

Environmental Impact Statement (EIS)

Report under the *Environmental Protection Act 1994*

Arrow Bowen Gas Project
Proposed by Arrow Energy Pty Ltd



Prepared by: Statewide Environmental Assessments, Department of Environment and Heritage Protection

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Excerpt figures from the EIS are reproduced in Appendix 6 of this assessment report.

List of acronyms and abbreviations

AADT	Annual average daily traffic
ACH Act	<i>Aboriginal and Cultural Heritage Act 2003</i>
AEP	Annual exceedance percentage
ARI	Average recurrence interval
ATP	Authority to prospect
CGPF	Central gas processing facility
CHMP	Cultural Heritage Management Plan
CMA	Cumulative Management Area
CRG	Community Reference Group
CSG	Coal Seam Gas
CTM	Chemical Transport Model
Cwth	Commonwealth
DAFF	Department of Agriculture, Fisheries and Forestry
DATSIMA	Department of Aboriginal and Torres Strait Islander and Multicultural Affairs
DCCSDS	Former Department of Communities, Child Safety and Disability Services
DCS	Department of Community Safety
DDRP	Darling Downs Regional Plan
DDSD	Darling Downs Statistical Division
DERM	Department of Environment and Resource Management
DSEWPaC	Former Commonwealth Department of Sustainability, Environment, Water, Population and Communities
DHPW	Department of Housing and Public Works
DLG	Department of Local Government
DNRM	Department of Natural Resources and Mines
DO	Dissolved oxygen
DOE	Commonwealth Department of the Environment
DSDIP	Department of State Development, Infrastructure and Planning
DSITIA	Department of Science, Information Technology, Innovation and the Arts
DTMR	Department of Transport and Main Roads
EA	Environmental authority
EHP	Department of Environment and Heritage Protection
EIS	Environmental impact statement
EM plan	Environmental management plan
EP Act	<i>Environmental Protection Act 1994</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>

EPP (Air)	Environmental Protection (Air) Policy 2008
EP Regulation	Environmental Protection Regulation 2008
ERA	Environmental relevant activities
ESA	Environmentally sensitive area
EVNT	Endangered, Vulnerable or Near Threatened
FCF	Field compression facility
GAB	Great Artesian Basin
GARID	Guidelines for Assessment of Road Impacts of Development
GDE	Groundwater Dependent Ecosystems
GHG	Greenhouse Gas
GQAL	Good quality agricultural land
HEV	High ecological value
IAS	Initial advice statement
IESC	Independent Expert Scientific Committee
IRC	Isaac Regional Council
Land Act	<i>Land Act 1994</i>
LNG	Liquefied natural gas (LNG)
MIA	Mine infrastructure area
ML	Mining lease
MLA	Mining lease application
MNES	Matters of National Environmental Significance
MR Act	<i>Mineral Resources Act 1989</i>
MRC	Mackay Regional Council
MSES	Matters of State Environmental Significance
NC Act	<i>Nature Conservation Act 1992</i>
NEPM	National Environment Protection (Ambient Air Quality) Measures
NOX	Oxides of nitrogen
NT Act	<i>Native Title Act 1993</i>
OCG	Office of the Coordinator General
OGIA	Office of Groundwater Impact Assessment
PAA	Priority Agricultural Areas
PLA	Priority Living Areas
PL	Petroleum Lease
PPL	Petroleum Pipeline License
PVMO	Policy for Vegetation Management Offsets
P&G Act	Petroleum and Gas (Production & Safety) Act 2004
QBOP	Queensland Biodiversity Offsets Policy
QGEOP	Queensland Government Environmental Offsets Policy
QH	Queensland Health
QPS	Queensland Police Service
QTT	Queensland Treasury and Trade

QWC	Queensland Water Commission
RE	Regional Ecosystems
RIA	Road impact assessment
RMP	Road-use management plan
RO	Reverse Osmosis
ROW	Right of Way
SCL	Strategic Cropping Land
SCL Act	<i>Strategic Cropping Land Act 2011</i>
SDPWO Act	<i>State Development and Public Works Organisations Act 1971</i>
SMP	Species management plan
SP Act	<i>Sustainable Planning Act 2009</i>
SREIS	Supplementary report to the EIS
SSBV	State Significant Biodiversity Values
TAPM	The Air Pollution Model
TEC	Threatened Ecological Community
TMP	Traffic Management Plan
TOR	Terms of reference
TSS	Total suspended solids
VM Act	<i>Vegetation Management Act 1999</i>
VOC	Volatile organic compounds
WQO	Water Quality Objectives

1 Introduction

Arrow Energy Pty Ltd (the proponent) is seeking approval to construct, operate and decommission the Arrow Bowen Gas Project (herein referred to as the 'project'). Arrow Energy Pty Ltd is a Queensland-based wholly owned subsidiary of Arrow Energy Holdings Pty Ltd, a 50:50 joint venture between a subsidiary of Royal Dutch Shell plc and a subsidiary of PetroChina Company Limited. The project would cover an area of approximately 8000 square kilometres (km²), approximately 150 kilometres (km) south-west of Mackay, with the main area extending from Glenden in the north to Blackwater in the south.

This report provides an evaluation of the environmental impact statement (EIS) process pursuant to Chapter 3 of the *Environmental Protection Act 1994* (EP Act) for the project proposed by the proponent. An application to prepare a voluntary EIS was granted by the Department of Environment and Heritage Protection (EHP) in May 2012 and the draft terms of reference (TOR) were advertised in June 2012. Following a period of public consultation, the TOR were finalised in November 2012.

EHP, as the administering authority of the EP Act, coordinated the EIS process. This EIS assessment report (herein referred to as the 'assessment report') has been prepared pursuant to sections 58 and 59 of the EP Act.

In meeting the requirements of the EP Act, this assessment report describes the project and the places likely to be affected by the project. It summarises the key issues associated with the potential adverse and beneficial environmental, economic and social impacts of the project. It also discusses the management, monitoring, planning and other measures proposed to minimise adverse environmental impacts. Finally, this assessment report identifies those issues of particular concern that were not resolved or that require specific conditions for the project to proceed.

Section 2 of this assessment report describes the project in order to provide context for the findings of the report. **Section 3** outlines the EIS process that was followed for the project and the approvals that would be necessary before the commencement of the project. **Section 4** addresses the adequacy of the EIS documents in addressing the TOR, discusses the main issues with regard to the environmental management of the project and refers to the environmental protection commitments made in the EIS documents as well as any recommended conditions. **Section 5** assesses the adequacy of the EIS documents in addressing potential impacts on matters of national environmental significance (MNES). **Section 6** assesses the adequacy of the environmental management plan (EM plan) for the project. **Section 7** is the certification of the assessment report. The giving of this assessment report to the proponent completes the EIS process under the EP Act.

2 Project description

This section provides a summary of the proposed project as outlined in the EIS (section 5) and the supplementary report to the EIS (SREIS) section 3.

The EIS discussed the project's petroleum tenures which cover an area of approximately 8000km². These tenures are located approximately 150km south-west of Mackay, with the bulk of the area extending from Glenden in the north to Blackwater in the south (Figure 1). The project area follows the Connors Range to the east and the Denham Range to the west and is located within the Isaac River and Mackenzie River sub-catchments of the Fitzroy River catchment and the Belyando Suttor sub-catchment of the Burdekin River catchment.

2.1 Project proponent

The proponent for the project is Arrow Energy Pty Ltd, a wholly owned subsidiary of Arrow Energy Holdings Pty Ltd—a 50:50 joint venture between a subsidiary of Royal Dutch Shell plc (Royal Dutch Shell) and a subsidiary of PetroChina Company Limited (PetroChina). Royal Dutch Shell operations in Australia include:

- petroleum refining
- sale of petroleum products and retail businesses
- exploration and development of large gas resources off the coasts of Western Australia and the Northern Territory.

Royal Dutch Shell has developed liquefied natural gas (LNG) projects in Qatar, Nigeria, Russia and Southeast Asia and through a subsidiary, operates a large LNG carrier fleet. PetroChina is a subsidiary of China National Petroleum Corporation, and is one of the world's largest oil companies with extensive experience in exploration, refining and marketing of oil and natural gas in China and other countries.

The proponent has interests in more than 65,000km² of petroleum tenures, mostly within Queensland's Surat and Bowen basins but also in the Clarence-Moreton, Coastal Tertiary, Ipswich, Styx and Nagoorin Graben basins. The proponent currently operates existing gas fields, facilities and infrastructure in the Bowen Basin (Moranbah Gas Project) and the Surat Basin near Dalby (Tipton West, Daandine and Kogan North Projects) and supplies gas to the domestic market for power generation and other domestic uses.

The proponent's existing petroleum operations in the Bowen Basin are approximately 300 km south of Townsville and 150 km south-west of Mackay. The Moranbah Gas Project is one of the largest operating CSG projects in Australia. The Moranbah Gas Project petroleum tenures are separate from the proposed Bowen Gas Project tenures.

The proponent and its equity partner in the Moranbah Gas Project, AGL Energy, have access rights to the North Queensland Pipeline, which supplies gas to Townsville from the Moranbah Gas Project, and hold the pipeline licence for the proposed Central Queensland Pipeline between Moranbah and Gladstone.

2.2 Objective of the project

The EIS documents stated that the principal objective of the project is to commercialise gas reserves held in the proponent's Bowen Basin petroleum tenures.

2.3 Need for the project

The EIS documents state that the Australian and global demand for gas presents an opportunity to develop the proponent's gas resources for export while supporting and expanding the existing domestic market. It also presents supporting information on gas resources, demand for energy and gas, and the influence of greenhouse gas reduction measures on demands for gas. The EIS documents assert that the project would provide a net benefit to Queensland and Australia through long-term royalty contributions to the state economy, have direct benefits to areas surrounding the project through the creation of employment and small business opportunities, promote the development of a highly skilled workforce, and contribute to diversification of the regional, state and national economies. Should LNG export not proceed, the proponent's gas field developments in the Bowen Basin would progress but on a smaller scale, at a slower rate, and with a reduced level of investment and economic output.

The EIS outlines a range of consequences should the project not proceed, including positive and negative environmental, economic and social impacts, such as the

- potential adverse impacts on land, biodiversity, water and air, and the associated visual and social impacts, would not occur
- potential adverse impacts on the local and broader economy, labour market, and community services would not

occur

- potential for benefits to the Queensland economy would not occur - the project's contribution to gross regional product above the baseline scenario, is estimated to increase steadily over a six year ramp up period to approximately \$600 million by 2021-22 and plateau at approximately \$600 to \$700 million (or just over 2% of the gross regional product for the region)
- job creation (up to 2450 jobs during construction, up to 300 jobs during operation), investment in local and regional infrastructure and services, and increased export and local use of LNG, would not be realised.

2.4 Alternatives

The EIS documents outline a range of options for gas field infrastructure, and for the design and location of specific infrastructure. Final selection would be based on further planning, technology development, engineering and economic considerations, and on environmental (including land, water, biodiversity and air) and social constraints. Consultation with landholders would inform the location of gas wells and associated infrastructure to limit impacts on current land uses.

The Supplementary Report to the EIS (SREIS) presents significant changes to the proposed project which would significantly reduce some impacts. These changes are summarised in section 4.3 (Description of the project) of this assessment report. The SREIS provides details of indicative development areas and indicative timing of each gas drainage area commencing production as well as the likely general location of gas processing and water treatment infrastructure. A more detailed outline of project infrastructure and potential location is provided in section 2.6 (Project description) of this assessment report.

The EIS documents present a planning and management approach, referred to as the environmental framework approach, proposed to be used by the proponent to manage the impacts of coal seam gas (CSG) development (site selection, construction and operation) through which the location of infrastructure becomes progressively defined over the life of the project. The framework approach provides for the application of environmental management controls (avoidance, mitigation and management) that reflect the level of sensitivity of environmental values, and is supported by a process of description, classification and mapping of a range of constraints.

2.5 Relationship to other projects

The project forms part of a larger Arrow LNG Project with separate approvals being sought for each component. Components include:

- Arrow LNG export facility on Curtis Island. Assessment was completed under Part 4 of the *State Development and Public Works Organisation Act 1971* (SDPWO Act) in September 2013. The Commonwealth approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was issued in December 2013.
- Arrow Surat Pipeline from the Kogan area of the Surat Basin to Fisherman's Landing (Petroleum Pipeline License (PPL) 144 granted in February 2010)
- Surat Header Pipeline to connect the Arrow Surat Pipeline to the proponent's production facilities in the southern region of the project area
- Surat Gas Project with proposed gas field development in the Surat Basin between Wandoan in the north to the southwest of Millmerran. This component completed assessment by EIS under the EP Act in October 2013.
- Arrow Bowen Pipeline to convey CSG from the proponent's gas fields in the Bowen Basin to Gladstone. Assessment by EIS under the EP Act was completed in March 2013.

See Figures at Appendix 6 of this assessment report for the location of these related projects.

2.6 Project description summary

The following description is based on the SREIS (Section 3) and summarises the main activities, infrastructure and facilities proposed. The EIS project description was modified by the SREIS as a result of further development of the engineering and infrastructure design, new exploration data and to address the submissions made on the EIS. Section 4.3 of this assessment report provides further details of the changes made.

Location

The project is located approximately 850km north of Brisbane and 150 km south-west of Mackay, Queensland. The project area is approximately 8000km². The project area extends north to south from Glenden to Blackwater, and follows the Connors Range to the east and the Denham Range to the west. It incorporates catchment of the Suttor River and Bowen River catchments in the Burdekin Basin, and the Isaac River, Connors River and the Mackenzie River in the Fitzroy Basin.

Tenements and tenures

The project area comprises Authorities to Prospect (ATPs) 1103, 1031, 1025, 749, 742 and a small portion of 759 (see Figures at Appendix 6 of this assessment report).

Resource base, reserve life, and extraction sequencing

The EIS stated that CSG and conventional gas reservoirs produce both gas and water. With CSG, the coal cleats are filled with water and the gas is sorbed to the coal matrix. For the Bowen Gas Project groundwater must be pumped from the confined coal seam aquifers to reduce hydrostatic pressure to allow the CSG to desorb from the coal and mobilise into the production well. Given the large volume of gas sorbed in the coal it likely to take up to 20 years for the coal seams to release most of the gas.

The Bowen Basin contains much of the known Permian coal resources in Queensland. The gas resources associated with these deposits are significant and have capacity to supply large volumes of gas for development. The Bowen Basin contains 23% of Australia's 2P (proven and probable) CSG reserves.

Appendix 6 figures of this assessment report show the sequence of the 33 drainage areas likely to be worked by the proponent in extracting the available CSG.

The target coal seams are the Moranbah Coal Measures and Rangal Coal Measures. Opportunities to develop the Fort Cooper Coal Measures at some stage over the project life would be considered however the EIS stated that this is not included in the current project development planning and is not a part of this project description or the associated impact assessment for the EIS documents.

Drainage (development) areas

The EIS documents (SREIS section 3) described the main proposed infrastructure components of each drainage area as including the following features, noting that the actual size and shape of each gas drainage area was indicative and may vary from the 6 km radius areas indicated

- two central gas processing facilities (CGPFs) to treat the gas to pipeline specification
- two water treatment facilities (WTFs) co-located with the CGPFs with a potential third WTF located near Blackwater
- production wells
- wellhead facilities
- low pressure water and gas gathering systems
- field compression facilities (FCFs) to boost the gas pressure for export to the CGPF
- water transfer stations (WTSs) located with the FCFs to pump the CSG water to the WTFs
- raw water trunkline for transport of raw water to the WTFs
- medium pressure infield gas pipelines to transport the gas from the FCFs to the CGPFs
- infrastructure required for power distribution.

The SREIS provided an updated production well design that included multi-seam, hydraulically stimulated vertical wells but replaced the dual lateral configuration described in the EIS by multi-branch lateral wells (SREIS section 7 Figure 7.1). The multi-branch lateral well configuration would reduce the surface disturbance area, as it would not require two dedicated horizontal wells. It was also intended to co-locate up to six multi-branch lateral wells to reduce the number of well pads and reduce disturbance such that the number of production wellheads at the surface would reduce from 6625 to around 4000.

Construction

The EIS describes a proposed indicative development sequence with 17 drainage areas developed during Phase 1 (year 0 to year 5 of production). Both CGPFs and their co-located WTFs would also be constructed in Phase 1. 11 drainage areas would be developed during Phase 2 (year 6 to year 10 of production) with the remaining five drainage areas and potentially a third WTF (near Blackwater) being developed in Phase 2+ (year 11 onwards) (see Appendix 6 EIS excerpts of this assessment report).

Table 3.3 of SREIS section 3 shows the proposed development sequence. The table is reproduced in Appendix 5 of this assessment report. Construction activities for the project are proposed to occur over the expected 35 year project life at a rate that maintains constant gas production following ramp-up. Production wells would be installed progressively throughout the project life starting in 2015.

Construction of wells, gathering pipelines, gas processing facilities, water treatment facilities, and high pressure pipelines would involve a similar sequence of planning, construction and rehabilitation, including:

- survey, geotechnical investigations, consultation, and planning to determine most appropriate location based on technical, environmental, social and landowner constraints
- clearing and earthworks to specified and agreed requirements, including topsoil and erosion management

- construction and testing or commissioning
- progressive rehabilitation and waste removal.

The EIS outlined the proposed method of construction, equipment and chemicals used, and likely disturbance areas for construction and operation. The SREIS presented revised estimates for the quantity of aggregate required for all construction over the life of the project with a total requirement of up to five million tonnes. The proposed source/s of aggregate is not specified in the EIS documents.

The proponent intends to source as much of the required construction water as possible from CSG water and this is estimated as an initial peak requirement of approximately 175ML per year for the first two years (assuming 2x CGPFs, 16x FCFs, 2x WTFs with associated dams and roads) with a further 10ML allowed for dust suppression and access roads. An average of approximately 10ML per year of water would be required for the remaining life of the proposed project.

Operation and maintenance

The EIS documents describe the following operational features proposed for the project.

- **control of the production facilities** - these would be managed centrally from the Brisbane Central Control Room on a 24 hour / seven day basis. The facilities would incorporate a high level of monitoring, automation and communications
- **production wells** - were proposed to be remotely operated and monitored and subject to regular inspection and maintenance. Well work-overs, involving cleaning the production zone, maintaining or replacing the pump, and possibly replacing the well tubing and rods, were estimated to be required at least every three years to ensure continued flow of gas and/or water from the coal seam. A work-over drilling rig would be required for well maintenance
- **gas and water gathering pipelines** - gas and water gathering pipeline flow rate would be remotely monitored and the right of way and surface equipment subjected to regular inspection and maintenance
- **gas processing facilities** - CGPF and FCF would be fully automated and operate 24 hours a day, seven days a week. Major compressor inspection and maintenance would be required every three to five years
- **coal seam gas water and brine management** - operational WTFs with their associated dams (including the brine dam) and transfer stations would be operated 24 hours a day, seven days a week, be fully automated and designed for minimal operator intervention. Major maintenance (outages / overhauls) would be undertaken in accordance with manufacturer specifications and based on condition monitoring and exception based surveillance including microfiltration / ultrafiltration membranes every five to ten years and reverse osmosis membranes every three to five years
- **workforce and accommodation** - construction workforce was expected to peak at around 2,450 personnel in 2018. From 2017 to 2019 the average daily workforce is expected to be over 1,000 personnel coinciding with the construction of the two CGPFs and the Phase 1 FCFs. The average daily construction workforce would reduce to around 500 to 900 personnel from 2020, after which it would further reduce to 400 or less personnel from 2028 onwards. Purpose-built accommodation would include two main villages located near CGPF1 and CGPF2, designed and built as permanent accommodation to house the construction workforce as well as long term permanent staff expected to be fly-in / fly-out (FIFO) (including workover crews). To minimise staff travelling time several smaller temporary villages were expected to be required when the facilities associated with the drainage areas furthest away from the CGPFs are under construction. Temporary accommodation would be used in the early stages of the project (i.e. 2015 – 2016) until the permanent accommodation has been constructed. 250 to 300 permanent operations and maintenance personnel would be required in the operational phase (this excludes Arrow Brisbane based staff, workover crew and field maintenance contractors) peaking in 2028 for approximately 13 years. The majority of the operations and maintenance personnel would be 80% FIFO.
- **water supply and storage** - The EIS documents stated that the proponent would, where possible, source as much of the required construction water as possible from CSG production water from the project. It was proposed that there would be an initial peak requirement of approximately 175 ML per year for the first two years (assuming 2x CGPFs, 16x FCFs, 2x WTFs with associated dams and roads. A further 10 ML would be required for dust suppression and access roads. An average of approximately 10 ML per year would be required for the remaining life of the proposed project.

The EIS estimated the project's total water production as 153 GL. Average production over 36 years would be 4.25 GL/a with peak production of 10.4 GL/a. For the SREIS reference case and for planning purposes the dam sizing (per WTF) was adopted (based on a nominal facility throughput of 20 ML/d) was

- associated water storage (feed) dam – 400 ML (providing a minimum of 20 days storage),
- clear (treated) water dam – 600 ML,
- brine storage dam(s) – 1,800 ML

Subject to water quality requirements, treated (and in certain instances untreated) CSG water was proposed to

be made available for a range of beneficial uses. This included own use of CSG water by the proponent, in which case it was proposed to be used for industrial purposes in the operations e.g., dust suppression, drilling and construction water supply.

- **transport** – the proponent proposed using road transport for most requirements and approximately 80% of the operations workforce would be on fly in fly out (FIFO) arrangements. Project related materials that require freight by sea would be shipped as general cargo. The SREIS modelled the impact of the project's traffic on roads to be used by the project including State and council-controlled roads within the region encompassing the project area including the Mackay / Whitsunday region. Information included a summary of the recently commenced or under investigation projects with potential cumulative traffic impacts in and within proximity to the project area.
- **communication** – it was proposed that four free standing permanent up to 100m high communications towers would be required including buried fibre optic cables and microwave radio links. The fibre optic cables would be placed in the same easement as the low pressure gas gathering pipelines and medium pressure infield pipelines. An average tower would disturb 10 m x 10 m located on rocky hilltops and would be solar powered (unless located with other facilities) and have remote monitoring, closed-circuit television, proximity and security systems installed.
- **waste** - wastes generated during construction would include:
 - solid wastes—general trash, scrap metal, cleared vegetation, cut and fill material, empty drums and containers, timber, drill cuttings, plastic pipe, steel pipe offcuts, filter cartridges, batteries, concrete, cardboard and other packaging materials, pallets, soil contaminated with chemicals/oils, oily rags and sorbents, x-ray film, sandblast grit, electrical cable and tyres
 - liquid wastes—drill fluids, residual drilling mud, CSG water, hydrostatic-test water, filters and filter media, used lubricating oil and filters, acids and caustics, glycol, paints and paint wastes, unused or spent chemicals/oils/solvents, grey water, stormwater, sewage from amenity blocks, radioactive wastes from integrity testing, pesticides and herbicides
 - gaseous waste—CSG, flare emissions, and engine emissions.

Wastes generated during operation and maintenance would include:

- solid wastes—filter cartridges, activated carbon, membrane modules, batteries, general trash, scrap metal, empty drums and containers, sandblast grit, cardboard and other packaging materials, wood pallets, oily rags and sorbents, electric cable, spent filter media bulk bags and tyres
- liquid wastes—workover drilling fluids, cleaning acids, domestic cleaners, fuel, greases, lube oils, glycol, paint waste, water treatment chemicals, sewage from amenity blocks, triethylene glycol, brine, CSG water, stormwater, pigging waste, pesticides and herbicides
- gaseous waste—CSG, engine emissions and flare emissions.

Sewage generated at production facilities would be transported off-site to a municipal treatment facility or treated onsite with sludge disposed off-site at a regulated waste facility.

Decommissioning and rehabilitation

The project infrastructure has a design life ranging between 15 and 35 years and decommissioning and rehabilitation would occur progressively throughout this period. Final decommissioning and rehabilitation would occur at the end of life for individual infrastructure in accordance with relevant approvals and regulatory requirements.

The EIS documents state that detailed objectives, criteria and performance indicators for decommissioning and rehabilitation would be developed in consultation with the regulatory agency and landholders with the goal of ensuring the project area was left safe for humans and wildlife, non-polluting, stable (landforms), and able to sustain a useful land use.

Production wells - installation of wells would result in a construction footprint of up to 130m by 295m reducing to an operational footprint area of 100m by 275m for the largest of the multi-well pads. The wells would be decommissioned at the end of their production life (approximately 15 to 25 years) in accordance with requirements of the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act). Well casing and the gathering line connections would be cut off below ground surface and the well plugged with concrete to isolate formations and prevent gas leakage to the surface. Well sites were proposed to be rehabilitated to a standard consistent with the surrounding land use, or as agreed with the landholder.

Gas and water gathering systems - gathering lines would be left in the ground but isolated, purged of gas and filled with an inert gas or water. Where necessary, the pipe would be filled with a stabilising material such as concrete to prevent subsidence under roads, utilities or railway lines.

Production facilities, water treatment and storage facilities and power generation facilities - these facilities

may be decommissioned and rehabilitated progressively or at the end of life (approximately 30 years). Any potentially contaminated soil would be remediated or removed to an appropriate treatment or disposal facility. Sites would be rehabilitated to a standard consistent with the surrounding land use, or as agreed with the landholder. Any infrastructure, such as roads, tracks or dams, left on site would be subject to an agreement with the landholder and acceptance by the relevant regulatory agency.

The EIS stated that any brine residue would be removed as waste and disposed of at an appropriately licensed facility .

High-pressure gas pipelines – this infrastructure would be either suspended for future use or decommissioned in accordance with Australian Standard AS 2885: Pipelines-Gas and liquid petroleum. Suspending a pipeline would involve filling it with inert gas (e.g. nitrogen) or water containing corrosion-inhibiting chemicals and capping the ends. Decommissioning of high-pressure pipelines would be consistent with the gas gathering pipelines methods.

Supporting infrastructure - Accommodation camps would be removed and the sites rehabilitated to a standard consistent with the surrounding land use, or as agreed with the landholder and the relevant regulatory agency.

Location of project infrastructure

The proponent was yet to determine the exact locations of production wells, gas processing facilities, water treatment facilities, temporary workers accommodation facilities, and other project infrastructure. The EIS presented conceptual designs and potential areas for development for the purposes of identifying, describing and assessing the likely impacts. The SREIS presented a significantly revised development area and conceptual design, including

- central gas processing facilities (CGPF) and water treatment facilities (WTFs) co-located at CGPFs
- field compression facilities (FCFs) to boost the gas pressure and enable transportation of the gas over long distances and a water transfer station (WTS) to facilitate transfer of water from FCF to FCF en route to a CGPF.
- 33 development (or drainage) areas each having an approximate 6 km radius catchment area for gathering well production (gas and water)
- around 4000 production wells drilled throughout the project area over the life of the project (up to 40 years) to maintain gas feed to the LNG plant at Gladstone
- well development plans involving drilling and completion of two base case well types multi branch laterals (MBLs) described as multi branched horizontal wells drilled in-seam to intersect a vertical producer, and multi-seam hydraulically fractured types with vertical, cased and cemented wells, which would be perforated and fracture stimulated to provide formation access. It was proposed that up to 25% of wells could be hydraulically fractured.

Uncertainty about the exact location of wells, pipelines, production facilities and other infrastructure remained a limitation of the SREIS.

The EIS outlined the following key factors as influencing the location of project components:

- ongoing exploratory drilling and pilot well programs to define viable gas reserves
- consultation with landholders
- environmental and social impact management
- economic and commercial risks that influence the extent and rate of field development
- ongoing refinement of the field development plan over the life of the project
- development of new technologies, standards and practices.

The proponent proposed that specific locations for project infrastructure would be defined as engineering studies progressed, with details to be provided to government in applications for operational approvals, which in turn may be publicly advertised for comments.

The EIS presented a planning and management process based on technical studies and defined constraints (referred to as an 'environmental framework') to inform site selection of project components and to manage the potential impacts of project development.

3 EIS process

3.1 Legislative basis for the EIS

On 20 April 2012 the proponent applied for approval to prepare a voluntary EIS for the project under Chapter 3 of the EP Act. The former Department of Environment and Resource Management (DERM now EHP), granted approval on 2 May 2012.

On 8 May 2012 the project was referred (EPBC 2012/6377) to the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities (now the Department of the Environment) and hereafter referred to as the Commonwealth Environment Minister) for a determination as to whether the project would constitute a 'controlled action' with respect to potential impacts on MNES under sections 75 and 87 of the EPBC Act.

The EPBC Act establishes an Australian Government process for assessing environmental impacts and approving proposed actions that are likely to have a significant impact on MNES or on Commonwealth land.

On 15 June 2012, the delegate of the Commonwealth Environment Minister determined the project to be a 'controlled action' pursuant to section 75 of the EPBC Act. The relevant controlling provisions for the project were determined as:

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

Coal seam gas and large coal mining developments with the potential to have a 'significant impact' on water resources now require referral to, and possibly approval from, the Commonwealth Environment Minister under the EPBC Act. Under the transitional arrangements for commencement of the amendments to the EPBC Act, the project was assessed as to whether the new water trigger would apply. In September 2013, the Commonwealth Environment Minister made a proposed decision that the water trigger applied to the project. On 17 October 2013 the Commonwealth Environment Minister made a final decision that the water trigger (sections 24D and 24E) applied to the project. Section 5 MNES of this assessment report includes an assessment of impacts on water resources which refers to sections 4.9 Groundwater and 4.10 Surface Water of this assessment report.

3.1.1 Independent Expert Scientific Committee

The Australian Government established an Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) in late 2012 through amendment to the EPBC Act. The IESC provides advice to the Commonwealth Environment Minister on research priorities to improve the understanding of potential impacts of CSG and large mining developments on water resources. The IESC can be requested by federal, state and territory governments to provide advice on water-related aspects of environmental impact assessments for CSG and large coal mining proposals.

The Bowen Gas Project EIS was referred to the IESC by the Department of Environment and Heritage Protection (EHP) on 22 March 2013. The committee's advice to the department was dated 24 May 2013. Due to the Commonwealth Environment Minister's decision to apply the water trigger to the project, the SREIS was referred by the Commonwealth government to the IESC for review and comment on 4 June 2014. The IESC's advice to the Commonwealth was dated 18 July 2014. Both sets of IESC advice have been considered in the preparation of this assessment report.

3.2 Timeline of the EIS process

Table 3.1 outlines the stages, timing and actions undertaken in the EIS assessment process for the project.

Table 3.1 EIS process stages, timing and actions

Stage	Section of EP Act	Relevant Dates and Actions
Application for voluntary EIS under section 71 of the EP Act	71	An application for a voluntary EIS was lodged with EHP on 20 April 2012
Decision on application for voluntary EIS	72	Voluntary EIS process for the project was approved by EHP on 2 May 2012
TOR stage		
The proponent prepared and submitted draft TOR	41	Lodged with EHP 5 June 2012 The Commonwealth Department of the Environment (DOE) decision on controlling provisions made on 15 June 2012 with the addition of the water trigger on 17 October 2013
EHP prepared TOR Notice	42	TOR Notice was finalised and provided to the proponent on 27 June 2012

Stage	Section of EP Act	Relevant Dates and Actions
EHP published TOR Notice	43(1)	TOR Notice was published on 30 June 2012
The proponent gave TOR notice to affected and interested persons	43(3)	2 July 2012
Public review and submissions	42(3)	The period for public review and submissions on the draft TOR commenced 2 July 2012 and ended at close of business 14 August 2012. A total of 32 submissions were received.
EHP provided comments to the proponent	44	EHP provided all submissions to the proponent on 23 August 2012
The proponent responded to comments (period can be extended by request)	45	The proponent provided a response to comments on the draft TOR to EHP on 21 September 2012
EHP prepared and published final TOR	46	The TOR were finalised by EHP, issued to the proponent, and published on 5 November 2012
EIS preparation stage		
The proponent prepared and submitted the EIS	47	The proponent submitted the complete EIS to EHP on 21 February 2013. Early versions of the EIS materials were submitted and reviewed from 11 December 2012.
EIS submission and assessment stage		
EHP initial review and decision on whether or not the EIS could proceed	49(1) & (2)	EHP decided that the EIS could proceed on 22 February 2013. The decision period was extended from 24 January 2013 to 22 February 2013 at the request of the proponent to allow the proponent to make changes to the submitted EIS.
EHP prepared and gave notice of decision to the proponent	49(5)	22 February 2013
The proponent gave EIS notice to affected and interested persons and made EIS available on the proponent's web site	51	9 March 2013
The proponent published EIS Notice	51	The EIS Notice was published on 9 March 2013 in the state and national daily publications. The publishing date was earlier for local weekly publications (Miners Midweek, CQ News, and Moranbah Advertiser on 6 March 2013).
EIS public submission period	52	The period for public review and submissions on the EIS commenced 11 March 2013 and ended at close of business 23 April 2013. A total of 53 submissions were received.
The proponent provided statutory declaration of compliance with notice requirements	53	19 March 2013
EHP provided all submissions to the proponent	56(1)	EHP provided all submissions on the EIS to the proponent on 7 May 2013
EHP referred project materials to the Independent Environmental Scientific Committee (Cwth)		22 March 2013
Advice from Independent Environmental Scientific		Received by EHP 24 May 2013

Stage	Section of EP Act	Relevant Dates and Actions
Committee (Cwth) provided to EHP		
The proponent responded to submissions in a supplementary report to the EIS	56(2) & (3)	The response period was extended from 4 June 2013 to 13 June 2014 at the request of the proponent. The proponent provided an 'advance copy' of the supplementary report on 2 May 2014. The supplementary report to the EIS was lodged by the proponent on 13 June 2014.
Commonwealth referral to the Independent Environmental Scientific Committee (Cwth)		10 June 2014
Advice from the IESC		18 July 2014
EHP decided if EIS and response to submissions were adequate for the EIS process to proceed	56A(2) & (3)	11 July 2014
EHP prepared and gave decision notice to the proponent	56A(4)	25 July 2014
EHP prepared the EIS assessment report	57	8 September 2014
EHP gives EIS assessment report to proponent—completes EIS process	60	8 September 2014

3.3 Approvals required

The EIS and the SREIS provide adequate information on likely approval requirements. This was based on the later (post EIS) development of detailed applications for relevant approvals, approval processes, and for assessment by the relevant agencies with jurisdiction for approvals. The EIS and SREIS outlines the likely timing of applications in relation to gas field development, and identifies important linkages among statutory requirements. A summary of the key statutory requirements follows.

3.3.1 *Petroleum and Gas (Production and Safety) Act 2004*

The project requires petroleum leases under the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) before sale of gas can commence. The project requires a petroleum pipeline licence under the P&G Act for the construction and operation of any pipelines required to transport CSG outside the area of a petroleum lease.

The project may require a petroleum survey licence to allow access to land to investigate, survey and identify a pipeline route associated with a petroleum pipeline licence.

An authority to prospect (ATP) under the P&G Act allows the holder to undertake gas exploration activities (such as geological and geophysical surveys), chemical or other analyses and environmental, engineering and design studies to evaluate the development potential of CSG. The proponent holds various ATPs and authority to prospect applications within the project area, which would be required to be replaced with petroleum leases in order to undertake the project.

The proponent must satisfy the minimum requirements of the Land Access Code in order to gain land access for the project. The Land Access Code requires an entry notice for 'preliminary activities' that cause no impact or only minor impact on landholders, a negotiated Conduct and Compensation Agreement, and a process for negotiation and resolving disputes about agreements

3.3.2 *Environmental Protection Act 1994*

The project requires a site-specific environmental authority for petroleum activities and other environmentally relevant activities (ERAs) associated with the project, with the exception of the environmental authority to support a petroleum survey licence.

An environmental authority imposes environmental management conditions on petroleum activities undertaken on

a petroleum lease or petroleum pipeline licence and must be issued before a petroleum lease can be granted. The SREIS stated that the proponent may apply to amend an environmental authority or may apply for a new environmental authority for each stage of the development. The EIS process under the EP Act must be finalised before an environmental authority can be issued for the project.

The SREIS identified the following ERAs that are currently regulated under the EP Act, which may be undertaken in the course of constructing, operating and decommissioning the project (Table 33.2).

Table 3.2 Project environmentally relevant activities (source: SREIS)

Environmentally Relevant Activities	Description	Applicable project activities
Resource activity		
A Petroleum Activity	<p>An activity that, under the <i>Petroleum Act 1923</i> (Petroleum Act), is an authorised activity for a 1923 Act petroleum tenure under that Act; or</p> <p>an activity that, under the P&G Act, is an authorised activity for a petroleum authority under that Act; or</p> <p>Exploring for, exploiting or conveying petroleum resources under a licence, permit, pipeline licence, primary licence, secondary licence or special prospecting authority granted under the <i>Petroleum (Submerged Lands) Act 1982</i>.</p>	Activities relating to gas production.
Schedule 2 - Prescribed ERAs		
ERA 14 – electricity generation	Electricity generation (the relevant activity) consists of generating electricity by using gas at a rated capacity of 10 megawatt (MW) electrical or more.	Power generation for electricity supply to gas compression and water treatment facilities.
ERA 15 – fuel burning	Fuel burning (the relevant activity) consists of using fuel-burning equipment that is capable of burning at least 500kg of fuel in an hour.	Flaring of gas at production facilities including CGPFs and FCFs.
ERA 56 - regulated waste storage	Regulated waste storage (the relevant activity) consists of operating a facility for receiving and storing regulated waste for more than 24 hours.	Storage of regulated waste (brine) at water treatment facility.
ERA 58 – regulated waste treatment	Regulated waste treatment (the relevant activity) consists of operating a facility for receiving and treating regulated waste or contaminated soil to render the waste or soil non-hazardous or less hazardous.	Operation of a brine treatment facility (the preferred option for disposal of brine).
ERA 60 – waste disposal	Operating a facility for disposing of regulated waste; more than 200,000t/yr	Operation of a brine treatment facility (the preferred option for disposal of brine).
ERA 63 – sewage treatment	Operating one or more sewage treatment works at a site that has a total daily peak design capacity of more than 21 equivalent persons.	Sewerage facilities at construction camp sites and/or production facility sites.
ERA 64 – water treatment	Water treatment (the relevant activity) consists of carrying out any of the following activities in a way that allows waste, whether treated or untreated, to be released into the environment: Desalinating 0.5 ML or more of water in a day. Treating 10ML or more of raw water in a day. Carrying out advanced treatment of	CSG water treatment process

Environmentally Relevant Activities	Description	Applicable project activities
	5 ML or more of water in a day.	

The proponent would be required to obtain either a beneficial use approval under the EP Act, or an environmental authority, that specifically provides for the use of the CSG water for beneficial use(s).

3.3.3 *Water Act 2000*

A petroleum tenure holder's right to take underground water as part of authorised activities is regulated under the P&G Act and the *Water Act 2000* (Water Act). The holder is required to 'make good' if the taking of water causes a landholder bore to have impaired capacity.

A development permit may be required to take or interfere with water from a watercourse, artesian water, subartesian water or overland flow.

Any disturbance (the destruction of vegetation, excavation or placing of fill) to the bed and banks of a watercourse outside a proposed petroleum authority would require a riverine protection permit in accordance section 266 of the Water Act.

Water licenses may be required under the Water Act to supply CSG water outside of the purposes permitted under the P&G Act.

3.3.4 *Strategic Cropping Land Act 2011*

The *Strategic Cropping Land Act 2011* (SCL Act) required resource companies to apply for a compliance certificate or a protection decision for development on SCL. The *Regional Planning Interests Act 2014* has repealed and replaced the SCL Act.

The SCL Act (Qld) allowed for certain resource activities that have a temporary impact on SCL or potential SCL to apply for a compliance certificate to operate under the Strategic Cropping Land: Standard Conditions Code for Resource Activities. The proponent stated that most of its activities on SCL would have met the requirements of the code.

3.3.5 *Regional Planning Interests Act 2014*

The *Regional Planning Interests Act 2014* (RPI Act) commenced on 13 June 2014. The RPI Act requires resource companies to apply for a Regional Interests Development Approval (RIDA).

The RPI Act seeks to manage the impact of resource activities and other 'regulated activities' on areas of regional interest, and to promote the coexistence of resource activities and regulated activities with other activities, such as agriculture. The RPI Act identifies four 'areas of regional interest'

- 'priority agricultural areas' (generally, areas being used for 'highly productive agriculture')
- 'priority living areas' (generally, the settled areas of existing communities of 200+ people, plus a 2-3km buffer zone)
- the 'strategic cropping area' (the area mapped as strategic cropping land on the SCL trigger map)
- 'strategic environmental areas' (areas containing an 'environmental attribute' identified in a regional plan).

The proponent must notify underlying landowners (and potentially the broader public) of any application for a RIDA, there may be submissions made on the application, and the application may be referred to other agencies for assessment and advice (including local government and the Gasfields Commission).

3.3.6 *Nature Conservation Act 1992*

Requirements of the *Nature Conservation Act 1992* (NC Act) relevant to the project that applied at the time were described in the EIS. Since then, a number of changes to the NC Act and the Nature Conservation (Wildlife Management) Regulation 2006 have occurred in relation to approvals for resource activities.

EHP advised that the following requirements would apply to the project, particularly in relation to native fauna.

The Nature Conservation (Wildlife Management) Regulation 2006 (s332 (1)) specifies that, "A person must not, without a reasonable excuse, tamper with an animal breeding place that is being used by a protected animal to incubate or rear the animal's offspring". It is important to note that this includes 'least concern' wildlife.

However, s332(3) allows that, “It is a reasonable excuse for a person to tamper with the breeding place if—

- (a) the tampering happened in the course of a lawful activity that was not directed towards the tampering; and
- (b) the tampering could not have been reasonably avoided”.

In addition, s332(4) allows that, “ Also, subsection (1) does not apply to a person removing or otherwise tampering with the breeding place if—

- (a) the removal or tampering is part of an approved species management program for animals of the same species; or
- (b) the person holds a damage mitigation permit for the animal and the permit authorises the removal or tampering”.

An approved species management program (SMP) ensures adequate management of the animal’s population and habitat. Currently these fall into two broad categories:

- industry-generic SMPs for the majority of least concern animal species
- specific SMPs for endangered, vulnerable or near threatened (EVNT) and special least concern species.

It is important that project proponents enter into discussions with EHP to confirm their compliance with the statutory provisions.

3.3.7 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

As a controlled project, the project requires approval by the Commonwealth Environment Minister under the Commonwealth EPBC Act. The assessment provided in section 5 and Appendix 4 of this assessment report would inform the Minister in making this decision.

3.3.8 Other Approvals

If a petroleum tenement is to be granted over land where native title has not been extinguished, the requirements of the *Native Title Act 1993* must be met, and agreements may need to be reached with relevant Aboriginal groups, before petroleum tenements can be granted. The proponent holds Indigenous Land Use Agreements for the whole of the project area.

3.3.8.1 *Cultural Heritage Act 2003*

A Cultural Heritage Management Plan or equivalent agreements would need to be developed and approved in accordance with the Aboriginal *Cultural Heritage Act 2003*.

3.3.8.2 *Sustainable Planning Act 2009*

Operational works approval under the *Sustainable Planning Act 2009* for waterway barrier works to carry out activities through or across watercourses may be required.

3.3.8.3 *Water Supply (Safety and Reliability) Act 2008*

The Queensland Competition Authority (QCA) released its final report on 11 March 2014 into the regulation of the coal seam gas (CSG) industry in Queensland. The report found duplication of the regulation of CSG water as it relates to public health requirements for drinking water under the *Water Supply (Safety and Reliability) Act 2008* (WSSR Act) and the *Environmental Protection Act 1994* (EP Act).

Consequently, the WSSR Act has recently been amended in line with the recommendations from the QCA. These amendments commenced on 1 July 2014 and removed the requirements for proponents to apply for recycled water management plans (RWMP) or exclusion decisions (ED) when intending to discharge or inject CSG water to a water source. Public health conditions for drinking water will now be solely regulated under the EP Act through environmental approvals and the *Waste Reduction and Recycling Act 2011* through beneficial use approvals.

3.3.8.4 *Forestry Act 1959*

Any resource, including natural grown forest products and/or quarry material extracted, removed or sterilised from an area of State held tenure or State owner freehold land will require a sales permit under the *Forestry Act 1959*. The EIS identified that there were 84 reserves and 53 allotments of unallocated State land in the project area which may be subject to project activities. Specific locations of project infrastructure and the extent of forest products and quarry materials administered under the *Forestry Act 1959* which may be sterilised and/or restricted will need to be quantified.

3.3.8.5 *Transport Infrastructure Act 1994*

The *Transport Infrastructure Act 1994* provides for integrated planning and management of a system of transport infrastructure. The proponent would be required to obtain approval should project activities affect railway lines or state-controlled roads.

3.3.8.6 *Land Protection (Pest and Stock Route) Management Act 2000*

Any project activities would need to comply with the *Land Protection (Pest and Stock Route) Management Act 2000*, particularly in relation to crossing and working around pest fences. The project operational layout would be required to account for Barrier Fences (<http://www.daff.qld.gov.au/plants/weeds-pest-animals-ants/pest-animals/barrier-fences>) with accompanying explanations of process and possible crossings.

