in Ecowise, 2008b)	16-23
Figure 16-7 Diurnal conductivity profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008b)	16-24
Figure 16-8 pH profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-25
Figure 16-9 Conductivity at sites sampled during the 2008 pre wet-season baseline survey (as presented in Ecowise, 2008b)	16-25
Figure 16-10 Diurnal pH profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-26
Figure 16-11 DO profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-27
Figure 16-12 DO at sites sampled during the 2008 pre wet-season baseline survey (as presented in Ecowise, 2008b)	16-28
Figure 16-13 Diurnal DO profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-28
Figure 16-14 Turbidity at sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-29
Figure 16-15 Turbidity at sites sampled during the 2008 pre wet-season baseline survey (as presented in Ecowise, 2008b)	16-30
Figure 16-16 Turbidity profiles for sites sampled during the 2008 post wet-season baseline survey (as presented in Ecowise, 2008a)	16-30
Figure 17-1 Sensitive Receivers	17-4
Figure 17-2 Seasonal wind roses for Taroom by season	17-5
Figure 17-3 Seasonal wind roses for Taroom by time of the day	17-6
Figure 17-4 Deposited dust sampling locations (approximate)	17-8
Figure 17-5 Identification of site establishment extent	17-12
Figure 17-6 PM <sub>10</sub> impacts from dam construction activity	17-15
Figure 17-7 TSP impacts from dam construction activity	17-16
Figure 17-8 Deposited dust impacts from dam construction activity	17-17

Figure 17-9 PM <sub>10</sub> impacts from pipeline construction activities	17-21
Figure 17-10 TSP impacts from pipeline construction activities	17-22
Figure 17-11 PM <sub>10</sub> impacts from clay borrow area activities	17-25
Figure 17-12 TSP impacts from clay borrow area activities	17-26
Figure 17-13 PM <sub>10</sub> impacts from access road construction activities	17-28
Figure 17-14 TSP impacts from access road construction activities	17-29
Figure 19-1 Identified Noise Sensitive Receivers (NSRs)	19-9
Figure 19-2 Site establishment noise contour map	19-17
Figure 19-3 Typical L <sub>Aeq,1hr</sub> noise levels produced by clearing operations	19-19
Figure 19-4 Explosive mass charge required to produce 115 dBL at the closest NSRs with varying site constants	19-20
Figure 19-5 Typical L <sub>Aeq,1hr</sub> noise levels produced by the pipeline installation operations	19-22
Figure 19-6 Typical predicted pump station noise levels - a weighted	19-24
Figure 19-7 Typical predicted pump station noise levels - linear weighted	19-25
Figure 19-8 Proposed road works and approximate location of NSRs	19-27
Figure 19-9 Typical L <sub>Aeq,1hr</sub> produced by roads upgrades	19-28
Figure 19-10 Resource extraction (clay borrow areas) noise contour map	19-30
Figure 21-1 Location of Nathan Dam and pipeline and surrounding transport infrastructure	21-6
Figure 21-2 Location of Nathan Dam and surrounding local access road network	21-10
Figure 21-3a Location of pipeline and surrounding local access road network	21-14
Figure 21-4 School bus routes – dam and surrounds	21-20
Figure 21-5a School bus routes – pipeline	21-21
Figure 21-6 Potential resource extraction zones	21-31
Figure 22-1 Native title claims relevant to the Project	22-3
Figure 23-1 Location of identified historic sites in the dam and surrounds study area (5km buffer)	23-17
Figure 23-2 Location of identified historic sites within 5km of pipeline alignment	23-20
Figure 24-1 Local community area	24-7
Figure 24-2 Social infrastructure in the dam and surrounds	24-17
Figure 24-3a Social infrastructure along the pipeline	24-21
Figure 24-4 Age profile by gender, 2006	24-26
Figure 24-5 Cultural diversity, 2006 (%)	24-28
Figure 24-6 Participation in volunteer activities, 2006 (%)	24-38
Figure 24-7 Median individual weekly incomes, 2006	24-43
Figure 24-8 Project construction workforce	24-49
Figure 24-9 Other project developments in the study area	24-51
Figure 24-10 Glebe Weir Camping Reserve	24-62
Figure 24-11 Projected workforce for the Western Downs Region	24-74
Figure 24-12 Projected resident population impact for the Western Downs	24-75
Figure 24-13 SIMP development timeline	24-88