3.3.8.7 *Chemical Usage (Agricultural and Veterinary) Control Act 1988 and Agricultural Chemicals Distribution Controls Act 1966*

The proponent would need to ensure compliance with both the *Chemical Usage (Agricultural and Veterinary) Control Act 1988* (use controls) and *Agricultural Chemicals Distribution Controls Act 1966* (licensing controls) to ensure that the use of agricultural chemicals or other industrial chemicals does not have an adverse impact on human health, trade or the environment through contamination of agricultural produce. Landholders would need to be involved in consultation on uses of herbicides (regardless of whether the operation is organic or biodynamic) to ensure that appropriate risk management actions can be implemented where stock could be exposed.

3.3.9 Planning framework

The EIS notes that petroleum activities (activities within a Petroleum Lease (PL) or PPL) are exempt from the requirements of the Queensland State Planning Policy and local planning schemes. For off lease infrastructure the EIS documents considered the key state planning policies and local planning schemes as they would relate to the project. On 2 December 2013 the state planning policies listed in the EIS were consolidated into a single state planning policy with some changes to policy. SREIS section 2 Table 2.1 summarised the 5 themes and 16 state interests set out in the new single SPP and how they would apply to the project.

The following plans were also identified, and their purpose outlined in the EIS:

- Mackay, Isaac and Whitsunday Regional Plans
- Central Queensland Regional Plan (CQRP).
- Water Resource (Burdekin) Plan
- Water Resource (Fitzroy Basin) Plan
- Water Resource (Great Artesian Basin) Plan

The project area would include three local government jurisdictions Whitsunday, Isaac and Central Highlands Regional Council areas. Relevant planning scheme codes were assessed in EIS Appendix Q Land Use and Tenure technical Report. The majority of the project area was zoned rural with some rural residential zones. Attachment A of EIS Appendix Q summarised the proposed project's compatibility with the regional plans.

3.3.9.1 *Regional plans*

On 18 October 2013 the Qld Government Gazette included notifications under section 64 of the *Sustainable Planning Act 2009* (SPA) of the making of the CQRP. Part of the project would be located within the area of the CQRP (much of ATP1025 near Blackwater) and a substantial portion would be within an area mapped as a Priority Agricultural Area in the CQRP.

The Mackay Isaac and Whitsunday Regional Plan was made in February 2012. EIS Appendix Q Figure 1.1 provides a map overlay showing the extent of overlap between the project petroleum tenures and the regional plans.

The EP Act requires that the standard criteria (Schedule 3 EP Act) must be considered in preparing this assessment report. This includes consideration of 'any applicable Commonwealth, state or local government plans, standards, agreements or requirements'.

3.4 Consultation program

3.4.1 Public consultation

In addition to the statutory requirements for advertising the TOR and EIS notices, and the mailing of the notices to interested and affected parties, the proponent undertook community consultation as part of the EIS process. The EIS provided details of a series of four consultation phases with a range of stakeholders and focus groups involving

a variety of consultation tools and activities, with consultation centred on major service centres within the project area including Moranbah, Middlemount, Blackwater, Glenden and Dysart. Consultation phases included

- **Phase 1:** stakeholder and community engagement undertaken between February and August 2012 including the initial round of public consultation in June 2012 to provide stakeholders and the broader community with an overview and advice on the draft ToR release.
- **Phase 2:** project update undertaken between September and December 2012 with a summary of preliminary findings of the EIS addressing issues and concerns raised by stakeholders during Phase 1. Consultation undertaken in Phases 1 and 2 was reported in the EIS section 5 Community consultation and EIS Appendix F Consultation Report.
- **Phase 3:** consultation included the public exhibition period for the EIS (11 March to 23 April 2013) and consultation with regulators, stakeholders and community for the period January to April 2013.
- **Phase 4:** consultation included continued engagement with stakeholders via meetings, briefings and free call telephone number, email address and reply paid postal service. Consultation occurred over the period May to December 2013 and included regulators, coal mine companies on the project petroleum tenures, local suppliers, and local government.

The SREIS stated that since the consultation report was prepared for the EIS, the proponent had continued to consult and engage with the community and relevant stakeholders. The SREIS reported a range of key stakeholder issues identified in consultation activities that were reflected in submissions to the EIS including:

- impact on groundwater
- road traffic impacts
- public access and input at the EIS and environmental authority stages
- safety and amenity issues
- potential impacts to cropping land and conflict with agricultural activities
- CSG water and salt management including the impacts of treated and untreated CSG water and brine disposal
- obligations on CSG producers to 'make good' on any impacts
- compensation for project activities on third-party properties and the influence of the project on property values, existing and future farm plans, and rural amenity and lifestyle
- social and economic impacts, such as employment opportunities and pressure on services.

3.4.2 Advisory bodies

The administering authority invited the following organisations to assist in the assessment of the TOR and the EIS by participating as members of the advisory body for the project EIS process. Due to the change in the structure of government, ('machinery of government'), the names and responsibilities of a number of Queensland departments changed on 3 April 2012 (refer to Appendix 1).

- Commonwealth Department of the Environment (DOE)
- Department of Natural Resources and Mines (DNRM)
- Department of Communities, Child Safety, and Disability Services (DOCCSDS)
- Department of Community Safety (DOCS)
- Department of State Development, Infrastructure and Planning (DSDIP)
- Department of Education, Training and Employment (DETE)
- Queensland Treasury and Trade (QTT)
- Department of Communities, Child Safety and Disability Services (DCCSDS)
- Department of Community Safety (DCS)
- Department of Justice and Attorney-General
- Department of Energy and Water Supply (DEWS)
- Department of Housing and Public Works (DHPW)
- Department of Local Government, Community Recovery, and Resilience (DLGCRR)
- Department of Agriculture, Fisheries and Forestry (DAFF)
- Department of Science, Information Technology, Innovation and the Arts (DSITIA)
- Department of National Parks, Recreation, Sport and Racing (NPRSR)
- Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA)
- Department of Tourism, Major Events, Small Business and the Commonwealth Games (DTESB)
- Department of Transport and Main Roads (TMR)
- Queensland Police Service (QPS)
- Queensland Health (QH) Mackay and Brisbane
- Skills Queensland
- Isaac Regional Council (IRC)
- Whitsunday Regional Council (WRC)

- Mackay Regional Council (MRC)
- Rockhampton Regional Council
- Gladstone Regional Council
- Central Highlands Regional Council
- SunWater Limited
- Ergon Energy
- Powerlink Queensland
- Road Accident Action Group Inc (RAAG).
- Aurizon
- Fitzroy Basin Association
- Capricorn Conservation Council
- Mackay Conservation Council

3.4.3 Public notification

In accordance with the statutory requirements, public notifications of the draft TOR and EIS and public comment periods were made through notices in *The Australian*, *The Courier-Mail*, *Daily Mercury*, *Miner's Midweek*, *CQ News*, *Blackwater Herald*, and *Moranbah Advertiser* as well as posting on the EHP and the proponent's websites.

The draft TOR and EIS were placed on public display at the locations listed in Table during their respective public comment and submission periods.

Table 3.3 Locations for the public display of documents

Display Location	Public Display Document
EHP's web site: www.ehp.qld.gov.au	TOR
The proponent's website: www.arrowenergy.com.au	TOR and EIS
Department of Environment and Heritage Protection, George Street Brisbane Business Centre	TOR and EIS
Department of Environment and Heritage Protection, Mackay Business Centre	TOR and EIS
Department of Environment and Heritage Protection, Emerald	EIS
Department of the Environment, Canberra – Central Library	EIS
Blackwater Library	TOR and EIS
Duaringa Library	TOR and EIS
Middlemount Library	TOR and EIS
Bluff Library	TOR and EIS
Dysart Library	TOR and EIS
Moranbah Library	TOR and EIS
Bowen Customer Service Centre	TOR and EIS
Arrow Energy Community Information Centre, Moranbah	EIS
Clermont Library	TOR and EIS
Emerald Library	TOR and EIS
Nebo Library	TOR and EIS
Proserpine Customer Service Centre	TOR and EIS

Display Location	Public Display Document
Collinsville Customer Service Centre	TOR and EIS
Glenden Library	TOR and EIS

Copies of the draft and final TOR were available from EHP's web site, while the EIS was available on the proponent's web site and by request throughout the submission period. Copies of the SREIS were made available upon request from the proponent. The SREIS has also been placed on the proponent's web site.

3.5 Matters considered in the EIS assessment report

As required under section 58 of the EP Act, this assessment report considered the following matters:

- the final TOR for the EIS
- the submitted EIS
- all properly made submissions and any other submissions accepted by the chief executive
- the response to submissions and amended EIS (Supplementary Report to the EIS – referred to as the SREIS)
- the standard criteria
- another matter prescribed under a regulation.

These matters are further described in the following subsections.

3.5.1 The final TOR

The final TOR were considered when preparing this assessment report. While the TOR were written to include all the major issues associated with the project that were required to be addressed in the EIS, they were not exhaustive, nor were they to be interpreted as excluding other matters from consideration.

Where matters outside of those listed in the final TOR were addressed in the EIS, those matters have been considered when preparing this assessment report.

In deciding to allow the EIS to proceed to the preparation of an assessment report, EHP was required to consider the submitted EIS documents and determined if the information provided in this documentation adequately met the requirements of the TOR. In making this determination, EHP considered not only the information provided by The proponent, but also the scale and nature of the project, including the commitment by the proponent to use the environmental framework in determining the specific siting of the project infrastructure, details provided on the siting of major infrastructure associated with the first phase of the project development, and the general details provided on the siting, extent and timing of delivery and management of the various project components.

3.5.2 The submitted EIS

The submitted EIS was considered when preparing this assessment report. The submitted EIS comprises:

- Bowen Gas Project EIS that was made available for public review
- Supplementary Report to the Bowen Gas Project EIS incorporating details of submissions received on the EIS, responses to submissions, changes to the project, and additional technical information.

In this assessment report, the term 'EIS documents' refers to the combined documents consisting of the submitted EIS, the SREIS that includes amendments made to the EIS following public submission and any other documentation provided by the proponent including attachments, appendices and other specialist reports.

The term 'EIS' in this document refers to the submitted EIS document that was made available for public review, while the Supplementary Report to the EIS is referred to as the 'SREIS'.

In addition, EHP requested additional information from the proponent on the extent of impacts of the project on MNES, assessment methodology and offsets that was required to complete the assessment of those impacts. The proponent's responses are provided in Appendix 2 of this assessment report as summaries. The information in Appendix 2 was used in the preparation of section 5 Matters of National Environmental Significance of this assessment report and Appendix 4 MNES Assessment Report.

3.5.3 Properly made submissions

There were 53 submissions on the EIS. Of these 4 were from regional councils, 19 from state government

agencies, 14 from individuals, five from non-government organisations and 10 from businesses or corporations. DOE also made a submission on the EIS.

All government agencies that made submissions stating outstanding issues arising from their review of the EIS were given the opportunity to review and provide comments on any amendments made to the EIS. This included comments on conditions that should apply to the project and on the adequacy or otherwise of the amended EIS chapters in addressing issues raised in submissions. Letters were sent to all private submitters advising them on the submission of the SREIS together with details for obtaining the proponent's response to their submission and information on the changes to the project as a result of the submissions.

The EIS documents were referred to the IESC for advice. Although not formally a submission, the IESC's advice, dated 24 May 2013 and 18 July 2014, to DOE and EHP, was considered in the relevant sections of this assessment report (see section 4.9 Groundwater, 4.10 Surface water, and 5.0 MNES).

3.5.4 The standard criteria

Section 58 of the EP Act requires that, among other matters, the standard criteria listed in schedule 3 of the EP Act must be considered when preparing the EIS assessment report.

The standard criteria under the EP Act are:

- a) the principles of ecologically sustainable development as set out in the National Strategy for Ecologically Sustainable Development
- b) any applicable environmental protection policy
- c) any applicable Commonwealth, state or local government plans, standards, agreements or requirements
- d) any applicable environmental impact study, assessment or report
- e) the character, resilience and values of the receiving environment
- f) all submissions made by the applicant and submitters
- g) the best practice environmental management for activities under any relevant instrument, or proposed instrument, as follows—
 - i. an environmental authority
 - ii. a transitional environmental program
 - iii. an environmental protection order
 - iv. a disposal permit
 - v. a development approval; and
- h) the financial implications of the requirements under an instrument, or proposed instrument, mentioned in paragraph (g) as they would relate to the type of activity or industry carried out, or proposed to be carried out, under the instrument
- i) the public interest
- j) any applicable site management plan
- k) any relevant integrated environmental management system or proposed integrated environmental management system; and
- l) any other matter prescribed under a regulation.

The department has considered the standard criteria when assessing the project.

3.6 Matters of national environmental significance

The MNES potentially impacted by the project as listed by the controlled action decision under section 75 of the EPBC Act are listed threatened species and communities and listed migratory species.

Under recent changes to the EPBC Act, an additional MNES, coal seam gas and large coal mining development impacts on water resources (water trigger), was added. In October 2013, the Commonwealth Environment Minister decided that the 'water trigger' would be a controlling provision under EPBC Act for the project.

In December 2012, the Commonwealth Government established the Independent Environmental Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). The IESC provides scientific advice to decision makers on the impact that coal seam gas and large coal mining development may have on Australia's water resources.

The IESC was established as a statutory committee in 2012 by the Australian Government under the EPBC Act in response to community concerns about coal seam gas and coal mining. The IESC provides

- independent, expert scientific advice on coal seam gas and large coal mining proposals as requested by federal and state government regulators
- advice to the Australian Government on bioregional assessments and research priorities and projects.

The EIS was referred to the IESC on 22 March 2013 by EHP. The IESC's advice was dated 24 May 2013. The Supplementary Report to the project EIS was referred by the Australian Government to the IESC on 4 June 2014. The IESC's advice was dated 18 July 2014 and has been considered in preparing this assessment report.

An assessment of impacts and the management of the relevant MNES to the project are contained in section 5 of this assessment report. Appendix 4 of this assessment report is the MNES Assessment Report.

4 Adequacy of the EIS

This section of the assessment report discusses the adequacy of the EIS submitted by the proponent, taking into account key matters set out in the terms of reference and submissions made. Relevant issues are discussed including commitments made by the proponent, identified agency requirements and stakeholder recommendations.

Matters that need further assessment are identified, particularly those required by the proponent to meet State and Commonwealth policy and legislative requirements.

Specifically, each EIS section is discussed in the following manner

- a brief outline of the assessment methodology and environmental values identified
- statement of impacts as identified in the EIS documents and adequacy of the avoidance, minimisation and management measures proposed
- assessment of the proponent responses to EIS submissions and adequacy of this response
- recommendations on outstanding issues identified from the EIS assessment process and any recommended conditions for an environmental authority

The full list of commitments made by the proponent (including changes described in the SREIS) is shown in SREIS Appendix O Commitments Update.

4.1 Introduction

The EIS identified environmental values, likely impacts, and impact management commitments. The EIS provided background on the proponent, an overview of the project, its objectives and scope, and an outline of the EIS process including the process for public review and submissions. The SREIS outlined changes to the project description, and provided additional information where required to address submissions on the EIS, changes to legislation and policy, and changes to project impacts and management resulting from the revised project description.

The EIS did not define the specific locations of project infrastructure. This created uncertainty for the

- assessment of compliance with the TOR
- provision of specific approval requirements
- public availability of relevant information
- timing of information required by regulators for assessment of statutory requirements
- likelihood of compliance with specific legislative requirements including the 'standard criteria' under the EP Act.

The proponent proposed an environmental framework approach (EIS section 7 Environmental framework) to inform proponent decisions on the siting of infrastructure post EIS, as detailed in SREIS Figure 2.1. The EIS stated that development may occur on any parcel of land within the project area, except urban areas, other 'no go' areas (other than low impact petroleum activities), and areas subject to other environmental constraints. Section 4.3 of this assessment report provides further information on the implications of the environmental framework approach for the EIS process and information requirements for environmental authorities that would be required after the EIS process is completed.

The SREIS provided an updated overview of the assessment and approval requirements and processes, significant changes in the project description and development staging, and changes in relevant State and Commonwealth legislation and policies, including biodiversity offsets policies and water management. The SREIS provided a comprehensive assessment of likely impacts on biodiversity and the discharge option for excess CSG water.

The proponent provided detail on consultation with individuals and organisations, including support provided to review the EIS and to make submissions (see SREIS section 4 Community consultation). The proponent highlighted continuing processes of engagement with stakeholders through a range of forums reference groups, Gas Fields Commission Queensland, community information sessions, individuals and interested groups.

4.2 Project need and alternatives

EIS section 3 Project need provided an overview of the justification for the project, based on availability of gas resources within tenures held by the proponent and projected Australian and global demand for gas. It presented supporting information on gas resources, demand for energy and gas, and the influence of greenhouse gas reduction measures on demand for gas. The EIS section 3.2.1 presented demand projections and estimates of domestic gas resources by Geoscience Australia and ABARES. The EIS asserted that the project would benefit Queensland and Australia through

- long-term royalty contributions to the state economy

- potential to increase the use of gas in Queensland electricity generation
- direct benefits to local and regional employment and small business
- development of a highly skilled workforce
- contribution to diversification of the regional, state and national economies.

The EIS further stated that, should LNG export not proceed, the proponent's gas field developments in the Bowen Basin may still progress but on a smaller scale, at a slower rate, and with a reduced level of investment and economic output.

The EIS outlined a range of options for gas field infrastructure, and for the design and location of specific infrastructure. Final selection would be based on further planning, technology development, engineering and economic considerations, and on environmental (land, water, biodiversity, air) and social constraints. Consultation with landholders would inform the location of gas wells and associated infrastructure to limit impacts on current land uses. The SREIS section 3 Project description presented significant changes to the proposed project which would reduce some impacts and increase others. A more detailed outline of project infrastructure and location is provided in section 2.6 (Project description) of this assessment report.

The EIS presented the Environmental Framework Approach, which would be used by the proponent to manage the impacts of CSG development (site selection, construction and operation) whereby the location of infrastructure would become progressively known over the life of the project. The framework approach would provide for the application of environmental management controls (avoidance, mitigation and management) that reflect the level of sensitivity of environmental values, and would be supported by a process of description, classification and mapping of a range of constraints.

The EIS outlined a range of consequences should the project not proceed, including the potential positive and negative environmental, economic and social impacts, such as

- adverse impacts on land, biodiversity, water and air, and associated visual and social impacts, would not occur
- adverse impacts on the local and broader economy, labour market, and community services would not occur
- for economic benefits to the Queensland economy, job creation (approximately 2450 jobs during construction and up to 300 jobs during operation), investment in local and regional infrastructure and services, and increased export and local use of LNG, would not be realised.

4.3 Description of the project

EIS sections 1 and 4 described the project location including tenures, maps showing the extent of the project area, the project gas extraction estimates and project infrastructure, staging, and general considerations that could influence project development. EIS section 1 and 4 also provided a high level description of the natural, social, and economic environment within the project area. EIS section 4 provided a description of the project including gas resource, project components options for electrical power supply and CSG water management, conceptual development sequencing and infrastructure location, proposed environmental and social constraints to location of infrastructure, and proposed construction, operation, maintenance, decommissioning and rehabilitation activities. The description of the project was presented as 'conceptual' and the actual location of infrastructure was not defined.

The SREIS section 3 presented a significantly revised project footprint and revised production areas, development sequencing, infrastructure requirements, power supply, CSG water management, and workforce and accommodation. Appendix 5 of this assessment report provides a summary table excerpt from the SREIS of key project changes. The changes included

- revised development planning and sequencing

Appendix 6 of this assessment report provides excerpt maps from the SREIS showing the indicative location of the project, development sequence and proposed life of the project's 33 drainage areas. Phase 1 of the project would target regions with high gas production and include 17 drainage areas (first five years of production) and both CGPFs with associated water treatment facilities (WTFs).

- change to number, type and layout of wells

The well types proposed were revised to be based on both (a) multi branched horizontal wells (lateral well) drilled in-seam to intersect a vertical producer (vertical production conduit) and (b) multi-seam hydraulically stimulated vertical, cased and cemented wells, which would be perforated and fracture-stimulated to provide formation access (as presented in the EIS). A total of 4,000 production wells lasting about 25 years each were proposed over the approximate 40 year life to maintain gas feed to the proposed LNG plant on Curtis Island. Up to 25% of these wells were proposed to be hydraulically stimulated, if required.

- CGPFs and WTFs

Two CGPFs, one located in the drainage areas in the north of the project area and one in the south would be installed to treat the gas to pipeline specification. The indicative location (drainage areas 2 and 40) of these two CGPFs is shown in Appendix 6 of this assessment report and Figure 3.1 SREIS section 3 Project description. A WTF would be co-located with each CGPFs and would operate 24 hours per day. A third WTF may be constructed near Blackwater.

- revised strategy for water management

Produced water (CSG water) from drainage areas was proposed to be degassed and directed to a feed water dam (400ML capacity) adjacent to each WTF and then treated for either discharge to the Isaac River (2nd priority) or for a beneficial use (1st priority). Each WTF would be associated with a brine storage dam (1800ML capacity) and treated water dam (600ML capacity). The strategy was detailed in SREIS Appendix D and summarised in SREIS section 3.5.

- changes to supply of electricity

Power to run production and infrastructure facilities was proposed to be delivered via connection to the national electricity grid pending agreements with electricity service providers. In any case the proponent intends temporary gas powered generation for about the first two years to address possible delays in connection to the grid. If no agreement with the electricity service provider can be made a reversion in part or whole to the initial EIS assessed option of onsite power generation may be needed. Detailed analysis of these options was provided in SREIS section 3.6 Project description.

- changes to construction techniques

The SREIS stated that construction of production wells and supporting infrastructure would occur throughout the 35-40 year project life. Techniques detailed in the SREIS section 3 and supporting appendices were proposed to avoid or minimise impacts including minimising gas flaring, disturbance footprints, water contamination and waterway crossing impacts. Techniques proposed included horizontal drilling, gathering line plough-in, and common use of the same trench for water and gas lines.

- operations and maintenance changes

The SREIS described how production facilities would be centrally controlled and managed from the Brisbane

Central Control Room on a 24 hour / seven day full time basis using automated monitoring and communications. It was proposed to have a maintenance base for north and south drainage areas located with each central operating base adjacent to the CGPFs.

- changes to workforce and accommodation

The SREIS described a revised predicted construction workforce peak of 2,450 personnel in 2018 and average daily workforce of over 1000 personnel (2017-2019) to construct the two CGPFs and the Phase 1 FCFs. This average would reduce to 500 to 900 personnel from 2020 declining to 400 or less personnel from 2028.

4.4 Impact assessment method and environmental framework

4.4.1 Adequacy of assessment method

EIS section 7 Environmental framework provided a description of the assessment approach adopted to determine potential impacts of the project. Potential impacts of the proposed development on environmental values were assessed using one of three methods: significance assessment, risk assessment or compliance assessment for example

- significance assessment was adopted for technical studies where an understanding of the vulnerability of the environmental asset or resource was important to the assessment e.g. an understanding of the sensitivity of ecosystems in their current state would provide a basis for determining the severity of potential impacts
- potential impacts that may occur from wastes and were assessed using risk management
- compliance assessment was adopted for environmental values regulated by statutory guidelines including air and water quality, noise and vibration. Application of these methods required an understanding of the affected environmental values which were described in the relevant sections of the EIS as required by the TOR.

The EIS acknowledged that a key premise of environmental impact assessment should be that the location, type, scale and duration of development was known; thus enabling the impacts of the proposed construction, operation and maintenance activities on the environmental values at that place, at the nominated time, to be assessed.

The EIS stated that the lack of certainty about the likely location of project facilities and infrastructure was an issue for the assessment because the impacts at a specific location could not be fully understood. Furthermore, changes may occur to the project as described during detailed planning which may affect the actual impacts associated with the project. The proponent adopted the assessment approach outlined above to address these issues, and proposed an environmental framework given for the project based on the identification of constraints to development and the establishment of environmental management controls that would apply to project activities in constrained areas.

4.4.2 Environmental framework and major issues raised

The EIS stated that while locations and timing of the full development of the project were not precisely known for the EIS planning phase the likely impacts from construction and operation could be (and were) accurately simulated. The proponent proposed constraints to development and applied nominated management controls for project activities in constrained areas. The impacts were proposed to be mitigated and residual impacts estimated using a conservative set of assumptions. Appendix 2 of this assessment report provides a summary of the methodology used in estimating impacts on biodiversity as set out by the proponent.

The information requirements of the TOR for the project depend on the known location of project activities. This enables specific impacts at a site to be identified, the level of impact to be described and specific mitigation measures proposed. The flexibility in the location of CSG project facilities provides for a planning approach to selection of sites for project activities whereby impacts could be minimised or avoided and residual impacts managed. The site specific impact information would be available before construction commences and before applications for operational approvals such as the EA would be finalised.

For the purposes of the EIS under the EP Act, the constraints approach described by the Environmental Framework (EIS section 7) is appropriate for the assessment of this scale of CSG project. This approach is consistent with the sequence of avoiding, minimising, managing and offsetting impacts set out in the EP Act in dealing with the environmental management of impacts of development.

EHP and other EIS submitters acknowledged that the project would be planned, designed and implemented progressively across the project area. Submitters requested that the proponent demonstrate how the siting of facilities would be determined, and where they would be located, for at least the initial phase of the project.

The proponent included in the SREIS a more detailed and site specific five year Phase 1 proposal. The SREIS also described changes to the project that would reduce overall impacts, and outlined the preferred localities for two

CGPFs, two associated temporary workers accommodation facilities (TWAF) and an indication of the 33 drainage areas which are proposed to be sequentially developed to feed gas to the two CGPFs located within drainage areas two and 40. The preferred localities of the two WTFs (and potential water discharge sites) were also described. Impacts associated with the construction, operation and decommissioning of these facilities was also provided.

The specific location of gas wells, gas and water gathering systems, and the location of other facilities including FCF and associated water transfer stations were not specified in the SREIS. Submitters and landholders requested this information. The SREIS section 21 Submission responses stated that the location of these facilities would be negotiated post EIS on a site by site basis with landholders as further approvals to proceed were obtained and investment funding obtained.

A number of submissions stated that the lack of site specific details and other aspects of the project description meant that the EIS did not adequately identify environmental values that may be impacted by the project, restricted the community's capacity to fully understand and assess the environmental impact of the project and undermined the purpose of the EIS.

The proponent noted that the EIS studies included the assessment of project impacts at regional, state, national and sometimes global level. The outcomes of these studies informed the design of the project and the measures the proponent committed to implement in order to avoid, minimise, manage and offset the identified impacts. In many cases, further studies, monitoring, and review of mitigation measures were proposed to take place, including when final sites for the facilities were determined post EIS.

Some submissions stated that the adaptive management framework proposed by the proponent to deal with a number of impacts would not be workable as it did not specify an acceptable level of impact at a specific site, nor could the framework deal with potentially irreversible impacts. The proponent correctly identified adaptive management of environmental impacts (particularly water) as outlined in the EHP Information Sheet 'Integrated laws to manage water impacts', as an endorsed approach by EHP in dealing with new technologies and on ground experience. The proponent also committed to applying the adaptive management framework to key aspects of the project that require best management strategies to evolve over time.

A number of submissions requested further information on cumulative impacts as described in EIS section 31 Cumulative impacts including

- DEWS concerns about access to domestic gas supplies
- DAFF, DTMR and local government requests for information on gravel supply for roads
- Queensland Health and IRC requests for information on air quality cumulative health impacts
- IRC and private submissions requests for information on greenhouse gas emissions and transport issues
- DNRM, EHP, DOE and IESC raised issues about groundwater cumulative impacts

The proponent stated that a lack of suitable data in the public domain limited a full assessment of potential cumulative impacts resulting from the operation of the Bowen Gas Project. The proponent provided updated cumulative impact studies in the SREIS including Appendix E Supplementary Groundwater Assessment and Appendix K Road Impact Assessment. This information is discussed further in sections 4.5 to 4.20 (where relevant) of this assessment report.

4.4.3 Conclusions and recommendations

The assessment process used in the EIS was found to be appropriate for the nature and scale of the proposed project, and used methodologies that enable the EIS to adequately meet the requirements of the TOR and other requirements of the EIS process under the EP Act.

The EIS approach substantially met the requirements of the TOR for cumulative impact issues that required attention in the relevant section.

Recommendation – proponent's response to further information request on cumulative impacts

Agencies should consider the response at SREIS section 21 in setting approval conditions.

Recommendation – conditions for any environmental authority

The recommendations for conditions in Appendix 3 of this assessment report should be considered in developing the application for environmental authorities (EA) to be applied. The site specific information provided in an EA application and/or amended EA application should be made available to the community for advice as this information would provide the detail of site specific impacts and management requested in EHP's EIS submission.

4.5 Air

4.5.1 Overview

Air quality was discussed in EIS section 9 Air quality, which was supported by a technical assessment provided in EIS Appendix H Air quality technical report. A supplementary air quality assessment which addressed changes to the project and relevant legislation, and submissions on the EIS relating to air quality, was provided in SREIS section 5 Air quality. This was supported by a technical report provided in the SREIS Appendix B Supplementary air quality technical report. A summary of the air quality assessment follows.

4.5.2 Assessment methodology

The air quality assessment involved:

- identification of project air quality criteria for the protection of the environmental values in the study area
- atmospheric dispersion modelling focused on testing compliance of the predicted ground-level concentrations of air pollutants with defined project air quality criteria, involving:
 - selection of an appropriate study area based on the geographical scale and significance of potential effects on air quality
 - quantification of air emission rates from project sources, and development of an emissions inventory covering the life of the project
 - determination of meteorology for use in the regional and local air quality modelling studies using the Commonwealth Scientific and Industrial Research Organisation (CSIRO) prognostic meteorological model TAPM7 Version 4.0.4 (TAPM)
 - selection of meteorological data representing the most conservative dispersion conditions in the study area
 - screening level prediction of regional ground-level concentrations of air pollutants using TAPM with a photochemical dispersion module, the Generic Reaction Scheme (TAPM-GRS), for the baseline (existing air emission sources) and project emission scenarios
 - prediction of local (near field) ground-level concentrations of project air pollutants using the Ausplume model (Victoria Environmental Protection Agency 2000)
- assessment of compliance of the predicted ground-level concentrations of air pollutants with the defined project air quality criteria
- detailed description of avoidance, management and mitigation strategies for air quality where required.

The study area for the air quality assessment (airshed) was defined to allow modelling on a regional scale, with four smaller study areas or sub-regions selected for assessment of localised impacts. Study areas for the regional and local air quality assessments were defined in section 4 of EIS Appendix H Air quality technical report and illustrated in Figure 9.1 of the EIS. Modelling of the local air quality impacts from the project was limited to a 16km² area around the source.

Meteorological monitoring data obtained from the Bureau of Meteorology were used to determine long term local climate characteristics and seasonal conditions in the study area.

Sensitive receptors that may be affected by the project were determined by a desktop study and shown in Figure 9.2 of the EIS.

Relevant air pollutants, and the potential impacts of their emissions on the environmental values of the study area, were identified in Table 9.3 of the EIS. Air pollutants considered were: nitrogen oxides (NO_x), sulphur dioxide (SO₂), total suspended particles (TSP), particles with a mean diameter of less than 10 micrometres (µm) (PM₁₀), particles with a mean diameter of less than 2.5µm (PM_{2.5}), carbon monoxide (CO), volatile organic compounds (VOCs) such as contained in paints and solvents, and ozone (O₃). Methane (CH₄) was not considered in the air quality assessment but was considered in the greenhouse gas assessment (refer to section 4.6 of this assessment report).

Emission sources relevant to air quality associated with construction activities (and decommissioning) that were considered in the air quality assessment included

- clearing and earthworks
- well construction and completion
- vehicle use of unpaved roads
- vehicle and machinery exhausts.

Emission sources relevant to air quality associated with operation of facilities considered in the regional air quality assessment included

- fugitive gas emissions from project processes
- facility and well head power generation.

Emission sources relevant to air quality associated with operation of facilities considered in the local assessment included

- ramp-up facility flaring and upset condition flaring
- facility and well head power generation.

Two scenarios were considered in the regional impact assessment as follows

- scenario 1 which considered the emissions in year 2023 at predicted full production capacity with seven production facilities and 1699 wellhead engines at full capacity
- scenario 2 which considered the emissions associated with seventeen production facilities and 1980 wellhead engines at maximum capacity to represent the 'worst-case' emissions from project operations.

As the final locations of project facilities were not defined, a single location within each production area was selected for the local impact assessment, and wellheads were randomly distributed in the relevant production areas with an assumed well separation distance. Volatile organic compound (non-methane hydrocarbons) emissions associated with fugitive leaks were included in the modelling as an area source.

Section 9.5 of the EIS presented a summary of the key power generation and flaring sources and the emission rates used in the TAPM-GRS and Ausplume dispersion models, including:

- estimated emissions for each production facility (integrated processing facility (IPF) consisting of a CGPF and WTF, CGPF, and FCF) based on the maximum compression and power requirements (EIS Table 9.4)
- physical stack and gas consumption specifications for gas engines at the facilities and well heads (EIS Table 9.5)
- estimated pollutant emission rates for gas engines at the facilities and well heads (EIS Table 9.6)
- expected gas flow rates and frequencies during flaring for each facility during 'ramp-up' of facilities and under 'upset' or maintenance conditions during the operational phase
- physical stack parameters for flaring sources (EIS Table 9.7)
- estimated pollutant emission rates for flaring (EIS Table 9.8)
- an estimate of 10,000 kilograms per annum (kg/a) of VOCs to represent fugitive gas emissions associated with all infrastructure.

4.5.3 Air quality values

The following environmental values listed in Schedule 1 of the Environmental Protection (Air) Policy 2008 (EPP (Air)) were considered to be relevant to the study area

- the qualities of the air environment that are conducive to human health and wellbeing
- the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems.

The project air quality criteria adopted for the assessment were based on the National Environment Protection Measures (NEPM) for ambient air quality and the EPP (Air). The project air quality criteria were presented in Table 9.1 of the EIS.

The concentrations of PM₁₀, PM_{2.5}, SO₂ and CO within the study area were estimated using air quality data from monitoring stations operated by EHP (Moranbah for PM₁₀ and Gladstone for all other data) and assumed to be consistent across the whole study area. The concentrations of NO₂ and O₃ were modelled using TAPM-GRS and therefore varied across the study area depending on estimated emissions from background sources. The EIS stated that it was not possible to determine background concentrations for the VOCs included in the study (1,2-dichloroethane, 1,3-butadiene, benzene, ethane, propane, toluene and xylene).

Table 9.2 of the EIS provided a summary of the predicted maximum background concentrations of the pollutants considered in the assessment compared with the respective project air quality criteria. The maximum ground level concentrations of all key pollutants were estimated to be below the project air quality criteria.

The maximum one hour average background concentration of NO₂, which was predicted for a limited area surrounding Goonyella Riverside Mine, was adopted to represent the maximum 1-hour average background concentration of NO₂ for the assessment of localised impacts.

4.5.4 Air quality potential impacts

A comparison of the maximum and average predicted NO₂ and O₃ concentrations for the two regional scenarios was presented in Table 9.9 of the EIS and showed that predicted concentrations were below the project air quality criteria with no exceedances at sensitive receptor locations. Modelling results for Scenario 1 and Scenario 2 showed little difference in the maximum predicted concentrations, despite some spatial variability of concentrations between the scenarios. The EIS stated that the modelling results indicated that the separation distances between the conceptual locations of production facilities would be sufficient to ensure that the dispersion of plumes would not result in a significant project-related cumulative air quality impact.

The key predicted regional impacts from project related emissions were illustrated in Figures 9.3 to 9.6 and summarised as follows

- highest ground level concentrations of NO₂ were predicted for areas surrounding existing sources such as Blackwater, Saraji, Peak Downs and Goonyella Riverside mines
- a significant decrease in the maximum NO₂ 1-hour average concentration compared with baseline concentrations was predicted in limited areas surrounding the Goonyella Riverside and Saraji mines, while ground level concentrations of NO_x and O₃ increased at these locations
- the highest increase in annual average NO₂ of 5µg/m³ was predicted for the area near the Saraji Mine
- an increase in NO₂ of 1µg/m³ was predicted for distances up to 10km from project sources
- significant variation in the O₃ increase across the region but with maximum predictions for both the one hour and four hour averaging periods predicted to be approximately one third of the project air quality criteria
- no exceedance of any of the project air quality criteria were predicted by the regional scale modelling for any pollutant and any averaging period.

The localised impacts of emissions from flaring (NO₂, particulate matter and CO) predicted by Ausplume modelling are summarised as follows

- the maximum predicted ground level NO₂ concentrations presented in Table 9.10 of the EIS showed that maximum one hour average concentrations of NO₂ for ramp-up and upset condition flaring were predicted to be below the one hour NO₂ project air quality criterion for all modelled subregions
- the maximum predicted ground level particulate concentrations presented in Table 9-11 of the EIS showed that the maximum concentrations of the respective particulate fractions were predicted to be below the project air quality criteria
- the maximum CO concentration was predicted to be below the project air quality criterion.

The localised impacts of emissions from power generation (NO₂, particulate matter and VOCs) predicted by Ausplume modelling were presented in section 9.5.3.2 of the EIS and are summarised as follows

- maximum predicted 1-hour NO₂ concentrations as a function of distance from the project facility were presented in EIS Figure 9.7 (IPF), Figure 9.8 (CGPF), Figure 9.9 (FCF) and Figure 9.10 (wellhead)
- for both the IPF and CGPF power sources, the project air quality criterion for NO₂ was predicted to be exceeded within 1100m to 1400m of the facility, depending on the selected subregion, indicating that IPF and CGPF facilities should be located more than 1400m from sensitive receptors
- FCF and wellhead gas engine emissions were not predicted to exceed the project air quality criterion for NO₂
- the maximum predicted ground level particulate concentrations presented in Table 9.12 of the EIS showed that maximum concentrations of the respective particulate fractions were predicted to be below the relevant project air quality criterion
- the maximum predicted ground level VOC concentrations for a CGPF, representing the highest source of such emissions, as presented Table 9.13 of the EIS, showed that project air quality criteria for VOCs were not predicted to be exceeded at any location
- no significant releases of odour or SO₂ were predicted to occur from flaring, fugitive leaks or power generation.

4.5.5 Proposed mitigation measures

The following avoidance, mitigation and management measures were outlined in the EIS although it was indicated that additional measures could be developed.

Construction

- best management practice for site dust control including minimisation of clearing and earthwork stockpiles, progressive rehabilitation, and dust suppression measures particularly during high winds
- avoiding venting and flaring of gas as far as practicable and minimisation of potential fugitive emissions from construction of production wells and gas production infrastructure.

Operational

- a preventative maintenance program to minimise emissions from gas engines
- minimisation of potential fugitive emissions from construction of production wells and gas production infrastructure
- use of efficient gas and water separation methods on wellheads, gathering and process facilities to minimise fugitive gas release
- use of equipment with low NO_x emissions where practicable
- avoiding venting and flaring of gas as far as practicable
- minimisation of emissions from gas dehydration
- optimisation of gas-driven generator operations to minimise NO_x emissions
- implementation of a monitoring program for air quality
- possible constraints to location of power generation facilities based on the modelled minimum separation distance to sensitive receptors to achieve the project air quality criterion for 1-hour NO₂ concentration, or alternatively, design measures such as increased stack height or selective catalytic reduction to achieve the criterion.

4.5.6 Major issues raised

References to agencies and organisations in the following text are those who made submissions on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

EHP stated that the reliability of the assessment was uncertain as modelling inputs for both regional and local scale studies were based on limited site-specific information, ambient contaminant information drawn from historical data for unrelated locations or estimated using dispersion modelling techniques, and did not consider emissions from other CSG activities. EHP requested information on how and when detailed assessment of local impacts to air quality would be conducted, based on defined infrastructure locations and sensitive receptors, and how this information would be used to refine facility location and manage potential impacts. In response, the proponent stated that use of background data from areas that were more urbanised and industrially intensive (Gladstone data) than the project area provided a conservative estimate of existing air quality representing the highest potential background concentrations in the study area. A further review of available background pollutant datasets and non-project related sources was undertaken for the SREIS Appendix B Air Quality Technical Report (section 4.3.6, 4.4) and included emissions from other CSG activities.

The proponent further stated that, for the baseline and cumulative impact regional modelling, 68 industrial sources were identified based upon the latest (2011/2012) National Pollutant Inventory and available information on future approved projects. The highest predicted values of pollutants for the selected meteorological regions were adopted to represent background NO₂ concentrations in the local scale modelling. The desirable buffer distances between sensitive receptors and project air emission sources were reassessed for the SREIS based on new information (section 7.2 of SREIS Appendix B Air quality technical report), however the proponent acknowledged that further modelling would be required when the location and design of specific facilities was defined.

EHP requested an assessment of the level of error in the air quality modelling resulting from: use of generic emission factors sourced from the literature rather than data from existing facilities operated by the proponent; the adoption of background contaminant levels based on monitoring at a site remote from the project area; and inherent errors in air quality modelling tools. In response, the proponent stated that the existing facilities operated by the proponent were different to the facilities proposed for the Bowen Gas Project and therefore a conservative approach to emission estimates was used for the EIS. Emissions from project sources were reassessed for the SREIS (section 4.3 of Appendix B Air quality technical report) based on emission factors obtained from manufacturer specifications for typical equipment configurations adopted for the project under the current

development concept. The proponent presented further statements supporting the assertion of a conservative approach to modelling of potential air quality impacts and referred to sections 5.2 and 5.3 of SREIS Appendix B Air quality technical report.

EHP requested estimates of fugitive emissions from various aspects of the proposal, including methane and other VOC emissions, based on measurements from existing operations. In response, the proponent advised that fugitive emissions were included in the emissions inventory presented in section 5.2.1.3 of EIS Appendix H Air quality technical report and in SREIS Appendix B Air quality technical report. It was stated that the estimates used for the EIS represented a conservative estimate of VOC emissions associated with gas processing facilities, water gathering lines, degassing of feed dams, production well surface facilities and related gas production infrastructure. The proponent stated that, consistent with the definition in the National Pollutant Inventory, VOCs included in the air quality assessment were defined as any organic compound that participates in atmospheric photochemical reactions, which excluded methane. However, the impacts of methane emissions were assessed in EIS Appendix I Greenhouse gas technical report and SREIS Appendix C Greenhouse gas technical report.

Queensland Health recommended that the proponent provide a health impact assessment for air quality with consideration of worst case scenarios and the locations of sensitive receptors relative to wells, evaporation ponds and other industries (which may have a cumulative impact). Queensland Health also stated that air emissions from the project should not cause distress to residents and recommended that landholders be advised of any emission that could affect their health. In response, the proponent stated that the air quality assessment was conducted at regional and local scales, and was consistent with the EPP (Air) objectives for the protection of human health. The proponent further stated that the EIS and SREIS assessments were based on a number of conservative assumptions and for a number of worst-case scenarios, including cumulative impacts of air emissions from the project and existing and future industry. Reference was made to the estimates in the EIS and SREIS of minimum separation distances to sensitive receptors needed to achieve compliance with the NO₂ health-based objective while acknowledging that further modelling would be required when the actual location and design of facilities was defined. The proponent stated that emission of VOCs from evaporation dams was expected to be negligible and the only significant odorant in emissions from the project, hydrogen sulphide in flaring and fugitive emissions, would be present at trace levels and would not cause nuisance.

Queensland Health recommended that a detailed and quantifiable air monitoring program be developed and implemented during operational activities. The proponent referred to the EIS commitment to implementation of a quantifiable air quality monitoring program during operation.

Isaac Regional Council (IRC) expressed concern that the assessment had not addressed air quality outside the project area. The proponent referred to the modelling at a regional and local level, the contour plots of air pollutant estimates in section 9.5.2 of the EIS, and use of conservative estimates of background concentrations. The proponent further stated that regional scale modelling indicated there would be no exceedances of air quality criteria for the protection of human health as a result of air emissions from the project.

4.5.7 Air quality assessment for updated project

A number of changes were made to the project description after submission of the EIS. Changes relevant to the air quality assessment were listed in Table 5.1 of the SREIS and the project changes are summarised in Appendix 5 of this assessment report. The following air quality assessment updates were included in the SREIS to address these changes.

Regional air quality assessment (outlined in Table 5.7 of the SEIS)

- modelling of baseline air quality to incorporate additional information on emissions from industrial facilities
- modelling of cumulative impact to air quality based on updated emissions from industrial facilities and updates to project related emission sources for the following two power generation scenarios:
 - SREIS scenario 1 - temporary gas-fired power generation followed by grid connection with 10% of wells using local gas-fired power generation
 - SREIS scenario 2 - grid connection with 10% of wells using local gas-fired power generation.

Localised air quality assessment (outlined in Table 5.8 of the SREIS)

- modelling to re-estimate the minimum required separation distance between gas-fired power generation at a CGPF and sensitive receptors to achieve the project air quality criteria
- modelling of emissions from flaring, including flaring during well completions and well workovers which were not assessed in the EIS, but excluding ramp-up flaring which was not expected to be required
- modelling of emissions from diesel power generation for well drilling and completion operations which was not assessed in the EIS.

The SREIS assessment focused on the following key air pollutants: NO₂, O₃, PM₁₀, PM_{2.5}, SO₂, CO; and VOCs. Section 5.3.3 of the SREIS provided details of the updated maximum expected emission rates and physical stack parameters for the main potential sources of key air pollutants based on information in SREIS Appendix B Air quality technical report. Air emissions data for non-project related sources were presented in Appendix A to SREIS Appendix B, and Figure 5.1 of the SREIS showed the approximate location of each source.

The assessment of potential impacts on regional air quality was carried out using the same atmospheric dispersion modelling methodology, and the same background air quality monitoring datasets, as used for the EIS. As in the EIS, ground level concentrations of NO₂ and O₃ were obtained from baseline modelling to represent the background air quality in the localised assessment. However, the Aermid model (recently adopted by the Environment Protection Authority Victoria for regulatory air impact assessments), rather than the Ausplume model, was used to assess local impacts. Furthermore, SREIS scenario 1 emissions were assessed through dispersion modelling, but SREIS scenario 2 emissions were assessed qualitatively on the basis that they would be significantly lower than scenario 1 emissions.

Table 5.9 of the SREIS presented the predicted existing background concentrations of NO₂ and O₃ which were higher than those predicted in the EIS because more regional emission sources with higher emissions were included. Background annual average concentrations of NO₂ higher than the air quality objective for the health and biodiversity of ecosystems were predicted for three areas close to existing coal mines.

A comparison of the maximum and average predicted air pollutant concentrations for SREIS scenario 1 (regional scale modelling) with the EPP (Air) objectives for health and well-being was presented in Table 5.10 of the SREIS. Contour plots of the predicted ground-level concentrations of NO₂ and O₃ for SREIS scenario 1 were presented in Figure 5.2, Figure 5.3, Figure 5.4, Figure 5.5 and Figure 5.6 of the SREIS. No EPP (Air) objective for human health and well-being was predicted to be exceeded in the study area. The impact of project emissions on the ground level concentrations of NO₂ in areas predicted to currently exceed the air quality objective for health and biodiversity of ecosystems was stated to be very small. None of the predicted maximum ground-level concentrations of NO₂ and O₃ at sensitive receptor locations (based on regional modelling and as detailed in SREIS Appendix B Air quality technical report) exceeded the relevant EPP (Air) objective.

Modelling of localised impacts on air quality estimated that the required separation distance between a power generation source, co-located with a CGPF, and a sensitive receptor would range from 735m to 1160m depending upon the meteorological conditions. However, the actual separation distance required would depend on the equipment associated with a CGPF at start up and was proposed to be recalculated during the detailed design process which would inform site selection.

Table 5.15 of the SREIS showed the predicted ground level concentrations of modelled pollutants for diesel power generation for drilling operations in the subregions that were modelled. Table 5.16 showed the estimated minimum separation distance between the power generation source and sensitive receptors needed to achieve compliance with the NO₂ health-based objective to range from 198m to 225m depending on meteorological conditions.

The predicted 1-hour average NO₂ concentrations for upset flaring presented in Table 5.17 of the SREIS were below the EPP (Air) objective in each sub-region and for all sensitive receptors.

Aermid modelling results for air pollutant emissions associated with well completions and workover flaring (except VOCs which were expected to be very minor) for each subregion were presented in Table 5.18 of the SREIS. Air quality objectives were predicted to be achieved at all locations in each subregion.

The EIS commitments to mitigation and management measures for air quality were confirmed by the SREIS without change. Further assessment of cumulative and localised impacts was recommended at significant infrastructure development milestones or phases that could affect local air quality such as clustering of emission sources, location of emission sources in close proximity to existing or proposed sources, or location of emission sources in close proximity to sensitive receptors.

4.5.8 Conclusion and recommendations

The EIS has adequately described the existing condition of the air shed, identified emissions sources and predicted the impacts of the project on air quality at a regional and local level. Although the assessment was based on several assumptions which were described in the EIS documents, particularly in regard to background air quality data, infrastructure locations and plant/equipment performance, the proponent has committed to undertake further site specific air quality modelling when the location and design of project facilities have been determined.

The following recommendations provide advice on the key air quality issues raised during the assessment and the commitments proposed by the proponent.

Recommendation – EA application

The proponent should further address air quality and management requirements of the *Environmental Protection*

Act 1994. The proponent has committed to providing information relevant to air quality management to support applications for environmental authorities under the EP Act. The suite of information required under the EP Act is outlined in Appendix 3 of this assessment report and relevant EHP guidelines. In preparing an application for an environmental authority, or an amendment to an environmental authority, the proponent should consider the guideline “Application requirements for petroleum activities” (EM705) and should ensure that the information provided in the application meets the requirements of section 125 and section 126 of the EP Act.

Recommendation – EA conditions

The proponent should note that EHP would assess and impose relevant air emission conditions (including the control and management of nuisance odour) on environmental authorities required by the project. These conditions would include requirements for monitoring and reporting. The recommended EA conditions are in Appendix 3 of this assessment report.

Recommendation – proponent’s commitments on air quality

Where the proponent’s commitments outlined in SREIS Appendix O do not conflict with any subsequent approval conditions and any recommendations of this assessment report, the proponent should implement the commitments as stated.

Recommendation - modelling

The proponent’s site specific modelling of potential air quality impacts on sensitive receptors for defined project facility locations should

- use air emissions data for the specific design of equipment selected for the facility
- be completed prior to finalising the location and design of the facilities
- be supported by local air quality data where possible
- include emissions data for non-project sources that may result in cumulative impact.

4.6 Greenhouse gas emissions and climate change adaptation

Greenhouse gas emissions from the proposed project were discussed in EIS section 10 Greenhouse gas emissions which was supported by a technical assessment provided in EIS Appendix I Greenhouse gas technical report. A supplementary greenhouse gas emissions assessment which addressed changes to the project and relevant legislation following submission of the EIS, and submissions on the EIS relating to greenhouse gas emissions, was provided in SREIS section 6 Greenhouse gas, and supported by a technical report in SREIS Appendix C Supplementary greenhouse gas technical report. A summary of the greenhouse gas assessment follows.

4.6.1 Greenhouse gas emissions

4.6.1.1 Assessment methodology

Section 10.2 of the SREIS outlined the methodology used to develop a greenhouse gas emissions inventory for the life of the project, including all activities within the petroleum leases applied for or held for the project and areas proposed for gas gathering infrastructure, but excluding the gas transmission pipeline to Gladstone and the liquefied natural gas facility. A detailed description of the greenhouse gas emissions inventory was provided in EIS Appendix I Greenhouse gas technical report. The inventory was developed using the methods outlined in

- The National Greenhouse and Energy Reporting System Measurement Technical Guidelines 2011 (Technical Guidelines)
- The National Greenhouse and Energy Reporting (Measurement) Determination 2008 as amended – Reporting Year 2011-12
- The World Resources Institute / World Business Council for Sustainable Development Greenhouse Gas Protocol 2004
- The Australian Government Department of Climate Change National Greenhouse Accounts Factors 2011.

Project greenhouse gas emission estimates were separated into Scope 1 emissions (listed in Table 10.2 of the EIS), Scope 2 emissions (listed in Table 10.2 of the EIS), and Scope 3 emissions (listed in Table 10.3 of the EIS). The emission types were defined in the EIS as follows

- Scope 1 emissions would occur directly from sources owned or controlled by the proponent
- Scope 2 emissions would arise indirectly from the generation of energy products purchased for the project, such as electricity
- Scope 3 emissions would arise as a consequence of project activities, but from sources not owned or controlled by the proponent.

Section 10.3.2 of the EIS stated the key assumptions used in estimating greenhouse gas emissions.

4.6.1.2 GHG emission estimates

Figure 10.1 of the EIS showed the estimated emissions of greenhouse gas for each year of the proposed project. Estimated annual Scope 1 emissions increased to 1.3 million tonnes (Mt) carbon dioxide equivalent (CO₂-e) in 2017 then varied between 1.3Mt CO₂-e and 1.5Mt CO₂-e during the ramp up phase and 1.4Mt CO₂-e to 1.6Mt CO₂-e during the operational phase. Estimated annual Scope 2 emissions gradually increased in the ramp-up phase to a maximum of 0.3Mt CO₂-e and ranged from 0.3Mt CO₂-e to 0.4Mt CO₂-e during the operational phase. An estimation of the uncertainty of the emissions estimates was included in section 4.8 of EIS Appendix I Greenhouse gas technical report.

Table 10.4 of the EIS provided Scope 1 and 2 emission estimates for the predicted worst-case year of the ramp-up, operational and ramp-down periods as follows:

- ramp-up period (2016 – 2022) - 1.7Mt CO₂-e in 2021
- operational period (2023 – 2056) - 2.1Mt CO₂-e in 2046
- ramp-down period - 1.7Mt CO₂-e in 2057.

Table 10.5 provided Scope 3 emission estimates for the predicted worst-case year of the ramp-up, operational and ramp-down periods as follows:

- ramp-up period (2016 – 2022) - 10.5Mt CO₂-e in 2021
- operational period (2023 – 2056) - 11.2Mt CO₂-e in 2046
- ramp-down period - 8.7Mt CO₂-e in 2057.

Table 10.6 of the EIS (reproduced in Table 4.6.1 below) provided a summary of the total estimated greenhouse gas emissions that would be generated during each phase and Scope 3 emissions over the life of the Project.

Table 4.6.1 Estimated project greenhouse gas emissions (from Table 10.6 of the EIS)

	Ramp up Period 2016 – 2022 (t-CO₂-e)	Operational Period 2023 - 2056 (t-CO₂-e)	Ramp Down Period 2057- 2062 (t-CO₂-e)
Scope 1	8,817,223	51,335,961	7,497,589
Scope 2	978,432	13,366,019	876,606
Total Scope 1 & 2	9,795,655	64,701,980	8,374,196
Scope 3	43,807,678	350,651,846	26,021,718

4.6.1.3 Impact of greenhouse gas emissions

The EIS stated that the potential impacts associated with greenhouse gas emissions from the proposed project could be assumed to be in proportion to the project's contribution to global greenhouse gas emissions. Section 10.4 of the EIS presented a comparison of the predicted project emissions with estimates of global, Australian, and Queensland emissions (as presented in Table 10.7 of the EIS). The results of this comparison indicated that the estimated project Scope 1 and Scope 2 emissions for the predicted highest emission year (2046) equalled approximately:

- 0.007% of the global emissions from fossil fuel burning in 2009
- 0.4% of Australia's total emissions and 0.5% of emissions from Australia's energy sector in 2010
- 1.3% of Queensland's total emissions and 2.1% of emissions from Queensland's energy sector in 2010.

The EIS stated that project greenhouse gas emission estimates used to estimate the project's contribution to global, national and state greenhouse gas emissions were conservatively based on the predicted highest emissions and that actual emissions would be likely to be lower, and therefore the potential impacts of the project on climate change could be expected to be negligible.

EIS Table 10.8 presented greenhouse gas emission intensities (the quantity of greenhouse gas emitted during delivery and supply of the product or service per unit of product or service provided) for a range of fossil fuels referenced from the Commonwealth Department of Climate Change and Energy Efficiency (DCCCE). The EIS also presented the estimated average emissions intensity for the proposed project lifecycle. The greenhouse gas intensity for the project lifecycle (production of CSG) would be significantly higher than for other fuels, including natural gas extracted using conventional methods in Queensland. It was noted that the DCCCE estimates did not include construction and commissioning emissions. The EIS further noted that, although production of gaseous fuels would have a greater potential for greenhouse gas emissions than other fuels, end-use of gas for electricity production would result in much lower greenhouse gas emissions than for other fossil fuels.

4.6.1.4 Mitigation measures

The EIS stated that a decision to implement emission reduction technologies would consider economic viability and other aspects such as community concerns. The proponent proposed to trade emission permits to meet requirements under the carbon price mechanism of the *Clean Energy Act 2011* if internal costs of abatement were higher than the price of permits, and to directly reduce emissions if internal costs of abatement were lower than the price of permits. The *Clean Energy Act 2011* was repealed after the SREIS was submitted and the carbon pricing mechanism was abolished from 1 July 2014.

EIS section 10 Table 10.9 listed a number of commitments for minimising greenhouse gas emissions. The proponent proposed to consider reduction of greenhouse gas emissions in the planning and preparation phase of the project. The following measures were outlined in the EIS

- consideration of energy efficiency and emissions to air in selection of new equipment
- management strategies for potential sources of greenhouse gas emissions
- equipment maintenance and replacement to maximise efficiency
- options for offsetting greenhouse gas emissions.

4.6.1.5 Major issues raised

References to agencies and organisations in the following are based on submissions made on the publicly released EIS. The proponent responded to each submission with further explanatory material and information where required.

IRC contended that the greenhouse gas emissions associated with ‘fly in-fly out’ and ‘drive in-drive out’ employees should be included in greenhouse gas emission estimates and should be offset. The SREIS included these estimates as Scope 3 emissions and the proponent committed to exploring options for offsetting greenhouse gas emissions.

A submission argued that the greenhouse gas emissions assessment failed to address sustainable ecological development requirements and requested detail on the proportions of production intended for domestic use and export. In response, the proponent stated that the location of end use of the gas from the project was irrelevant to the assessment, that greenhouse gas emissions from the project were negligible in the context of global emissions, and that transition to gas-fired power generation was a recognised step in reducing national and international greenhouse gas emissions.

A submission stated that estimates of fugitive gas emissions should consider current science and findings in other gas fields and expressed concerns in relation to management of such fugitive emissions. In response, the proponent referred to the methodology adopted for the assessment of fugitive emissions from the project as described in sections A.3.2 and A.3.3 of the EIS Appendix I Greenhouse gas technical report. The proponent responded that, for facility level production and processing the EIS used the American Petroleum Institute of Greenhouse Gas Methodologies for the Oil and Gas Industry default emission factor modified to represent the project site, and for gas transmission the National Greenhouse Accounts Factors (2011) were used. The proponent argued that the methods used for assessing greenhouse gas emissions were the best available. Fugitive emissions were reassessed in the SREIS based on new engineering and infrastructure information and updated global warming potential values for methane and nitrous oxide.

In relation to management of fugitive emissions of greenhouse gas, the proponent stated that the project would be subject to international, national, state and corporate greenhouse gas policies with abatement objectives and performance standards as set out in section 2 of SREIS Appendix C. The proponent further stated that

- well head emissions would be monitored and managed in accordance with the Code of Practice for Coal Seam Gas Well Head Emissions Detection and Reporting and detailed in a formal Leak Management Plan
- a risk assessment would be conducted to identify risks posed by leaks from well sites and appropriate actions had been implemented to reduce these risks to as low as reasonably practicable as required under the *Petroleum and Gas (Production and Safety) Act 2004*
- detected leaks would be repaired as soon as practical in accordance with the proponent’s Leak Management Plan.

4.6.1.6 Greenhouse gas emission assessment for changed project

A number of changes were made to the project description after submission of the EIS and changes relevant to greenhouse gas emissions were summarised in Table 6.1 of the SREIS. The supplementary greenhouse gas assessment addressed these changes as well as updates to the legislative and policy context, emissions estimation methodologies, emission sources and likely impacts, and to abatement, management and mitigation commitments.

Section 3.4.3.2 of SREIS Appendix C Greenhouse gas technical report compared the total project greenhouse gas emissions for the two power options presented in the updated project description, as outlined for air quality in section 4.5 of this assessment report. Total greenhouse gas emissions were estimated to be higher for temporary power generation (by 2%) and the results for this option were presented in the SREIS as the worst case emissions, noting that grid power supply remained the preferred option.

An updated greenhouse gas emissions inventory was developed for the life of the project using the methods outlined in section 3 of EIS Appendix I Greenhouse gas technical report, with modifications outlined in Sections

6.3.1 and 6.3.2 of the SREIS to consider updated reference documents, and new documents relevant to the assessment of Scope 3 emissions from travel associated with 'fly in-fly out' and 'drive in-drive out' employees. The updated total greenhouse gas emission estimates for the ramp up, operational, and ramp down periods of proposed gas production are detailed in Table 4.6.2 below.

Table 4.6.2 Estimated total project greenhouse gas emissions (from Table 6-7 of the SREIS)

Greenhouse Gas Emissions Type	Ramp up Period 2017 – 2023 (t-CO₂-e)	Operational Period 2024 -2053 (t-CO₂-e)	Ramp Down Period 2054- 2058 (t-CO₂-e)
Scope 1	8,143,317	13,841,885	777,046
Scope 2	6,116,380	46,501,380	3,880,240
Total Scope 1 & 2	14,259,697	60,343,265	4,657,286
Scope 3	79,524,884	267,800,894	6,095,394

Changes in project emission estimates between the EIS and SREIS were outlined in section 6.4.4 of the SREIS including

- for the ramp-up period, emission estimates were significantly higher in the SREIS than the EIS due to higher gas production rates
- for the operational period, emission estimates were lower in the SREIS than the EIS due to reduction in fuel consumption for power requirements and reduction in estimated gas production
- for the ramp-down period, emission estimates were lower in the SREIS than the EIS due to lower gas production and use of purchased electricity.

A comparison of the project emission estimates with global, Australian and Queensland emissions (presented in Table 6.8 of the SREIS) showed project emissions for the predicted highest emission year (2019) were estimated to be

- 0.01% of the global emissions from fossil fuel burning in 2010
- 0.6% of Australia's total emissions and 0.7% of emissions from Australia's energy sector in 2011
- 2.0% of Queensland's total emissions and 3.1% of emissions from Queensland's energy sector in 2011.

The average emission intensity for the project was increased by the SREIS assessment from 11.7kg CO₂-e/GJ to 13.77kg CO₂-e/GJ. This was stated to be due to reduction in forecast gas production for the revised project that was not outweighed by predicted reduction in greenhouse gas emissions.

The SREIS did not present any changes to the abatement, management and mitigation measures stated in the EIS.

4.6.1.7 Conclusions and recommendations

The greenhouse gas emissions assessment adequately addressed greenhouse gas emission sources, estimated potential emissions, and proposed appropriate mitigation measures including commitments to reduce and report greenhouse gas emissions consistent with current legislative requirements. However, the legislative and policy framework relevant to greenhouse gas emissions from the project may change and the abatement, mitigation and management measures adopted by the proponent would need to reflect such changes.

Refinement of estimates of fugitive methane emissions from the project should be informed by current research on natural and gas field development related emissions in similar coal seam gas production areas such as the Surat Basin.

4.6.2 Climate change adaptation

EIS section 8 Climate, presented information on the climate in the project area, future climate predictions, the potential effect of climate change on natural hazards and extreme events in the region, the potential risk to the project, and proposed climate change adaptation strategies.

SREIS Appendix C, Greenhouse gas technical report, provided further information on the potential impacts of climate related hazards on the project and outlined the approach proposed to address such risks.

4.6.2.1 Assessment method

Monthly climate statistics based on meteorological monitoring data from Bureau of Meteorology stations located in Blackwater, Clermont, Emerald, Mackay and Moranbah were used to characterise long term air temperature, insolation and evaporation, relative humidity, rainfall, and wind speed and direction in the area.

Atmospheric stability and mixing height estimates were obtained by modelling using TAPM with 2009 meteorological data as representative of long-term average meteorological conditions based on analysis of data for the period of 1999 to 2011. EIS Appendix H Air quality technical report, provided detailed information on this modelling.

Future climate change predictions were based on data from

- Climate Change in Australia – Technical Report 2007 (CSIRO)
- Queensland Government Climate Change in Central Queensland Report 2010
- Queensland Government Climate Change in Queensland Report 2010.

Three greenhouse gas emission scenarios (from Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (2007)) were used in the assessment

- B1 lower emissions scenario which assumes a rapid shift to less fossil-fuel intensive industries
- A1B medium emissions growth scenario which assumes a diversity of energy sources
- A1FI higher emissions growth scenario which assumes a continued dependence on fossil fuels.

4.6.2.2 Potential impacts of climate change

EIS section 8 Table 8.3 presented a summary of existing and projected climatic conditions in the project area for the three IPCC emission scenarios which generally indicate potential for a decline in rainfall, increase in temperature and wind speeds, and more extreme climate events.

Section 8.4 of the EIS made the following key observations in relation to natural hazards and extreme weather events

- increased frequency of severe storm events but the predicted amount of increase varied significantly
- decreased total rainfall but an increase in rainfall intensity that could result in more frequent flooding events
- increased frequency of droughts from an average of one per 2.2 years to an average of one per 1.7 years by the period 2010 to 2040
- increased risk from bushfires due to decreases in rainfall and humidity, and increased evaporation rates.

Project risk assessment

Section 8.4 of the EIS outlined the semi-quantitative risk assessment procedure that was used to evaluate risks to the project as a result of the potential climate change. The key steps in the risk assessment were stated as:

- identification of potential climatic impacts on project operations
- analysis of the risks in terms of consequence and likelihood
- evaluation of risks, including risk ranking to identify priorities for their management.

Table 8.4 and Table 8.5 of the EIS detailed the descriptors and measures of consequence used in the assessment to interpret the likelihood and impacts of an event shown in Table 8.7 of the EIS. A risk assessment matrix presented in Table 8.6 of the EIS was used to establish the level of risk based on likelihood and consequence scores.

The highest level of risk to the project as a result of climate change was predicted to be from flooding due to increased rainfall intensity. Significant risk was also predicted for rehabilitation due to reduced soil moisture and increased erosion potential, and for damage to infrastructure by severe storm events.

The EIS stated that management measures proposed to address increased risk associated with climate change were addressed in relevant sections of the EIS including

- effect of rainfall on soil erosion - EIS section 12 Soils and land suitability, and EIS Appendix K Soils and land technical report
- effect of storm events on the capacity of waste containment systems - EIS section 28 Waste management
- contamination of waterways and design of the waste containment systems - EIS section 15 Surface water, and EIS Appendix N Surface water technical report
- flood mitigation measures - EIS section 15 Surface water.

Measures proposed to address other climate change risks such as dust generation, rehabilitation planting failure, and infrastructure maintenance were generally consistent with management proposed in relevant sections of the EIS.

4.6.2.3 Major issues raised

EHP requested further details on adaptation strategies proposed to be implemented to account for increased risk from climate change and a commitment to taking a cooperative approach with government, industry and other sectors to address adaptation to climate change. In response, the proponent stated that climate change adaptation would be considered in planning and design, construction, operation and decommissioning phases of the project and would include

- developing preventative and responsive measures for bushfire management and flooding
- designing and constructing production facilities in accordance with current Australian standards for climatic factors including wind, bushfires and floods.

SREIS Appendix C Greenhouse gas technical report provided further information on the potential impacts of climate related hazards on the project, outlined the approach proposed to address such risks, and stated a commitment to taking a cooperative approach with government, industry and other sectors to address adaptation to climate change.

4.6.2.4 Conclusion and recommendations

The climate change assessment adequately addressed the potential risks to the project associated with predicted climate change and proposed adequate measures to address such risks through planning, design, maintenance and emergency management. The EIS adequately addressed the requirements to address climate change adaptation.

Recommendation - commitments

In order to ensure that the project is fully prepared for the effects of climate change it is recommended that the climate change adaptation strategy commitments stated in the SREIS be fully implemented where they do not conflict with any approval conditions.

Recommendation – efficient water use

The proponent should implement efficient water consumption through water-efficient technologies and practices and/or by installation of water-efficient devices, in recognition of the importance of this valuable resource and its potential to be affected by changes in climate.

4.7 Geology and soils

EIS section 13 provided a summary description of the geology of the proposed project area and an assessment of the potential direct and indirect effects of the project on geological processes, and resultant potential impacts on infrastructure and environmental values. Detailed information on geology, including geological data compiled during the development of a predictive groundwater model, was included in EIS Appendix L Groundwater and geology technical report. Information on geological faults was included in EIS Appendix M Groundwater model technical report.

EIS section 12 provided information on soils and land suitability within the project area including the distribution of topsoil resources; an assessment of topsoil suitability for rehabilitation; an assessment of potential project impacts; and an outline of proposed mitigation measures. EIS Appendix K Soils and land suitability technical report, contained detailed methodology and results of the soils and land suitability assessment.

EIS section 11 outlined the proponent's proposed approach to management of contaminated land within the project area and was supported by SREIS Appendix J Contaminated land technical report.

EIS section 29 provided an outline of the proposed decommissioning and rehabilitation strategy for the project.

4.7.1 Legislative context

The EIS documents adequately described the applicable legislation, policies and guidelines that applied at the time the EIS was drafted relevant to identifying values and mitigating and managing impacts on geology, landform and soils. EIS section 2, Approvals identified approvals required under Queensland legislation for construction, operation and decommissioning of the project, and also referred to relevant planning schemes, policies and regional plans.

SREIS section 2 identified new approvals required as a result of changes to the project since the release of the EIS and changes to legislation and policy. Legislation and policy changes relevant to geology, landform and soils were identified as

- the imminent repeal of the *Strategic Cropping Land Act 2011* and commencement of the *Regional Planning Interests Act 2014*
- the Central Queensland Regional Plan which provided direction to resolve competing State interests relating to agricultural land use, resources development, and urban expansion.

4.7.2 Assessment methodology

The geology assessment involved

- desktop review of available information on the geology and CSG resources of the Bowen Basin
- description of the geology within the project area
- compilation and generation of geological data and GIS maps to support development of a numerical model for groundwater
- assessment of likely impacts of the project on the geological resources, and identification of management and mitigation measures.

The soils assessment involved

- desktop review of existing information
- a limited field survey of soils
- identification of land systems and land units
- determination of agricultural land capability and class
- preliminary assessment of strategic cropping land
- identification of soils suitable for use in rehabilitation works and soils with high erosion risk
- assessment of likely impacts of the project on soils and associated land use values, and identification of management and mitigation measures.

The contaminated land assessment involved a desktop review to identify the potential nature and likely frequency of contaminated sites within the project area. No site assessment for the presence of potential contaminated sites was conducted.

4.7.3 Existing environment

Geology

Section 13.4 of the EIS described the geology of the project area and was supported by additional information on

regional geology in EIS Appendix L, Groundwater and geology technical report. Figure 13.2 of the EIS illustrated the major structural elements of the geology in the project area and Figure 13.3 illustrated the surficial geology. Figures 13.4 to Figure 13.8 of the EIS illustrated cross sections of the geology in the project area and depicted localised thrust faults and resultant throws and compartmentalisation of geological blocks. The stratigraphy of the Bowen Basin within the project area was summarised in Table 13.2 of the EIS, including general information on the various coal measures. Table 13.3 of the EIS listed the target coal seams of the current project development plan, including seams in the Rangal Coal Measures, Fort Cooper Coal Measures, and Moranbah Coal Measures.

The EIS stated that the majority of the project tenements would be located within a zone mapped as having expected earthquake intensities of Modified Mercalli Intensity (MMI) III, which was less than the intensity (MMI V) at which minor damage to building contents could be expected to occur.

Soils

Table 12.1 of the EIS listed the 26 land systems defined as occurring within the project area, comprising 140 major land units and 28 dominant soil types. Land systems, land units and soil types were described in EIS Appendix K, Soils technical report, and illustrated in the Figure 12.2 of the EIS. Ten of the 27 land systems were assessed for their representative soil types and these were summarised in Table 12.2 of the EIS.

The agricultural land classes for assessed soil units were listed in Table 12.3 of the EIS. The soil units sampled within the project area were stated to be suitable for a range of agricultural enterprises with agricultural land classes (listed in Table 12.4 and illustrated in Figure 12.3 of the EIS) ranging from Class A through to Class C3. Most of the project area (70%) was identified as Class C1 and Class C2 land suitable for grazing with approximately 18% of the area suitable for cropping (mostly Class A).

A preliminary assessment to determine the potential for strategic cropping land to be present in the study area identified areas associated with vertosol and dermosol soil types as potential strategic cropping land, as shown in Figure 12.4 of the EIS.

Contaminated land

Known occurrence of notifiable activities (listed on the Environment Management Register under the EP Act) considered likely to be encountered during the development of the project were listed in Table 11-1 of the EIS. The EIS noted that areas of unidentified contamination may be encountered.

4.7.4 Impacts

Geology

The potential environmental impacts associated with the project relating to geology were stated as

- induced seismicity
- land subsidence due to coal seam depressurisation and dewatering
- coal seam subsidence from dewatering
- CSG migration.

The EIS stated that review of regional seismicity data and consideration of the location of potential geological hazards, indicated potential for damage to in-field gas and water gathering pipelines and associated facilities due to potential ground instability. Induced seismicity as a result of hydraulic stimulation was considered likely to result in minor seismic events of lower magnitude than historically recorded seismic events or seismic events caused by mining activities.

The EIS stated that the limited available published data relating to subsidence from CSG production' and the impacts of such induced subsidence, indicated that subsidence as a result of CSG production would be negligible.

Subsidence due to CSG water production was considered to be possible and having potential to damage project infrastructure but was not quantified for the project.

The EIS noted the potential for CSG to escape from the coal seam and migrate to areas where it would not be collected by the production wells. Migration would typically occur along fractures and through permeable soils and groundwater aquifers, as a result of well installation near faults or fractures, improper production well installation, improper abandonment of wells or from inappropriate well cementing techniques. However, the potential magnitude of such gas migration was not estimated for the project.

Soils

Areas disturbed by the project were proposed to be rehabilitated to land suitability classes consistent with the pre-development land classes C1 and C2, suitable for good to moderate quality grazing. The proponent confirmed with EHP that land would be rehabilitated to Class A or B where consistent with the pre-development land suitability class. The EIS identified the following impacts which could affect land suitability and may require mitigation measures

- increased erosion due to soil disturbance, vegetation clearance, or alteration of natural drainage
- soil compaction
- alterations to topography
- removal of topsoil
- increased soil waterlogging along pipeline trenches.

Contaminated land

Potential issues relating to contaminated land were identified as disturbance of existing contaminated land through construction works, leakage or spill of fuel or other chemicals, and salt contamination from CSG water or brine release.

4.7.5 Avoidance and mitigation measures

Geology

To address risks associated with seismic activity, including seismic activity induced by hydraulic stimulation activities, the proponent committed to

- consider geological structural features and faults when planning the location of well fields and bores to minimise the potential for induced seismicity
- design CSG production infrastructure in accordance with Australian Standard 1170.4:2007 to comply with the minimum criteria considered necessary for the protection of life, by minimising the likelihood of collapse or failure of project structures during a seismic event.

Risks associated with gas migration were proposed to be minimised by

- assessing the nature of the geological structures before locating CSG activities and fields on or adjacent to seismically active fault zones or faults that have high pressure differentials across them
- production well construction, operation and decommissioning measures, including (recommended) establishment of a monitored gas capture zone around production well(s) where geological structures were determined to have increased vertical hydraulic conductivity
- location of CSG production facilities and supporting infrastructure outside of the gas capture zone and use of ventilation systems to minimise the potential for unsafe gas concentrations
- regular well integrity testing.

The EIS stated that there would be potential for CSG migration at the edges of well fields due to depressurisation (by water extraction), and gas could migrate outside of the gas capture zone and migrate upwards through faults, abandoned bores, low pressure zones, production wells after shut-off, or could pool in geologic traps. No specific mitigation measures were proposed other than indicating that old and abandoned wells and bores within the CSG well fields should be tested for structural integrity.

Table 13.4 of the EIS listed the monitoring measures proposed to support minimisation of risk associated with seismic activity, subsidence, and CSG migration. The proponent proposed to use satellite data to monitor subsidence resulting from project activities, as well as other CSG project and coal mining operations, and indicated that trigger levels would need to be developed and action considered if measured subsidence was determined to be significant in terms of surface water flows or building integrity.

Soils

General mitigation measures proposed to minimise changes to land suitability included

- progressive clearing and rehabilitation with re-application of stripped topsoil
- use of existing roads and tracks, where practicable
- development and implementation of erosion and sediment control plans.

Recommended topsoil stripping depths for assessed soil types and locations were presented in Table 12.5 of the EIS. The EIS noted that the topsoil stripping depths were indicative only and further site-specific assessment would be required. Section 12.7.3 of the EIS listed a number of commitments in relation to topsoil and subsoil stripping, storage, and re-application in rehabilitation.

The assessed soil erosion hazard at each of the sites sampled for the EIS was presented in Table 12.6 and illustrated in Figure 12.5. Erosion hazard ratings for most sites were considered to be moderate with two sites assessed as having high risk. However, the EIS recommended that detailed erosion risk investigations be undertaken, particularly for site development purposes. Section 12.7.5 of the EIS listed a number of commitments to mitigation measures relating to erosion risk associated with clearing and earthworks, surface water flow management, and final landforms.

Table 12.7 of the EIS provided a summary of the mitigation measures proposed to be implemented during each phase of the project to minimise impacts for each assessed soil type and provided an estimate of the potential significance of any residual impact. All residual impacts were assessed as being of low significance.

Preliminary completion criteria for the rehabilitation of the CSG production areas and associated infrastructure were listed in Table 36 of EIS Appendix Z, Draft environmental management plan.

Contaminated land

Section 11.6.1 of the EIS listed commitments relevant to avoidance, mitigation and management of land contamination risks, including

- contamination assessment if project activities could occur on land listed on the environmental management or contaminated land register
- site investigations for potential contamination prior to finalising facility locations
- management of contaminated soil or groundwater in accordance with the Queensland government Draft Guidelines for the Assessment and Management of Contaminated Land 1998.

Section 11.6.2 of the EIS listed commitments relevant to avoidance, mitigation and management of land contamination as a result of project activities, including

- use of relevant standards and codes of practice for the handling and storage of hazardous materials
- emergency response and spill response procedures
- contamination assessment and remediation procedures
- staff training.

SREIS updated project proposal

SREIS Appendix E, Supplementary groundwater assessment, stated that, since completion of the EIS, additional investigations had been undertaken in order to further develop the geological understanding of the project area, and to refine key aspects of the project. Additional geological, structural and subsidence information were reviewed to allow re-assessment of potential impacts to groundwater, including

- the role of faulting and folding on the movement of groundwater and how the drawdown associated with depressurisation of the coal seam gas targets may be influenced by these features
- areas where the alluvial and sedimentary aquifers may be directly underlain by coal formations (i.e. absence of a confining layer) and there is the potential for increased hydraulic connectivity between the groundwater systems
- mechanisms associated with induced seismicity in response to coal seam gas extraction and hydraulic stimulation.

The SREIS presented further information on the influence of the tectonic stress regime on seismic activity, the characteristics of faults in the Bowen Basin, and the hydraulic behaviour of these faults. An updated map showing the location of known and potential faults, igneous intrusions and the stress orientation in the project area was presented in Figure 7.3 of the SREIS.

In relation to subsidence, the SREIS considered information obtained from a ground motion study of the Moranbah Gas Project area using satellite interferometry data from December 2006 to January 2011, a report prepared by Geoscience Australia that summarised potential impacts of CSG extraction in the Surat and Bowen basins, and other reports. The SREIS concluded that subsidence resulting from shrinkage of the coal seam due to CSG extraction by the project and compression of the coal seam and overlying formations due to groundwater extraction by the project, was likely to be relatively small, significantly less than for longwall coal mining, and consistent with measured subsidence in the Moranbah Gas Project area as follows

- subsidence due to gas extraction – approximately 10mm (with a range of 5mm to 15mm)
- subsidence due to reduced groundwater pressure - approximately 30mm (with a range of 10mm to 60mm)
- overall subsidence due to CSG production of 40mm (with a range of 15mm to 75mm).

The SREIS provided further review of published information on the natural seismicity in the Bowen Basin and the potential for induced seismicity as a result of hydraulic stimulation of CSG wells, and presented information on microseismic activity measured during the hydraulic stimulation of vertical CSG wells in the Moranbah Gas Project

area. The review found that

- the Bowen Basin has relatively low levels of seismic activity
- the risks of induced seismicity that could result from hydraulic stimulation were low compared with natural seismic events (earthquakes)
- the likelihood of hydraulic stimulation induced seismic events causing any damage was low.

4.7.6 Major issues raised

References to agencies and organisations in the following text are based on submissions made on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

No additional specific assessment of geology, soils, or contaminated land was made as a result of changes to the project description advised in the SREIS.

IRC requested information on management of salinity. In response, the proponent referred to the following commitments to addressing potential increases in secondary salinity as stated in the draft environmental management plan

- surface stabilisation and revegetation of areas mapped as saline soils as soon as possible following disturbance
- rehabilitation to a stable permanent landform
- monitoring of erosion and vegetative cover
- visual monitoring for any signs of surface salinity.

IRC also requested information on management of contaminated land. In response, the proponent referred to the relevant statements and commitments in the EIS.

The Department of Agriculture, Fisheries and Forestry (DAFF) requested a management strategy to address the risk posed to the product integrity of animals grazing on contaminated land following completion of project activities. In response, the proponent referred to the rehabilitation success criteria stated in the EIS and clarified that a site-specific contaminated land assessment and management plan would be developed for each site likely to have become contaminated. The assessments would be developed and conducted in accordance with the Guideline for Contaminated Land Professionals (EHP 2012) and the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended.

4.7.7 Conclusions and recommendations

The EIS has adequately described the geology and soils in the project area, the potential issues for the project associated with geology, and the potential direct and indirect impacts of the project on soils, land use suitability, and other environmental values. Risks to project infrastructure, and indirect risks to environmental values, associated with natural and induced seismic activity and subsidence resulting from gas and groundwater extraction by the project, were determined to be relatively minor. Appropriate mitigation and management measures were proposed, including design requirements and the need for additional site specific assessments to inform location and design of infrastructure, and to inform management and monitoring requirements.

Appropriate conditions for soil management and rehabilitation are included in the recommended EA conditions in Appendix 3.

Recommendations - gas migration and fugitive emissions

Based on advice from IESC and DNRM the following groundwater information and modelling issues should be addressed by the proponent

- undertake further studies during operations to confirm that faults present in the Bowen Basin (including subvertical faults and folds) do not provide preferential pathways for groundwater flow
- undertake drainage field planning to avoid all faults that are documented to be seismically active
- development of a strategy, including further studies (if required), to confirm predictions that faulting does not promote aquifer connectivity
- development of well integrity procedures to address potential coal seam gas migration arising from the proponent's drilling activities.

Recommendation – rehabilitation

Areas disturbed by the project should be rehabilitated to land suitability classes consistent with pre-development land suitability.

Recommendation – proponent’s commitments

Where the proponent’s commitments outlined in SREIS Appendix O do not conflict with any subsequent approval conditions and any recommendations of this assessment report, the proponent should implement the commitments as stated including locating wells away from faults and implementing site specific soils assessments.

4.8 Landscapes and Landuse

EIS section 18 Land Use and Tenure, provided a summary of land tenure and land use within and adjacent to the project area, relevant legislation and policy, an assessment of the potential direct and indirect impacts associated with the project, and proposed general avoidance, mitigation and management measures. EIS Appendix Q, Land Use and Tenure Technical Report, provided detailed information on land tenure and use.

EIS section 20, Landscape and visual amenity, provided an assessment of potential impacts of the project on landscape values and visual amenity.

SREIS section 13, Land use and tenure, provided supplementary information on land tenure and land use values within and surrounding the project area. No changes were made to the assessment of landscape and visual amenity. Table 13.1 of the SREIS provided an updated summary of the land tenures within the project area.

The SREIS stated that the general impacts to existing land uses that had been outlined in the EIS would not be affected by the changes to the project description (see Appendix 5 of this assessment report). The decrease in area likely to be disturbed by the project as a result of changes to the project description that were outlined in the SREIS would reduce the magnitude of impacts on some agricultural enterprises, urban and residential areas, mining and resource operations, areas of conservation tourism and recreation, and local infrastructure.

The SREIS made no significant changes to the proposed mitigation and management measures relating to land use. Table 13.2 of the SREIS provided a list of new or revised management measures relevant to mitigation of impacts to land uses that were released by the proponent since the EIS. Table 13.3 of the SREIS provided a summary of revised land use impact significance estimates based on updates to the project description and updated land use information.

4.8.1 Assessment methodology

Land use

The land use and tenure assessment involved

- a desktop study to identify land tenure and land use based on existing mapping and imagery
- field verification of land use
- assessment of potential direct and indirect impacts of the project on property values and property tenure, and an assessment of compliance with relevant planning policies.

Landscape and scenic amenity

A landscape and visual impact assessment was prepared for the EIS but was limited by the uncertain location of project infrastructure. The assessment involved

- a desktop assessment of landscape character areas and visual receptors
- site assessment to support the description of landscape character and visual amenity
- assessment of landscape and visual sensitivity and the potential magnitude of impacts of project activities and infrastructure, and estimation of the significance of the potential impacts
- identification of project constraints relating to landscape and visual amenity.

4.8.2 Existing values

Land use

Land tenure within the project area was illustrated in Figure 19.1 of the EIS and summarised as

- approximately 70% freehold allotments
- approximately 25% leasehold allotments
- unallocated State land and reserves
- State forests, timber reserves and forest reserves
- roads, rail and stock routes
- protected areas under the *Nature Conservation Act 1992*, including Homevale National Park, Homevale Conservation Park and Homevale Resources Reserve, as well as a number of native refuges
- a number of mining and petroleum tenements as shown in Figure 19.2 of the EIS.

Land use within the project area was described in EIS Appendix Q, Land use and tenure technical report, illustrated in Figure 19.5 and 19.6 of the EIS, and summarised as

- mainly low density, low intensity grazing (90% of the project area) with areas of rain-fed and dryland cropping (approximately 2.7% of the project area)

- urban communities of Glenden, Nebo, Coppabella, Moranbah, Dysart, Middlemount and Blackwater, with mining accommodation villages at Coppabella and Burton Gorge as well as residences and homesteads throughout the rural areas
- 22 operational coal mines and a large number of mining, petroleum and exploratory leases and permits
- areas of conservation, tourism and recreational land uses
- water, gas, electricity, rail, road, airport, stock route and other infrastructure.

Landscape and scenic amenity

The landscape and visual impact assessment identified six typical landscape character areas within the project area as follows

- mining tenements
- urban areas
- road and rail corridors
- agricultural areas (pastoral grazing and cropping)
- drainage
- forested areas (hills and plains).

The general location and extent of each landscape character area was illustrated in Figure 20.13 of the EIS and supported by photographic images in figures 20.14 to 20.19.

Landscape sensitivity assessments for each landscape character area were presented in tables 20.4 to 20.9 of the EIS and summarised in Table 20.10 of the EIS. Mining tenements, urban areas and road and rail corridors were assessed as having low sensitivity and other areas were assessed as having medium sensitivity.

The location of sensitive urban and point visual receptors was illustrated in Figure 20.21 of the EIS and roads representing the location of motorist visual receptors were listed in Table 20.11 of the EIS. Assumed levels of visual receptor sensitivity were listed in Table 20.12 of the EIS with medium to high sensitivity indicated for residences and recreational locations.

4.8.3 Impacts

Land use

Potential impacts to agricultural land uses were identified as: impacts to soils including disturbance of the soil profile; disruption to machinery operations; impediments to farm workability; increased or new farm management overheads; loss of amenity; and land contamination.

The EIS listed the following potential impacts to soils and provided discussion on each issue

- compaction by vehicle movements
- inversion or mixing of soil horizons during excavation and backfilling
- reduced organic matter content
- disrupted soil structure due to changes in soil constituents and plastic deformation
- crust formation
- biological degradation from stockpiling
- impeded infiltration and drainage
- increased runoff during rain events
- reduction in plant available water
- reduced soil air, which may induce anaerobic soil conditions
- reduced fallow efficiency
- reduced fertility due to lowered organic matter, soil water, or denitrification.

The proponent proposed to avoid locating the larger central gas processing facilities and integrated processing facilities on good quality agricultural land and strategic cropping land, and to allow agricultural activities to recommence after rehabilitation of construction areas for gas and water gathering systems other than well heads and production facilities.

Project infrastructure was not proposed to be located within existing urban areas and the EIS indicated that impacts on urban land uses were likely to be minor. However, rural accommodation centres (e.g. Coppabella, Burton Gorge village, mining camps) and rural residences could be affected by noise, vibration, air quality and visual emissions from the project. These impacts are discussed in sections 4.5 Air and 4.15 Noise of this EIS assessment report.

The EIS noted the potential for conflict with overlapping mining tenements but stated that coal seam gas extraction

was required prior to or in conjunction with coal mining. The proponent proposed to avoid location of major project infrastructure within existing mineral development leases, to determine the location of minor project infrastructure in consultation with tenement holders, and to enter into agreements with the holders of overlapping mining tenure.

The project would not directly impact on the Homevale National Park, Homevale Conservation Park or Homevale Resources Reserve, but project infrastructure could be located within State forests and nature refuges.

Potential impacts on roads were outlined as minor disruptions to the road network during construction, including trenching or drilling across roads. The EIS stated that no road closures and no ongoing impacts on the road network were expected as a result of project activities and only minor construction impacts on rail systems were considered possible. Stock routes would be temporarily impacted during construction of gathering systems. Further information on the transport impact assessment is contained in section 4.14 Roads and Transport of this assessment report.