Figure 25-1 Economic study area	25-4
Figure 25-2 Western Downs Regional Council (LGA) population forecast	25-7
Figure 25-3 Banana Shire Council LGA population forecast	25-8
Figure 25-4 Employment by industry – Taroom LGA	25-10
Figure 25-5 Employment by industry – Western Downs Regional Council LGA	25-11
Figure 25-6 Queensland coal map – South-east	25-16
Figure 25-7 Share of water use – Fitzroy Basin	25-22
Figure 25-8 Share of water use – Queensland	25-22
Figure 25-9 Median weekly income	25-25
Figure 25-10 Producer price index – final	25-25
Figure 25-11 Producer price index – materials used in open cut mining	25-26
Figure 25-12 Anticipated dam construction workforce	25-29
Figure 25-13 Estimated pipeline construction workforce profile	25-30
Figure 27-1 Valued attributes within the catchment / sub-catchment	27-7
Figure 27-2 Valued attributes within the dam and surrounds	27-8
Figure 27-3 Valued attributes along the pipeline route	27-9
Figure 27-4 Existing and proposed major infrastructure projects	27-13
Figure 27-5 Cause and effect relationships associated with existing activities within the dam and surrounds	27-18
Figure 27-6 Cause and effect relationships - dam construction footprint, water storage area and associated infrastructure	27-19
Figure 27-7 Cause and effect relationships associated with the pipeline	27-20
Figure 27-8 Cumulative Project impacts - dam construction footprint, water storage area and associated infrastructure	27-23
Figure 27-9 Cumulative Project impacts associated with the pipeline	27-25
Figure 27-10 Projected workforce for the Western Downs Region	27-37
Figure 27-11 Projected resident population impact for the Western Downs	27-38
Figure 28-1 Locality plan	28-7
Figure 28-2 Pipeline route and water storage	28-9
Figure 28-3 Flora survey sites, dam and surrounds	28-36
Figure 28-4a Flora survey sites, pipeline	28-37
Figure 28-5 Fauna survey sites, dam and surrounds	28-41
Figure 28-6 Boggomoss Snail survey sites	28-45
Figure 28-7 Distribution of the Brigalow ecological communities across the dam study area	28-49
Figure 28-8 Distribution of GAB spring communities across the dam study area	28-50
Figure 28-9 Map of the Great Artesian Basin Reproduced from <i>Great Artesian Basin Strategic Plan (Great Artesian Basin Consultative Council, 2000)</i>	28-57
Figure 28-10 Photos of GAB spring wetlands located in the water storage area (Chenoweth, 2009)	28-60
Figure 28-11 Location of threatened flora species – dam study area	28-64
Figure 28-12 Location of threatened flora species – pipeline	28-65
Figure 28-13 Location of threatened fauna - dam and surrounds	28-75



Figure 28-14 Boggomoss Snail records	28-78
Figure 28-15 Fitzroy River at Barrage daily flow duration curve (with dam)	28-91
Figure 28-16 Fitzroy River at end of system daily flow duration curve (with dam)	28-92
Figure 28-17 GAB spring wetlands inundated at FSL	28-106
Figure 28-18 Matters of national environmental significance potential impacted by changes to the flow regime	28-136
Figure 28-19 Isla-Delusion cross section used for hydrological modelling	28-138
Figure 28-20 Southend cross section used for hydrological modelling	28-138
Figure 28-21 Example daily flow duration curve	28-142
Figure 28-22 Example daily flow depth exceedance	28-142
Figure 28-23 End of Dawson River flow duration curve	28-143
Figure 28-24 Frequency analysis: 10 cm flows	28-144
Figure 28-25 Frequency analysis: 30 cm flows	28-145
Figure 28-26 Example of reduced flood peaks with increased duration	28-147
Figure 28-27 Example of reduced flood peaks no longer reaching trigger threshold	28-147
Figure 28-28 Regulated section of the Dawson/Fitzroy Rivers	28-150
Figure 28-29 Flow duration characterisation downstream of Nathan Dam (No Dam Scenario)	28-152
Figure 28-30 Flow duration characterisation downstream of Nathan Dam (With Dam Scenario)	28-154
Figure 28-31 Fitzroy Barrage outflow: daily flow volume exceedance	28-156
Figure 28-32 Fitzroy Barrage outflow: monthly frequency analysis	28-156
Figure 28-33 Isla Delusion: daily flow volume exceedance	28-158
Figure 28-34 Isla Delusion frequency analysis: half bankfull flows (4,600ML/day)	28-159
Figure 28-35 Isla Delusion frequency analysis: bankfull flows	28-160
Figure 28-36 Southend: daily flow volume exceedance	28-161
Figure 28-37 Southend frequency analysis: half bankfull flows	28-162
Figure 28-38 Southend frequency analysis: Bankfull flows	28-163
Figure 28-39 Isla Delusion: daily flow volume exceedance	28-164
Figure 28-40 Isla Delusion frequency analysis: 10 cm flows or greater	28-165
Figure 28-41 Isla Delusion frequency analysis: 30cm flows or greater	28-166
Figure 28-42 Isla Delusion frequency analysis: flushing flows 1,600 ML/day or greater	28-167
Figure 28-43 Southend: daily flow volume exceedance	28-168
Figure 28-44 Southend frequency analysis: 10 cm flows or greater	28-168
Figure 28-45 Southend frequency analysis: 30 cm flows or greater	28-169
Figure 28-46 Southend frequency analysis: flushing flows 1,100 ML/day or greater	28-170
Figure 28-47 Extent of cumulative flow impacts	28-172
Figure 28-48 Fitzroy Barrage Outflow flow duration curve: Cumulative Impact Scenario	28-173
Figure 28-49 Fitzroy Barrage Outflows Frequency: Estuary Flushing Flows (2yr ARI or greater) Cumulative Impacts Scenario	28-173
Figure 28-50 Wattlebank: daily flow volume exceedance	28-174
Figure 28-51 Wattlebank frequency analysis: 10 cm flows or greater	28-175



Figure 28-52 Wattlebank frequency analysis: 30 cm flows or greater

28-176

Figure 28-53 Wattlebank frequency analysis: Flushing flows (1,926 ML/day or greater)

28-177