Project infrastructure would cross a number of existing gas and water pipelines and the proponent proposed that the crossings would be either bored or directionally drilled in accordance with agreements with pipeline owners and operators. The proponent also proposed to consult with owners of existing high voltage electricity infrastructure during the detailed design stage of the project.

The project could impact on existing aeronautical facilities during construction. The EIS stated that site specific mitigation methods would be developed, depending on the intensity and scale of aeronautical facilities in proximity to project activities.

Landscape and scenic amenity

The assessed magnitudes of potential impacts to existing visual amenity resulting from project activities and infrastructure within the project area were listed in Table 20.14 of the EIS. The magnitude of visual impact for CGPFs and IPFs was assessed as 'medium' and for all other project activities as low. The estimated significance of landscape and visual impacts of project activities on a range of landscape character areas and sensitive receptors, and a qualitative indication of the level of constraint to project activities associated with mitigating such impacts, was presented in Table 20.17 and Table 20.18 of the EIS.

The EIS stated that views from aircraft would be transitory and unlikely to be significantly impacted by the project.

Potential lighting impacts were identified as being direct light spill that would be visible from dwellings and roads, particularly light from infrastructure areas and project access roads. The EIS concluded that there was unlikely to be a significant visual impact as a result of project lighting.

The potential impact of gas flaring on local sensitive visual receptors was not quantified but was stated to be subject to local factors such as topography, tree cover, buffer distance, and the timing and duration of flaring.

The potential for cumulative impact on landscape and visual amenity in conjunction with projects that had completed or were undergoing an environmental impact statement process, was qualitatively assessed for the EIS and summarised in Table 20.19.

4.8.4 Avoidance and mitigation measures

Land use

The proponent proposed to consult with landholders and the broader community during project planning with the aim of maximising coexisting land use without causing permanent alienation of land or diminished productivity from intensively farmed land. The hierarchy of preferred measures to be used to reduce potential impacts on agricultural land use was stated as the

1. siting of infrastructure
2. development of construction and operations methods that integrate with farm activities
3. application of management controls.

Measures to mitigate impacts on agriculture were proposed to be based on a number of performance objectives that would inform the design, implementation and management of appropriate measures. The stated objectives included:

- integration of project activities and infrastructure with farming operations through consultation with landowners/managers
- avoidance of intensive farming operations and provision of a buffer between animal enclosures and production wells and facilities as agreed with landowners/managers
- siting of production facilities, electricity substations and associated access tracks to avoid or reduce loss of cultivation areas and irrigation infrastructure

- location of medium-pressure pipelines along boundary fences, parallel to the direction of cultivation or soil conservation structures, or in the lowest quality soils to reduce impacts on cultivation and irrigation systems
- minimisation of additional headlands in cultivation paddocks
- minimisation of loss of productive land in controlled traffic paddocks
- maintenance of the operation and effectiveness of soil conservation structures
- location of wells, gathering lines and associated access tracks to not significantly interfere with irrigators
- maintenance of the integrity and efficiency of surface irrigation systems
- maximisation of opportunities to schedule project maintenance activities to suit the cropping cycle
- design and construction of access tracks in cultivation paddocks to maintain the existing hydrologic and hydraulic regime
- minimisation of disturbance and temporary loss of productive land associated with drilling wells by agreement with landowners/managers.

In relation to other land uses, the proponent proposed to

- consult with residents and other sensitive land users, including grazing property managers, to determine appropriate mitigation measures for potential project impacts
- enter into agreements with existing and future coal mine operators to coordinate the extraction of gas
- consult with the holders of mineral exploration permits in relation to project staging and potential additional controls required for access and conduct of exploration activities
- avoid areas that identified for their conservation, tourism or recreational attributes
- consult with the relevant stakeholders so as to minimise disturbance to road use, rail operations and aeronautical facilities
- provide temporary alternative stock route alignments during construction activities that ensure the safety of stock and people.

Table 19.4 of the EIS provided a summary of potential impacts prior to mitigation, proposed mitigation and management measures, and the potential residual impacts assuming successful implementation of proposed measures.

Landscape and scenic amenity

Mitigation measures proposed to address potential impacts to visual amenity included

- retention of existing vegetation and promotion of natural regeneration of vegetation where possible
- re-establishment of vegetation cover on disturbed areas
- colour selection and finishes for key infrastructure elements where practicable
- lighting design such as shielding of lights with hoods and louvers where practicable, and orientating infrastructure to minimise light spill.

The EIS concluded that some local characteristics of the landscape would be altered by the project but that, by and large, the landscape of the project would be able to visually absorb the majority of changes without unduly impacting on scenic amenity. The EIS also noted that detailed landscape and visual assessment studies may be required to inform project infrastructure siting and site-specific mitigation measures, where landscape and visual effects have the potential to impact highly sensitive locations such as residential dwellings.

4.8.5 Major issues raised

References to agencies and organisations in the following text are those who made submissions on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

EHP, DAFF and IRC requested more detail on the measures that would be implemented to mitigate impacts on stock route infrastructure and to avoid impeding of stock movement, consistent with provisions of the *Land Protection (Stock Route Management) Act 2002*. A number of other submissions expressed concern with the potential for interference with the use of the stock routes, outlining potential economic, social and cultural effects of stock route closure or relocation. In response, the proponent stated that more detailed information regarding major project infrastructure locations would be presented at the application stage for an environmental authority, and that where interference with stock route infrastructure could not be avoided, suitable mitigation measures would be implemented following consultation with the relevant stakeholders.

EHP requested further detail on the potential for land use conflict. In response, the proponent acknowledged that land use conflict would occur due to temporary displacement of existing land uses, but stated that this displacement could be adequately mitigated and managed through the proponent's existing measures to minimise land use conflict as stated in the EIS. The proponent proposed that appropriate development planning and consultation with landholders and the broader community could allow coexistence without causing permanent

alienation or diminished productivity of existing agricultural activities. EIS Appendix Q, Land use and tenure technical report, outlined the potential for land use conflicts and proposed measures to minimise such conflicts.

DAFF requested detail on how the project would maintain and improve coexistence with agricultural land use activities and landholders. The proponent referred to the EIS and restated the intention to consult with landowners on the locations of infrastructure and on co-existence during construction and operation.

DAFF stated that management of weeds by the project proponent should include inspection of vehicles and equipment following clean down, and training of staff. In response, the proponent referred to the commitment in the EIS to develop a declared weed and pest management plan in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008) and to the proponent's current Weed and Pathogen Management Procedure.

IRC requested further information on compensation for impacts to strategic cropping land. The proponent advised that such compensation would be in accordance with the *Strategic Cropping Land Act 2011* and Strategic Cropping Land Regulation 2011. This legislation has since been repealed and replaced by the *Regional Planning Interests Act 2014*.

Aurizon expressed concern that the project may have a greater impact on rail operations than was indicated in the EIS. The proponent confirmed the intention to work collaboratively with affected parties, to ensure there would be no disruption to rail operations and stated that the project would comply with all statutory obligations.

In response to concerns raised by Ergon Energy, the proponent advised that servicing and maintenance access requirements for Ergon Energy personnel and equipment would be taken into account where redesign of any Ergon Energy infrastructure was required, and easement holders and/or third party utility providers would be consulted to ensure that any terms of existing easements and services crossings designs requirements were considered in project planning.

Submissions from mining interests raised concerns in relation to development of agreements where mining tenures overlap with the project area, potential sterilisation of coal resources, and the potential for the steel casing used for gas exploration and production to present safety risks to coal mining operations, particularly to longwall operations. In response, the proponent outlined how potential conflicting interests for gas and coal resources was proposed to be addressed through compliance with legislative requirements, consultation and agreement with tenure holders, and through the tenure and environmental authority approvals processes. The proponent stated that steel casing used in gas production wells would not be placed in mineable coal seams and outlined potential benefits of gas extraction that the proponent considered would benefit future coal production.

A submission expressed concern that flaring of gas at each well could have a significant visual impact. The proponent confirmed that each well would require a temporary flare during construction (drilling) and during maintenance workovers which were estimated to occur every two years for each well. Flaring would also occur at FCFs through an 80m high stack. The proponent referred to the EIS assessment of the visual impact of flares which concluded that the visual impact of flaring would be determined by local topography and tree cover between the flare and visual receptor locations, the buffer distance, time of day and duration of flaring.

4.8.6 Conclusion and recommendations

The EIS adequately described the land uses, landscapes and scenic values in the project area, the potential general impacts of the project on these values, and the general measures to be used to minimise and manage adverse impacts. However, specific measures to address land use conflicts were proposed to be developed by consultation and agreement with affected parties, and in accordance with legislative requirements and proponent commitments and objectives stated in the EIS, either during the environmental authority and petroleum lease approval processes, or during the construction phase of the project. Furthermore, the significance of impacts on scenic amenity would not be known until the location and design of project infrastructure were determined during the detailed design phase of the project.

Recommendation – stock routes

Specific measures to maintain the functionality of stock routes should be agreed with relevant stakeholders prior issue of tenure for each stage of the project (or as agreed with stakeholders) and implemented prior to any interference with a stock route.

Recommendation - amenity

Where the project may impact on the landscape and scenic amenity at sensitive locations such as residential dwellings, site specific assessment of visual impact associated with project infrastructure and activities, including lighting and flaring, should be completed prior to final decisions on design and location of project infrastructure, and site specific mitigation measures should be defined and implemented to avoid significant impact.

4.9 Groundwater

EIS section 14 Groundwater described the existing groundwater values within and surrounding the project area and provided an assessment of the potential for these values to be affected by direct and indirect impacts associated with the construction, operation and decommissioning phases of the project. Detailed information on the groundwater assessment was included in EIS Appendix L Groundwater and Geological Technical Report. EIS Appendix M Groundwater Model Technical Report provided groundwater drawdown predictions associated with the proposed CSG production. The EIS described the aquifers of the Bowen Basin, those likely to be affected by the project, and the outcomes of modelling to predict the impacts of the project on these aquifers.

The SREIS section 7 Groundwater provided updated information on groundwater resulting from changes to the project description (SREIS section 3 Project description) and submissions on the EIS, and an updated assessment of impacts on groundwater. Detailed information on the supplementary assessment was contained in SREIS Appendix E Supplementary Groundwater Assessment.

Submissions on the EIS raised a number of issues on the groundwater modelling and the impacts of the project on groundwater and mitigation measures.

4.9.1 Legislative context

The EIS adequately described the legislation, policy and guidelines relevant to identifying groundwater values and avoiding, mitigating and managing impacts on groundwater that applied at the time the EIS was drafted. The SREIS outlined the legislative and policy framework changes associated with CSG developments and the management of groundwater resources since the publication of the EIS.

The Queensland Government regulatory framework includes provisions for assessment and management of the impacts from CSG water extraction on aquifers. The framework includes

1. **P&G Act and the Petroleum Act**¹—Production rights to extract gas and co-produced (associated) water are provided under the P&G Act and the Petroleum Act. These acts give tenure holders the right to take or interfere with groundwater to the extent necessary to extract the desired petroleum/gas.
2. **Water Act**²—Chapter 3 of the Water Act establishes the responsibility for tenure holders to monitor and manage any impacts caused by the exercise of these groundwater rights and to ‘make-good’ any impairment of private bore water supplies. The make-good obligations of a petroleum tenure holder are to undertake an assessment of the bore; and enter into, and comply with, a make-good agreement with the bore owner. These provisions exist because water is found in association with petroleum and gas and it is not practicable to manage the water separately. Chapter 3 also requires the preparation of underground water impact reports (UWIR) on the cumulative impacts of all groundwater users and establishes underground water management objectives.
3. **EP Act**³—The EP Act regulates the management of the associated (co-produced) water once produced. The State’s policy position on this is stated in EHP’s Coal Seam Gas Water Management Policy 2012. It also encourages CSG operators to consider the feasibility of using CSG water to meet make-good obligations as part of developing their CSG water management strategies and plans.
4. **Water Resources (Great Artesian Basin) Plan 2006** – statutory plan for groundwater management of the Great Artesian Basin (GAB) in Queensland. The southerly tenement of the proposed project (ATP 1025) includes a portion of the GAB recharge area. Due to the limited overlap with the Mimosa Management Area, the above mentioned GAB plans are of limited relevance to the current project.
5. **Fitzroy Basin Water Resource Plan 2011** - The Water Resource Plan (WRP) provides for the allocation and management of water in the Fitzroy Basin. The proposed project northern tenements are located within the declared Isaac Connors Groundwater Management Area (GMA), as defined under Chapter 2, section 7, Schedule 3, Schedule 4, and Schedule 7 of the Fitzroy Basin WRP. Water take or interference with groundwater sources would require a licence.

Note that the State government is currently amending the *Water Act 2000* including

¹ The P&G Act and the *Petroleum Act 1923* are administered by DNRM.

² The EP Act and Chapter 3 of the Water Act are administered by EHP.

³ The EP Act and Chapter 3 of the Water Act are administered by EHP.

- converting water licences to water allocations
- facilitating water-related development opportunities for large scale projects
- establishing a more consistent framework for underground water rights for the resource sectors and for the management of impacts on underground water due to the resource sectors' activities.

Other legislation that may regulate the use of CSG water includes

- *Waste Reduction and Recycling Act 2011*—for authorising particular and general beneficial uses of CSG water and what would otherwise be coal seam gas-related wastes.

The Code of Practice for Constructing and Abandoning CSG Wells in Queensland under the P&G Regulation specifies environmental and safety requirements.

4.9.2 Assessment methodology

The EIS groundwater impact assessment adopted a significance assessment approach. This accounted for the significance of potential impacts to the groundwater system environmental values and the magnitude of potential impacts on those values.

The EIS groundwater impact assessment comprised

- a desktop study of geological and hydrogeological information to gain an understanding of the existing environment using information from relevant publications, government databases, published literature and reports of similar projects in the Bowen Basin. EIS section 14 Figure 14.1 described the groundwater study area.
- the development of a numerical groundwater model to predict the groundwater drawdown response in particular aquifer units as a result of CSG extraction. This model also presented cumulative drawdown predictions that included extraction associated with adjacent coal and gas projects where data was available.

The EIS groundwater model used MODFLOW-SURFACTM (version 4) and Groundwater Vistas (version 6) software. The model predicted the groundwater drawdown response in aquifers as a result of CSG extraction under two scenarios

- **scenario 1 base case:** included production extraction in accordance with forecast CSG water extraction for the project only (in isolation from other industrial developments)
- **scenario 2 cumulative case:** included scenario 1 base case plus extraction from the Moranbah Gas Project and by licenced groundwater users included in the DNRM Water Management System database.

SREIS Appendix E provided an assessment of the level of uncertainty associated with the EIS model's adopted parameters. Groundwater drawdown for the base case scenario (scenario 1) was found to represent close to the 'worst case' predicted drawdown in this uncertainty analysis. The SREIS provided a summary of the predicted maximum groundwater drawdown impacts in the key aquifers for the scenarios.

The SREIS augmented the EIS studies with further studies on groundwater quality. An independent review of the EIS groundwater model was conducted with reference to the Australian Groundwater Modelling Guidelines. SREIS Appendix E Groundwater Assessment provided the details of the review. The peer review deemed the model to be appropriate for estimating regional groundwater impacts from the proposed project, and agreed that it conforms to best industry practice, is fit for purpose, and fulfils the appropriate criteria of the Australian Groundwater Modelling Guidelines.

To address subsidence and seismicity the groundwater assessment also included

- a ground motion study of the nearby Moranbah Gas Project (subsidence)
- reports on the potential impacts of CSG extraction in the Surat and Bowen basins and other gas fields overseas (subsidence)
- microseismic mapping during the hydraulic stimulation of vertical CSG wells near Moranbah for determining the geometry of fractures during well hydraulic stimulation (seismicity)
- reviews of studies, both in Australia and overseas, on hydraulic stimulation and sub-surface energy release during fracturing (seismicity).

4.9.3 Existing values

EIS section 14 Groundwater and SREIS section 7 Groundwater described the aquifers of the Bowen Basin, including those likely to be affected by the project.

The EIS identified waterways with sustained groundwater baseflow assumed to maintain groundwater dependent ecosystems (GDE) including the Connors River (upper and mid reaches), Funnel Creek (upper and mid reaches), Lotus Creek, and Isaac River (lower reaches). The Isaac River sub-basin of the Fitzroy Basin covers most of the

project area.

The environmental values of the Isaac River sub-basin of the Fitzroy Basin are described in Schedule 1 of the EPP (Water). The scheduled environmental values for groundwater to be enhanced or protected in the area are the qualities biological integrity of aquatic ecosystems, suitability for recreational use (primary recreation), suitability for minimal treatment before supply as drinking water, suitability for use in primary industries (irrigation, farm supply, stock water) and cultural and spiritual values. The EIS detailed each of the values in the project area and summarised these values in EIS section 14 Table 14.12.

The EIS documentation noted that the project area has been largely cleared for agriculture, cattle grazing and coal mining.

No known springs or watercourse springs were located in the project area (SREIS section 7 Figure 7.6). SREIS section 7 stated that the geological faults in the project area have limited permeability and are more likely to behave as barriers to groundwater flow, as opposed to conduits. 19 known spring vents and nine watercourse springs were identified within a 50km buffer around the outside of the project area. The 19 known spring vents were considered to be recharge springs and were all located to the south of Blackwater in the Blackdown Tableland with the source aquifer considered to be primarily the outcropping Rewan Formation or Clematis Sandstone, as well as Precipice Sandstone and single instances of younger Tertiary sandstone and Quaternary sediments. Two of the nine known watercourse springs were located in the Blackdown Tableland and occur where groundwater discharges to Mimosa Creek and a tributary of Mimosa Creek. The remaining watercourse springs were associated with the Isaac-Connors catchment.

SREIS section 7 Table 7.1 provided a summary of the nationally important wetlands within the study area, all of which were located within the 50km buffer around the project area including Lake Elphinstone (which may be dependent on groundwater) and Eungella Dam (not thought to be groundwater dependent).

Eight groundwater quality zones were identified in the project area (EIS section 14 Figure 14.7) with relevant groundwater quality data indicating a range of fresh to moderately saline shallow and deep aquifer groundwater. The groundwater quality map (Figure 14-7) showed the regionally dominant 'Isaac-Dawson' groundwater quality zone (No. 34) around Moranbah and Middlemount where groundwater was slightly to moderately saline, sodic, with an ionic balance dominated by Na⁺ and Cl⁻. The water was described as unacceptable for domestic use or stock or crop irrigation. SREIS section 7 Table 7.2 provided a summary of the groundwater quality for each aquifer.

Data from several hundred bores in the project area show that water levels (unconfined shallow aquifers) range from 5 to 20 mbgl (metres below ground level). Groundwater levels from CSG bores and private bores near Moranbah show groundwater levels in the Isaac River Alluvium, Tertiary basalt and other shallow sediments ranging from 9 to 29 mbgl. Limited data were available on any groundwater interaction between alluvial aquifers and adjacent and underlying aquifers.

Groundwater use was detailed in EIS section 14 Table 14.10 and Table 14.11. Groundwater uses included 35 groundwater allocations (totalling 14,165 ML/yr) in the Isaac-Connors sub-catchment and four allocations (totalling 3,034 ML/yr) in the McKenzie sub-catchment. Of the 14,165 ML/yr of groundwater allocations, 50% were for irrigation, and 25% were for intensive stock watering, domestic and town supply, commercial, industrial, and mining use. The remaining 25% was allocated to other uses such as amenities, aquaculture, education, and roadwork. A number of the irrigation entitlements were yet to be taken up and existing irrigation entitlements were not fully utilised.

The main source of groundwater (12,859 ML/yr or 91% by volume) was stated as being from alluvial aquifers. Minor groundwater sources include basalt (424 ML/yr), sedimentary rocks and coal seams of the Blackwater Group (842 ML/yr) and sedimentary rocks of the Back Creek Group (40 ML/yr).

4.9.4 Predicted groundwater impacts

EIS section 14 Groundwater and SREIS section 7 Groundwater described the modelling used to predict the impacts of the project on the Bowen Basin aquifers likely to be affected, and the predicted groundwater impacts. The potential groundwater impacts identified included reduced groundwater supply, aquifer depressurisation and groundwater quality impacts. The activities causing impacts addressed by the EIS included subsurface activities such as drilling and CSG extraction, as well as surface activities such as fuel, chemical and CSG water storage.

The impacts considered in the EIS included direct impacts caused by coal seam depressurisation, indirect impacts caused by coal seam depressurisation and impacts caused by field and infrastructure development, operation and decommissioning.

The SREIS described an updated project of 33 drainage areas each with a reduced 6km radius of influence compared to the EIS total of 17 drainage areas with a 12 km drainage radius (SREIS section 3 Figure 3.1). SREIS section 7 stated that the significance of residual impacts on each groundwater system was found to be low for the shallow groundwater system, low for the intermediate groundwater system, and very low to low for the coal seam

and deep groundwater systems. The assessed groundwater – surface water interaction across the project area was stated to be not markedly altered by the changes to the project described in the SREIS.

Depressurisation

SREIS Appendix E stated that indirect impacts caused by coal seam gas depressurisation include groundwater quality impacts caused by aquifer flux inter-connectivity, reduced groundwater supply to existing or future groundwater users, reduced groundwater availability for Groundwater Dependent Ecosystems (GDE) and for cultural and spiritual values, and subsidence.

The Clematis Sandstone was described as being underlain by the Rewan Formation and the conceptual hydrogeological model (EIS section 14 Figure 14.6) showed that the Rewan Formation and Blackwater Group interburden aquitards would limit the potential for vertical propagation of CSG depressurisation impacts to overlying aquifers. It was stated that drawdown impacts on springs associated with the Blackdown Tableland would be unlikely because the springs are associated with local groundwater flow systems. These recharge springs are disconnected from groundwater associated with the underlying target coal measures. These springs are also separated from the underlying aquifers by the Rewan Formation, which is considered to be a regional aquitard.

Subsidence

The EIS stated that subsidence would be likely to occur after extraction of water from aquifers with the subsidence caused by shrinkage of the coal seam due to gas extraction and compression of the coal seam and overlying formations due to reduced groundwater pressures. Subsidence was predicted to be similar to the measured and calculated range for the Moranbah Gas Project, of 15mm to 75mm. The subsidence potential and observed effects from CSG development in the Moranbah Gas Project area was stated as substantially less than that from longwall coal mining in the area (which was typically in range 1-3m). The project was considered to be analogous to the Moranbah Gas Project and subsidence resulting from CSG development by the project was expected to be broadly distributed with no differential subsidence. SREIS Appendix E provided detailed subsidence predictions.

Seismicity

SREIS section 7 stated that the Bowen Basin was relatively aseismic, with only a few small seismic events recorded. Evidence presented included the generation of few structural landscape features in the Bowen Basin resulting during recent geological times reflecting limited tectonic activity. Measurements were presented that showed that recorded seismic events could only be detected by sensitive equipment and were not perceptible to the human senses at the surface.

SREIS Appendix E stated that induced seismic events were non-cumulative in magnitude terms and the risk associated with induced seismicity in the Bowen Basin due to hydraulic stimulation was very low.

Drawdown

SREIS Appendix E Supplementary Groundwater Assessment Table 8.1 summarised the potential direct and indirect impacts from depressurisation of the Rangal Coal Measures and Moranbah Coal Measures, and SREIS Appendix E Table 8.4 highlighted the modelled maximum drawdowns in selected target aquifers for the cumulative scenario (scenario 2) and for the Bowen Gas Project only scenario (scenario 1) at the end of CSG production (40 year operation) and 50 years after project operations cease.

Where groundwater drawdown in an aquifer is predicted to exceed the bore trigger threshold specified under the Water Act (2m for unconsolidated aquifers and 5m for consolidated aquifers) existing groundwater users may have productive and/or consumptive uses impaired. Modelling predicted >5m drawdown at the end of coal seam gas production in the target coal formations over extensive parts of the project area and in some areas outside of the project area, (primarily associated with the Leichhardt and Vermont seams) with limited recovery in the 50 years after the cessation of coal seam gas production. For the shallow groundwater system, modelling predicted >2 m drawdown in isolated areas, including isolated instances outside of the project area (refer SREIS Figure 8.2a). For the intermediate groundwater system, modelling predicted >5m drawdown in isolated areas (refer SREIS Figure 8.2b) with continuing drawdown over the 50 years after the cessation of gas production although the areas of drawdown in excess of 5m was predicted to remain in isolated areas.

For the purpose of assessment of potential impact magnitude on springs, other GDEs and cultural and spiritual sites, the spring trigger threshold of 0.2m groundwater drawdown was adopted with an additional 10 km buffer zone applied beyond the extent of the predicted 0.2m drawdown, consistent with the approach adopted for the Surat CMA UWIR. A single spring was identified within the 10km buffer beyond the 0.2m drawdown contour for the Leichhardt seam. This spring's source aquifer is considered to be Cainozoic sandy gravel, disconnected from the underlying CSG formations. No drawdown was predicted at this location in formations overlying the Leichhardt seam and therefore this spring is not expected to be impacted. The SREIS stated that there may be some isolated areas, particularly where surface drainage channels coincide with outcropping coal measures, where drawdown of groundwater in the coal measures may impact on GDEs reliant on the subsurface presence or surface expression

of groundwater, but these areas were expected to be small due to poor quality groundwater and limited yield.

Modelling predicted that the springs located near Blackwater were located beyond the 10km buffer zone of the 0.2m drawdown for shallow and intermediate aquifers (refer SREIS Figure 8.1). Other GDEs, including Lake Elphinstone, may be affected by predicted drawdown in the shallow and intermediate groundwater systems. Lake Elphinstone is located within the 10km buffer zone of drawdown for the shallow groundwater system, therefore the likelihood of impact is low.

Post-production groundwater level recovery was predicted to be slow, with coal seam baseline pressures unlikely to be re-established after 1000 years. The rate of groundwater recovery may be further slowed by the adjacent existing and possible future mining operations.

It was stated that the model showed that faults in the Bowen Basin would behave as barriers to groundwater flow along and across fault planes near CSG wells.

Cumulative impacts

Mine dewatering and associated depressurisation potentially extended five to 30 km from the operating coal mines near Moranbah. The SREIS stated that there were 13 operational coal mines in the project area. A further 28 coal mines operated near the project area and 13 more are being planned. Information was presented in SREIS Appendix E Figure 8.3, Table 8.5, Table 8.6, Table 8.7, and Table 8.8 describing the groundwater impacts of these projects based on publicly available information. Expansion of coal mining in the Bowen Basin was stated to be contributing to cumulative impacts on groundwater resources.

The SREIS stated that the revised water production (life of project reduction from 274GL to 153GL) and the estimation of actual non-coal seam gas usage as less than 20% of the entitlements as recorded in the DNRM Water Management System Database, indicated the cumulative impact modelling of groundwater drawdown (see drawdown estimations above) presented in the EIS was likely to be an overestimation.

4.9.5 Managing impacts - avoidance, mitigation and offsetting measures

SREIS Appendix E section 9 set out the impact mitigation measures proposed for the revised project (see Appendix 5 of this assessment report for a summary of the revised project). The assessment stated that the implementation of the proposed mitigation measures for each of the identified impacts reduced the overall significance of residual impacts.

The EIS groundwater impact assessment (EIS section 14) proposed commitments for management of potential groundwater impacts (EIS Appendix D). SREIS section 7 presented a revised set of commitments (SREIS Appendix O) which detailed commitments no longer relevant, combined commitments, and additional commitments.

The EIS documents (SREIS Appendix O) describe groundwater impact mitigation commitments including actions dealing with

- nominated corrective actions of any contamination of groundwater
- groundwater monitoring reporting
- implementation of a regional groundwater monitoring network
- Underground Water Impact Report (UWIR) requirements for each petroleum tenure
- Establishment of groundwater quality and levels
- Establishment of datum levels for each aquifer system
- GDE and supporting aquifer identification and assessment
- construction and decommissioning of CSG production wells in accordance with relevant codes
- avoidance of use of oil-based drilling fluids
- avoidance of unnecessary vegetation clearing
- design, construction and management of CSG dams in accordance with EHP guidelines and EA conditions
- accounting for groundwater conditions when locating CSG infrastructure
- installing and regularly monitoring groundwater monitoring bores for identification of impacts arising from leakage of water
- inclusion of existing landholder bores in development and implementation of Baseline Assessment Plans
- periodic well integrity checks

SREIS Appendix E stated that the following proposed EIS mitigation options were found to be no longer feasible and/or were unnecessary

- injection of treated coal seam gas water to enhance shallow and deep aquifer recovery
- modelling of groundwater drawdown management options of substitution and injection
- groundwater modelling simulations for suitability of aquifers in make good measures

- monitoring for coal seam subsidence and land subsidence.

The SREIS identified additional groundwater management measures (included as commitments in SREIS Appendix O) including

- UWIR and make good obligations including water monitoring strategy, springs impact management strategy (SIMS), and bore assessments. A commitment was made to establish a UWIR for all tenements in the project area within which production testing or production of CSG are undertaken, and not just the tenements in the Surat Cumulative Management Area (CMA)
- management practices to protect identified environmental values to be included in any EA application, where applicable, including a groundwater monitoring program
- implementation of the Code of Practice for Construction and Abandoning Coal Seam Gas Wells in Queensland
- development of a procedure for hydraulic stimulation addressing site selection, a stimulation impact monitoring program for each hydraulic stimulation campaign, as well as monitoring stimulation activities in accordance with Petroleum & Gas Regulation 2004 and EP Act requirements
- impacted sites of Indigenous cultural and spiritual importance with dependence on groundwater to be subject of mitigation measures where required and as consulted with traditional owners.

A commitment to develop a SIMS was made for any springs found to be potentially impacted. The SIMS would be developed using the assessment and management methodology set out in the Surat CMA UWIR SIMS. The SREIS used this methodology for reassessing groundwater impacts to springs and identified a single potentially affected spring located outside the project area and within the Surat CMA. This spring is subject to an existing SIMS under the Surat CMA UWIR.

A CMA was declared for the Surat Basin and the southern area of the Bowen Basin on 18 March 2011. The Surat CMA includes the southern-most tenement (ATP 1025) in the project area. The remainder of the project area does not fall within a CMA. The proponent would be required to prepare Underground Water Impact Reports (UWIR) for operations within the project tenures.

SREIS Appendix E detailed the proposed content and target aquifers of the water monitoring and management strategy including a regional groundwater monitoring program and groundwater monitoring network. The proposed content of any application for an EA was detailed including development of GDE management strategies (including Lake Elphinstone), groundwater monitoring, heritage sites management, and regulated dam seepage monitoring and management.

Make good arrangements

The *Water Act 2000* would require the proponent to implement make good measures where third-party bores were found to be impaired. Conditions would require the proponent to complete a bore assessment for all bores located within an immediately affected area to determine whether the bore has, or is likely to have, an impaired capacity. The make good measures would continue over the period of impact to address supply of water for the same period.

The make good measures would usually be negotiated between the proponent and the bore owner and could include arrangements such as modifying the pumping infrastructure of the bore, modifying or deepening the bore, installing a new bore into the same or another aquifer, alternative source(s) of water or compensation as agreed.

The proponent addressed make good requirements in SREIS Appendix O.

4.9.6 Major issues raised

References to agencies and organisations in the following text are those who made submissions on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

Numerical model

OGIA requested improvements to the presentation of conceptualisation of the groundwater system with clearer schematics and diagrams. OGIA also advised that there is potential to improve the groundwater conceptualisation documented in the EIS through additional data and field investigations and that this should be completed before and during operations. However, OGIA acknowledged that the EIS documents presented a reasonable groundwater model and addressed potential cumulative impacts.

Hydraulic stimulation

DEWS requested information on the likely extent of vertical hydraulic conductivity following hydraulic stimulation. The proponent responded that fractures in the Bowen Basin were well studied and that they propagate in a horizontal plane not vertical. Studies have shown that fractures would be contained within target intervals with likely maximum vertical extent of approximately 32m (SREIS Appendix E section 5.7.2). Vertical hydraulic conductivity in the overlying and underlying formations would not be likely to be affected by hydraulic stimulation.

DEWS advised that hydraulic stimulation should not occur within 32m of underlying or overlying formations. The proponent advised that planning and development stages of hydraulic stimulation events would involve a detailed approach including understanding stress orientation, stress magnitude and contrast and specification of vertical fracture containment. The proponent noted that, given the heterogeneity of the Basin, each site would be different and would require specific assessment and management of each hydraulic stimulation event.

The conceptual site model developed as part of the risk assessment includes the identification of overlying and underlying aquifers. Where unacceptable risks to overlying or underlying aquifers were identified, mitigation measures were proposed to be implemented prior to commencing the hydraulic stimulation event

DNRM and DEWS requested further information on groundwater impacts from hydraulic stimulation in areas where the Rewan Formation is not present. The proponent responded with further work showing the larger extent of the Rewan Formation and stated that in areas where the Rewan Formation does not exist there is a general correlation with un-prospective shallow coal seams for which hydraulic stimulation would be unlikely to occur (SREIS Appendix E).

DEWS and EHP raised issues with the risk of water quality impacts from hydraulic stimulation in overlying and underlying formations. The proponent stated that water quality impacts to either the Rewan Formation or Back Creek Group aquifers as a result of hydraulic stimulation of the Blackwater Group target formation would be unlikely as there would be no pressure gradient and confining units would not be subject to stimulation.

Groundwater quality

DEWS also referred to EIS section 14 Groundwater Table 14.8 and Figure 14.7 which showed 40% of the project area not having been assessed for groundwater quality. DNRM requested further details on groundwater quality monitoring. IESC and NRM referred to the need for further groundwater quality data before commencement.

The proponent responded that additional work presented in SREIS section 7 Groundwater based on additional desktop sources of groundwater quality data provided sufficient spatial distribution for a regional overview of groundwater quality incorporating the geological formations present. EA conditions would require baseline water quality data to be provided before commencement of activities that may impact groundwater. The proponent committed to continually update the baseline as information from groundwater monitoring and assessments was developed.

Aquifers

DEWS and DNRM referred to statements in EIS section 14 that the connection between the Quaternary/Tertiary aquifers and the underlying Triassic/Permian strata aquifers was not known. The proponent responded with further details on the location of the Rewan Formation and where it is absent (SREIS section 7 and Appendix E) and provided conservative estimates of groundwater drawdown in overlying formations such as the shallow alluvium.

The proponent committed to manage non-spring groundwater-dependent ecosystems by identifying potential GDE landscapes, modelling to predict impacts, identifying GDEs at risk of impact through a risk assessment and where GDEs are identified as being at risk of impact, undertaking further assessment which may include field studies and monitoring to ascertain connectivity of GDE to underlying aquifers.

DEWS also commented on the transfer of water to underlying aquifers in some reaches along the Isaac and other streams where the Rewan Formation is not present. The proponent stated that water courses may gain and lose groundwater at different times of the year. The EIS (section 14) stated that watercourses are mostly losing watercourses and detailed when systems may gain or lose groundwater. Based on work completed since the EIS, the extent of the Rewan Formation used in the EIS groundwater modelling was found to be understated.

Monitoring

DNRM requested further information on the placement of monitoring bores and the monitoring strategy. The proponent provided further information in SREIS section 3 including the need for an approved UWIR, and final monitoring bores located once the production well layout, surface infrastructure and landholder bore locations that may be impacted are confirmed.

EIS section 14.9.5.4 Groundwater relates to groundwater monitoring of potential impacts to groundwater values from surface infrastructure (e.g. seepage from dams). The location of bores that make up these groundwater monitoring networks was stated as not identified until the location of surface infrastructure is finalised.

As part of an environmental authority (EA), the proponent would be required to identify the location of surface infrastructure, and accordingly, additional information on the location of the site impact groundwater monitoring network, the parameters to be monitored and the appropriate frequency and method of monitoring.

Table 14.20 outlines the initial site impact monitoring strategy, but it is noted that this strategy would be further refined as the location of project infrastructure is finalised. The proponent committed to determining the number of monitoring bores and their location by accounting for site-specific hydrogeology, preferential pathways, and

potential receptors of impacts. The list of parameters included in Table 14.20 reflects the initial monitoring strategy which would be revised as site-specific details are made available.

Any EA would need to include details on the location of surface infrastructure, site impact groundwater monitoring network, the water quality parameters to be monitored (see recommended conditions for an EA at Appendix 3 of this assessment report). The proponent presented monitoring details in SREIS Appendix E.

Several submissions, including from DNRM and IRC, requested further information on cumulative impacts arising from groundwater activities in the project area. The proponent provided further information (SREIS Appendix E section 8.3) on likely cumulative impacts as summarised in section 4.9.4 of this assessment report.

Make good water

IRC and private submissions requested further details on make good water arrangements and the risk of long term impacts on water quality and supply for local industry. The proponent detailed the make good requirements under the *Water Act 2000* (SREIS Appendix E). Section 4.9.5 of this assessment report summarises these arrangements. The risk of groundwater quality impact was addressed by several EIS documents, including details on numerical groundwater modelling and predicted the groundwater level response in aquifers. The recommended EA conditions (Appendix 3 of this assessment report) also address operational requirements for groundwater management. The proponent stated that both water volume and water quality may trigger make good arrangements.

Drawdown

Private submitters, FBA, and several government agencies requested further information on predicted groundwater drawdown and how the project would contribute to the regional drawdown impacts from all projects in the area. The proponent stated that the projects' groundwater drawdown impacts were assessed using peer reviewed numerical groundwater modelling, which predicted the drawdown due to coal seam gas activities would be very small in the shallow groundwater system (see EIS Appendix L Groundwater and Geology Technical Report, and SREIS Appendix E Supplementary Groundwater Assessment). The proponent stated that it is standard practice for groundwater models to be calibrated to the available data, and then over time, to be 'validated' as new data becomes available. The drawdown predictions were therefore proposed to be validated as the project developed.

Overlapping resources

DEWS questioned how the CSG wells proposed for hydraulic stimulation in likely future open cut coal mining areas would be managed and whether such wells should not be developed in these areas. The proponent detailed the requirements of the *Petroleum and Gas (Production and Safety) Act 2004* and the *Mineral Resources Act 1989*, which require negotiations leading to Co-Development Agreements and / or Coordination Arrangements. These documents include, amongst other things, agreement between the CSG proponent and the relevant overlapping coal party, as to the location of wells in coal seams to be mined in the future. In addition to well locations, the following issues are also required to be addressed between the parties

- minimising interferences to coal activities, gas activities and all infrastructure relating to coal and gas operations
- safety provisions to minimise risk to future safe and efficient mining and gas extraction
- undertakings to work in good faith to facilitate access to abandoned areas, or areas where wells may be located safely proximate to mining operations.

New legislation is under development (Mineral and Energy Resources (Common Provisions) Bill 2014) to deal with future overlapping tenement areas. A Joint Development Plan may be required to record the coal and gas proponent's agreement to well locations. This may be the primary document, rather than Co-Development Agreements or Coordination Arrangements referred to above.

Other advice

The Independent Expert Scientific Committee (IESC) provided advice on the EIS (May 2013) and the SREIS (July 2014). The proponent responded to both submissions in documents not included in the SREIS. DNRM's (including OGIA) advice on the EIS and SREIS addressed similar issues. IESC and DNRM advice addressed the need for further studies, updates and information, including

Monitoring

- develop an adequate monitoring strategy to confirm predictions that faulting does promote aquifer connectivity. The proponent should nominate the further studies required to fully understand the extent of fault systems
- develop a groundwater monitoring strategy identifying the work that would occur as the gas fields develop.

Modelling

- validate the groundwater model parameters and calibrate using spatially representative hydrostratigraphic and potentiometric field data. Long term pump test data should be used validate the model's aquifer parameters.

Time-series groundwater level or pressure data is required to enable transient calibration of the regional groundwater model.

- address the further conceptualisation of groundwater processes accounting for hydrogeological variation across the northern Bowen Basin by providing details of the further conceptualisation studies to be undertaken and changes that have been made to earlier conceptualisations
- regularly update the existing numerical groundwater class 1 model with data collected before and during operations
- update predicted drawdowns for each groundwater model layer and not only for drawdowns stated for selected formations as presented in SREIS Appendix F
- undertake groundwater monitoring to confirm model predictions that aquifer interconnectivity risks are low
- undertake further field studies to characterise local scale impacts, verify the groundwater conceptualisation and establish a robust baseline
- update the extent and representation of the Rewan Formation in the groundwater model.

Faults

- undertake further work during operations to confirm that faults present in the Bowen Basin (including subvertical faults and folds) do not provide preferential pathways for groundwater flow
- undertake drainage field planning to avoid all faults that are seismically active
- identify areas not addressed in existing faulting studies and map faulting, assess the risk of aquifer connectivity and install groundwater monitoring wells to address this risk.

Subsidence

- undertake further work on groundwater movement as a result of subsidence and induced seismicity by conducting reviews, periodically through the life of the project and beyond, to confirm no adverse subsidence impacts due to CSG activities. Reviews should include liaison with national jurisdictions including Geoscience Australia and Bureau of Meteorology, regular review of seismicity data, identification of seismically active areas, and implementation of safety measures.

Migration

- develop procedures to address potential coal seam gas migration including the mechanism of migration, the gas volume in wells and any increase in gas concentrations in natural water features.

Groundwater quality and groundwater dependent ecosystems

- characterise existing groundwater quality
- complete preliminary GDEs mapping and impact studies.

Recharge

- address data gaps on recharge for the project water balance

Proponent response

The proponent responded in detail to the request for further work and to both sets of IESC advice. The response referred to commitments to undertake further work on the groundwater model, monitoring and assessment. The proponent contended that the SREIS presented adequate further work for the EIS stage of project planning including

- uncertainty analysis of the groundwater modelling results
- horizontal flow barrier modelling to determine the behaviour of groundwater at faults
- analysis of faulting in the Bowen Basin and its susceptibility to seismic events from hydraulic stimulation activities
- analysis of historic and potential subsidence
- water quality data and aquatic ecology survey results from project area mining developments addressing the past three years and aquatic ecology survey results addressing the early wet and late wet seasons over a 12-month period
- independent peer review of the numerical groundwater model, confirming
 - that the model conformed to best industry practice, was fit for purpose, and fulfilled the appropriate parts of the Australian Groundwater Modelling Guidelines
 - that the model had many of the features of a higher class model and was classified a Class 1 model due only to the limited availability of regional groundwater data
 - the modelled predicted drawdown (from an uncertainty analysis)
- a ground motion study of the Moranbah Gas Project as an analogue for the project on the low likelihood of subsidence impacts
- cumulative impact studies using combined extraction data from licensed users and mines

- regional conceptual water balance
- review of regional hydrogeology and the extent of the Rewan Formation.

4.9.7 Conclusions and recommendations

The *Petroleum and Gas (Production and Safety) Act 2004* and *Petroleum Act* provide tenure holders the right to take or interfere with groundwater to the extent necessary to extract petroleum/gas. The *Water Act* requires CSG tenure holders to monitor and manage the impacts caused by the exercise of these groundwater rights and to make-good any impairment of private bore water supplies. The proponent has committed to comply with these requirements.

The proponent provided detailed groundwater modelling in the EIS. The validity of the model was reviewed in the SREIS with consideration of the revised project description, including revised water and gas extraction rates and quantities. OGIA advised that the EIS documents reasonably addressed cumulative impacts on groundwater and provided an acceptable assessment of the risks to groundwater from the project. The groundwater impacts on aquifers would be regulated under Chapter 3 of the *Water Act 2000*, including the periodic reassessment of data gathering programs and periodic reassessment of potential impacts. OGIA and DNRM advised that any cumulative impact issues resulting from the interaction of CSG impacts with mining impacts is not a basis to establish a cumulative management area under the *Water Act*. The potential for cumulative impact to groundwater and the need for appropriate management responses would be a matter for ongoing review through underground water impact reporting under the *Water Act*.

The EIS modelling indicated that only a very small amount of drawdown would occur in the shallow groundwater system, based on the extent of the predicted 2 m drawdown (refer Figure 8-2a of the SREIS Appendix E).

In the context of existing and likely coal projects and other CSG projects in the Bowen Basin, it was concluded that the groundwater modelling to date indicates that the likely impacts of drawdown of groundwater were acceptable and could be managed through existing regulatory mechanisms.

The possible proximity of the proponent's proposed treated CSG water discharge points to the intakes for town water supply schemes along the Isaac River would necessitate consideration as part of any EA application to authorise water discharges.

Appropriate conditions for groundwater management are included in the recommendations for EA conditions in Appendix 3 of this assessment report.

Recommendation – EA application

The proponent should further address groundwater and associated CSG water management requirements under the *EP Act* and *Water Act 2000*. The proponent has committed to providing information relevant to CSG water management to support applications for environmental authorities under the *EP Act*. The suite of information required under the *EP Act* is outlined in Appendix 3 of this assessment report and in relevant EHP guidelines.

Recommendation – beneficial use approval

The proponent should address the information requirements for any application for beneficial reuse of treated CSG water including a beneficial use approval under the *Waste Reduction and Recycling Act 2011* and *Environmental Protection Act 1994*.

Recommendation – recycled water management & amended legislation

Any proposed treated CSG water discharges entering watercourses upstream of the urban water supply schemes for townships along the Isaac River or any other waterway proposed to receive discharges, should be detailed by the proponent. The *Water Supply (Safety and Reliability) Act 2008* legislation was recently amended. These amendments commenced on 1 July 2014 and removed the requirements for proponents to apply for recycled water management plans (RWMP) or exclusion decisions (ED) when intending to discharge or inject CSG water to a water source. The proponent should address public health conditions for drinking water under the *EP Act* through environmental approvals and the *Waste Reduction and Recycling Act 2011* through beneficial use approvals.

Recommendation – legislative requirements

The proponent should further address, as necessary, the requirements of the

- *Water Act 2000* including the Burdekin and Fitzroy Water Resource Plans, codes, and guidelines
- CQ Regional Plan as well as the Mackay Isaac and Whitsunday Regional Plans
- information for an application and any approval conditions of any environmental authority under the *EP Act*
- requirements under the *Waste Reduction and Recycling Act 2011* for the beneficial reuse of CSG water.

Recommendation – project design and groundwater modelling requirements

The proponent should address groundwater information and modelling issues discussed in section 4.9.6 of this assessment report.

- develop an adequate strategy, including further studies (if required), to confirm predictions that faulting does not promote inter aquifer connectivity.
- develop a groundwater monitoring strategy identifying the work that would occur as the gas fields develop
- address the further conceptualisation of groundwater processes accounting for hydrogeological variation across the northern Bowen Basin by providing details of the further conceptualisation studies to be undertaken and changes that have been made to earlier conceptualisations
- develop a UWIR for the project tenures that sets out report obligations that require the establishment of a Water Monitoring Strategy and where relevant, a Springs Impact Management Strategy
- develop through the UWIR and Water Management Strategy periodic reviews and monitoring, ongoing updates to the characterisation of local scale impacts, verification of the groundwater conceptualisation and establishment of a robust baseline
- undertake groundwater monitoring to check model predictions that aquifer interconnectivity risks are low
- undertake further work during operations to confirm that faults present in the Bowen Basin (including subvertical faults and folds) do not provide preferential pathways for groundwater flow
- undertake drainage field planning to avoid all faults that are documented to be seismically active
- provide for a suitably qualified person to undertake further work on subsidence as a result of groundwater movement and induced seismicity in relation to the proponent's activities by conducting reviews periodically through the life of the project and beyond, to confirm no adverse subsidence impacts due to the proponent's CSG activities. Reviews should include liaison with national jurisdictions including Geoscience Australia and Bureau of Meteorology, regular review of seismicity data, identification of seismically active areas, and the implementation of safety measures
- develop procedures to address potential coal seam gas migration from the proponent's activities
- regularly update the existing numerical groundwater class 1 model with data collected before and during operations and review predicted drawdowns for key aquifers.

Recommendation – cumulative impacts

The proponent should contribute data and advice to any quantitative assessment of cumulative impacts to be implemented by agencies.

4.10 Surface water

This section describes surface water values potentially affected by the project, potential impacts on these values, and proposed mitigation measures. The issues assessed include overland flow, flooding, water quality, the potential discharge of CSG water to surface waters, erosion and sedimentation, stormwater management, the management of hazardous substances, and potential effects of subsidence around wells.

Surface water values and potential impacts on surface water values were described in EIS section 15 Surface water. Technical information, including overland flow assessments and flood modelling, was addressed in EIS Appendix N Surface Water Technical Report.

A number of other matters addressed by the EIS were identified as having potential impacts on surface waters. The adequacy of the EIS in assessing these related matters is assessed in sections

- 4.7 Geology and soils - erosion and subsidence
- 4.9 Groundwater – subsidence and discharge of CSG water
- 4.11 Aquatic ecology - impacts to aquatic ecology.
- 4.13 Hazard and risk - catastrophic events such as dam failure, uncontrolled releases, extreme weather events, and the management of potential contaminants and hazardous substances
- 4.20 Waste - the management of hydrotest water and CSG water.

4.10.1 Assessment methodology

EIS section 15 provided a desktop review of existing information on surface waters within the project area and surrounding sub-basins, an overview of field surveys of surface water, hydrology, geomorphology and condition, and a general description of existing and potential surface water uses.

Field surveys were conducted for water quality, geomorphology and benthic sediments at sites indicated in EIS Appendix N between April and May 2012. Additional water sampling was also undertaken (25 October 2011, 24-26 April 2012, and 26 October 2012) at selected sites as part of the aquatic ecological survey during the EIS study (see Table 7.4, EIS Appendix N). Three field sampling events were undertaken (1-3 April; 24-28 April, and 20-24 May 2012) at 22 locations (refer to EIS section 7.2.2.2 and Table 7.3). Field assessments of the water quality of the Isaac River in drainage areas 2 and 40 as potential receiving environments for CSG water releases were not undertaken due to a lack of waterway flows.

SREIS section 8 Surface water, included additional information on the surface water quality at, or adjacent to, areas proposed for central gas processing facilities, CSG water treatment facilities, and proposed CSG water discharge areas. Detailed information was included in the SREIS Appendix F Surface Water Technical Report on the baseline water quality of the Isaac River which was identified as a possible receiving waterway for CSG water discharges.

Potential for natural surface deformation as a result of CSG water extraction were described in EIS section 14 Groundwater.

SREIS section 9 Hydrology and geomorphology addressed flow regimes, hydraulic parameters and the geomorphology of the Isaac River reaches identified as possible receiving environments for discharges of treated or untreated CSG water. This section also addressed flood immunity of the areas identified as preferred localities for the two CGPFs with associated WTFs. Water treatment facilities and surface water impacts on aquatic ecosystems were described in the SREIS section 10 Aquatic ecology. Impacts on surface water quality resulting from the discharge of CSG water were discussed in the SREIS section 8 Surface water, and impacts on aquatic ecosystems were described in the SREIS section 10 Aquatic ecology.

SREIS Appendix F Surface Water Technical Report provided a surface water quality assessment incorporating surface water quality data obtained from operational mines within the Bowen Basin between 2010 and 2013. Data from the DNR database was also used to assess the relationship between stream flow and EC for the Isaac River. The assessment was undertaken to determine the baseline character of the surface water environment and to inform the potential impacts of proposed discharges on the receiving watercourses. In this study WQOs for the Project area were derived using the methodology recommended in the Queensland Water Quality Guidelines 2009.

SREIS Appendix G Hydrology and Geomorphology Technical Report provided an environmental flow assessment to characterise the existing flow regime in the Isaac River under a range of climatic conditions. This provided information on seasonality, and spatial and temporal extent of flow conditions. This would provide for the determination of discharge frequencies, timing and volumes of flow at the proposed Isaac River discharge reaches with recommendations for further development and assessment of proposed discharge regimes. The project area is within the Fitzroy Basin and Isaac River flows are regulated by releases from upstream dams (Burton Gorge Dam and Teviot Dam) and weirs.

The SREIS hydrology and geomorphology assessment used estimates of sub-catchment peak runoff for the 1% AEP event using RORB software (v6.15). RORB simulates the runoff response of a catchment area, including the effects of stream and reservoir routing, by subtracting infiltration losses from rainfall inputs to calculate runoff hydrographs. Three hydrology models estimated peak flows namely regional flows along the Isaac River from the top of the catchment down to 30 km north-east of Dysart, local flows along streams in the vicinity of the proposed WTF1 locality, and local flows along streams in the vicinity of the proposed WTF2 locality.

Peak flows from this assessment were used in the hydraulic modelling, and a flood assessment of the Isaac River down to Deverill was conducted as part of a cumulative impact assessment of mine developments in the Isaac River catchment. A RORB model was developed for parts of the Isaac River catchment and calibrated with observed stream flow gauges at Burton Gorge, Goonyella and Deverill. The results of this model were used to guide the selection of hydraulic model parameters.

Wetlands were identified by consulting a number of sources including Queensland Wetland Mapping version 3, Ramsar Convention on Wetlands, Directory of Important Wetlands of Australia, Map of referable wetlands, report on Aquatic Conservation Assessments (ACA), using AquaBAMM for the non-riverine and riverine wetlands of the Great Barrier Reef catchments (EHP), and Wetlandinfo.

4.10.2 Existing environment

EIS section 15 Surface water (Table 15.1) summarised the relevant environmental values for the waterways likely to be affected by the proposed project. These values included biological integrity of the aquatic ecosystems, as well as human values such as water supply, cultural / spiritual, recreational, agricultural and industrial purposes. The project area surface water users were identified in EIS Appendix N Surface Water Technical Report (Table 4.3).

SREIS section 8 summarised water quality measured in the relevant sub-catchments namely the Upper Isaac River, Connors River, Mackenzie River, Suttor River and Bowen River. All five catchments were described as containing extensive ephemeral stream networks with wet season flow periods except for the Mackenzie River at Riley's Crossing which has perennial flows.

A detailed desktop assessment of surface water quality was undertaken for the project area. The assessment included a review of data collected for the project during April 2012 and water quality data obtained from operational mines within the Bowen Basin collected during the period between 2010 and 2013. This additional data analysis was used to refine the EIS nominated Water Quality Objectives (WQOs) relevant to the project area.

The updated WQOs were presented in SREIS section 8 Table 8.1 to Table 8.4. The report proposed environmental values and trigger indicators for slightly to moderately disturbed aquatic ecosystems. The proponent also committed to further field studies in the proposed water discharge reaches on the Isaac River to determine environmental values and suitable water quality trigger values. Information from such studies would be incorporated in applications for any environmental authorities.

River health indicators for water quality, hydrology, geomorphology and aquatic ecology were presented as a basis for identifying potential impacts on environmental values associated with the Isaac River. The WTF1 reach of the Isaac River was described as an ephemeral river with a sand bed and bankfull width from 20m to 40m, floodplain width from 150m to 500m and an upper terrace approximately 2m to 4m higher than the floodplain. The channel of Skull Creek and the Isaac River near the indicative locality of WTF1 were classified as a riverine system. The WTF2 reach of the Isaac River was characterised as a low sinuosity, single channel (30m to 40m bankfull width), with floodplain up to 800m in width and was classified as a riverine system.

The Isaac River was shown to carry excess sediment inputs from historical changes in land use, mainly agriculture and mining.

The SREIS identified 109 riverine and 423 non-riverine wetlands in the project area incorporating a range of wetland types (described in SREIS Appendix H section 4.2.4.1) varying in ecological value and incorporating riverine systems including the Isaac River and non-riverine lacustrine and palustrine wetlands such as modified dams and vegetated swamps. Of the listed wetlands, 66 riverine and 191 non-riverine wetlands were identified as occurring within the gas drainage areas and of these 14 riverine and 29 non-riverine wetlands were identified as high or very high ecological value under the AquaBAMM classification. Section 4.11 Aquatic ecology of this assessment report addresses these values.

Lake Elphinstone in the upper catchment of the Isaac River was identified as an Environmentally Significant Area (ESA) and is listed in the Directory of Important Wetlands in Australia. The lake is the largest natural fresh water body in Central Queensland and is an important breeding ground and bird refuge.

Overland flow was identified as a significant hydrological process and was described for the project area. SREIS Appendix G Hydrology and Geomorphology Technical Report provided an assessment of the potential for flood inundation from 1% AEP events and overland flows of sub-catchments that were identified as preferred areas for the WTF1, WTF2 and the associated holding dams.

4.10.3 Impacts and significance of impact

SREIS section 8 stated that potential impacts to surface water may occur during construction, operation and decommissioning. Table 8.5 provided an updated surface water impact assessment that reflected the changes to the project design from the EIS. The activities listed in the EIS that may cause impacts to surface water environmental values (EIS section 15 Table 15.2) were stated to remain relevant for the updated project namely

- exploration and drilling activities
- watercourse crossings by roads, tracks and pipelines
- construction, operation and decommissioning of infrastructure including field compression facilities (FCFs), central gas processing facilities (CGPFs), water treatment facilities and water storage dams
- pipeline construction
- discharge and storage of hydrotesting water
- discharge and storage of treated and untreated CSG water
- storage of brine concentrate
- discharge of treated sewage.

The major potential impacts to surface waters were identified as

- interference with naturally occurring overland flow and flooding
- degradation of surface waters resulting from the discharge of treated or untreated CSG water
- increased erosion and sedimentation associated with overland flow restrictions, controlled CSG water releases, and construction, operation and decommissioning activities
- uncontrolled releases of stormwater and contaminants.

For each project phase, EIS section 15 identified the following impacts at risk of occurring

Construction of wells, gathering lines and production facilities

- changes to physical form and diminished water quality from the removal of riparian vegetation, with subsequent reduced bank stability and increased erosion and sediment mobilisation
- diminished water quality due to the removal of terrestrial vegetation leading to increased runoff and sedimentation in the watercourses
- changes to water quality resulting from improper releases of hydrotest fluids
- diminished water quality resulting from spills of hazardous substances or drill muds
- flooding, changes to physical form and changes to hydrology resulting from placement of infrastructure in overland flow paths
- diminished water quality resulting from earthmoving and soil stockpiling leading to increased sedimentation in watercourses
- changes to physical form and diminished water quality resulting from pipeline or vehicle watercourse crossings causing bed and bank erosion and subsequent mobilisation of sediment
- changes to hydrology due to blockages in streams associated with pipeline watercourse crossings (open-cut crossings).

Operation of the wells and production facilities

- changes to hydrology, diminished water quality and changes to physical form resulting from controlled and uncontrolled releases of CSG water and hydrotest fluids
- diminished water quality from increased runoff from compacted areas leading to sedimentation in the watercourses
- surface water quality impacts resulting from a catastrophic failure of a water storage dam
- diminished water quality resulting from spills of hazardous substances
- flooding, changes to physical form and changes to hydrology resulting from placement of infrastructure in overland flow paths
- changes to hydrology caused by changed overland flow paths
- changes to physical form due to scour and generation of sediment at watercourse crossings caused by the use and maintenance of access tracks
- surface water quality degradation due to contaminated runoff.

Decommissioning of wells, gathering lines and production facilities

- diminished water quality from spills of hazardous substances
- diminished water quality from earthmoving and soil stockpiling leading to sedimentation in watercourses
- diminished water quality from increased runoff in cleared areas leading to sedimentation in watercourses
- changes to physical form causing sediment movement into watercourses due to the proximity of works to watercourses and wetlands.

Water discharges

The SREIS section 3 provided an updated project description including potential discharge of treated or untreated CSG water to reaches of the Isaac River or its tributaries adjacent to the preferred localities for the CGPFs and co-located WTFs (as shown in SREIS Appendix G and excerpts in Appendix 6 of this assessment report), and potentially to a waterway associated with a WTF which could be located near Blackwater. The SREIS did not specify the actual location of any CSG water discharge points.

The hydrological regime of the Isaac River and the likely impacts of water discharges on flow in the Isaac River were presented in SREIS sections 9.3 and 9.4.1 respectively. The reaches of the Isaac River proposed to receive discharges were shown to have highly ephemeral flow regimes which were limited to short duration flows between December and April with the remainder of the year dry or with limited isolated pools. It was proposed that discharge in either reach of the Isaac River would take account of when high flow conditions persisted. For the Isaac River in the vicinity of drainage area 2 (the potential WTF1 site), flows exceeded 43ML/d for 20% of the time, and exceeded 1262ML/d for 5% of the time with high flow events occurring three to four times per wet season and lasting an average of eight to 16 days. Flows that occurred on average once every two years for (identified as "bankfull flows" as per adopted methodology) had a channel discharge of 1928ML/d and lasted up to four days. Flows in the reach of the Isaac River near the preferred locality for WTF2 were stated to be similar. Further monitoring would be required to confirm flows in the specific reach and site proposed for discharge.

The EIS documents did not describe in detail the beneficial water uses to be implemented. No planned discharges of untreated CSG water to surface waters were proposed. Untreated CSG water quality was not detailed other than the following typical description for Surat and Bowen Basin CSG water

- pH 7 to 11
- salinity from 3,000 to 8,000 mg/L (i.e., brackish) and total dissolved solids (TDS) including sodium salts, bicarbonate salts, chlorides and others
- presence of suspended solids, ions including calcium, magnesium, potassium, fluoride, bromine, silicon and sulphate (as SO₄), trace metals and low levels of nutrients.

Historical data within the BGP Project Area were assessed to understand the hydrological setting. No field assessments for water quality in the nominated discharge reaches of the Isaac River were undertaken as there were little to no flows in the 2013/14 wet season.

The proponent has committed to undertaking field surveys at confirmed discharge locations as part of the EA application process. The recommendations for EA conditions in Appendix 3 of this assessment do not include a discharge schedule as information provided in the EIS was insufficient.

The SREIS stated that the WTF's would have capacity to treat up to 20 ML/d each. Both WTF1 and WTF2 would discharge CSG water to the Isaac River during operations and also in emergency situations depending on wet season rainfall and demands for distribution via the Isaac River channel to water users for beneficial use. The proponent has committed to undertake site specific impact assessment for any EA application.

The SREIS focused on identifying and assessing specific impacts of CSG water discharges on the water quality of the Isaac River in the WTF1 and WTF2 reaches where discharge points were proposed.

Disposal to watercourses is not a preferred option under the CSG waste hierarchy in EHP's CSG Water Management Policy 2012, which promotes avoidance, reduction, reuse, recycling, recovering, treatment and disposal. Section 4.20 Waste of this assessment report contains further information on proposed CSG water management, including disposal. Treated CSG water was not characterised in the EIS documents. The SREIS stated that treated CSG water may be blended with untreated CSG water prior to discharge to meet the water quality guideline values for the protection of beneficial uses, including irrigation, stock watering, drinking water and aquatic ecosystem function.

The CSG water discharge frequencies, timing and volumes were not defined. The SREIS used the estimates of bankfull elevation along with the discharge rating curves, to estimate bankfull discharge. SREIS section 9 Table 9.2 provided these estimations for the Isaac River reaches proposed for the WTFs. This scoped the Isaac River assimilative capacity for potential discharges without significantly impacting the flow and geomorphic characteristics of the Isaac River. The SREIS stated that such increases in flow, if managed properly, would not result in significant adverse impacts on watercourse geomorphology, water quality and aquatic ecology. The SREIS proposed further assessments to determine appropriate frequency, timing and volume of proposed discharges. Any discharge would require assessment and approval under the EP Act and the *Water Supply (Safety and Reliability) Act 2008*. Detailed information on flows, water quality and assimilative capacity would be required by the administering authority to assess and condition the proposed discharge(s).

The SREIS listed the following potential impacts associated with the proposed discharges including

- increased bank erosion and changes in geomorphic character of banks due to increased flows

- changes in stream hydrological regime and perturbations to flow-dependent ecosystems
- impacts on the Isaac River water quality.

SREIS section 9 Table 9.5 provided a summary of the estimated significance of impacts remaining after management and mitigation measures were applied. The significance of likely impacts was judged to be low.

Cumulative impacts

SREIS section 8 summarised the surface water resources in the project area and impacts by historic and current land uses such as agriculture, mining and urban development. The SRES stated that the competing land uses should all be subject to appropriate water quality management and that there were, at times, large volumes of coal mine affected water discharged to the Isaac River such that any Bowen Gas project CSG water that may be discharged under EA conditions into the Isaac River would not have significant additional impacts on water quality and flow. This statement assumes that continuously produced CSG water is stored and released during periods of sufficient water flow in the Isaac River.

4.10.4 Proposed management

SREIS section 9 stated that providing all management commitments were fully implemented including as yet undefined discharge strategies, significant cumulative impacts on the river's flow regime, geomorphic character and water quality would not occur. SREIS section 8 Table 8.7 summarised the estimated potential small size and low significance of residual impacts to surface water. The proponent's commitments (SREIS Appendix O) on water management included the following summary of the major management actions proposed.

Overland flow

Mitigation measures (or principles) were proposed to avoid or mitigate potential changes to overland flow, flood flows with the potential for erosion, water-logging, interference with irrigation systems and infrastructure, loss of access to water, impacts to general farming operations, and potential conflict between neighbouring landholders including

- avoid disrupting overland natural flow paths and, where avoidance is not practicable, maintain connectivity of flow in watercourses
- communicate and negotiate with landholders
- reach agreement with landholders on access tracks and other infrastructure location to minimise overland flow impacts
- seek landholders' knowledge of overland flow regimes on their properties
- design access tracks, gathering lines and well pads so they do not impede overland flow
- construct all weather access tracks to maintain the existing hydrologic and hydraulic regimes including overland flows
- reinstate natural drainage lines and follow fence lines, roads or tracks to minimise disturbance
- decommission infrastructure in such a manner that it will not adversely affect overland flow
- develop and implement erosion and sediment control plans based on Best Practice Erosion and Sediment Control Manual (IECA, 2008) supported by topographic LIDAR data and landholder advice
- avoid stockpiling of soil in irrigated floodplain areas to avoid impacts to overland flow
- design and implement fences for security and low impacts on surrounding land use and overland flow.

Flooding

The SREIS Appendix G included information on flood levels, flooding history, and overland flow modelling. The proponent's commitments to managing the risk posed by floods to project infrastructure, and the risk of environmental harm resulting from flood events, included design of watercourse crossings to minimise impacts on geomorphology and river flows, location of major facilities above the 1:100 year flood level where practicable, scheduling of construction works during the dry season wherever possible, and checking for flood warnings or subscribing to flood warning services where relevant during construction of watercourse crossings.

Maps of overland flow, flooding and stream characterisation summaries were included in SREIS appendix G. The SREIS stated that a flood frequency analysis had been undertaken for the project river systems.

Coal seam gas water discharge

The SREIS section 8 and Appendix D addressed the potential impacts associated with the discharge of treated and untreated CSG water during operations and in emergency situations. The water quality assessment provided limited water quality information and was not adequate to define local WQOs. The potential impact on receiving water quality as a result of discharges of CSG water of unspecified quantity and quality was not adequately assessed. The proposed discharge water quality for operational discharge was not defined. SREIS Appendix D

included recommendations for additional studies of the natural flow regime, stream geomorphology, water quality and ecological response to changed habitat as a result of discharges, to inform development of a discharge strategy.

The SREIS Appendix D stated that selecting and designing the discharge points on the Isaac River and developing the discharge strategy would involve a number of considerations including river flows, water quality (discharge and receiving) and dam capacity. Commitments for managing proposed discharge of CSG water were provided in the SREIS Appendix F and Appendix O including commitments relating to timing and volume of discharge, waterway flows and mixing zone capacity.

Hydrostatic test water

The source and chemical treatment of pipeline hydrostatic test water were not detailed in the EIS documents. Hydrostatic test water, estimated at 100ML per gas field, was proposed be reused, and at the end of its useful life, collected in segregated storage for removal to a licenced facility for processing.

The proponent committed to develop and implement a hydrostatic testing procedure prior to commencement of hydrotest activities, including consultation with landholders and regulatory authorities prior to sourcing and disposing of hydrotest water. The EIS stated that specific details on hydrostatic test water would be provided in support of applications for environmental authorities. A hydrostatic testing strategy would be developed to manage hydrotest activities to prevent contaminants from entering waterways. Information on the proposed hydrostatic testing was provided in EIS section 4 and SREIS section 3 Project Description.

Residual impacts

The EIS section 15 and SREIS section 8 stated that the proposed avoidance, mitigation and management measures would avoid or reduce the severity of potential impacts on surface water environmental values. The use of buffer zones to restrict project activities near watercourses, and location of facilities above the level of a one in 100 year ARI flood event were highlighted as significant measures to limit residual impacts. The width of buffers to watercourses was not defined and the location of facilities above the 100 year ARI flood event would only occur where this was considered to be practicable by the proponent.

SREIS section 8 Table 8.7 summarised the estimated significance of residual impact on each defined category of surface water, based on assumed effective implementation of stated mitigation measures and only emergency discharge of CSG water. Estimates ranged from low impact on sedimentation and overland flows resulting from alteration of flow paths, to moderate impact on waterways from uncontrolled release of CSG water.

The potential impacts resulting from the proposed discharge of treated or untreated CSG water at the two locations specified in the SREIS have not been sufficiently assessed for the purposes of an EA, and the effectiveness of proposed mitigation measures for such impacts is not able to be determined. The EIS documents identified the matters that would need to be addressed in any application for an approval to discharge. The proponent has committed to providing the site-specific details when applying for an approval.

Beneficial use

The SREIS stated that beneficial use options for managing CSG water would be the first priority before consideration of discharge to the Isaac River. Beneficial use options were listed as follows

- supply of treated CSG water to augment the domestic water supply within the project area
- supply of treated CSG water to water service providers (such as Sunwater)
- supply of treated (and in certain instances untreated) CSG water to coal mines within the Bowen Basin
- supply of treated CSG water to third party agricultural users
- use of treated or untreated CSG water by the project.

Details on each option were provided in the SREIS Appendix F Surface Water Technical Report Table 7.6.

Cumulative Impacts

EIS section 15 Surface water and SREIS section 8 Surface water provided a high level qualitative assessment of potential cumulative impact on surface water resources. It was stated that CSG water discharges from this project would only be as controlled releases. The assessment highlighted changes to watercourse hydrology as a potential cumulative impact but concluded that the project would not significantly contribute to cumulative impact. It was recognised that numerous coal and CSG developments in the region had indicated that water could be released to watercourses during operations. However, no cumulative impact assessment of current and approved discharges to the Isaac River from coal projects was presented.

4.10.5 Major issues raised

References to agencies and organisations in the following text are those who made submissions on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required. The IESC provided advice on the EIS in May 2013 and the SREIS in July 2014.

The IESC's key conclusion on the EIS stated that "the surface water and ecological surveys conducted do not adequately address seasonal and temporal variability, and no field studies were undertaken to collect site-specific surface water data. Further assessment must expand the field surveys to allow for thorough assessment of impacts to downstream ecosystems and ecological receptors, including Matters of National Environmental Significance (MNES)". EHP (and DSITIA), DoH, IRC, FBA and DNRM made similar requests for information on proposed discharges.

The proponent responded that beneficial use is the preferred option for the management of coal seam gas water. Beneficial use would be further investigated when preparing an application for an EA, and if beneficial use is found not to be feasible then, controlled discharge to watercourses would be the management solution intended. The proponent currently holds an EA allowing discharge by the proponent's Moranbah Gas Project where a reverse osmosis plant is in operation. This allows discharges to the Isaac River during and immediately after flow events. The proponent committed to providing information on proposed discharges as referred to by the IESC and EHP and as set out in the EA application information requirement summary in Appendix 3 of this assessment report.

The IESC advised that site-specific and regional water balance models are needed to enable an assessment of changes to water resources. The proponent's commitment to developing a water balance model post EIS was not considered appropriate by the IESC.

The proponent responded that the conceptual water balance presented in SREIS section 3 and Appendix D addresses reservoir engineering, numerical groundwater modelling incorporating gross recharge, evapotranspiration and river baseflow which provided a strategic prediction of the regional water balance. The proponent committed to providing site-specific information for proposed discharges as part of an application for an EA. The application would need to be supported by detailed environmental flows analysis with water quality and aquatic ecology information based on monitoring and surveys to inform the determination of proposed frequency, rate and duration of discharges.

The IESC advised that when the location of infrastructure is known, sampling points used for baseline characterisation should be located so as to adequately identify baseline environmental values, and that impacts mitigation and management measures should be reassessed, having regard to the location and sizing of water management infrastructure, discharge point locations, discharge water quality, discharge scenarios including timings and volumes, as well as baseline aquatic ecology, receiving water quality and trigger values for water quality indicators for intervention. This advice was also provided by EHP (as summarised in Appendix 3 of this assessment report) and DOE.

The proponent's response referred to commitments to providing such information as part of any EA applications. The proponent also revised the project to include only two proposed WTFs for any water discharge to the Isaac River if beneficial use was not shown to be feasible. Some data was provided on the geomorphology, hydrology and environmental flows of the Isaac River reaches potentially receiving CSG water discharges. Data from operating and new coal mines in the region was also presented. This was stated as providing some of the information that would be required to fully describe the baseline reach conditions in any EA application.

The IESC advised that sampling of groundwater and surface water prior to the hydraulic stimulation process should include an analysis of the hydraulic stimulation chemicals to enable assessments of any risk to surface water from chemical spill events.

The proponent confirmed that 25% of production wells may require hydraulic stimulation, especially in the later stages of the project, to enhance coal seam gas production. The chemicals to be used were subject to a risk assessment (EIS Appendix L) that showed no unacceptable risks. The proponent would also be required to undertake baseline water sampling before commencement as part of information requirements for any EA application (see Appendix 3 of this assessment report). The proponent stated that procedures for hydraulic stimulation would ensure no hazardous chemicals or compounds in potentially harmful concentrations would be used in hydraulic stimulation. The proponent committed to setting coal seam gas activities away from watercourses. This was stated as providing a basis for no proposed additional water quality sampling at hydraulic stimulation sites and no testing for these chemicals in surface water.

The IESC suggested that a number of mitigation actions should be implemented to better protect surface water environmental values, including siting infrastructure above the 1 in 1000 average recurrence interval (ARI) flood level, lining of drilling sumps, and treatment of stormwater draining from disturbed areas and infrastructure. EHP and DNRM requested further information on potential flood impacts on project infrastructure (gas leaks, CSG water leaks from wells, dams, or pipelines, dam failure, brine release) including details on the proposed location of

infrastructure relative to 1% annual exceedance probability (AEP) flood events, and assurance of the integrity of infrastructure following flood events.

The proponent committed to siting major infrastructure above the one in 100 ARI flood level, consistent with Queensland guidelines and the proponent's risk assessment for a 40 year CSG project. The proponent also committed to the lining of drilling sumps and the safe management of drilling muds in accordance with industry best practice. The proposed management of stormwater by the proponent includes commitments to the collection and treatment of contaminated stormwater runoff as part of the wastewater treatment system, as well as a 50 m buffer zone between coal seam gas activities (except watercourse crossings) and the high bank of all watercourses. Recommendations for EA conditions would also address stormwater management such that stormwater runoff from disturbed areas would be controlled and contaminated stormwater runoff collected and treated.

The proponent stated that the location and design of infrastructure would have regard to flood mapping and natural flow paths on floodplains and maintenance of overland flow would be a key input to route selection and rehabilitation methods determined at a property level. A commitment was made to avoid disrupting natural overland flow paths and, where avoidance was not practicable, to maintain connectivity of flow in watercourses.

Further details on flood risk were proposed to be made available after the completion of detailed field development planning and as required to meet statutory information requirements in accordance with the EHP Guideline Application requirements for petroleum activities to accompany the application for an environmental authority.

The IESC requested further information on the system of pipelines, aggregation dams, water treatment, permeate storage and disposal, and proposed brine management. The IESC advised on the details that should be provided on water management, dam design, how treatment by reverse osmosis treatment would be implemented, water discharge management, and water quality and flow monitoring.

The proponent stated that the SREIS Appendix D Coal Seam Gas Water and Salt Management Strategy sets out management options for the beneficial use and disposal of excess CSG water and brine that reflects the Queensland Coal Seam Gas Water Management Guidelines (EHP, 2012). CSG water would be made available for beneficial use by the agricultural industry, other industry, and domestic uses or would be discharged to the Isaac River under EA conditions should there be excess water remaining after beneficial use. Brine produced from the treatment of coal seam gas water using reverse osmosis would be stored in dams and reduced to a waste salt concentrate by evaporation. The waste salt concentrate would then be disposed of to a regulated waste facility. The EIS stated that this was currently the only viable option. Other brine management options, (including selective salt recovery, injection and discharge to the ocean) were studied but rejected. Information about the beneficial use options was proposed to be made available once detailed design was completed post the EIS process.

The proponent stated (SREIS section 8) that dams for coal seam gas water and brine would be designed and constructed in accordance with EHP's Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EHP, 2013). Any EA application would contain the details on specific sites for infrastructure such as WTF locations, discharge points, and associated dam capacities. The EIS documents identified potential impacts to downstream aquatic ecosystems and receptors, sensitive areas the risk of seepage, failure or overtopping from dams. The proponent stated that information on stream flows, watercourse water quality, coal seam gas water quality and the extent of mixing zones, as well as aquatic ecology would be provided in any EA application. The proponent currently operates reverse osmosis plants at two locations in central Queensland and the proposed Bowen Gas Project plant would operate on a similar basis.

IESC advice on the SREIS identified the need for further information for monitoring and managing the risks to surface water and aquatic ecosystems in the project area, including

- surface water hydrology and the storage/disposal/re-use of co-produced CSG water
- cumulative impacts on surface water resources from CSG and mining projects in the area and determination of the assimilative capacity of the Isaac River reaches nominated for discharge points
- refinement of surface water hydrology information and relationship to GDEs
- use of particular hydraulic stimulant chemicals and details of risk assessment for use of the chemicals
- recommended 24 months of receiving environment data on Isaac River water quality and aquatic ecology including the Fitzroy River turtle
- re-examine beneficial use options including re-injection
- establish WQOs using a more robust dataset
- develop a discharge strategy.

The proponent responded to the IESC advice by reference to commitments made in the EIS (SREIS Appendix O) including those dealing with identifying features potentially at risk within the project area, risk management, application of mitigation measures (SREIS Appendix E section 9.3.6.2) such as identification of GDEs, ongoing modelling for impacts, further assessment, field studies and monitoring on connectivity of aquifers, and monitoring/management of impacts as required. The proponent also referred to the requirements of the Water Act,

EP Act and the UWIR process which would address the IESC advice including groundwater modelling iterations, potentially affected aquifers, annual review of new data, and model prediction updates. The requirement for a new UWIR every three years would facilitate updates of the groundwater model.

EHP and IRC requested information on the risk of accidental spills and potential contamination associated with hazardous substances, drilling fluids, and CSG water, and risk assessments at defined locations for project infrastructure.

In response, the proponent referred to EIS section 28 Waste management and EIS section 27 Preliminary hazard and risk and to commitments on the construction of infrastructure in accordance with relevant guidelines, standards and legislative controls, implementation of bunding and lining to prevent release of potential spills or leaks to the environment, and quality control and assurance procedures and monitoring. Commitments include timely communications with land holders and emergency response systems.

EHP and DSITIA stated that the EIS documents did not provide adequate information for an EA application on the receiving surface water quality, proposed quality and quantity of discharge water, baseline for receiving water quality, local water quality objectives for receiving waters, and proposed limits for discharge water quality and quantity.

DSITIA recommended

- further assessment of proposed discharge scenarios, using available data on stream discharge flow rates and expected discharge water quality, to derive expected dilution rates for potential contaminants and the extent of the mixing zone
- further ecological surveys in reaches of watercourses proposed to receive discharges to account for the natural variability in aquatic ecosystems (seasonal and/or flow periods)
- ecological impact assessment of potential changes in water quality (physical and chemical stressors and toxicants).

This advice reinforced EHP, DAFF and IESC advice on the adequacy of assessment of impacts of discharge of CSG water and supported the need for further assessment.

DNRM advised that the proponent should reference the Burdekin WRP area which allows for construction of works for the taking of overland flow if the works have a capacity less than 250ML or through an environmental authority provided that the works are in accordance with the DNRM – “Code for self assessable development for taking overland flow water using limited capacity works” or “Code for self-assessable development for taking overland flow water to satisfy the requirements of an environmental authority or a development permit for carrying out an environmentally relevant activity”. DNRM further advised that within the Fitzroy WRP area the construction of works for the taking of overland flow with a capacity less than 50ML or through an environmental authority is permitted in accordance with the above self-assessable codes.

Recent amendments to the *Water Act 2000* and regulation have also set minimum requirements for minimising impacts on water quality, water flow and the physical integrity of a watercourse lake or spring. Details were provided in the DNRM document “Riverine protection permit exemption requirements”.

The proponent committed to consulting with DNRM on Water Act and WRP requirements, including requirements for take and interference (diversion or impoundment) of overland flows.

Private submitters and IRC requested information on erosion control during construction of infrastructure. The proponent referred to SREIS section 8 Surface water and to relevant commitments including

- site facilities would avoid wetlands and watercourses that are highly susceptible to erosion
- development areas would avoid permanent pools, chains of ponds, and alluvial islands, where practicable
- watercourse crossings would be minimised
- site-specific management plans would be developed for permanent and semi-permanent watercourse crossings
- buffers would be established around environmentally sensitive areas and watercourses
- site specific Erosion and Sediment Control (ESC) Plans would be developed (in accordance with EA Conditions) prior to disturbance taking place
- surface water quality discharge objectives would be adhered to.

Queensland Health, DSITIA and IESC required further information on the cumulative impact of CSG water and coal mine discharge and the development of integrated management and monitoring using a collaborative approach. The IESC also recommended further assessment of potential cumulative impacts on groundwater dependent ecosystems, particularly those not listed in the Underground Water Impact Report (refer to section 4.9 of this assessment report for details).

4.10.6 Conclusions and recommendations

The EIS provided acceptable whole-of-project information on the scale of the likely water quality and flow impacts and how those impacts would be managed to achieve the nominated level of impact. The EIS process has partially addressed the overland flow and flooding requirements of the TOR. Detailed impacts of the project on overland flow and flooding remain unclear due to the lack of information on the locations of project infrastructure and qualified commitments in relation to locations and design. While the commitments to mitigation measures outline an acceptable approach, specific and measurable/auditable measures would need to be developed. The EIS documents did not describe how, and to what extent, connectivity of flow would be maintained in the event that infrastructure interferes with overland flow.

The EIS adequately described management of erosion, sedimentation, stormwater and hazardous goods management. The EIS did not adequately identify the site specific environmental values to be protected, and a detailed risk assessment has not been completed. Site specific and measurable mitigation measures were also not specified and there is a reliance on general commitments to a selection of site specific mitigation measures. This was recognised in the SREIS, which recommended the development of site specific management plans for certain activities.

Water quality was not adequately defined and local water quality objectives are required for all waters potentially affected by project activities particularly for the Isaac River reaches proposed to receive discharges of CSG water. The SREIS included commitments for further monitoring of water quality, without specifying the scope and timing of the proposed monitoring program.

The EIS documents did not determine the appropriate amount and quality of any discharge of CSG water or offer proposed conditions that would be applied to an EA approval of discharge to the Isaac River. Details of the quantity, timing and quality of proposed discharges would be required in an application for an EA. The assessment focused on hydrological and geomorphological impacts while deferring water quality and much of the aquatic ecology impact management to further studies and provision of information with future applications for environmental authorities or amendment to environmental authorities.

The proponent identified two potential CSG water discharge areas (reaches) in the Isaac River. If discharges are to occur to these reaches (or downstream of these reaches) the proponent would need EA conditions to authorise such discharges. Monitoring data, hydrological modelling and risk assessment would be required as part of an EA application for discharge.

The assessment of cumulative impacts did not adequately consider the combined effect of proposed discharges of CSG water from the proponent's operations (existing and project) in conjunction with current and approved discharges (CSG and coal mining) into the Isaac River. It is acknowledged that the proponent does not have access to much of this information and there is a need for a catchment framework to consider all major water users including potable water supplies, agriculture (grazing and irrigation), environmental requirements and CSG water.

The proponent would need to reflect the guideline, application requirements for petroleum activities (EM705) in any EA applications. The application information would also need to meet the requirements of section 125 and section 126 of the EP Act. Appendix 3 of this assessment report provides a summary of the information to be provided and recommendations for EA conditions.

Site-specific discharge conditions should be developed once data on treated and untreated CSG water quality, receiving water quality, stream flow regimes, and aquatic ecology, is available. The information requirements set out in Appendix 3 of this assessment report should be considered in any application for an EA. Appropriate conditions for water management are included in the recommendations for EA conditions in Appendix 3 of this assessment report.

Recommendation – proponent's commitments on surface water

Where the proponent's commitments outlined in SREIS Appendix O do not conflict with any subsequent approval conditions and any recommendations of this assessment report, the proponent should implement the commitments as stated.

Recommendation – water quality and EA applications

The proponent should undertake further field studies in the reaches of the Isaac River identified for discharge of CSG water, and downstream, to determine existing environmental values, WQOs, suitable trigger values for receiving water quality, natural flow regime and limits to variation in flow regime to meet stream morphology and ecological requirements. Study results should be incorporated in applications for environmental authorities. EA applications should be made publicly available for advice as required under the EP Act.

Recommendation – EA application information

The proponent should address the information required for an application for an EA or EA amendment as outlined in Appendix 3 of this assessment report which may include

- an assessment of site-specific risks and impacts from changes to overland flow or flooding at operational sites and adjacent properties and appropriate site-specific mitigation measures
- an assessment of potential impacts to waterbodies resulting from altered flows or water quality resulting from infrastructure development and site-specific mitigation measures
- management plans for watercourse crossings, particularly for sediment and erosion control
- undertaking further field studies where possible when flows occur in the reaches of the Isaac River proposed to receive CSG water discharges to determine existing environmental values and suitable receiving water quality trigger values
- site-specific CSG water discharge conditions based on data obtained from further water quality, aquatic ecology, and stream flow assessments, and an assessment of the potential cumulative impact of existing and approved discharges from CSG and coal mine operations within the Isaac River catchment.
- undertaking further field studies in the proposed water discharge areas (reaches) of the Isaac River to determine suitable trigger values and existing environmental values.

Recommendation – beneficial uses

The proponent should consult relevant government agencies on requirements for managing beneficial uses for CSG water.

Recommendation – water resource plans (WRPs)

The proponent should consult DNRM on requirements for managing overland flow and water use under the Burdekin (if applicable) and Fitzroy WRPs and Water Act requirements.

Recommendation – cumulative impact decision framework

The proponent should consult with relevant government agencies on any future regulatory framework for management of the cumulative impacts on water quality in the Isaac River. All major water users in the Isaac River catchment should be considered, including potable water supplies, agriculture (grazing and irrigation), environmental requirements and CSG water.

4.11 Aquatic ecology

EIS section 16 Aquatic ecology described the existing aquatic ecological values within and surrounding the project area and provided an assessment of the potential for these values to be affected by direct and indirect impacts associated with the construction, operation and decommissioning phases of the project. Detailed information on the aquatic ecology assessment was included in EIS Appendix O, Aquatic Ecology Technical Report. Stygofauna was addressed in EIS Appendix EE. Broad environmental protection objectives, to avoid or minimise impacts to aquatic ecology and to control the introduction or spread of exotic aquatic flora or fauna species, were stated and avoidance, mitigation and management measures to achieve these objectives were identified. The estimated residual impact was based on the assumption that the proposed avoidance, mitigation and management measures had been applied.

The SREIS section 10 provided updated information on aquatic ecology resulting from changes to the project description (SREIS section 3), submissions on the EIS, and further desktop and field studies. Detailed information on the supplementary assessment was contained in SREIS Appendix H, Supplementary Aquatic Ecology Technical Report.

The assessment of MNES was addressed as part of the aquatic ecology assessment and as a stand-alone assessment in SREIS Appendix J Matters of National Environmental Significance. The evaluation of the assessment of MNES is in section 5 of this assessment report.

4.11.1 Assessment methodology

The potential impacts of the proposed project on aquatic ecology were assessed using the significance assessment approach described in the EIS section 7 Environmental framework and in section 4.4.1 of this assessment report. Significance assessment was adopted where an understanding of the vulnerability or sensitivity of the environmental value or resource was important to the assessment. The magnitude and significance of the impacts were estimated in the EIS and impacts with a high significance were given priority for the development of mitigation measures.

The aquatic ecology baseline assessment comprised a desktop study and a field survey to gain an understanding of, and describe, the existing environment. The methodology for the aquatic ecology assessment was outlined in section 16 of the EIS, and detailed in EIS Appendix O Aquatic Ecology Assessment. The SREIS provided an updated assessment of impact significance to address changes to the project and proposed discharge of CSG water to watercourses.

EIS Appendix O provided detailed information on aquatic ecology surveys conducted for the EIS and justification for selection of survey sites. Figure 3.2 Aquatic ecology sampling sites of EIS Appendix O showed the approximate location of aquatic ecology survey sites. Figure 16.1 and Table 16.1 of EIS section 16 provided a summary of field survey site locations, site hydrology, timing and land use. EIS Appendix O described how the proponent undertook aquatic field surveys during the late 2012 wet season at 15 locations representative of the aquatic environment across the project area. Thirteen sites were located within the Fitzroy Basin (ten within the Isaac River sub-catchment and three within the Mackenzie River sub-catchment) and two sites were surveyed within the Burdekin Basin. Each survey site was sampled and surveyed for the following

- physico-chemical water quality parameters
- aquatic flora (macrophytes)
- fish assemblages
- aquatic macro-invertebrates and macro-crustaceans
- turtles.

4.11.2 Existing environment

The EIS documents stated that the aquatic ecosystems in the project area range from large permanent and semi-permanent watercourses of the Isaac and Mackenzie Rivers, to small permanent and semi-permanent watercourses that include Bee Creek, Scotts Creek, Stephens Creek, Rolf Creek and Phillips creek, to ephemeral watercourses that include Suttor Creek, Devlin Creek, Sagittarius Creek and Taurus Creek. The EIS stated that aquatic ecosystems within the study area were assessed to be in moderately good health.

The desktop and field investigations findings are summarised as follows

Macro-invertebrates

- eighteen taxa were identified in EIS field studies while the recent Red Hill Mining Lease EIS identified 28 taxa from a similar area
- no macroinvertebrate species (including crustaceans) of conservation value were recorded in the study area by historical surveys or by field surveys for the EIS

Fish

- fish assemblages were relatively species poor and dominated by a small number of taxa
- twelve fish species were observed in the vicinity of the proposed water discharge points on the Isaac River namely: *Ambassis agasizzii* olive perchlet, *Craterocephalus stercusmuscarum* fly-specked hardyhead, *Hypseleotris sp1* Midgley's carp gudgeon, *Leiopotherapan unicolor* spangled perch, *Macquaria ambigua oriens* golden perch, *Melanotaenia splendida splendida* eastern rainbowfish, *Mogurnda adspersa* purple-spotted gudgeon, *Nematalosa erebi* bony bream, *Neosilurus hytilii* Hyrtle's tandan, *Oxyeleotris lineolata* sleepy cod, *Porochilus rendahli* Rendahl's catfish, *Scortum hillii* leathery grunter
- no fish species listed as endangered, vulnerable or near threatened under State or Commonwealth legislation were recorded during field studies though three recorded fish species are endemic to the Fitzroy River Basin and are therefore of conservation significance namely *Macquaria ambigua oriens* (golden perch), *Scleropages leichardtii* (southern saratoga), and *Scortum hillii* (leathery grunter)
- the water quality in the northern and southern reaches of the Isaac River was within the tolerance ranges for fish species except for eastern Rainbowfish (*Melanotaenia splendida*) and sleepy Cod (*Oxyeleotris lineolata*) where pH and electrical conductivity recorded for the EIS slightly exceeded the maximum tolerance values

Turtles

- no turtle species of conservation significance were recorded during the field surveys though two species are possibly present within the upper reaches of the Mackenzie River namely *Rheodytes leukops* (Fitzroy River turtle), *Elseya albagula* (southern snapping turtle)
- the Fitzroy River turtle (*Rheodytes leukops*) is listed as vulnerable under both the NC Act and EPBC Act. Whilst not observed during surveys of the proposed project area, the species may occur and is listed by EHP (2010) as occurring in the Fitzroy River tributaries including the Isaac River. The EIS stated that this species requires flowing streams and permanent waterbodies while the Isaac River is ephemeral and may not provide suitable core habitat for this species within the project area.

Wetlands

- wetlands within the project area, identified in wetland mapping and conservation assessment tools such as AquaBAMM and the Map of Referable Wetlands, included 454 lacustrine wetlands, 411 palustrine wetlands, and 109 riverine wetlands, including 37 wetlands categorised as having high ecological significance (HES) and mapped as Great Barrier Reef wetland protection areas
- of the mapped wetlands within the project area, 66 riverine and 191 non-riverine wetlands were located within the 33 proposed project gas drainage areas. Of these wetlands, 14 riverine and 29 non-riverine wetlands were identified as having high or very high ecological value (EHP AquaBAMM classification), and 24 were mapped as HES wetlands. Lake Elphinstone occurs adjacent to the project area (within approximately 100m) and is listed on the Directory of Important Wetlands
- no wetlands listed under the Ramsar convention or Directory of Important Wetlands in Australia were mapped within the project area.

Stygofauna

- desktop studies indicated that stygofauna habitat may occur in the project area in aquifers along perennial rivers, and in fractured areas where there is enhanced hydraulic interconnectivity. The likelihood of finding stygofauna in coal seams was considered to be low due to low permeability, low connectivity to recharge, and unfavourable water quality.

Aquatic flora

- fifteen species of macrophyte were observed during the field surveys of 2012 and 2013, all of which were native species
- no conservation significant species were recorded.

4.11.3 Impact significance and proposed management

Table 16.5 of EIS section 16 provided a summary of potential impacts to aquatic ecology values prior to mitigation, along with proposed mitigation and management measures, and estimated residual impacts assuming implementation of proposed mitigation and management measures.

Potential impacts from project activities (construction, operation and decommissioning), identified by the Aquatic Ecology Technical Report (EIS Appendix O) included

- degradation of water quality and smothering of benthic habitat as a result of erosion and sediment transport processes
- loss of riparian or aquatic vegetation

- contamination of waterways resulting from fuel, oil or chemical spills
- altered surface water hydrology
- spread and proliferation of aquatic pest species.

Table 16.3 of EIS section 16 summarised the potential impacts from site clearing, construction, drilling, and hydrology changes on aquatic ecological values and rated the significance of unmitigated potential impacts as low, moderate and high for semi-permanent watercourses and negligible for ephemeral waterways.

The EIS stated that, with appropriate management, impacts were predicted to be moderate for permanent waterways. Impacts to ephemeral waterways from emergency releases of treated CSG water during dry season conditions were predicted to be moderate to low, and impacts from normal or routine operations were predicted to be low.

Commitments relating to minimising impacts to aquatic ecological values were outlined in the EIS section 16 Aquatic Ecology and EIS Appendix Z Draft Environmental Management Plan, and were updated in SREIS Appendix O. The main measures proposed for protection of aquatic ecology values were the application of buffers between project construction activities and riparian zones, timing of unavoidable works within buffer zones to occur during the dry season, and discharge of suitably treated excess water to the Isaac River at ecologically suitable times.

The SREIS stated that the CSG water management options of injection to suitable formations and discharge to the ocean were not feasible. Discharge to waterways was the proposed option for disposal of treated or untreated CSG water that could not be beneficially used. Site specific assessment was proposed to be undertaken as part of the EA application process leading to suitable EA conditions for discharge.

The EIS stated that wetlands with very high or high ecological value would be incorporated into the proponent's risk based management framework and constraints mapping to ensure that such wetlands were identified during the preliminary planning stages of the project allowing for avoidance and mitigation management measures to be applied. The EIS stated that no significant residual impacts on wetlands and associated aquatic values were expected following the application of proposed mitigation measures.

Downstream impacts on aquatic ecological values, particularly for the Isaac River, may occur during water discharges. The proponent committed to implementing a water management plan to discharge CSG water in accordance with approved discharge criteria, based on treatment of CSG water to nominated water quality standards.

A desktop assessment was undertaken for the likelihood of stygofauna in the project area (EIS Section 16 and Appendix EE). It was predicted that stygofauna habitat may occur in the project area, particularly in aquifers along perennial rivers. Well drilling and construction procedures would aim to minimise the potential impact to any aquifers that may be intersected. No further surveys for stygofauna were intended.

The EIS documents concluded that the potential residual impacts of the project on aquatic ecological values would be reduced to "moderate to low", and many to "negligible", if the impact avoidance (constraints) framework and specific mitigation strategies outlined in section 16.6 of the EIS) were properly implemented.

The qualitative assessment of potential cumulative impacts (EIS section 31) considered open cut coal mines within, or within 3km of, the project area namely Middlemount Coal Project, Eaglefield Expansion Project, Daunia Mine and Codrilla Coal Mine Project, noting that the aquatic habitats across the sites were extensively disturbed by historic land use (prior to mining). No endangered, vulnerable or near threatened aquatic species were considered likely to be present on any of these sites and potential impacts from the projects were considered to be minor. The assessment concluded that the significance of the potential cumulative impact of the coal projects considered and the Bowen Gas Project on aquatic ecological values was low.

4.11.4 Offsets

EIS Appendix DD presented an offsets strategy that addressed impacts on aquatic ecology. This was updated in SREIS Appendix P. The proponent committed to delivering offsets for impacts on aquatic ecological values that could not be avoided or sufficiently mitigated. The offsets strategy presented a summary of state significant biodiversity values (SSBVs, as listed in Appendix 1 of the Queensland Biodiversity Offsets Policy) and the relevance of these values to the project. Wetlands and watercourses were included in the list of state significant biodiversity values. Offsets were proposed for predicted impacts to State Significant Biodiversity Values (SSBV's) including water courses. The proponent committed to avoiding impacts on wetlands such that no offsets for wetlands would be required.

Table 7.6 of SREIS Appendix P provided an estimate of the potential area of disturbance of SSBVs in the project area based on the conceptual field layout, publicly available mapping, and mapping prepared for the SREIS. EIS section 17 and SREIS Appendix I presented comparisons between detailed mapping of regional ecosystems

completed for the SREIS and publicly available regional ecosystem mapping which indicated significant errors in the published mapping. The actual area of these communities within the project area, and therefore the actual area of SSBVs, may vary significantly from the estimated area. Field survey validated mapping of regional ecosystems and associated SSBVs was not provided in the EIS documents for most of the project area. The proponent has committed to providing detailed information on the location and disturbance of SSBVs (now MSES) based on field surveys as part of applications for operational approvals (including the EA), to quantify impacts in a staged approach, at a site specific level prior to disturbance.

The proponent's preferred approach to the provision of environmental offsets was to stage the provision of offsets in line with progress in defining actual impacts. Environmental offsets were not proposed in the SREIS as the actual offset area requirements would not be determined until pre-construction surveys were completed and the actual location of infrastructure defined.

4.11.5 Major issues raised

References to agencies and organisations in the following text are those who made submissions on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

EHP requested further information on wetlands in the project area, how any impacts would be managed and if there would be a requirement for offsets. DOE requested that suitable wetland habitat within the project area for migratory species should be shown on a map (including farm dams and wetlands). The proponent provided

- geographical information on migratory species showing ecologically important water bodies likely to exist on site, and an update to the assessment of wetland's within the project area (see SREIS section 10 Supplementary Aquatic Ecology Assessment and SREIS Appendix H)
- more detailed assessment of potential impacts on wetlands (SREIS section 10.6.1) and a review of proposed mitigation measures (SREIS section 10.7)). The proponent claimed there would be no likely residual significant impacts on wetlands and associated aquatic values following the application of updated mitigation commitments. Mitigation commitments included buffer zones between aquatic habitat and project activities (with the exception of required creek crossings), pre-construction or pre-clearance surveys, including site specific surveys of wetlands, to identify any additional areas for avoidance. These surveys would involve or inform vegetation mapping at a scale suitable for site-specific planning, identification of core habitats for threatened species, as well as identification of site-specific sensitive areas
- a commitment to avoid significant impacts on wetlands.

The proponent stated that palustrine and lacustrine wetlands of high or very high ecological value were included in the proponent's risk based constraints mapping along with constraint buffers.

DOE and EHP requested further information on the likely impact of CSG water discharges on aquatic ecology of the proposed receiving waters (Isaac River). The proponent responded with

- further information on impacts for potential discharge areas on the Isaac River was presented in the SREIS Aquatic Chapter (Section 10) and the Supplementary Aquatic Technical Report (SREIS Appendix), in conjunction with the supporting and linked impact assessments in the SREIS Surface Water Chapter (Section 8), Supplementary Surface Water Technical Report (SREIS Appendix F), SREIS Hydrology and Geomorphology Chapter (Section 9), and the Supplementary Hydrology and Geomorphology Technical Report (SREIS Appendix G). The interconnectedness of these complimentary impact assessments and how they input into an overall impact assessment of the water environment was outlined in Figure 10-3 in the SREIS Aquatic Ecology Chapter (Section 10). The SREIS stated that site specific impact studies would be completed to support any specific approvals required for EA applications.
- an assessment of the assimilative capacity of the likely receiving environments downstream of the potential WTFs localities (SREIS Appendix H Supplementary Aquatic Technical Report) based on defined discharge scenarios. The assessment indicated no significant impacts of discharge of CSG water on the downstream receiving environment or to the Fitzroy River turtle. The EIS Surface Water Technical Report (Appendix N) also did not find significant impacts to downstream aquatic values arising from the discharge of CSG water.

DOE requested specific information on the Fitzroy River Turtle and how future surveys would inform avoidance and mitigation measures. DOE also requested a Fitzroy River Turtle management plan. The proponent provided refined potential habitat mapping for this species in SREIS Appendix J MNES Report which showed that "core known habitat" for the species occurred downstream of the proposed project area. The proponent stated that no significant impact on the species was likely due to the ephemeral nature of the Isaac River. A species profile for the Fitzroy River Turtle, as well as an assessment of potential impacts and mitigation measures, were detailed in the SREIS Appendix J (section 9.4.2).

DOE requested further quantitative cumulative impact information on listed threatened species based on publically

available data for other projects such as the Bowen Pipeline project. The proponent referred to further information in species profiles in SREIS Appendix J MNES Report. The proponent also pointed to the need for cooperative approaches to cumulative impact management using joint funding and data sharing to improve outcomes for threatened species and threatened ecological communities.

EHP and DOE requested more detailed information on specific impacts on MNES, such as from watercourse crossings. The proponent provided more detailed information on management of potential impacts in the species profiles in section 9 and 10 of SREIS Appendix J MNES Report and further general commitments in the SREIS Appendix H Aquatic Technical Report.

EHP requested further details on identification, likely impact to, and management of groundwater dependent ecosystems (GDE). The proponent referred to the assessment of GDEs in the EIS section 14 Groundwater, EIS Appendix L Groundwater and Geology Technical Report, and to further information in the SREIS section 7 Groundwater and the SREIS Appendix E Groundwater Technical Report. The supplementary information considered the likelihood of potential impacts to GDEs within a 50km buffer around the project area. Table 7.4 of SREIS section 7 detailed a number of shallow groundwater systems where possible impacts on GDE's could occur. The proponent has committed to the following actions

- identify potential GDE landscapes
- use modelling to predict impacts
- identify GDEs at risk of impact through a risk assessment
- where identified as being at risk of impact conduct further assessment including field studies and monitoring to ascertain connectivity of the GDE to underlying aquifers
- monitor and manage impacts as required.

EHP, FBA, IRC DOE, Mackay Conservation Group and DNRM requested information on the conduct of more comprehensive local ecological surveys when there was a high risk of impacting aquatic ecosystems, and how local species that might be sensitive to changes in water quality or changes in hydrological conditions would be identified. The proponent responded with a commitment to undertake detailed field assessment of the receiving environment for the EA applications once infrastructure locations had been identified.

EHP advised that some aquatic species may be integral to ecosystem health, such as the Australian bony bream (*Nematolosa erebi*) which is a non-threatened Australian freshwater fish, and that significant impacts to aquatic ecosystems may occur when severe impacts occur to species that are not necessarily listed as endangered, threatened or vulnerable. In response, the proponent conducted further studies on the tolerance of the assemblage of fish species typical for the project area as reported in SREIS Appendix H Aquatic Ecology Technical Report. The report concluded that the greatest risk to native fish within the reaches of the Isaac River would be from the uncontrolled release of untreated CSG water during high flow conditions (dam failure or operational emergency would be very low risk events). In addition it was found that any such discharge would be unlikely to exceed the receiving environment 80th percentile salinity level and that all fish assessed have a salinity tolerance higher than the 80th percentile of the Isaac River. It was considered that a temporary increase in salinity within the receiving environment would be likely have a low to negligible impact on fish.

EHP requested that the proponent ensure that “feed water characterisation studies” (as stated in section 1.3 of EIS Appendix N) detail all contaminants that may impact aquatic ecology including a sampling and analysis design with location of sampling points and list of analytes. The proponent updated the water quality monitoring program in SREIS Appendix F Surface Water Quality Technical Report to include some of these details and stated that water quality parameters for proposed ongoing water quality monitoring would be detailed during the EA application process once details of any possible CSG water discharges and receiving environments were available.

EHP requested that all EA applications for the project address the legislative requirements relevant to the management of CSG water (see Appendix 3 of this assessment report) and stated that the details provided must be site and project specific, and based on sampling of water quality in the proposed receiving waters (Isaac River). The proponent’s framework approach (see section 4.4 of this assessment report) and EIS commitments reflect this request. The proponent committed to only discharge treated or untreated CSG water where disposal to receiving waterways would not significantly impact the environmental values of the aquatic environment.

4.11.6 Conclusion and recommendations

The description of aquatic plants and animals and their habitat within the project area was adequate to meet the requirements of the TOR given the large aerial extent of the project, the strategic level of project planning and constraints framework approach chosen to address these issues whereby detailed site specific assessment is deferred to the EA application stage. The EIS provided a qualitative assessment of potential impacts of an outline of the project including estimates of mitigation of impact through implementation of stated measures, and estimates of the residual impact on specific aquatic ecology values. As the actual location of project infrastructure was not defined, the impacts on aquatic ecology could not be expressed quantitatively and auditable environmental

outcomes were not stated.

A number of qualitative commitments to inspection and monitoring related to protection of aquatic values were provided in SREIS Appendix O. Many of these commitments are statements of operational intent and not outcome statements. Detailed measures for management of risks associated with accidental releases or spills, and for weed and pest management, were proposed to be included in management plans developed as part of the approvals for the delivery of the project.

Assessment of the potential impact of discharge of treated and untreated CSG water to watercourses, including the assessment of potential cumulative impact on water quality, was not adequate to meet the requirements of the EP Act to support an application for an environmental authority for an activity involving such discharge.

Environmental offsets were not proposed as the actual offset area requirements will not be determined until pre-construction surveys are completed and the actual location of infrastructure is defined. A draft strategy outlining a proposed approach, with estimated habitat disturbance figures, has been presented to meet environmental offset obligations under Queensland and Commonwealth legislation (SREIS Appendix P).

The proponent has committed to preparing detailed technical information to support EA applications. Matters that the proponent will be required to address are outlined in Appendix 3. This includes the detailed information requirements relating to proposed discharge of CSG water, potential impact on aquatic ecology, and measures to limit impacts.

Recommendation – proponent’s commitments on aquatic ecology

Where the proponent’s commitments outlined in SREIS Appendix O do not conflict with any subsequent approval conditions and any recommendations of this assessment report, the proponent should implement the commitments as stated.

Recommendation – constraints mapping to identify any additional areas for avoidance for site-specific planning identification of core habitat for EVNT species

In developing the Constraints Mapping (Appendix BB of the EIS) for pre-construction/pre-clearance surveys to identify any additional areas for avoidance, as well as the development of vegetation mapping at a scale suitable for site-specific planning identification of core habitats for EVNT species, the core habitat for *Elseya albagula* (Southern snapping turtle) should be specifically addressed as this species is proposed to be upgraded to the status of Endangered under the NC Act.

Recommendation – water discharge locations

The proponent should avoid water discharge locations and/or management options that may impact core habitat for Fitzroy river turtle, southern snapping turtle, and *Eucalyptus raveretiana*.

Recommendation – EA application guideline

In preparing an application for an environmental authority, or an amendment to an environmental authority, the proponent is to consider the guideline Application requirements for petroleum activities (EM705) and should ensure that the information provided in the application meets the requirements of s.125 and s.126 of the EP Act.

Recommendation – EA application

The proponent should ensure that EA applications address all of the legislative requirements relevant to the management of CSG water (see EHP web page) and that the details provided are site and project specific, and based on sampling of water quality in the proposed receiving waters (Isaac River). Applications should also be publicly available for advice.

Recommendation - mapping

The proponent should present amended regional ecosystem mapping for the purpose of offset area estimation and support the mapping with adequate site data, photographs and justification.

Recommendation – basin wide issues

The State government should consider coordinating project proponents in the Bowen Basin affected by this proposed project in developing collaborative studies and basin wide ecological management including the facilitation of

- research into species ecology and effective impact mitigation techniques to be sponsored collaboratively by proponents of the projects contributing to potential impact
- a collaborative approach between project proponents for the purpose of effective ecological offsetting including joint funding for management of a specific habitat offset for a species or ecological community that is impacted by a number of projects.

4.12 Terrestrial ecology

EIS section 17 Terrestrial ecology described the terrestrial ecology values within the project area and provided an assessment of the potential for these values to be affected by direct or indirect impacts associated with the construction, operation and decommissioning phases of the project. Detailed information on the terrestrial ecology assessment was included in EIS Appendix P Terrestrial Ecology Impact Assessment. Broad environmental protection objectives, to avoid or minimise impacts to terrestrial ecology and to control the introduction or spread of exotic flora or fauna species, were stated. Avoidance, mitigation and management measures to achieve these objectives were stated as commitments. The estimate of residual impacts to terrestrial ecology by the project assumed that the proposed avoidance, mitigation and management measures would be fully implemented.

SREIS section 11 Terrestrial ecology provided updated information on terrestrial ecology resulting from changes to the project description stated in SREIS section 3 Project description (refer to section 4.3 of this assessment report), submissions on the EIS, and further desktop and field studies. Detailed information on the supplementary assessment was contained in SREIS Appendix I Supplementary Terrestrial Ecology Technical Report.

The assessment of matters of national environmental significance (MNES) was addressed as part of the terrestrial ecology assessment and as a stand-alone assessment in SREIS Appendix J Matters of national environmental significance. This report updates and supersedes the previous MNES report to the EIS (Appendix CC of the EIS). The evaluation of the assessment of MNES is contained in section 5 of this assessment report.

In order to quantify the environmental impacts of the project, the proponent used a conceptual disturbance footprint estimation based on the maximum footprint of the conceptual project layout for seven representative drainage areas. The proponent stated that the likely actual disturbance for the project would be lower than the estimates presented in the EIS documents. The proponent undertook a peer review process of the methodology used to estimate disturbance areas and implemented the resulting recommendations. Appendix 2 of this assessment report provides a summary of the proponent's habitat mapping methodology, habitat mapping rules, habitat maps, disturbance calculation methodology and disturbance calculations. Appendix 2 also provides a summary of the proponent commissioned third party review of the methodology.

4.12.1 Assessment methodology

The impact assessment methodology for terrestrial ecology was outlined in section 17.2 of the EIS section 17, and detailed in section 4 of EIS Appendix P. Further explanatory material was provided by the proponent (see Appendix 2 of this assessment report) to clarify the rationalisation method. The potential impacts of the proposed development on terrestrial ecology values were assessed using the significance assessment approach (as described in the EIS section 7 Environmental Framework and outlined in section 4.4 of this assessment report) using criteria outlined in Section 17.2 of EIS section 17. The magnitude and significance of the impacts were estimated and impacts with a high significance were given priority for the development of mitigation measures.

The EIS documents stated that the size of the project area made a detailed survey for listed species and communities (threatened species and communities listed under the NC Act and EPBC Act) impractical and outlined the approach proposed by the proponent to determine the extent of ecological assets (including SSBV and MNES) present within the project development area including

- desktop assessment and field surveys carried out for the EIS
- the environmental framework approach outlined in EIS section 7
- proposed site validation of environmental values (SREIS section 11 Terrestrial ecology)
- proposed preclearance surveys in accordance with guidelines
- further surveys reported in the SREIS Appendix I.

The desktop study included a review of relevant literature, database searches, and examination of aerial photography to inform the selection of sites to target during the field surveys. Sites for field surveys were selected to sample a range of ecosystems and validate their presence, and to identify sensitive vegetation communities and in particular potential core habitat for threatened flora and fauna species.

Section 17.2.4 of the EIS outlined the field survey methodology, which included 11 days (17 to 27 October 2011) of field work followed by a second phase of field survey completed in May 2012 (4 to 20 May) to allow for seasonal variations in floristic and faunal composition of habitats. Figure 17.1 of the EIS showed the approximate location of terrestrial flora survey sites for the EIS.

Details of secondary, tertiary and quaternary survey methodologies were provided in EIS Appendix P Terrestrial Ecology Technical Report. Six hundred and thirty-two floristic survey sites were recorded comprising 102 secondary, 20 tertiary and 510 quaternary sites. A total of 334 sites were assessed for fauna composition including 260 sites subject to active fauna searches during the field survey, 39 sites subject to formalised trapping techniques, and 35 sites subject to fauna observation recorded in recent associated studies. The location of fauna

survey and trapping sites were provided in Figure 17.2 of the EIS.

Data from the desktop review and field surveys for both flora and fauna provided a list of threatened species, ecological communities and regional ecosystems (REs) that were deemed potentially relevant. A likelihood of occurrence assessment was undertaken based on available records, known species, habitat distribution and habitat suitability.

SREIS Appendix I and Appendix J provided the methodology for determining the potential maximum disturbance footprint for MNES and State significant biodiversity values (SSBVs). This methodology was further detailed in a report provided to EHP by the proponent entitled “Bowen Gas Project SREIS Disturbance Calculation EAR Summary” (summarised in Appendix 2 of this assessment report). The methodology used potential habitat mapping for each MNES and SSBV that had been ‘rationalised’ according to the level of confidence in the mapping. The estimated maximum disturbance footprint for the life of the project was based on conceptual layouts assumed for the 33 drainage areas proposed for the project area based on layouts designed for seven representative drainage areas. The disturbance area for each MNES and SSBV was calculated from the sample conceptual footprint, with the area of disturbance calculated as a percentage of the total value within each sample conceptual drainage area. These disturbance percentages were then applied to each environmental value within drainage areas that had the same well densities as the sample conceptual footprint.

4.12.2 Ecological Values

The EIS identified 78 regional ecosystems (excluding RE sub-types) within the project area including 18 ‘endangered’ and 20 ‘of concern’ REs based on biodiversity status. Two threshold REs were also recognised. No ‘critically limited’ REs were known to occur in the project area. The total area of remnant vegetation in the project area was estimated to be 306371ha of which 32071ha comprised REs with ‘endangered’ biodiversity status, 95,186ha comprised REs with ‘of concern’ biodiversity status, and 178276ha comprises REs with ‘no concern at present’ biodiversity status. Field surveys refined some of the mapping of REs.

The SREIS estimated the area of remnant vegetation within the 33 drainage areas to be 109428ha and comprising 51 regional ecosystems including 13 ‘endangered’ biodiversity status REs (12342.5ha) and 18 ‘of concern’ biodiversity status REs (35139.1ha). These estimates for the 33 drainage areas did not include pipeline or transportation corridors linking the drainage areas.

Three EPBC Act listed threatened ecological communities (TECs) were identified within the project area during the field surveys

- brigalow (*Acacia harpophylla* dominant and co-dominant)
- natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin Ecological Community (natural grassland)
- semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (SEVT).

Within the project area, the weeping myall woodland TEC was potentially represented by REs 11.3.2. However, no occurrence of the weeping myall woodlands TEC was observed during the field survey. Table 4.12.1 lists the endangered and of concern REs that were identified in the 33 drainage areas.

Table 4.12.1 Endangered and Of Concern Regional Ecosystems in the 33 drainage areas (Source: Table 7-3 of SREIS Appendix P)

Regional ecosystem	Description	VM Act class ¹	Biodiversity status ²	Corresponding TEC ³	Total area in drainage areas (ha)	Rationalised Area ⁵ of RE within Disturbance Footprint (ha)
11.3.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains	Endangered	Endangered	Brigalow	4070.2	44.06
11.3.11	Semi-evergreen vine thicket on alluvial plains	Endangered	Endangered	SEVT	23.5	0
11.3.21	<i>Dichanthium sericeum</i> and/or <i>Astrebla spp.</i> grassland on alluvial plains.	Endangered	Endangered	Natural	460.9	0.5

Regional ecosystem	Description	VM Act class ¹	Biodiversity status ²	Corresponding TEC ³	Total area in drainage areas (ha)	Rationalised Area ⁵ of RE within Disturbance Footprint (ha)
	Cracking clay soils			Grassland		
11.4.1	Semi-evergreen vine thicket +/- <i>Casuarina cristata</i> on Cainozoic clay plains	Endangered	Endangered	SEVT	23.8	0
11.4.7	<i>Eucalyptus populnea</i> with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest to woodland on Cainozoic clay plains	Endangered	Endangered	Brigalow	3.7	0
11.4.8	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains	Endangered	Endangered	Brigalow	1821.8	35.64
11.4.9	<i>Acacia harpophylla</i> shrubby woodland with <i>Terminalia oblongata</i> on Cainozoic clay plains	Endangered	Endangered	Brigalow	9083.1	179.86
11.5.16	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest in depressions on Cainozoic sand plains/remnant surfaces	Endangered	Endangered	Brigalow	190.1	7.86
11.5.17	<i>Eucalyptus tereticornis</i> woodland in depressions on Cainozoic sand plains/remnant surfaces	Endangered	Endangered		72.4	0.57
11.8.13	Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks	Endangered	Endangered	SEVT	2210.9	67.80
11.8.15	<i>Eucalyptus brownii</i> or <i>E. populnea</i> woodland on Cainozoic igneous rocks	Endangered	Endangered		370	
11.9.1	<i>Acacia harpophylla</i> - <i>Eucalyptus cambageana</i> woodland to open forest on fine-grained sedimentary rocks	Endangered	Endangered	Brigalow	1360.2	8.45
11.9.4	Semi-evergreen vine thicket or <i>Acacia harpophylla</i> with a semi-evergreen vine thicket understorey on fine-grained sedimentary rocks	Endangered	Endangered	SEVT	685.5	12.06
11.9.5	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on fine-grained sedimentary rocks	Endangered	Endangered	Brigalow	5263.3	108.42

Regional ecosystem	Description	VM Act class ¹	Biodiversity status ²	Corresponding TEC ³	Total area in drainage areas (ha)	Rationalised Area ⁵ of RE within Disturbance Footprint (ha)
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding	Endangered	Endangered	SEVT	42.6	0
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	Of Concern	Of Concern	Weeping myall woodland (possible minor component)	25218.1	289.02
11.3.3	<i>Eucalyptus coolabah</i> woodland on alluvial plains	Of Concern	Of Concern		1983.2	27.66
11.3.4	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus spp.</i> woodland on alluvial plains	Of concern	Of concern		7445.1	107.03
11.3.36	<i>Eucalyptus crebra</i> and/or <i>E. populnea</i> and/or <i>E. melanophloia</i> on alluvial plains	Of Concern	Of Concern		96.5	0.01
11.4.2	<i>Eucalyptus spp.</i> and/or <i>Corymbia spp.</i> grassy or shrubby woodland on Cainozoic clay plains	Of Concern	Of Concern		3640.5	82.84
11.4.4	<i>Dichanthium sericeum</i> , <i>Astrelba spp.</i> grasslands on Cainozoic clay plains	Least Concern	Of Concern	Natural Grassland	1642.5	3.45
11.4.11	<i>Dichanthium sericeum</i> , <i>Astrelba spp.</i> and patchy <i>Acacia harpophylla</i> , <i>Eucalyptus coolabah</i> on Cainozoic clay plains	Of Concern	Of Concern	Natural Grassland	<1	
11.5.18	<i>Micromyrtus capricornia</i> shrubland on Cainozoic sand plains/remnant surfaces.	Of Concern	Of Concern		242.7	6.62
11.7.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> and <i>Eucalyptus thozetiana</i> or <i>E. microcarpa</i> woodland on lower scarp slopes on Cainozoic lateritic duricrust	Least Concern	Of Concern		312	2.53
11.8.3	Semi-evergreen vine thicket on Cainozoic igneous rocks	Of Concern	Of Concern	SEVT	1033.5	4.35
11.8.11	<i>Dichanthium sericeum</i> grassland on Cainozoic igneous rocks	Of Concern	Of Concern	Natural Grassland	13826.8	793.72

Regional ecosystem	Description	VM Act class ¹	Biodiversity status ²	Corresponding TEC ³	Total area in drainage areas (ha)	Rationalised Area ⁵ of RE within Disturbance Footprint (ha)
11.8.14	<i>Eucalyptus crebra</i> , <i>Corymbia dallachiana</i> woodland on Cainozoic igneous rocks	Of Concern	Of Concern		40.3	0.66
11.9.7	<i>Eucalyptus populnea</i> , <i>Eremophila mitchellii</i> shrubby woodland on fine-grained sedimentary rocks	Of Concern	Of Concern		18873.3	285.55
11.9.10	<i>Eucalyptus populnea</i> , <i>Acacia harpophylla</i> open forest on fine-grained sedimentary rocks	Of Concern	Endangered		1234.8	35.18
11.9.13	<i>Eucalyptus moluccana</i> or <i>E.microcarpa</i> open forest on fine grained sedimentary rocks	Of Concern	Of Concern		1214.7	36.21
11.10.8	<i>Semi-evergreen vine thicket on sheltered habitats on medium to coarse-grained sedimentary rocks</i>	Of Concern	Of Concern		655.8	10.45
11.5.15	Semi-evergreen vine thicket on Cainozoic sand plains/remnant surfaces	Least Concern	Endangered	SEVT	1193	
11.9.3	<i>Dichanthium spp.</i> , <i>Astrebla spp.</i> grassland on fine-grained sedimentary rocks	Least Concern	No Concern At Present	Natural Grassland	2103	

¹VM Act class - Conservation status under the VM Act

²Biodiversity status - Conservation status under the REDD and EP Act

³TEC – Threatened ecological community listed under the EPBC Act & REs listed as components of the TEC

⁴HVR – High value regrowth

⁵Rationalised area – refer to Appendix 2 of this assessment report

A total of 63 flora species listed as either endangered, vulnerable or near threatened (EVNT) under Commonwealth and/or state legislation were identified by desktop searches as being potentially present, including 17 species listed under the EPBC Act and 49 species listed under the *Nature Conservation Act 1992* (NC Act). Of these, 51 species of flora were excluded from the assessment due to the absence of recent records and absence of suitable habitat within the project area. Of the 12 listed flora species identified as potentially occurring in the project area, 11 species listed under the NC Act and 4 species listed under the EPBC Act were known to occur in the project area (see Table 4.12.2 below). These listings were current at the time of the study and some listings have been varied since that time.

A total of 599 vertebrate species were identified from records as potentially occurring in the project area and surrounding area, including 41 frog, 131 reptiles, 334 birds and 94 mammals. Thirty three fauna species listed as EVNT under the NC Act and/or the EPBC Act considered likely to occur in the project area including 1 amphibian, 4 reptiles, 19 birds and 8 mammals. Fourteen migratory fauna species were considered to be known to occur or to possibly occur in the project area.

'Category A' environmentally sensitive areas (ESAs) under the EP Act (including national parks, regional parks, forest reserves) within the project area were identified as

- Redcliffvale NP (proposed)
- Homevale NP

- Dipperu NP
- Taunton NP
- Junee NP.

'Category B' ESAs under the EP Act within the project area were identified as endangered regional ecosystems (biodiversity status) RE 11.3.1, 11.3.11, 11.3.21, 11.4.1, 11.4.7, 11.4.8, 11.4.9, 11.4.13, 11.5.15, 11.5.16, 11.5.17, 11.8.13, 11.8.15, 11.9.1, 11.9.4, 11.9.5, 11.9.10, 11.11.18.

'Category C' ESAs within the project area were identified as

- essential habitat mapped under the VM Act
- Newlands, Kemmis Creek and Norwich Park Nature Refuges, of which two are registered offset areas
- Homevale Regional Park (resource reserve)
- Arthur's Bluff State Forest
- of concern regional ecosystems – 11.3.2, 11.3.3, 11.3.4, 11.3.36, 11.4.2, 11.4.4, 11.4.11, 11.5.18, 11.7.1, 11.8.3, 11.8.11, 11.8.14, 11.9.7, 11.9.13 and 11.10.8
- high value habitats including state significant wildlife corridors, essential habitat for threatened wildlife, extensive tracts of natural grassland, wetlands of state significance and well developed, contiguous riparian forests.

Tables 4.12.2 and 4.12.3 summarise the likely presence of threatened species for the project area. These listings were made at the time of the EIS study and some species have been removed or upgraded since that time.

Table 4.12.2 Threatened flora species & likelihood of occurrence (Source Table 17-6 EIS section 17)

Scientific Name	Common Name	Status	Likelihood of Occurrence
<i>Aristida annua</i>	A tufted grass	EPBC Act – V NC Act - V	possible
<i>Bertya pedicellata*</i>		EPBC Act – V NC Act - NT	known
<i>Capparis humistrata</i>		NC Act - E	likely
<i>Cyperus clarus*</i>		EPBC Act – V NC Act - V	possible
<i>Cerbera dumicola*</i>		EPBC Act – V NC Act - NT	known
<i>Croton magneticus</i>		NC Act - V	possible
<i>Desmodium macrocarpum</i>	Large podded trefoil	NC Act - NT	known
<i>Dichanthium queenslandicum</i>	King blue-grass	EPBC Act – E NC Act - V	known
<i>Dichanthium setosum*</i>	Blue grass	EPBC Act – V NC Act - NT	known
<i>Digitaria porrecta</i>	Finger panic grass	NC Act - NT	known
<i>Eucalyptus raveretiana</i>	Black ironbox	EPBC Act – V NC Act - V	known
<i>Euphorbia sarcostemmoides</i>		NC Act - V	known
<i>Macropteranthes leiocaulis</i>		EPBC Act – V NC Act - NT	known
<i>Omphalea celata</i>		EPBC Act – V NC Act - V	unlikely
<i>Paspalidium scabrifolium</i>		EPBC Act – V	known

Scientific Name	Common Name	Status	Likelihood of Occurrence
		NC Act - NT	
<i>Peripleura scabra</i>	Hairy seeded fuzzweed	NC Act - NT	likely
<i>Solanum adenophorum*</i>		NC Act - E	possible
<i>Solanum elachophyllum</i>		NC Act - E	known
<i>Trioncinia retroflexa</i>		NC Act - E	possible

*EPBC listing changed since the EIS study was completed.

Table 4.12.3 Threatened fauna species & likelihood of occurrence (Source Table 4.2 SREIS Appendix I)

Group	Scientific Name	Common Name	Status	Likelihood of occurrence
Insects	<i>Jalmenus eubulus</i>	Pale imperial hairstreak	NC Act – V	possible
Reptiles	<i>Delma labialis*</i>	Striped-tailed delma	EPBC Act – V NC Act – V	known
	<i>Denisonia maculata</i>	Ornamental snake	EPBC Act – V NC Act – V	known
	<i>Egernia rugosa</i>	Yakka skink	EPBC Act – V NC Act – V	possible
	<i>Paradelma orientalis</i>	Brigalow scalyfoot	NC Act - V	extremely high
Birds	<i>Geophaps scripta scripta</i>	Squatter pigeon (southern)	EPBC Act – V NC Act - V	known
	<i>Calyptorhynchus lathami</i>	Glossy black-cockatoo	NC Act - V	possible
	<i>Rostratula australis</i>	Australian painted snipe	EPBC Act – E NC Act - V	possible
	<i>Melithreptus gularis</i>	Black-chinned honeyeater	NC Act - NT	known
	<i>Accipiter novaehollandiae</i>	Grey goshawk	NC Act - NT	possible
	<i>Lophoictinia isura</i>	Square-tailed kite	NC Act - NT	possible
Mammals	<i>Nyctophilus corbeni</i>	South-eastern long-eared bat	EPBC Act – V NC Act – V	possible
	<i>Dasyurus hallucatus</i>	Northern quoll	EPBC Act – E	possible
	<i>Phascolarctos cinereus</i>	Koala	EPBC Act – V NC Act - SLC	known

* EPBC listing changed since the EIS study was completed.

A total of 454 lacustrine, 411 palustrine and 109 riverine wetlands were mapped within the project area, including 37 wetlands categorised as having high ecological significance (HES) and mapped as Great Barrier Reef wetland protection areas. Within the 33 proposed drainage areas, 66 riverine and 191 non-riverine wetlands were mapped, of which 14 riverine and 29 non-riverine wetlands were identified as having high or very high ecological value), and 24 were mapped as HES wetlands.

The EIS stated that Lake Elphinstone was not located within the project area. The lake was identified immediately adjacent to the project area. Much of the catchment of the lake is within the project area but not within one of the

proposed drainage areas.

The EIS identified 117 exotic plant species occurring or potentially occurring within the project area, and noted the high proportion of infested ecosystems classed as Category B or Category C ESAs on fertile clay soils and alluvial landforms, highlighting the requirement for stringent weed management control in the vicinity of these areas. The following declared weeds (*Land Protection (Pest and Stock Route Management) Act 2002* (LP Act)) and weeds of national significance (WONS) were identified by database searches and field survey (Table 17-7 of the EIS)

- velvet pear (*Opuntia tomentosa*) Class 2
- prickly pear (*Opuntia stricta*), Class 2
- harissia cactus (*Harissia martinii*), Class 2
- mother of millions (*Bryophyllum delagoensis*), Class 2, WONS
- bellyache bush (*Jatropha gossypifolia*)
- rats tail grass (*Sporobolus fertilis/ Sporobolus pyramidalis*), Class 2
- rubber vine (*Cryptostegia grandiflora*), Class 2, WONS
- parthenium (*Parthenium hysterophorus*), Class 2, WONS
- parkinsonia (*Parkinsonia aculeata*), Class 2, WONS
- lantana (*Lantana camara*), Class 3, WONS

The following feral vertebrate species were recorded from the project area including seven listed as Class 2 declared animals under the LP Act and four species (feral dog/dingo, fox, cat and cane toad) known to pose significant risks to biodiversity

- cane toad (*Rhinella marina*)
- feral dog/dingo (*Canis lupis*), Class 2 listed
- european fox (*Vulpes vulpes*), Class 2 listed
- feral cat (*Felis catus*), Class 2 listed
- european rabbit (*Oryctolagus cuniculus*), Class 2 listed
- feral pig (*Sus scrofa*), Class 2 listed
- house sparrow (*Passer domesticus*)
- common myna (*Sturnus tristis*)
- common starling (*Sturnus vulgaris*)
- european hare (*Lepus capensis*)
- black rat (*Rattus rattus*)
- house mouse (*Mus musculus*).

4.12.3 Impacts and significance of impact

Potential impacts from project activities (construction, operation and decommissioning) identified by the terrestrial ecology impact assessment included vegetation clearing which could result in direct mortality, habitat loss and fragmentation, edge effects and pest plant and animal invasion.

The protection of terrestrial ecological values was proposed to be primarily achieved through design and site selection that would result in avoidance of high-value environmental areas. Commitments for avoiding and minimising impacts to terrestrial ecological values were made in the EIS documents and listed in SREIS Appendix O.

SREIS section 11 Terrestrial ecology stated that the maximum project disturbance footprint would be 6836 ha of remnant vegetation including approximately 580ha of 'endangered' biodiversity status REs and 1618ha of 'of concern' biodiversity status REs, with the remainder having status of 'no concern at present'. Terrestrial ecological values likely to be impacted were summarised in SREIS Appendix P.

EIS Appendix P Terrestrial Ecology Technical Report provided an analysis of the significance of likely impacts from the various project development activities on threatened species and communities, ESAs, and REs. No activities would occur within Category A ESAs but essential petroleum activities were proposed within Category B ESAs and Category C ESAs (see Table 17.11 of the EIS).

EIS Appendix P presented a detailed review of project development activities and potential associated impacts and provided a summary of potential direct and indirect impacts of project activities on terrestrial ecological values including

- vegetation clearing resulting in plant and animal mortality, loss of habitat, and increased erosion or

sedimentation

- fragmentation of habitat and populations
- loss or modification of habitat important for threatened flora and fauna species, including the creation of dispersal and movement barriers, potentially isolating existing populations and reducing genetic flow
- edge effects associated with vegetation clearing including weed invasion, increased predation and competition, and changes in abiotic factors that may affect ecosystems and/or species
- changes to other ecological processes such as fire frequency, fire extent, surface water availability, surface water flow, and potential discharge of saline waters into vegetation and/or surface waters including wetlands.

The following Table 4.12.4 lists the project activities that were identified as having potential to cause adverse impacts on terrestrial ecological values during the construction, operations and decommissioning phases of the project.

Table 4.12.4 Project activities that may impact terrestrial ecological values (Source EIS Appendix P)

Construction	Operations	Decommissioning
<ul style="list-style-type: none"> • Production well design and installation • Gathering infrastructure design and installation • Access track design and installation • FCF and CPGF design and installation • Water storage and treatment facility design and installation • Power generation facility and/or powerlines design and installation • Sewerage treatment facility design and installation. 	<ul style="list-style-type: none"> • Production well operation and maintenance • Gathering infrastructure operation and maintenance • Access track operation and maintenance • Electricity supply operation and maintenance • FCF and CPGF operation and maintenance • Water storage and treatment facility operation and maintenance • Sewerage treatment facility operation and maintenance. 	<ul style="list-style-type: none"> • Production well decommission and rehabilitation • Gathering infrastructure decommission and rehabilitation • Electricity supply decommission and rehabilitation • Water storage and treatment facility (at WTF/CGPF) decommission and rehabilitation • Sewerage treatment facility decommission and rehabilitation.

The avoidance, minimisation and management measures proposed by the proponent, included

- **avoidance:** avoiding vegetation clearing, avoiding sensitive vegetation patches or species assemblages, and applying buffers to sensitive areas. Pre-clearance surveys, coupled with revised vegetation mapping at an appropriate scale, were proposed be undertaken prior to development to determine the occurrence, or likely occurrence, of EVNT species or threatened ecological communities allowing appropriate mitigations measures to be implemented.
- **minimisation:** minimising disturbance to sensitive vegetation or habitats by reducing development footprints, minimisation of habitat fragmentation, and minimisation of edge creation
- **active management:** rehabilitation, propagation of plants, translocation of threatened species, biodiversity offsets, and ongoing monitoring programs.

4.12.4 Cumulative impacts

EIS section 31 Cumulative Impacts discussed the potential cumulative impacts of known future developments on the environmental values within the project area. EIS Appendix P addressed cumulative impacts on terrestrial ecology focusing on habitat loss, habitat fragmentation and fauna mortality resulting from vegetation clearance and earthworks.

The EIS documents concluded that the following threatened ecological communities (and associated regional ecosystems) and threatened species would have high potential for cumulative impact

- brigalow (*Acacia harpophylla* dominant and co-dominant)
- natural grasslands of Queensland Central Highlands & Northern Fitzroy Basin
- semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.
- king blue-grass (*Dichanthium queenslandicum*)

- large podded trefoil (*Desmodium macrocarpum*)*
- *Euphorbia sarcostemmoides*
- *Cerbera dumicola*
- ornamental snake (*Denisonia maculata*)
- brigalow scaly foot (*Paradelma orientalis*)
- koala (*Phascolarctus cinereus*).

* EPBC listing changed since the EIS study was completed.

The above communities and species were identified as having attributes for susceptibility to cumulative impact including

- a restricted distribution
- sensitivity to disturbance
- core populations within the project area
- endemism to the Brigalow Belt North Bioregion.

The desirability of a cooperative approach with other project proponents was recognised in the EIS documents. Measures were stated in the EIS documents for mitigating potential project impacts on ecological values.

4.12.5 Offsets

The EIS did not include information required by the TOR on offsets for residual impacts on Matters of Environmental Significance (MNES). DOE requested detailed information on offsets, including offsets for residual impacts to MNES, consistent with the draft EPBC Act Environmental Offsets Policy.

SREIS Appendix J Matters of Environmental Significance Report replaced the EIS MNES report and addressed the residual impacts to MNES required by the TOR.

EHP requested detailed information to meet the requirements of the *Queensland Environmental Offset Act 2014* which came into effect on 1 July 2014, including the extent of impact on each Matter of State Environmental Significance (MSES).

SREIS Appendix P Environmental Offsets Strategic Management Plan presented a high level strategy outlining a proposed approach to meet environmental offset obligations for the project. The plan referred to measures stated in the EIS documents to avoid and minimise impacts, including preclearance surveys, proposed environmental constraints, and commitments to mitigation and management. Tables 6.2 and 7.6 of SREIS Appendix P presented a summary of state significant biodiversity values (as listed in Appendix 1 of the Queensland Biodiversity Offsets Policy), likely impacts, and the relevance of the values to the project.

The proponent submitted an updated offset management plan (dated 18 July 2014) with maximum disturbance estimates for the life of project and for phase 1. The plan also dealt with the likely direct offset availability and offset options. A summary of the offset management plan is provided in Appendix 2 of this assessment report.

Table 7.3 of SREIS Appendix P provided an estimate of the potential area of disturbance of 'endangered' and 'of concern' regional ecosystems in the project area based on the conceptual field layout, publicly available mapping, and mapping prepared for the SREIS. SREIS Appendix I Terrestrial Ecological Technical Report Appendix A Table A.1 presented an estimate of the total area of regional ecosystems for each of the 33 drainage areas based on Queensland Herbarium regional ecosystem mapping. Table B.1 of Appendix B to SREIS Appendix I presented the estimated maximum extent of regional ecosystems potentially impacted by the conceptual project development footprint. The actual area of regional ecosystems within the project area may vary significantly from the estimated area due to errors in the Queensland Herbarium mapping. Revised regional ecosystem mapping presented in the SREIS for areas that were subject to field survey, may be accepted by EHP for the purpose of offset area estimation, provided that the mapping is supported by adequate site data (data sheets, photographs, shapefiles) which was not provided in the SREIS.

Table 7.5 of SREIS Appendix P provided an estimate of the potential area of disturbance of habitat for threatened species that were determined to be likely to occur in the project area. This was based on a conceptual field layout and habitat mapping prepared for the EIS. It was noted that the habitat of threatened species may overlap and therefore the total area of disturbance for threatened species would likely be less than the sum of estimated areas for each species.

The SREIS did not include an estimate of the area of potential impact on MSES (such as NC Act listed flora and connectivity) within the project area. The SREIS did include an estimate of areas of potential impacts to State Significant Biodiversity Values (SSBVs) such as NC Act listed flora and fauna species, under the legislation relevant at the time of submission. Subsequent to the SREIS the proponent provided an estimate for MSES

impacts as set out in Appendix 2 of this assessment report.

Table 8.1 of SREIS Appendix P provided an estimate of the availability of ecological communities and habitat (based on regional ecosystems) in the bioregion to meet potential requirements for offsets. The estimate of maximum impact and available offset areas indicated that adequate offset areas may be available for the estimated maximum potential offset requirements.

Section 9 of SREIS Appendix P outlined the proponent's preferred staged approach to the provision of environmental offsets. Environmental offsets were not proposed in the SREIS as the actual offset area requirements would not be determined until preclearance surveys were complete and the actual location of infrastructure was defined.

4.12.6 Major issues raised

References to agencies and organisations in the following text are those who made submissions on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

EHP requested clarification of a number of apparent discrepancies between Tables 7.4 (Potential area of disturbance of TECs in project area), 7.6 (State significant biodiversity values potentially impacted within the project area) and 8.1 (Estimate of Potential Offset Areas within the Bioregion) of SREIS Appendix P Environmental Offsets Strategic Management Plan and Table A.1 (Areas of regional ecosystems present within drainage areas 1 to 20) in SREIS Appendix I Terrestrial Ecology Technical Report. The proponent provided further advice, in the SREIS and additional information provided to EHP, on the methodology used to estimate the extent of regional ecosystems and potential species habitat, including the way in which inherent inaccuracies in data and mapping were taken into account in estimating disturbance areas. A summary of the methodology used to estimate the conceptual footprint of the project for the purpose of estimating disturbance areas for MNES and SSBVs, and method used to rationalise potential habitat mapping is contained in Appendix 2 of this assessment report.

EHP and DOE requested that the biodiversity offset strategy more definitively estimate the impact areas and quantification of the impacts to MNES and MSES for phase 1 (comprising drainage areas 1, 2, 4, 8, 12, 19, 20, 22, 28, 29, 30, 31, 36, 37, 38, 39, and 40) of the proposed project, and for the entire project. The request referred to the need for detailed quantification and assessment of phase 1 offset requirements including condition assessment (either habitat quality assessment or similar), and potential offset areas for all MNES and MSES. The proponent provided additional information to EHP subsequent to the SREIS which satisfactorily addressed the request. A summary of this information is provided in Appendix 2 of this assessment report (Note: The Queensland *Environment Offset Act 2014* was enacted on the 1st July 2014 and thereafter SSBVs became MSES).

DOE advised that the identification of disturbance limits for phase 1 would be required at the time of any approval, with a commitment to providing acceptable offsets for phase 1 impacts within an agreed timeframe. The proponent confirmed that this would be the case.

The proponent committed to undertaking staged pre-clearance surveys to provide estimated disturbance figures for each stage and with subsequent stages also including a reconciliation to calculate offsets credits/debits prior to commencing the next stage.

EHP requested clarification on whether the proposed national park "Redcliffevale" in proposed drainage areas 19 and 20 would be affected by the project. The proponent clarified that while the current development plan would avoid impacts on Redcliffevale, the proponent's ability to meet petroleum tenement obligations may be impeded if the property was gazetted as national park.

EHP requested clarification on whether the proponent commitment B131 (SREIS Appendix O) was for avoiding disturbance to Weeping Myall Woodland TEC (REs 11.3.2 and 11.3.28). In the Bowen Basin Weeping Myall Woodland is unlikely to be present throughout these regional ecosystems but could occur in the southern part of the project area around Blackwater. The proponent clarified that the commitment stated the aim to avoid disturbance to Weeping Myall Woodland TEC wherever it occurs.

DOE requested confirmation that, due to the broad scale nature of the project and the inherent inaccuracies of available mapping, confirmation of presence/absence and extent of MNES would occur during pre-clearance surveys. The proponent confirmed that this would be the case.

DOE advised that, where EPBC Act listed TECs would be cleared or were likely to be impacted indirectly, evidence would be required to confirm that the TECs could be re-established to their full suite of species (i.e. meet the EPBC definition of the TEC). Otherwise, an offset for the residual significant impact that provided for an environmental gain would be required. The proponent confirmed that this would be the case and referred to commitments to undertake rehabilitation of available areas consistent with pre-clearing habitats and use plant species specific to the original ecosystem and local provenance, wherever possible in rehabilitation are (SREIS Appendix O, commitments B157 and B162).

DAFF (Biosecurity Queensland) raised concerns in relation to use of herbicides with long withholding periods for livestock, inspection of vehicles for weed hygiene, and training of staff in weed management. Isaac Regional Council, Fitzroy Basin Association and a large number of other submitters also requested more information on weed and feral animal management. The proponent advised that the draft environmental management plan for the project committed to development of a site specific weed management plan and pest management plan in accordance with all relevant legislation, guidelines (including Petroleum Industry - Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008)) and recommended procedures, and would include inspection of vehicles, training and awareness programs for staff.

NPRSR requested clarification of proposed project activities within Arthur's Bluff state Forest and Homevale National Park. The proponent confirmed the commitment to avoid disturbance to category C ESAs (including Arthur's Bluff State Forest and gazetted nature reserves) where possible, as outlined in Table 17.11 of the EIS. The proponent has committed to avoiding project activities within category A ESAs which includes national parks.

Isaac Regional Council (IRC) expressed concern that increased surface water availability may increase exotic species abundance. The proponent advised that a pest management plan would be developed and would include strategies for managing availability of water for feral animals.

IRC also raised issues around how the offset areas will be chosen and how would the proponent's offset strategy success be measured and assessed. The proponent would be required to submit regular offset management plans and progress reports by suitably qualified persons under both the EPBC and EA conditions (see Appendices 3 and 4 respectively). There would also be enforcement provisions under the Queensland *Offsets Act 2014*.

4.12.7 Conclusion and recommendations

The EIS description of terrestrial ecology values within the project area was adequate to meet the requirements of the TOR. The EIS provided a qualitative assessment of potential impacts of the project on terrestrial ecology, proposed measures to avoid or mitigate impacts, and estimates of the residual impact on specific ecological values following implementation of the stated mitigation measures. As the actual location of project infrastructure was not defined, and the accuracy of mapping of values within the project development area was uncertain except where detailed ground surveys had been completed, estimates of the potential maximum disturbance area for MNES and MSES are uncertain.

A number of drainage areas which have relatively intact remnant habitat, and are likely to be areas with significant biodiversity values, were not subject to field survey of flora and fauna values, notably drainage areas 1, 6, 18, 19, 20, 23, 25, and 40. The proponent's commitment to pre-clearance surveys for flora and fauna values should address uncertainty in the extent of MNES and MSES in areas potentially impacted by the project.

A number of qualitative commitments to inspection and monitoring related to protection of ecological values were provided but key species for monitoring were not identified. The proponent committed to development of species management procedures, when activities were considered likely to impact on a threatened species that would include species specific measures for protection and mitigation of impact.

While the project development plan currently avoids disturbance to the Redcliffvale property, which may be gazetted as part national park and part regional park by the end of 2014⁴, the proponent has stated that tenement obligations may be impeded by this.

Detailed measures for management of risks associated with weed and pest management, were proposed to be included in management plans to be developed after the EIS process. The EIS included a number of general commitments relevant to terrestrial ecological values for rehabilitation and decommissioning. These commitments included site planning, preparation and management requirements in accordance with an approved plan.

Environmental offsets were not identified in the EIS documents as the proponent proposed that the offset area requirements would not be accurately determined until pre-clearance surveys were completed and the actual location of infrastructure defined. A draft strategy outlining a proposed approach to meet environmental offset obligations under Queensland and Commonwealth legislation was provided at SREIS Appendix P and subsequently updated in an offset management plan provided to EHP on 18 July 2014 which included estimates of

⁴ Further information on this proposal is available at: <http://www.nrm.gov.au/about/caring/report-card/2009-10/pubs/2009-10-outcome-sheets/nrs-increasing-nrs.pdf>

disturbance areas for MNES and MSES in phase 1 of the project and for the total project. The potential offset areas for values impacted in phase 1 were also discussed.

In preparing an application for an environmental authority, or an amendment to an environmental authority, the proponent should consider the EHP guideline Application requirements for petroleum activities (EM705), and should ensure that the information provided in the application meets the requirements of s.125 and s.126 of the EP Act. The proponent has committed to preparing detailed technical information to support applications for environmental authorities as required. Appendix 3 of this assessment report provides an outline of recommendation for EA conditions and the EA application information that would be required.

Recommendation – proponent’s commitments on terrestrial ecology

Where the proponent’s commitments outlined in SREIS Appendix O do not conflict with any subsequent approval conditions and any recommendations of this assessment report, the proponent should implement the commitments as stated.

Recommendation – preclearance surveys

The proponent should complete pre-clearance surveys of flora and fauna to determine the occurrence and extent of MNES and Matters of State Environmental Significance (MSES) and to quantify and map the likely extent of disturbance to MNES and MSES for the purposes of defining and meeting offset requirements.

Pre-clearance surveys should especially target *Aristida annua* and Yakka skink (*Egernia rugosa*) and ensure that all impacts to these species and their habitat requirements are avoided consistent with the estimates of maximum impact provided by the EIS documents.

The proponent should undertake site specific preclearance surveys of disturbance areas prior to the commencement of clearing of each construction site. Preclearance surveys must be undertaken by a suitably qualified person and in accordance with agreed survey methods. The proponent should regularly report the outcomes of the surveys in order to reconcile actual impacts against whole of project disturbance limits for EPBC listed threatened species and communities.

Recommendation – preclearance survey methodology

The preclearance flora and fauna survey methodology should be consistent with relevant DOE/EHP/DSITIA guidelines or alternative approved methods and should assess the condition of vegetation communities and species habitat consistent with the Queensland government habitat quality assessment guideline (Guide to determining terrestrial habitat quality, EHP July 2014).

Where impacts on suitable habitat for MNES species cannot be avoided, the proponent must undertake preclearance surveys targeted at MNES species that could be present based on the suitability of habitat. These surveys should be consistent with the EPBC survey guidelines or approved alternative methods including

- Survey guidelines for Australia's threatened mammals. EPBC Act survey guidelines 6.5
- Survey Guidelines for Australia's threatened Birds. EPBC Act survey guidelines 6.2
- Survey Guidelines for Australia's threatened Bats. EPBC Act survey guidelines 6.1
- Survey guidelines for Australia's threatened reptiles. EPBC Act survey guidelines 6.6

Recommendation – certification of mapping

The proponent should provide site specific field survey data supporting any proposed revised regional ecosystem mapping to EHP, in the required format, to allow for review and endorsement of the revised mapping by the Queensland Herbarium.

Recommendation – avoidance of proposed ‘Redcliffevale’ National Park.

The proponent should avoid disturbance to the Redcliffevale property, due to the likely imminent gazettal of the property as part national park and part regional park.

Recommendation – fauna management

The proponent’s fauna management plans and project guidelines (based on SREIS Appendix O and Appendix I Terrestrial Ecology Technical Report) should be updated prior to project commencement to address conservation significance species and breeding place management measures for fauna species occurring in the Bowen Gas Project area.

Recommendation – offsets

- the proponent should develop a Biodiversity Offset Plan which includes quantification of the impacts on MNES and MSES for the life of project, with detailed quantification and assessment of construction stages offset requirements for all MNES and MSES matters
- the proponent should conduct a comprehensive desktop assessment of offset availability by tenure with focus on the EHP's Galilee Basin Offset Strategy in order to ensure viable long-term landscape conservation outcomes
- the proponent should identify co-located offsets for both MNES and State biodiversity assets on the same land parcel with preliminary desktop assessment of where these land parcels can be found
- the proponent should complete a desktop analysis to identify areas of overlap between Commonwealth and State offset requirements to clearly define offset requirements in a Biodiversity Offset Plan and identify potential offset areas for all matters.

Recommendation – EA application

The proponent should ensure that future EA applications address all of the legislative requirements relevant to the management of terrestrial ecology (see EHP web page) and that the details provided are site and project specific, and based on accurate field data. Any application for an environmental authority, or an amendment to an environmental authority, for the project should be supported by information that meets the requirements of s.125 and s.126 of the EP Act and is consistent with the EHP guideline - Application requirements for petroleum activities (EM705).

Recommendation – NC Act

The proponent should implement and comply with the statutory requirements of the *Nature Conservation Act 1992* as outlined in section 3.3.5 of this assessment report.

Recommendation – basin wide issues

The State government should consider coordinating the development of collaborative studies and basin wide ecological management involving project proponents in the Bowen Basin, including the facilitation of

- research into species ecology and effective impact mitigation techniques to be sponsored collaboratively by proponents of the projects potentially contributing to impacts
- a collaborative approach between project proponents for the purpose of effective ecological offsetting
- joint funding arrangements for management of a specific habitat offset for a species or ecological community that is impacted by a number of projects.

4.13 Hazard and risk

EIS section 27 Preliminary Hazard and Risk described the potential hazards associated with construction, operation and decommissioning phases of the project, provided an assessment of their risks to people and property and outlined avoidance, mitigation and management measures. EIS Appendix Y Hazard and Risk Technical Report provided a preliminary hazard analysis that included a quantitative risk analysis that estimated and assessed the risk at offsite land uses.

4.13.1 Assessment methodology

A preliminary hazard assessment (PHA) analysis was undertaken following the methodology in Hazardous Industry Planning Advisory Panel (HIPAP) No. 6 Hazard Analysis (New South Wales Department of Planning, 2011b) and risk assessed against the criteria in HIPAP No. 4 Risk Criteria for Land Use Safety Planning (New South Wales Department of Planning, 2011a). This analysis undertook a probabilistic risk analysis for the operations phase of the project. Loss of containment of CSG and subsequent ignition was identified as the main hazardous incident which could affect locational aspects or land use planning for facilities and pipelines in the operations phase.

The PHA process involved the establishment of the context, methodology of assessment and relevant risk tolerability criteria. The PHA performed a hazard identification study and also identified controls throughout all development phases. Qualitative assessment of the risks was carried out for all project phases using a risk matrix. Credible scenarios identified were carried forward for the quantification of consequences and likelihood in the operations phase. In the consequence analysis of the identified credible scenarios and where an offsite impact had the potential to occur, the scenarios were carried forward for frequency analysis and this frequency analysis was used to estimate the likelihood of hazardous events for scenarios with potential for offsite impacts.

The consequences of loss of containment of CSG from pipelines and facilities were modelled for a range of event sizes and under various representative weather conditions. The likelihood of loss of containment and subsequent ignition of individual scenarios was estimated using historical data for the equipment and location of the facilities and pipelines. The consequence and frequency were mathematically combined in a risk model to produce risk contours and transects for the facilities and pipelines respectively. These were then assessed against risk criteria to ascertain minimum separation distances for specific land uses.

4.13.2 Existing environment

The EIS describes the environment and community that may be affected by the proposed project activities. The project area covers an area of approximately 8000km² in the Bowen Basin, extending from Newlands in the north to south of Blackwater. Most of the project area supports low density, low intensity grazing and agricultural activity.

While grazing and agricultural land use dominates the project area, the urban communities of Glenden, Nebo, Coppabella, Moranbah, Dysart, Middlemount and Blackwater, accommodation villages at Coppabella and Burton Gorge, and homesteads and residences on pastoral leases also occur in the project area.

There are 22 operational coal mines as well as a larger number of mining and petroleum exploration leases which present risks in terms of blasting and increased vehicle and people movement within the project area.

The project area is subject to extreme climate events such as droughts, floods and cyclones. On average 4.7 tropical cyclones per year affect the Queensland area. Climate change projections predict an increase in rainfall intensity that could result in more frequent flooding events. Drought projections indicate there is likely to be an increase in drought because of an increased mean temperature and decrease in rainfall and soil moisture. Predicted decreases in rainfall and humidity, together with increased evaporation rates, are expected to increase the risk of bushfires.

4.13.3 Impacts

Coal seam gas is predominantly comprised of methane, which is flammable, and when confined, potentially explosive. Additionally, methane can displace air, creating an oxygen-deficient atmosphere. These characteristics have the potential to impact on public safety and the safety of the project workforce.

The EIS details the consequences of an ignited methane gas release and the likely causes of a loss of containment. Loss of containment may be a result of equipment failure, mechanical impact, external events or releases during venting operations with a potential for fire incidents if ignition sources are within the dispersion distance.

Hazard identification tables for all facilities and infrastructure are presented in EIS Appendix Y Hazard and Risk Technical Report. Table 5.1 (Appendix Y) summarises the types of hazards (and their risk ranking) that could

impact offsite and therefore affect members of the public. The majority of the risks were assessed as either medium or low. High risk was associated with transport accidents.

4.13.4 Mitigation

The EIS documents outlined prevention, minimisation, control and mitigation measures to minimise the potential risks to employees, the community, property and the environment from the phases of project activities.

EIS Appendix Y section 5 detailed the prevention and minimisation, control and mitigation measures to be undertaken for facilities, pipelines and water treatment. Hazard identification tables detailed the risks, causes and consequences, and the required prevention and protection measures to be taken for the design and installation of

- production wells (Table B.6)
- gathering systems (Table B.7)
- field compression facilities (Table B.8)
- central gas processing facility (Table B.9)
- integrated processing facilities (Table B.10)
- operation and maintenance - production wells (Table B.11 and Table B.12)
- operation and maintenance – gathering system (Table B.13)
- operation and maintenance – field compression facilities (Table B.14)
- operation and maintenance – central gas processing facilities (Table B.15)
- operation and maintenance – integrated processing facilities (Table B.16)
- decommissioning – gathering systems (Table B.17).

Section B4.3 detailed the required controls with respect to decommissioning production wells, field compressor facilities, central gas processing facilities, integrated processing facilities and medium pressure infield pipelines.

EIS section 27.6 Preliminary hazard and risk presented an overview of the proponent's health, safety and environment management system (HSEMS). The proponent would develop a health safety and environment management plan for the life of the project from design and construction, through to operation and decommissioning. This plan would be based on the proponent's HSEMS which includes a hierarchy of controls.

The proponent's integrated risk management plan would address the life of the project to ensure that hazard and risk to people and property would be systematically managed to a level that is as low as reasonably practicable (ALARP). Aspects of the proponent's HSEMS for hazard and risk that relate to the management of natural events would be addressed in accordance with HSE standard Natural Events procedure. Likely natural events would be considered during design and operation of the project to ensure adequate provision and maintenance for

- the foundation and earthworks design
- road, water and overhead line crossings construction
- protection from flooding
- provision of fire breaks
- design of occupied buildings
- evacuation and/or shelter in accordance with the Natural Events standard.

4.13.5 Major issues raised

Submissions on hazard and risk management issues were received from the Department of Community Safety, Queensland Health, Queensland Police Service and the Isaac Regional Council.

The main issues raised related to facilitating relevant key stakeholder input and collaboration for the development of the project HSEMS and the proposed integrated risk management plan for health, safety and environment. The proponent committed to continue to consult with emergency services, local disaster management groups and key stakeholders as field development progressed and in determining the locations of infrastructure.

The Isaac Regional Council's referred to the EIS lack of workable solutions for emergency responses and that this would draw down existing levels of service in the region. The proponent stated that an emergency management plan would be developed that would cover joint emergency response planning in collaboration with emergency service providers.

Queensland Police Service raised the issue of how the proponent would deal with trespass action, nonviolent direct action and other protest related activities that could close operations and place police, workers and protesters in danger. The proponent committed to conducting security risk assessments on the project's CSG activities and the development of plans to deal safely with any such action.

4.13.6 Conclusion and recommendations

The EIS has adequately met the TOR requirements in relation to hazard impacts. The EIS identified hazards in all phases of the project and these were assessed, controls identified to manage the stated risk. The proponent referred to the existing corporate level Health, Safety and Environment Management System (HSEMS). The proponent should develop a project HSEMS for the whole life of the project incorporating the local area, prevailing legislation and local environment (see SREIS Appendix O commitment B474).

Recommendation - HSEMS

The proponent should develop relevant emergency management plans in consultation with key stakeholders including Isaac Regional Council, Queensland Health, Queensland Ambulance Service, Queensland Police Service, Department of Community Safety, Queensland Fire and Rescue Service, and the Local and District Disaster Management Groups to ensure that emergency and risk management for the project would not conflict with and/or place any unnecessary burdens on existing disaster management arrangements.

Recommendation - consultation

The proponent should continue to engage local key stakeholders (detailed above) as the field development progresses and location of infrastructure is determined. It is recommended that the proponent meet with key stakeholders and present updated emergency management plans to stakeholders as each drainage area is developed.

Recommendation - commitments

The proponent should implement the commitments on hazard and risk outlined in SREIS Appendix O Commitments Update.

4.14 Roads and transport

EIS section 21 Roads and Transport provided a summary of the likely impacts to roads and transport in the project and surrounding areas. The EIS addressed existing and future use of roads, an assessment of the potential direct and indirect impacts on the roads and road use associated with the construction, operation and decommissioning phases of the project. Road transport was assessed as the dominant transport mode for the project. Detailed information on the assessment was included in EIS Appendix R Traffic Technical Report.

The proponent committed to avoid or minimise impacts on roads and road transport values (SREIS Appendix O) and proposed high level mitigation and management measures to achieve transport commitments.

SREIS section 12 Roads and Transport presented a summary of a supplementary roads and transport assessment (based on SREIS Appendix K Roads Impact Assessment) undertaken to address changes to the project description as outlined in SREIS section 3, and to address issues raised in submissions on the EIS such as cumulative impacts.

4.14.1 Assessment methodology

The SREIS set out an updated project description detailing establishment, operational and decommissioning periods for wells and infrastructure. The proposed project schedule provided a worst-case development scenario for road and transport requirements including assumptions on

- rapid establishment of up to 4000 wells and supporting facilities
- the majority of facilities being established in the year prior to the individual facilities commencing operations
- all 4000 production wells ultimately being established, operated and decommissioned.

The proponent stated that the SREIS documents provided a high or conservative estimate of both the peak traffic demands and the total transport requirements.

The proponent undertook a Road Impact Assessment (RIA) and updated it in the SREIS documents. The SREIS RIA presented a strategic assessment of the intensity and context of the potential road impacts associated with the project. The SREIS RIA sought to establish if there would be any road impacts that cannot be effectively managed through the typical approval requirements supported by the implementation of planned management strategies. That is, the SREIS RIA seeks to confirm if there are likely to be any residual road impacts so significant (postapplication of typical approval requirements and post-implementation of the planned management strategies) that would necessarily preclude approval of the Project. Both the intensity and context of the Project's impacts were assessed to establish the significance of the Project's potential impacts. The proponent stated that the methodology for preparing the SREIS RIA included

- collection of updated data (additional to the EIS) from relevant authorities on existing road conditions including traffic volumes, traffic growth, vehicle crash history and pavement condition
- inspection of the road network potentially servicing case study sites to further characterise existing road conditions
- review of historical traffic growth and consideration of potential future traffic growth associated with the cumulative impact of other projects
- estimation of the number and type of vehicles likely to be generated by the activities associated with establishment, operation and decommissioning of each of the different facilities types
- estimation of the project traffic demands based on consideration of the activities scheduled to occur in any given year, the traffic generation potential of each of the individual scheduled activities and the location of the activities
- formulation of planned management strategies to avoid, minimise and mitigate the Project's potential road impacts
- assessment of the effectiveness of planned management strategies utilising both a traditional traffic engineering assessment approach and also an environmental values assessment approach.

Traffic modelling was based on assumptions of the infrastructure likely to be constructed, operated and decommissioned within defined zones within the project development area for each year of the project life based on the conceptual development schedule outlined in SREIS section 3 Project description. The EIS acknowledged limitations in the assessment of the expected traffic volumes and impacts given that the actual location of project infrastructure was not yet defined.

The SREIS RIA considered the impact on State and local roads including within the TMR's defined Mackay / Whitsunday Region. The extent of the SREIS RIA study area was shown in SREIS section 12 Figure 12-1. The assessment did not consider impacts associated with other transport modes (e.g. air, rail and sea) as

- rail was not proposed as a mode of transport for project materials
- potential rail impacts would be limited to construction of new or modified roads or pipelines crossing rail lines

- fly-in fly-out operations staff (80% of the total) were proposed at approximately 240 persons
- freight delivered by sea would be shipped as general freight with no project-specific cargo ships required.

The proponent stated that options to utilise rail transport would be further considered post EIS approval once greater detail on project material is provided and the results would be incorporated into the updated Road Impact Assessments and preparing RMPs, and Infrastructure Agreements.

The EIS documents did not present a detailed road impact assessment for the project due to the lack of site details for locating wells and infrastructure. The assessment did consider a hierarchy of roads (highways, regional connecting roads and rural connecting roads/rural access roads) without providing details of specific road impacts from traffic generation and mitigation measures. Detailed information required in the RIA to be provided before commencement and not provided in the EIS documents included

- estimates of pavement impact
- increase in road safety risk (e.g. school bus routes and crashes)
- congestion and intersection performance
- access roads and transport corridors including railways and rail level crossings
- impacts on road structures (e.g. floodways and bridge load limits)
- maintenance of community access and amenity.

4.14.2 Impacts, avoidance and mitigation measures

SREIS section 12 stated that the likely project traffic generating activities would be construction activities (production well installation, gathering infrastructure installation, facility establishment), operation and maintenance activities (production well operation and maintenance including well workovers, gathering infrastructure operation and maintenance, project facility operation and maintenance), and decommissioning and rehabilitation activities (production well decommissioning and rehabilitation, gathering infrastructure decommissioning and rehabilitation, project facility decommissioning and rehabilitation).

The traffic generation potential of these activities was presented (SREIS section 12 Table 12.4) and some mitigation measures proposed. The SREIS provided information on how the revised project design lowered traffic demands and impact including measures dealing with project schedule, development sequence, change in facility size and layout, and accommodation strategy.

SREIS section 12 Table 12.8 and Table 12.9 summarised the adopted environmental values and their sensitivities both pre and post-implementation of the proposed management strategies. SREIS section 12 Figure 12.5 shows the level of significance of the potential road impacts based on the environmental values assessment approach with no implementation of proposed management strategies. Figure 12.6 accounts for the effect of implementation of proposed management strategies.

The SREIS Road Impact Assessment (Appendix K) stated that the proposed road impact management strategies would likely be effective at avoiding, minimising or mitigating all major road impacts. The proponent committed to a range of assessments, plans and other measures to address potential project impacts including commitments to

- develop Road-use Management Plans (RMP) to manage and mitigate the risks and impacts of any transport issues including
 - strategy to safely manage road usage by construction vehicles
 - interaction of project vehicles with school bus routes
 - interaction between stock and freight routes
 - detail safe driver behaviour and fatigue management protocols
 - consideration of specific requirements for over dimensional vehicles
 - interaction between project traffic and at grade road / rail crossings
 - dust and noise issues and mitigation strategies
 - detail road maintenance and/or road upgrade requirements
 - liaise with relevant stakeholders
 - define community engagement strategies
 - suitability of existing road infrastructure.
- assess and identify works required to manage the increased traffic volumes and road safety issues associated with the project in RMPs prepared and regularly reviewed in consultation with the relevant council TMR
- assess and identify the need to upgrade unsealed roads or widen sealed roads where project activities and traffic will create road safety issues. Such works will be done in consultation with the relevant council (if a local government road) or TMR (if a state road).
- undertake threshold assessments to determine whether upgrading of rail crossings is warranted
- implement driver training and fatigue awareness for employees and contractors
- schedule roster changes to avoid peak traffic times

- develop project logistics plans to provide safe movement of people and materials, as well as to minimise traffic volumes
- develop and implement journey management plans in consideration of high-risk roads
- use heavy-vehicle routes that avoid unsuitable bridges
- where assessed necessary, provide protected turning lanes for entry to permanent facilities to address road safety issues
- ensure access driveways to project facilities and infrastructure have appropriate sight distances
- maintain the integrity of private roads and tracks and minimise dust generation, where appropriate, in consultation with relevant landowners and council
- confine project traffic to designated roads and access tracks, where practicable
- limit project traffic on school bus routes during pick-up and drop-off times on school days or install appropriate school bus infrastructure such as signage or pullover areas where necessary
- make workers aware of school bus routes, as well as typical pick-up and drop-off times in the vicinity of the work sites
- coordinate with local law enforcement for movement of heavy or oversized loads
- manage project-related activities in the vicinity of existing stock routes in accordance with the *Land Protection (Pest and Stock Route Management) Act 2002*
- routinely monitor road integrity and amenity on project-related roads
- monitor compliance with the project's road safety requirements through regular review of reports generated by the in-vehicle monitoring system
- conduct regular safety inspections of project vehicles.

It was stated that the SREIS RIA did not seek to identify a comprehensive list of the proponent funded road works or contributions ultimately required to manage the road impacts of the project and that such details would be addressed in consultation with the Department of Transport and Main Roads and relevant councils post EIS. The EIS documents therefore provided limited information on the potential impacts of the project on specific roads and road use values.

The SREIS proposed that application of the proposed management strategies would result in intersection works, link works, and pavement contributions that meet or exceed typical engineering practice requirements.

4.14.3 Major issues raised

DCS advised that Mackay based fire emergency vehicles may be delayed by poorly managed traffic increases along the Suttor Development Road and public use intersections. The proponent stated that the post EIS development of the Road-use Management Plan (RMP) in consultation with stakeholders would address this risk.

Submissions on the EIS from landholders, councils, TMR and Queensland Police Service (QPS) questioned the lack of detailed information on road condition, project road use, likely impacts on road condition, road use and safety for local roads. Submitters also stated concerns about road safety and the deferment of consideration of road safety issues to the development of RMPs. The proponent committed to update the Road Impact Assessment when detailed design is underway post EIS.

TMR advised that the Road Impact Assessment (RIA) presented in the EIS (Appendix R) should be revised to include the latest traffic data and agreed assumptions about background traffic. The proponent responded with the SREIS (Appendix K) that included

- an expanded historic crash assessment for all affected State roads
- assessment of State-controlled roads including the potential impact of project traffic on the level of maintenance activity required and the pavement service life for in excess of 1000 assessment segments
- case study assessments
- commitment to engage with relevant stakeholders during development of the RMP post-EIS approval including with regards to the consideration of over-mass and over-size movements
- link level of service assessment for State roads
- consideration of the cumulative impact generated by other planned projects with the potential to affect future traffic demands
- a commitment to identify access route works potentially required at the case study locations.

TMR requested inclusion of freight data for the project in an advised TMR template format. The proponent did not provide the data in the requested form stating that the data presented in SREIS Appendix K Road Impact Assessment is suitable for EIS stage assessment. The proponent committed to update the Road Impact Assessment when detailed design is underway with freight data updated and consideration of the TMR template.

TMR advised that some transport tasks would be Notifiable road uses and be subject to road use directions under the *Petroleum and Gas (Production and Safety) Act 2004* for the construction of a pipeline above threshold rates

defined for state controlled roads and local roads. These activities may be subject to a road use direction and the proponent may also be liable to pay compensation for any cost, damage or loss incurred by TMR in relation to the Notifiable road use. TMR and local road authorities may therefore require further assessment of notifiable road use where it has not been adequately assessed in the EIS, and give road use directions about the undertaking of the notifiable road use, and enter into a compensation agreement in relation to works or contributions required to maintain the safety and condition of affected state controlled and local roads.

TMR also requested further information on rail crossings and advised on relevant rail infrastructure managers and the need for consultation. The proponent provided more detailed rail crossing information (SREIS Appendix K Figure 5.10) and referred to the development of the RMP post EIS as including consultation with relevant railway managers.

TMR also requested information for each mode of transport and each phase of the project including the expected volumes and weights of materials, products, hazardous goods or wastes, the likely number and timing of trips, all types of vehicles to be used and the likely routes. The proponent referred to the SREIS Appendix K content including the logistics information and annualised traffic forecast.

TMR advised that the RIA, including the likely impacts on road safety, transport efficiency, amenity, condition of the road network (pavements and intersections), and any proposed mitigation measures, should be further detailed in accordance with the TMR's Guideline for Assessment of Road Impacts of Development (GARID).

TMR also advised that the sensitivity to impact approach used for the EIS did not fully meet GARID requirements and was difficult to assess at this strategic project design stage. TMR also stated that the EIS should identify the specific location of key project-related infrastructure, assets, accesses and activities, to help determine road link intersections and pavement areas likely to be most affected. The proponent committed to update the Road Impact Assessment when detailed design is underway post EIS.

TMR expressed concern that the proponent needed to allow time for providing the transport design detail and assessment by TMR for any approvals under relevant legislation including the *Transport Infrastructure Act 1994*. The proponent committed to timely liaison with TMR as required.

TMR questioned the EIS Appendix R Table 6.2 sensitivity analysis of the Suttor Developmental Road and Collinsville-Elphinstone Road and the lack of analysis undertaken on the Bowen Developmental Road. The proponent responded with a revised analysis that included Bowen Developmental Road. The SREIS Appendix K Road Impact Assessment modelled the latest project description including revised material and equipment requirements for use of Mackay Port as the main materials hub.

Private submitters stated that heavy traffic haulage was not properly assessed for impact on landholder cattle grazing operations and did not adequately detail mitigation measures for the stock route network affected by heavy vehicle use. The proponent stated that adjacent land uses such as cattle grazing were assessed as 'amenity' (EIS Appendix R section 6.1) and the road network amenity before and after the implementation of impact management measures was addressed in EIS section 21 Roads and Transport. The proponent referred to commitments to monitor integrity and amenity on affected roads (SREIS Appendix O). In addition SREIS Appendix K provides annualised project traffic forecasts for all impacted roads during each year of the project life.

The Isaac Regional Council (IRC) requested compensation for landholders and councils for road use. The proponent stated that it would likely enter into Infrastructure Agreements with road authorities as the mechanism to address road authority needs for impacts such as increased maintenance requirements. Compensation would not therefore be required. Compensation related to track use for landholders would be dealt with through the Conduct and Compensation Agreements between the proponent and landholders.

Private submitters questioned the capacity of the Peak Downs Highway and Annandale Road as examples of the need for upgrades on the road network to cope with the project increased traffic. The proponent responded by referring to the updated and future development of the RIA (SREIS Appendix K) which included annualised traffic figures and identified the peak project traffic demands exceeding 5%. Management of traffic impacts would be in line with TMR's guidelines through development of an approved RMP.

Private submitters stated that narrow State and local roads (such as Annandale/Daunia Road) and roads with cattle grids, roads used by residents for schools, roads in the local network, and operation of roads in the wet season would need to be addressed, avoided or upgraded to ensure safe operation with increased heavy load traffic. The proponent stated that assessment of individual roads was not addressed by SREIS Appendix K Road Impact Assessment as the proponent has committed to identify post EIS the need for widening and sealing roads in consultation with State and local government. Seal width and safety would be considered when fitness for use assessments are completed. Existing seal widths for State-controlled roads were shown in SREIS Appendix K Figure 5.7. The RMP would consider traffic management to minimise impacts following adverse weather.

Submitters questioned the evidence presented for determining the impact significance and the assertion (EIS Appendix R) that implementation of management and mitigation would reduce the significance of the road impacts

to negligible. The proponent responded that the assessment included an environmental significance assessment, a traffic engineering assessment as well as case studies that all demonstrated that normal road agreements and approvals would reduce impacts to negligible.

Submitters, including Mackay Regional Council (MRC) and IRC, raised several related issues dealing with with availability and transport impacts of road building materials, cost, fuel transport, lack of detail in the cumulative impacts assessment, flood immunity and the method of pipeline crossing construction (whether trenching or horizontal drilling. The proponent's responses included reference to detailed project design, fitness for use assessments, and commitments to deal with these issues at the detailed design phase in a consultative manner. The development of the RMP was cited as a key document to address these issues post EIS.

The IRC requested further detail on goods/freight delivery to sites including disaster management of fuel and dangerous goods. The proponent referred to the proposal to co-ordinate freight from a Mackay marshalling yard to each project site. The relevant RMP would address safe transport of hazardous and dangerous goods including fuel. The RMP would be in accordance with TMR's guidelines to manage and mitigate the risks and impacts of any transport related issues including liaison with all of the entities with an interest in the RMP.

The IRC also requested a road hierarchy plan for road upgrades. The proponent stated that identification of specific works would not occur until preparation of Infrastructure Agreements post EIS.

MRC requested details on the provision of industrial land and services, sourcing and transport movements of workers as well as the transportation of materials and equipment from Mackay. The proponent provided further detail in SREIS Appendix K and referred to the development of the RMP based on detailed fitness-for-use assessments undertaken post EIS. The proponent committed to developing the RMP and Social Impact Management Plan as detailed design and operation details become available. The provision of industrial land is not an RMP issue and would need to be addressed with MRC separately to the RMP.

The Road Accident Action Group Inc. (RAAG) provided a range of information on the safety and road crash risks of the road network and requested further work on the cumulative impacts of the many large projects in the area. The proponent referred to further information on managing traffic as well as details on cumulative impact management set out in SREIS Appendix K and committed to best practice strategies as required. Reference was made to the development of the RMP to best manage the identified impacts.

RAAG requested details for a more accurate picture of growth volumes of traffic and the road safety risk. The proponent referred to the SREIS Appendix K Road Impact Assessment which identified best practice management strategies to manage and where appropriate mitigate any significant impacts associated with project traffic in line with relevant legislative requirements

TMR acknowledged the proponent's responses to TMR's advice on the EIS and noted the proponent's proposed upgrades (using case studies) to some state road intersections and identified roads where average annual daily traffic (AADT) or pavement impacts (ESA's) are likely to exceed 5% of existing impacts.

TMR provided detailed advice on the proponent's commitment to further develop the RIA and RMPs post EIS and stated that a number of issues should be further addressed in post EIS planning and consultation with TMR including

- the SREIS Appendix K RIA Table 2.1 project schedule identifies 2015 for the first construction activity. This would not allow adequate time for development and approval of an updated RIA, any necessary works to be designed, approved and constructed, and any future Infrastructure Agreement
- the SREIS Appendix K RIA Figure 12.1 identifies road links that exceed 5% of AADT. An assessment for turning lane warrants should be included in the future RIA for any other intersections on the state road within these links
- the location and design of accesses on the state road (including accesses to the proposed 4000 gas wells) would need to be approved by TMR and the accesses will need to be removed as part of well decommissioning
- the SREIS Appendix K RIA Section 14 Environmental Values Assessment is not referenced in any TMR documents including GARID. The future RIA should be assessed against the provisions of GARID
- TMR noted that materials and equipment are expected to arrive at the Port of Mackay and Townsville. The Bowen Developmental Road connects the northern portion of the study area with the townships of Collinsville, Bowen and ultimately Townsville. This road is not dealt with in the SREIS Appendix K RIA. The proponent should include an assessment of anticipated development traffic impacts on this and any other key state road identified in the future RIA
- SREIS Appendix K RIA Section 6.3 assumes a linear increase in background ESA's of 3%. TMR would accept a background growth consistent with the 10 year average compound growth for each road segment
- for SREIS Appendix K RIA Appendix F Pavement Impact Assessment - TMR Road numbers used are not consistent with TMR's road inventory data. The TMR road numbering system should be used in the future RIA
- Section 12 - Roads and Transport (Summary) Subsection 12.10 states pavement maintenance data has not

- been provided from TMR Mackay/Whitsunday to allow calculation of an indicative pavement maintenance contribution. TMR Mackay/Whitsunday has, in fact, provided this data as rationalised maintenance data based on AADT and width. These values are to be used to determine pavement maintenance contributions in the RIA
- to simplify the implementation and delivery of any necessary impact mitigation strategies for the proponent's Bowen projects, the proponent should sum the impact assessment and mitigation requirements of both projects, with a view to preparing a combined Road-use Management Plan and Infrastructure Agreement. This cumulative summary should
 - combine the traffic generation figures for both projects to identify cumulative any impacts (i.e. instances where traffic from both projects will be operating in the same area at the same time)
 - assess whether the impact mitigation measures proposed for the projects individually are adequate to mitigate the cumulative traffic impact
 - identify any additional impact mitigation works or strategies that may be required to mitigate the cumulative traffic impact
 - document these strategies in the updated RIA, RMP or IA as appropriate.

4.14.4 Conclusions and recommendations

While the EIS documents satisfactorily addressed many of the terms of reference requirements, a number of issues remain to be further addressed as discussed above.

Once further information is available on the final design of the project, the proponent is advised to undertake a review of the RIA and provide an updated assessment which clearly identifies any necessary safety improvements works, rehabilitation and maintenance costs to mitigate the impacts of project traffic prior to undertaking any project construction works.

The recommendations below refer to the further steps and work required. Reference to TMR offices is generic as it is likely that cargo would be transported through Mackay and Townsville. A combined RIA may also involve Fitzroy regional TMR office for Rockhampton and Gladstone regions.

Recommendation – timely liaison with TMR

The proponent should liaise with relevant TMR Regional Offices (Manager, Project Planning and Corridor Management) no later than 9 months prior to the commencement of any project construction works for the purpose of addressing the preparation of the finalised road impact assessment (RIA), road-use management plan (RMP) and traffic management plan (TMP).

Recommendation - update Road Impact Assessment and Road Use Management Plan

The proponent should provide the following no later than six months prior to the commencement of any project construction works

- review and finalise the road impact assessment (RIA) to include details of the latest project traffic generation and all project transport impacts on the safety condition and efficiency of state controlled roads in accordance with *Guidelines for Assessment of Road impacts of Development (2006)* in consultation with relevant TMR Regional Offices (Manager, Project Planning and Corridor Management)
- clearly indicate where detailed information is not available and use methodologies as agreed with DTMR and Councils, prior to RIA finalisation.
- undertake a Cumulative Impact Assessment and/or include project transport impacts of the related Bowen Pipeline project
- submit the updated RIA to the relevant TMR Regional Offices for review and approval
- prepare a RMP for all use of state-controlled roads for each phase of the project, in accordance with TMR *Guide to Preparing a Road Use Management Plan* (<http://www.tmr.qld.gov.au/business-industry/Technical-standards-publications.aspx>). The RMP must receive TMR's approval prior to its implementation and must include
 - latest traffic generation figures (eg vehicle numbers)
 - finalised impact assessment of safety and efficiency at intersections, impact on road links and pavements and other elements as per the above guideline
 - updated impact mitigation strategies, focussing on road-use management strategies, particularly road safety measures such as bussing workers, fatigue management, avoiding school bus routes during peak operating times. These RMP strategies should be listed in a Table of Commitments to allow review of their implementation/ completion.

Recommendation – update Traffic Management Plans

Three months prior to the commencement of any project construction works, the proponent should prepare detailed drawings and traffic management plans (TMP) for all construction and other activities in state-controlled road (SCR) corridors to demonstrate how these road works will be safely undertaken. The following elements should be

addressed

- the proponent should implement the traffic management plan during construction and commissioning of the project and construction of all access road intersection/s and other works to be undertaken within a SCR corridor
- the proponent should consult with TMR, the Queensland Police Service and the relevant Regional Councils
- The proponent should obtain the necessary permits for any excess mass or over-dimensional loads associated with the project as required under the *Transport Operations (Road Use Management) Act 1995*.

Recommendation – road impact mitigation strategies

The proponent should undertake any required roadworks and road-use management strategies detailed in the approved RMP and supporting TMP prior to the commencement of any significant project traffic. If the agreement with TMR/Councils is for the proponent to undertake works, the proponent should present detailed drawings of any required roadworks for review and approval by TMR/Councils, in addition to any other approvals required before construction work commences.

Recommendation – infrastructure and funding agreements

The proponent may enter into infrastructure and funding agreements with TMR and the relevant Regional Councils to formalise arrangements about transport infrastructure works, contributions and road-use management strategies detailed and required under the approved RIA and RMP. If an agreement is proposed, the infrastructure and funding agreement/s should identify all required works and contributions, and incorporate

- project specific works and contributions required to upgrade impacted road infrastructure and vehicular access to project sites as a result of the proponent's use of state-controlled and local roads by project traffic
- project specific contributions towards the cost of maintenance and rehabilitation to mitigate road or pavement impacts on state-controlled and local road infrastructure
- Infrastructure works and contributions associated with shared (cumulative) use of state-controlled and local road infrastructure by other projects subject to an EIS
- performance criteria that detail protocols for consultation about reviewing and updating of project-related traffic assessments and impact mitigation measures that are based on actual traffic volume and impacts, should previously advised project details, traffic volumes and/or impacts change
- the proponent's undertaking to fulfil all commitments made in the EIS documents (including SREIS Appendix O).

4.15 Noise and vibration

Noise and vibration from project construction and operational activities was discussed in EIS section 22 Noise and vibration, and a technical assessment was provided in EIS Appendix S Noise and vibration technical report. A supplementary noise and vibration assessment which addressed changes to the project and relevant legislation following submission of the EIS was provided in SREIS section 14 Noise and vibration and supported by a technical report in SREIS Appendix L Supplementary noise and vibration technical report. Noise and vibration-related submissions on the EIS were also addressed.

A summary of the noise and vibration assessment follows.

4.15.1 Assessment methodology

The following production and processing facilities and activities were subject to noise assessment

- well sites (initial drilling, completion, work over, hydraulic stimulation and ongoing operation)
- field compression facilities at expected largest production capacity of 120 terajoules per day (TJ/d)
- central gas processing facilities (CGPFs) at expected largest production capacity of 210 TJ/d
- integrated processing facilities at a production capacity of 210 TJ/d.

The noise and vibration assessment involved the following key elements

- a baseline noise survey in April 2012 at ten typical sensitive receptor locations as shown in Figure 22.1 of the EIS, with measurements in accordance with the EHP Noise Measurement Manual and assessment periods consistent with the EHP guideline Prescribing noise conditions for environmental authorities for petroleum and gas activities
- review of predominant meteorological conditions to determine appropriate input for noise modelling using data from the air quality assessment outlined in section 4.5 of this report
- establishment of noise criteria using the EHP guideline: Prescribing noise conditions for environmental authorities for petroleum and gas activities
- noise modelling to predict emissions from conceptual layout designs of typical noise-producing facilities, without terrain screening, assuming maximum operational capacity and meteorological conditions favourable to sound propagation to
 - determine setback distances to achieve the defined noise criteria without additional mitigation measures
 - assess additional mitigation measures where a setback distance would not be practicable
- development of mitigation packages for reduction of source noise levels through engineering treatment, as detailed in Tables 5.8, 5.9 and 5.10 of EIS Appendix S Noise and vibration technical report, to be used in conjunction with facility design, location and distance from nearest sensitive receptors
- assessment of residual noise impact after mitigation by comparing potential project noise at nearest sensitive receptors to the likely background noise levels and the environmental values defined by Schedule 1 of the Environmental Protection (Noise) Policy 2008.

Infrasound assessed for the EIS as source noise data in the one hertz (Hz) to 100Hz range was not available. The EIS adopted an operational indoor low frequency noise criterion of 20dB(A) for the noise assessment but noted that assessment of low frequency noise may be required for the detailed project design, in accordance with the draft EHP guideline Assessment of low frequency noise.

The vibration criteria for human comfort and building damage, as defined by British Standard BS 5228.2-2009, was used for the assessment.

Blasting was not considered in the assessment as no blasting was proposed for the project.

4.15.2 Identified acoustic environmental values

The measured daily background and ambient noise levels during the daytime, evening, night-time and early morning periods for each location were summarised in EIS section 22 Table 22.2. Operator-attended noise measurements were conducted to confirm unattended noise measurements.

Background noise levels were found to be consistently low and typical of rural areas, except for sites near towns where typical suburban noise levels were recorded during the daytime. Operator-attended noise measurements were conducted to confirm the unattended monitoring findings.

4.15.3 Potential noise impacts

Construction Noise

EIS section 22 Table 22.9 summarised the predicted noise levels for a range of construction activities and at a range of distances from the activities, based on noise data for construction equipment sourced from AS 2436-1981 and British Standard (BS) 5228-1. Construction noise was predicted to exceed the long-term noise criterion for daytime activities of 40dB(A) at noise sensitive receptors within 1km of the activity for all periods of the day unless mitigations measures were implemented.

Operational noise

Operational noise was predicted for a range of distances from production facilities (FCF, CGPF, IPF), with and without noise mitigation measures, by using a computer acoustics model which took meteorological effects into consideration.

The predicted noise levels for receptors at a range of setback distances from each facility type for long-term noise sources without noise reduction measures were presented in EIS section 22 Table 22.7. The most stringent noise criterion of 28dB(A) for night-time operations was predicted to be achieved only at distances of over 5km from all facilities.

EIS section 22 Table 22.8 presented the predicted noise levels for receptors at a range of setback distances from each facility type for long-term noise sources following implementation of noise reduction measures selected to achieve the most stringent noise criterion of 28dB(A) at distances of one, two and 3km from the facilities (as detailed in Tables 5.8, 5.9 and 5.10 of SREIS Appendix S Noise and vibration technical report). The predicted noise levels indicated that within one kilometre from a CGPF or IPF, additional noise screening would be required in addition to the modelled mitigation measures in order to achieve the noise criterion.

The EIS stated that, in remote areas where the nominated noise criteria would be based on the deemed background levels, noise from the project would be greater than 5dB(A) above the background environment, would be audible outside of dwellings, and may cause some disturbance.

The EIS stated that short-term noise sources (such as flaring noise) at the production facilities would not produce significant noise levels at distances greater than 2km but exceedances of up to 4dB(A) were predicted at 1km from the production facilities.

For production wells and pipelines, the EIS stated that the long-term noise criterion of 28dB(A) would be achieved without mitigation measures at locations greater than 300m from the noise source.

The EIS predicted that low-frequency noise during operation, following implementation of noise reduction measures, would be below the indoor low frequency noise criterion of 20dB(A) at distances of 1km or more from each facility type.

The potential impact of noise and vibration on livestock was assessed by comparing predicted noise and vibration levels to those generated by common noise sources. Noise levels at adjoining properties resulting from project activities were predicted to be approximately 60dB(A) based on predicted noise levels at a distance of 2km from a production facility with noise mitigation, and on predicted noise levels adjacent to a production well. This was stated to be similar to noise levels adjacent to existing rail lines and roads, where livestock graze with no obvious impact.

Traffic noise

The EIS stated that increased vehicle movements on public roads due to the project would not significantly increase noise from traffic and that exceedance of the nominated noise criterion was not anticipated.

Vibration and blasting

Based on a conservative consideration of vibration potentially resulting from drilling activities, the Noise and vibration technical report (EIS Appendix S) considered that a buffer distance of 70m between sensitive receptors and construction sites or operational facilities would be adequate to avoid nuisance and building damage from any potential vibration. Blasting was not assessed on the basis that no blasting was proposed.

Cumulative impact

A qualitative assessment of potential cumulative noise impacts (EIS section 31.4.11 Cumulative impacts) concluded that, as the noise and vibration footprint of the project would be localised, there would not be a cumulative increase in the noise or vibration impact from project activity unless noise or vibration sources from other projects were in close proximity.

A cumulative increase in general noise and vibration was predicted due to the increase in development activity associated with coal mining and CSG development but the contribution from the project was considered to be of low significance.

4.15.4 Proposed mitigation measures

EIS section 22 Table 22.11 listed proposed noise limits at sensitive receptors for short term, medium term and long term noise events associated with particular activities as listed in Table 22.10 of the EIS. For measured noise with tonal or impulsive characteristics, adjustments to noise limits were proposed as listed in Table 22.12 of the EIS. The EIS stated that there would be no significant potential for adverse impacts from vibration, low-frequency noise, infrasound and blasting, and indicated that limits for these aspects of noise and vibration would not be necessary.

The proponent proposed to have regard to environmental and engineering constraints, including the modelled setback distances needed to achieve the nominated noise criteria, when determining the location of production facilities and wells. The required noise mitigation would be selected during the detailed design of the production facilities based on the attenuation required to achieve the noise criteria at the nearest sensitive receptor. The proponent committed to modelling of noise levels for the final design of facilities to confirm compliance with the noise criteria. The proposed modelling would include any terrain screening or local meteorological effects which could alter noise propagation.

The proponent proposed to locate wells or other infrastructure more than 200m from sensitive receptors such that vibration impacts were not anticipated.

The EIS stated that noise monitoring may be required at sensitive receptors during construction and operation, either in response to complaints, or to demonstrate that predicted noise levels were not exceeded.

4.15.5 Major noise issues raised

References to agencies and organisations in the following text are based on submissions made on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

EHP requested more detailed information on the noise mitigation measures presented in EIS Appendix S Noise and vibration technical report to allow more objective consideration of the predicted noise attenuation. The proponent clarified that the noise mitigation treatments were indicative only, with no detail of sound directivity included. The proponent stated that detailed design of acoustic treatments during project implementation would be based on measured plant noise emissions, including separate noise emissions and noise source directivity from mechanical components with regard to the location of potential receptors.

EHP requested further information on the likely sizing of equipment and use of the corresponding sound power level in modelling. Tables A.1 and B.1 of Appendix A to SREIS Appendix L Noise and vibration technical report provided further information on the size of construction and operational equipment likely to be used for the project and the estimated sound level that was used in the noise modelling.

EHP requested details on specific environmental values and proposed noise mitigation and protection commitments for major infrastructure for the initial phase of project delivery. The updated project description in the SREIS (see Appendix 5 of this assessment report and SREIS section 3) provided indicative locations for major project infrastructure without additional detail on noise mitigation measures.

Queensland Health requested further assessment in relation to potential noise impact within habitable dwellings and low frequency noise, and the development of a noise management and monitoring strategy to include proactive as well as reactive management of noise. In response, the proponent referred to the noise criteria adopted for the assessment of potential noise impact to sensitive receptors at a range of distances for project activities or facilities, noting that assessment of maximum noise levels at actual sensitive receptors could occur until the location of project facilities was defined, and confirming that the noise levels from the final design would be modelled to confirm compliance with the nominated noise criteria. The proponent also referred to the assessment of low frequency noise in the EIS and commitments to addressing noise monitoring and complaints management through an environmental management plan.

Isaac Regional Council requested analysis and mapping to illustrate the predicted noise impacts across the project footprint and an assessment of the cumulative impact of noise emissions. In response, the SREIS included a map of potential noise sensitive receptors (Appendix L section 2 Figure 2.1) which the proponent stated would be included in the noise constraints criteria for use in selection of locations for production facilities and wells in conjunction with estimated setback distances for noise attenuation to achieve the nominated noise criteria. In relation to cumulative impacts, the proponent referred to section 31.4.11 of the EIS (Cumulative Impacts) and the low significance of noise impact by the proposed project.

Noise assessment for changed project

A number of changes were made to the project description for the SREIS. Changes relevant to the noise assessment were listed in Table 14.1 of the SREIS.

The only significant change in construction noise predictions as a result of the change in the project description was the addition of noise emissions from a concrete batching plant. The predicted noise levels at distances of 50m to 1000m increased by up to 1dB(A), indicating that the predicted project noise levels in the EIS remained valid.

As the actual locations of wells and facilities remained unknown at the time of assessment of potential noise impacts associated with the revised project description, noise level predictions for the SREIS were undertaken by modelling the noise levels at a range of distances from the noise sources rather than at specific sensitive receptors, consistent with the methodology used for the EIS. The following key findings were presented

- predicted noise levels from production wells were listed in Table 14.5 of the SREIS and it was concluded that the noise emissions from all modelled well configurations would comply with the limit of 28dB(A) at sensitive receptors located at a distance less than 1km by use of an appropriate noise reduction strategy using a combination of distance attenuation and engineering noise control treatments
- predicted noise levels from a 7-train FCF were listed in Table 14.7 of the SREIS and it was concluded that noise mitigation treatments may be required for FCFs powered either electrically or by temporary power generation in order to achieve the noise limit criterion of 28dB(A) at sensitive receptors within 5km of the facilities
- predicted noise levels from CGPFs and co-located WTFs were listed in Table 14.8 of the SREIS and it was concluded that noise mitigation treatments may be required for CGPFs in order to achieve the noise limit criterion of 28dB(A) at sensitive receptors within 4km of the facilities if powered electrically, or within 5km for temporary generator powered options
- predicted noise levels from planned and unplanned flaring at FCFs were listed in Table 14.9 of the SREIS and it was concluded that the medium-term noise criterion of 28dB(A) may be exceeded at sensitive receptors within 1km of the flare but would be complied with at 2 km or more provided no other project noise sources contributed
- predicted noise levels from flaring at CGPFs were listed in Table 14.10 of the SREIS and it was concluded that the medium-term noise criterion of 28dB(A) may be exceeded at sensitive receptors within 8km of the flare
- flaring events generating the highest noise levels were expected to occur only rarely (2 to 5 years) but were predicted to exceed the medium-term night-time noise criterion at sensitive receptors within 5km of the flare
- changes to heavy vehicle trips were considered to be minor and the potential increase in traffic noise was considered to be insignificant.

A range of noise mitigation measures were outlined in section 14.9 of the SREIS, and detailed in SREIS Appendix L Supplementary noise and vibration technical report, to demonstrate that effective measures could be implemented in conjunction with separation distances to achieve the noise criteria at nearest sensitive receptors.

4.15.6 Conclusions and recommendations

The noise and vibration assessment adequately meets the information requirements of the TOR. The EIS adequately described the existing acoustic environment that may be affected by the construction and operation of the Bowen Gas Project.

The environmental protection noise related commitments outlined in the EIS (SREIS Appendix O) and the recommendations for EA conditions for noise levels at sensitive receptors in Appendix 3 of this assessment report should be considered for the development of any EA application. These conditions reflect the EHP guidelines

- Prescribing noise conditions for environmental authorities for petroleum and gas activities (2012)
- Streamlined model conditions for petroleum activities (2014)

The following agency specific recommendations should also be implemented.

Recommendation - Queensland Health recommendations

The proponent should implement

- further assessments in regard to the maximum sound pressure level ($LA_{1, adj, 1hr}$) inside habitable dwellings to determine if sleep is likely to be disturbed
- a noise management and monitoring strategy that includes proactive as well as reactive management strategies
- preventative management strategies prior to the criterion being exceeded
- noise attenuation at sensitive receptors e.g. noise attenuation at residences if required as a mitigation measure
- an effective complaints management system in managing noise issues.

Recommendation - EHP requirements

Any application/s for an environmental authority or amendment to an environmental authority under the EP Act for petroleum activities within the project areas must provide

- site-specific noise and vibration assessments for each proposed infrastructure location

- site-specific identification of sensitive receptors and potential impacts on sensitive receptors

Impacts identified should at least meet the noise objectives in the Environmental Protection (Noise) Policy 2008.

Recommendation - DNRM advice

The proponent should provide for

- noise impacts in site selection and in any applications for approvals for project infrastructure
- the potential for noise nuisance impacts to neighbours and other sensitive receptors not located on land parcels subject to compensation agreements.

4.16 Economics

EIS section 23 Economics provided a summary of the existing local and regional economic environment, identified economic values that would be affected by the project and proposed mitigation, management and economic enhancement measures to achieve stated objectives for the economy. The detailed findings of the economic assessment were presented in EIS Appendix T Economic technical report.

4.16.1 Methodology

The economic assessment was a desktop study including

- characterisation of the existing economic environment, broader economic context, and identification of issues relevant to the project through consultation and review of available relevant information, policies and strategies
- estimation of the project related expenditure and revenue and the associated distribution of expenditure and revenue
- assessment of the economic impacts of the project using
 - economic modelling
 - consultation with business, industry and key industry organisations
 - interpretation of modelling output in the context of the regional and state economies, and analysis of other, non-quantified changes to the economic environment
 - evaluation of the significance and magnitude of impacts.

Detailed information on the assessment methodology was provided in the EIS Appendix T Economics technical report.

4.16.2 Existing values

The study area for the assessment of economic impacts was selected to represent the local economies most likely to be affected by the project and comprised the Isaac, Mackay and Central Highlands local government areas (LGAs). EIS section 23.4 summarised the key aspects of the economy within the study area for the economic assessment, including

- major contribution to the economy from mining but with consequent exposure of the economy to resource price fluctuations
- rapid population growth, particularly in Isaac LGA, and associated pressures on public infrastructure and local government services
- relatively low unemployment, high labour demand, and skill shortages leading to growth in the fly-in fly-out workforce
- changes in communities and social identity due to changes in infrastructure, land ownership and land use associated with mining development
- increased property sale prices and rental prices reflecting high demand for accommodation.

4.16.3 Impacts

The EIS stated that the economic modelling indicated that the project would generate significant economic benefits for the study area as well as for the Queensland and Australian economies, including significant increases in industry output, gross regional product, employment and incomes. Regional, state and national economies were projected to steadily increase over the period from 2015 to 2022. Gross regional product was projected to increase (above the projected baseline gross regional product) by approximately \$600 million by 2021-22, level at approximately \$600 to \$700 million at peak gas production, and then slowly decline. EIS Figure 23.1 illustrated the modelled impact of the project on gross regional product, gross state product and gross domestic product.

The EIS estimated that the project would benefit national employment with a net increase of approximately 1000 full time equivalent employees in the economic study area (approximately 1.1% increase in employment) during peak labour demand in the production ramp-up period. A lower beneficial impact was predicted for Queensland and this was stated to reflect the proposed high fly-in fly-out labour component of the project workforce. EIS Figure 23.2 illustrated the predicted impact of the project on employment in the economic study area and Queensland.

The EIS estimated that the project would result in an average increase (above the projected baseline) in real wages in the economic study area of 0.5% in the period from 2015 to 2037, with a peak increase of more than 0.6% in 2019-20. This was stated to reflect pressure on the local labour force to meet project requirements but was not anticipated to significantly destabilise the labour market in the region. EIS Figure 23.3 illustrated the predicted annual percentage change in real wages as a result of the project.

Other anticipated beneficial economic impacts of the project as outlined in the EIS included

- opportunities for local businesses to supply goods and services to the project
- increased population and business activity with subsequent increase in demand for goods and services
- increased local skills base
- increased employment and income earning opportunities for households
- increased taxation revenues
- increased exports of LNG
- potential for use of gas removed prior to mining activity that may otherwise have been released to the atmosphere
- potential improvement in the economic feasibility of some mining projects through extraction of gas prior to mining.

Potential adverse impacts of the project on the economy were summarised in the EIS and detailed in EIS Appendix T Economics technical report. Predicted adverse impacts included

- adverse impact on some businesses and industry due to competition for labour (with resultant skill shortages, increased labour costs, and reduced profit margins)
- adverse impact on some businesses and industry due to upward pressure on the Australian dollar making exported products and services less competitive
- loss of productivity on cropping and pastoral land, and possible decline in property values due to loss of productivity and negative perceptions of CSG production
- potential for increased demand for local housing with resulting upward pressure on housing prices
- increased demand for industrial and commercial land, particularly in Mackay, Clermont and Moranbah, with resulting upward pressure on land prices
- potential delays in access to coal resources until gas has been extracted
- additional demand on infrastructure, particularly roads and air infrastructure, with potential capacity issues requiring upgrades and maintenance.

4.16.4 Avoidance and mitigation measures

EIS Table 23.1 presented a summary of potential economic impacts, proposed mitigation and management measures, and the predicted residual impacts as a level of risk. The proponent committed to negotiate and provide appropriate compensation for agricultural area landholders where impacts could not be avoided. Details on the basis for such compensation would be developed post EIS. All residual risks were assessed as 'medium' or 'low' with the higher risk level associated with skill shortages, the capacity of local businesses to benefit from servicing the project, and potential impacts to agricultural production.

The EIS concluded that a cost-benefit analysis of the project indicated that the benefits generated by the project outweighed the costs and that the project would be economically desirable for Queensland.

4.16.5 Submissions

References to agencies and organisations in the following text are those who made submissions on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

DSDIP requested that the proponent reflect key strategies and commitments contained in the economic assessment in the social impact management plan, associated action plans and commitments, where appropriate. The proponent referred to an outline of proposed staging of implementation of key commitments and strategies contained in SREIS section 15 Social, SREIS Appendix M Supplementary social technical report, and SREIS Appendix N Social impact management plan.

DEWS stated that the assessment of impacts of the project on the domestic gas market, completed in July 2011, was out-dated and should have included the effect of two additional LNG export compression trains approved for the Arrow LNG Plant on Curtis Island. DEWS noted increasing concern from domestic customers regarding access to gas in the short to medium term and noted that projections for gas reserve levels available for domestic market were highly sensitive to, and dependent upon, planned or above planned reserved conversion and development rates. DEWS requested a current analysis to assist government and industry to understand the cumulative impact of export projects on gas supply and production.

In response, the proponent stated that a study in 2011 had concluded that the development of the CSG gas resource to supply the first two trains of the Arrow LNG Plant may increase pressure on eastern Australian gas consumption and prices and referred to chapter 27 and Appendix 22 of the Arrow LNG Plant EIS. The proponent stated that the EIS concluded that higher domestic gas prices were a potential impact of the project but maintained that the benefits generated by the project would outweigh the costs and the project would be economically desirable for Queensland.

A submission by a rail operator requested that the effect of delays in accessing coal resources on rail coal haulage rates be included in the assessment of economic impacts. In response, the proponent stated that assessment of the indirect impacts of the project on rail networks through delayed coal mining projects was not required by the terms of reference.

A submission stated that the terms of reference required the EIS to include an outline of a strategy committing to the development of a local industry participation plan, but no such outline was included in the EIS. In response, the proponent referred to discussions between DSDIP and the Queensland Resources Council in relation to a voluntary code of conduct for local content in private sector projects that would replace the requirement to develop a local industry participation plan. The proponent proposed to develop an Australian industry participation plan for the Arrow LNG Project, which includes the Surat Gas Project, Arrow Surat Pipeline, Surat Header Pipeline, Bowen Gas Project and Arrow Bowen Gas Pipeline.

A submission argued that the costs associated with delays caused by wide loads, damage to roads by heavy vehicles, and increased road safety risk, should be considered in the economic assessment. The proponent stated that a road-use management plan would be prepared as design and operations details were finalised and that the plan would present management and mitigation measures for all transport related issues, including impacts to rural roads.

4.16.6 Conclusion and recommendations

The EIS adequately met the requirements of the TOR in relation to economic impacts. The EIS documents adequately described the baseline economic environment of the project area and surrounding region, provided qualitative and some quantitative predictions on the impacts of the project and outlined broad strategies to minimise some adverse economic impacts of the project on landowners and businesses.

Recommendation – commitments

The proponent should implement the economic commitments made in the EIS documents.

4.17 Social

EIS section 24 Social provided a summary of the surrounding social values and potential for these values to be affected by impacts from the construction, operation and decommissioning of the project. Detailed information was provided in EIS Appendix U Social Technical Report and EIS Appendix V Social Impact Management Plan (SIMP).

SREIS section 15 Social summarised the findings of the SREIS Appendix M Social Technical Report. The SREIS addressed changes to the social baseline and project description as set out in SREIS section 3 Project description. The SREIS Appendix N included a revised draft SIMP. The social impact assessment (SIA) presented in EIS Appendix U was revised by SREIS Appendix M.

4.17.1 Methodology

The study area was defined as mainly including Moranbah and Dysart as well as Glenden, Nebo, Middlemount and Blackwater. Moranbah and Dysart would be close to the proposed temporary workforce accommodation facilities (TWAFs) and infrastructure. Glenden, Middlemount and Nebo would be affected by recruitment of the workforce, traffic and construction material transport. EIS section 24 including Table 24.1 and Figure 24.1 described the affected communities.

The EIS used the following methodology to assess and describe social values and the likely impacts to social values.

- scoping phase including literature review, identify affected area, identify stakeholders, develop stakeholder consultation strategy
- baseline assessment – collation of Australian Bureau of Statistics information, State agency data (such as Office of economic and Statistical Research), local government data, local and State plans and policies
- impact assessment – initial assessment to identify impacts using existing similar developments in the area followed by a more detailed assessment in consultation with stakeholders that addressed the criteria
 - when in the project life-cycle the impact could occur
 - frequency and duration of the impact
 - magnitude of the impact
 - geographic context and the communities affected
 - ability of those affected to adapt to change
 - reversibility or minimisation of the impact.
- significance of possible impacts considered based on the likelihood and significance of occurrence resulting in low, medium, high, or very high significance ranking (EIS section 24 Table 24.2)
- mitigation and monitoring – proposed mitigation of negative impacts and enhancement of positive impacts
- residual impacts – estimated unavoidable impacts after effective mitigation
- cumulative impacts – aggregated individual future impacts of all existing projects in the region and assessed impact interactions
- development of the project SIMP.

The social assessment included community consultation throughout the process commencing in 2010. EIS Appendix F Consultation Report detailed the stakeholder and community consultation undertaken.

The revised project description presented in SREIS section 3 Project Description included identified changes to the project with potential social impacts. The revised social impact assessment (SREIS section 15) included changes to

- component facilities and the footprint with land disturbance amendments
- the construction and operations workforce size and makeup including changes to camp accommodation arrangements and the estimated population influx to affected townships
- the phasing of development across the project area
- the expected traffic levels and durations on local and State-controlled road networks in the project area.

The SREIS study method included

- updated regulatory and policy requirements
- updated baseline profile indicators
- review and validation of likely impacts.

SREIS section 15 Table 15.1 summarised the project changes with likely social impacts resulting from locating support facilities in Mackay and Moranbah. The SREIS Appendix N included a revised draft SIMP with updated commitments that addressed the project changes affecting social impacts.

4.17.2 Existing environment

The EIS included a description of the existing social environment of the area. Information included a collation of Australian Bureau of Statistics data, State agency data (such as Office of Economic and Statistical Research), local government data, local and State plans and policies. The SREIS identified the policy and regulatory changes that occurred since the publication of the EIS. The policy changes were aimed at supporting the co-existence of gas development projects with existing land uses including the

- Queensland government establishment of the GasFields Commission to improve co-existence between landholders, communities and the gas industry to review legislation and regulation, publish factual information, advising on coexistence issues, facilitate relationships and resolve issues, promote scientific research to address, and knowledge gaps, make recommendations to government and industry.
- establishment of the Royalties for the Regions program to provide funding such as enhancing the Dysart Medical Centre
- DSDIP release of a suite of regulatory guidelines for the assessment and management of the impacts of major resource projects including Managing the impacts of major projects in resource communities, Preparing an environmental impact statement: Guideline for proponents, and a Social Impact Assessment guideline
- DSDIP release of Regional and Resource Towns Action Plan that addresses housing availability and affordability and land supply within Moranbah, Dysart, Middlemount and Blackwater
- DSDIP finalised Central Queensland Regional Plan effective from 18 October 2013.

SREIS also updated the baseline information for the affected project area including

- the population statistics for affected townships with increases in Moranbah, Dysart and Middlemount. Non resident workers now comprise 40% of the full-time equivalent population in the Isaac Regional Council area centred on Moranbah
- industry conditions causing rapid employment changes presenting social impact challenges to local government and industry
- dramatic declines in median housing costs (both rental and sales) across all primary towns in the project area particularly notable in Moranbah
- a rise in unemployment in the coal industry accompanied by continued growth in the labour force in the project area. This would affect project recruitment locally in the longterm.

4.17.3 Potential impacts

EIS section 24 and SREIS section 15 described the likely social impacts of the proposed project. EIS section 24 Table 24.11 summarised the likely negative and positive social impacts of the project and included a significance assessment. The SREIS described a modified project with changed social impacts. The SREIS project description included a significant reduction of the footprint with reduced land access operational requirements.

The SREIS stated that the changes in social impact from the EIS to the SREIS project were minimal. The potential impacts on the deterioration of roads and negative effect on agricultural activity land use and property were stated to be lower. The expected impacts on roads, land use and property were stated as likely to be low.

The likely impacts of the updated project are summarised below.

Workforce

Approximately 250 to 300 operations and maintenance personnel would be required for peak operations, maintenance, and support and administration teams excluding Brisbane-based staff and field maintenance contractors. This workforce would peak and last for 13 years commencing 2028 before declining as gas is depleted. Most would be FIFO positions sourced from outside the region. The EIS reference case assumed that 10% of operational workers could be recruited locally and the SREIS case increased that to 20%.

Population and demographics

The EIS stated that the project would cause a decrease in the size of the local resident community. The SREIS found that recent falls in housing costs may lead to relocation of project workers to the area. The SREIS projected increase of non-resident workers (2.2% or approximately 400 workers) estimated for the construction phase of the project between 2015 and 2019 was stated as not likely to impose any incremental social impact due to the intention of housing all workers in temporary quarters. The SREIS also stated that the operational workforce would increase the residential population of Moranbah by up to 125 persons (or approximately 1.0% above the projected population level at 2020). It was stated that detailed logistical planning would be undertaken post EIS.

Housing

The EIS stated that no direct increase in demand for housing would occur as little relocation to the region by the operational workforce was predicted due to the infrastructure and construction work places proposed to be

dispersed across a large area. The SREIS stated that with significant falls in rent costs and in median house prices over the last 12 to 18 months some relocation may occur. Given the volatile housing market it was proposed to monitor the relocation risks and impacts during the detailed design phase of the project post EIS.

Employment

The EIS referred to positive impacts such as a likely increase in the number and type of apprenticeships, improved regional training facilities, improved retention of students to year 12, more diversified skills base, and increase in opportunities for smaller local businesses. The negative impacts identified included the possibility of supply chain issues, local business labour shortages, and billing issues. The SREIS indicated a likely increase in the peak workforce during the construction phase and increased opportunity for local employment with any significant increase in local employment still constrained by the lack of local labour. The reduced operational workforce would also be significantly reduced through automation on well-field and facilities operation.

Landuse

The EIS identified potential land use impacts arising from increased road use and road impacts with potential medium level negative impacts on agricultural production.

The SREIS outlined a revised project with reduced footprint and use of multi-well pad sites. The revised project was stated as reducing the potential road use and impact on agricultural production. The revised project included greater automated control of the CSG production facilities managed centrally from Brisbane which was stated as would reducing the frequency of access and potential impact on landholders.

Community values

The EIS identified potential impacts from non-resident workers on local communities and rated the potential impact as medium. The potential impacts were stated as including accommodation camps outside residential areas, impacts of FIFO workforces, and personal safety issues from possible anti-social behaviour of workers in camps.

The SREIS updated project described accommodation camps that would remain separate from townships but larger and with a higher level of amenity than previously proposed. Also the revised housing impacts would allow more construction and operations workers and their families to relocate into the area. The SREIS referred to possible improvement in, and increased viability of, local sporting and recreation facilities through greater use by project workers. Possible negative impacts were stated as including amplification of community concern regarding potential CSG impacts through the use of social media.

Community Infrastructure

The EIS stated that

- likely impacts on community facilities (such as libraries) and services (such as childcare and other support services) would be limited
- impacts (including cumulative impacts from other projects) on recreational facilities such as clubs, shops and hotels would be higher and would need to be mitigated
- impacts on health services for the community of Moranbah were to the extent that it was planned to have on-site medical facilities in workers camps.

The SREIS revised project stated a potential for persons living in Moranbah to rise by up to 125 broadly in line with Queensland Health planning.

Health and environment

The EIS stated a potential for community anxiety (rated as medium) over potential negative impacts on groundwater, and safety issues with the production and transport of gas.

The SREIS stated that changes to the project would not fully address the community perceptions of the above issues. It was stated that the reduction in impact area would not change the significance of the impact. The SREIS stated that the likely health impacts would be as stated in the EIS.

4.17.4 Mitigation measures

EIS section 24 and SREIS section 15 summarised the measures the proponent proposed to manage adverse impacts and enhance social values. The residual impact on social values would result from the implementation of such measures. The SREIS proposed mitigation measures that would leave residual social impacts rated as medium to low. The draft SIMP (SREIS Appendix N) provided commitments, monitoring and verification measures that addressed the potential medium to high social impacts identified. SREIS Appendix O Commitments did not contain the social impact mitigation commitments. The EIS section 24 Table 24.11 summarised the mitigation measures proposed. The SIMP was proposed as a living document addressing positive and negative social impacts. The measures proposed included the following.

Workforce

- the revised smaller footprint project reducing the potential construction impact on land use from moderate to minor
- the workforce and camp residents to be subject to a Code of Conduct to manage the behaviour of camp-based employees.

Community infrastructure

- Queensland Health planning parameters for the delivery of public health services to Moranbah
- engagement with other industries, government, and service providers to plan and share information relating to preferred growth patterns and managing potential impacts associated with any population growth or decline
- provision of information through the implementation of community engagement and health, safety and environment plans, reducing the consequences to minor.

Housing

- participate in discussions with State government, councils, the building industry and other project proponents to foster an understanding of cumulative housing demands
- monitor, through HR, the number of workers moving into the local and regional area and formulate a housing strategy for implementation and monitoring within the evolving SIMP as required
- visiting workers would stay in TWAFs in preference to hotel / motel accommodation wherever possible to reduce stress on accommodation
- examine opportunities to invest in the Isaac Affordable Housing Trust in consultation with IRC as means to help alleviate housing stresses in the region training organisations on training and skill development programs, to identify workers within the region who have the ability to obtain qualifications based on Recognition of Prior Learning.

Training and skills

- implement training and skill development programs including: apprenticeships, scholarships, vocational training, support for work readiness programs and pre-trade training
- identify the range of skills required for the labour force and undertake a gap analysis against skills availability. Where gaps exist, in consultation with the Energy Skills Queensland, Manufacturing Skills Queensland and Construction Skills Queensland, identify the method or strategy for filling these skills.

Community

- establish a process providing means of contact for local project areas businesses to contact the proponent with billing issues
- organise local supplier information sessions to inform business of the proponent's development plans, tender opportunities for local business; and how to complete tender requirements
- continue to use ICN database for potential suppliers in the area.

Landholders

- develop and implement a compensation framework which is consistent for all landholders and which seeks to 'add value' rather than just compensating for impacts
- adherence to the Conduct and Compensation Agreements between the proponent (and contractors) and landholders
- communicate with landholders at least three months before activities take place on private property
- close engagement with landholders to minimise impacts on their land and existing agricultural activities.

Infrastructure - Transport

- traffic management plans developed including preferred routes for travel and measures to reduce risk of accidents; road safety awareness initiatives for Project personnel and local residents; procedure for notifying council and road authorities for any disruptions / road closures
- road management strategy to manage any increased road maintenance requirements imposed by the project
- details of the approved traffic management plans will be made available on the proponent's website
- ongoing consultation will occur with appropriate levels of QPS regarding the development and implementation of the traffic management plan including vehicle movements and coordination of efforts where possible
- traffic management plans developed including preferred routes for travel and measures to reduce risk of accidents; road safety awareness initiatives for project personnel and local residents; procedure for notifying council and road authorities for any disruptions / road closures
- road management strategy to manage any increased road maintenance requirements imposed by the project

- ongoing consultation will occur with appropriate levels of QPS regarding the development and implementation of the traffic management plan including vehicle diagnostic services and allied health services movements and coordination of efforts where possible.

Local community

- maintain a grievance mechanism for the community to register complaint / issue / comment / suggestion within the community feedback mechanism, and action issues in a timely manner
- consult with Councils for their views on which social, community or recreational infrastructure in the IRC or CHRC is being directly impacted by the project and to what extent. Liaise with the relevant body to coordinate efforts across all proponents and identify opportunities that may potentially ease or mitigate impacts.
- in the development of the TWAF strategy, the proponent will consider opportunities to access / use community facilities, including consideration of appropriate timing where feasible in consultation with key stakeholders
- development of a Community Engagement Plan that includes the provision of opportunities to discuss concerns with the community
- provision of high quality TWAF accommodation for workforce
- ongoing provisions of Community Officers, Land Liaison Officers and the 1800 free call number, for people to ask questions or raise concerns about Arrow's activities
- provision of an on-site health service for the workforce in TWAFs and liaison with emergency services and Queensland Health in the planning of this facility
- consideration of medical contractors openly communicating with community health service providers.

The SREIS states that no highly significant residual negative impacts would occur after implementation of the measures such as listed above, and as outlined in the SIMP.

4.17.5 Major issues raised

References to agencies and organisations in the following summary are based on submissions made on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required (see SREIS section 21 Submissions and Responses).

Comments and advice on social impacts were received from local government, DSDIP, DHPW, DETE, QH, QPS, Skills Queensland, private submitters, infrastructure providers and DCS.

The issues raised included

- requests for progress on consultation with social impact stakeholders including councils, emergency services, housing and community service providers
- requests for ongoing involvement in development and implementation of the SIMP
- advice to include social commitments in the SIMP and not separate plans or programs
- advice on social programs and the proponent's involvement or program links
- workforce wellness, location, safety, and recreational infrastructure
- skills, training and apprenticeships to be available
- workforce FIFO and the proponent's employment hierarchy with local employment prioritised
- health, police and emergency services infrastructure
- developing and monitoring clear key social performance indicators.

The proponent responded (SREIS section 21) with further information and commitments (SREIS SIMP and SREIS Appendix O Commitments) to update the SIMP including social commitments for use as a living document, maintaining ongoing consultation with stakeholders, developing and implementing workforce policies and programs, and engaging with infrastructure providers for agreements on rail/roads/electricity/water post EIS.

The SREIS provided further information on social programs and commitments including the following key issues.

Social Impact Management Plan (SIMP)

DSDIP and local government submitters requested the inclusion of commitments in the commitments summary and the SIMP action plans for mitigating identified project social impacts. The proponent updated the social impact commitments presented in the EIS for SREIS Appendix O and SREIS Appendix N Draft SIMP and committed to continue to consult with DSDIP on the agreed social impact initiatives.

IRC requested advice on how the SIMP would be developed, implemented and monitored by local and State governments. The CHRC and QPHS suggested that KPI's would be required to effectively implement and monitor the implementation of the SIMP. The proponent committed to implement the SIMP in consultation with stakeholders and agreed targets.

Workforce, employment and training

Submitters provided advice on workforce issues including the

- assumed high FIFO proportion (up to 100%)
- risk of antisocial behaviour after work hours
- workforce accommodation strategy would lead to further community division (temporary workforce accommodation facilities (TWAFs))
- unclear size of the workforce
- lack of specific employment training and skills development strategies for underrepresented groups such as women and indigenous persons should be part of a Workforce management action plan and commitments
- request for training and skills details for workers including contractors.

The proponent provided an updated workforce accommodation strategy and workforce profile in SREIS section 3 Project description. Housing and accommodation were assessed in the EIS Appendix U section 6 Social Technical Report. The operational workforce was stated as half of that described in the EIS (from approximately 600 to 300) due to a combination of well automation and the use of multi-pad wells.

The proponent committed to increasing the training and skill development opportunities for the local population (SREIS Appendix N SIMP and SREIS Appendix O Commitments Update). The proponent committed to continue as an Equal Opportunity Employer with no restrictions on the employment of women or the disabled. The proponent also referred to indigenous participation initiatives such as the Aboriginal and Torres Strait Islander Reconciliation Action Plan with strategies on indigenous employment and enterprise opportunities, as well as the Reconciliation Action Plan (SREIS Appendix N SIMP Sections 2.2, 2.3 and 2.4). The EIS documents also include indigenous groups in action plans for employment and skills opportunities.

The proponent's commitment to a Workforce Management Plan for the whole of workforce (employees, contractors) addresses training development and employment opportunities for local and regional workers, antisocial behaviour risks, and management of FIFO workers. The proponent's proposed social management program would include vocational and specialist training program, traineeships, graduate development program; school based training programs

The proponent committed to increasing the training and skill development opportunities for local residents including schools training programs (SREIS Appendix N SIMP) with commitments for training and workforce programs. The proponent also committed to contractor involvement in these programs in addition to industry-wide initiatives for up-skilling the gas industry workforce. Project-specific strategies and initiatives would be coordinated with industry-wide initiatives.

Local community

IRC, QPS, CHRC and DCS questioned the lack of focus on community values and lifestyle impacts. The proponent responded with further information (SREIS Appendix N SIMP) and commitments on managing community values including

- ongoing consultation with local councils on affected social, community or recreational services
- SIMP development and implementation that incorporates stakeholder views
- development and implementation of action plans that provide direction on the mitigation strategies agreed with councils
- consideration for programs addressing workforce behaviour management to maintain and enhance community values and lifestyles by
 - continued community liaison
 - developing a code of conduct for worker induction
 - statement of community expectations for new arrivals
 - cultural awareness briefing
 - disciplinary procedures for inappropriate behaviour of employees
 - code of conduct zero tolerance for drugs and alcohol
 - all personnel subject to random drug testing

The proponent committed to continue to consult with IRC and CHRC on affected social and community values. The proponent referred to the established community consultation program that would be ongoing as part of the post-EIS process. The proponent committed to address community expectations by maintaining community relationships and liaison during construction, operation and decommissioning via an ongoing communications and engagement plan.

Community infrastructure

DSDIP, DCS, QH and IRC requested more detailed strategies and SIMP action plans on the mitigation of direct

community health impacts identified in the SIA including likely increased potential disease outbreaks, increased demand on medical centres, hospitals and emergency services. The submitters advised that the proponent consult, liaise and agree mitigation strategies with Regional Queensland Health for inclusion in the SIMP Action Plan and proponent commitment summary. IRC requested details on actions proposed for managing impacts on community services overall.

The proponent committed to implementing a range of management measures on health services and community infrastructure. The proponent committed to engaging with Regional Queensland Health on health service delivery issues. Community infrastructure and management measures were outlined in the SIMP (SREIS Appendix N section 2.2) including

- the provision of an on-site health service for the TWAF workforce
- developing an emergency management plan (SREIS Appendix N, Section 2.2)
- the emergency management plan supported by relevant plans such as road-use management plans (RMPs) and community safety plans
- development of a community infrastructure and services action plan
- appropriate siting of TWAFs to avoid pressure on community services and infrastructure.

The proponent stated that more detailed information on major infrastructure locations would be presented at the EA application stage post EIS process. Potential impacts and interference with infrastructure such as the Stock Route Network would be identified impacts avoided or mitigated. Mitigation measures would be in accordance with relevant stakeholders such as Isaac Regional Council.

Mackay Regional Council requested further details on regional infrastructure and community services. The proponent referred to the EIS Appendix M Social technical Report and SREIS Appendix N SIMP which described

- the impacts on communities with provision of TWAFs to accommodate the construction and operations workforce
- impacts managed and monitored through the development and implementation of a SIMP
- participation in a RCCC
- impacts on regional infrastructure such as roads, would be managed through the development of road management plans with State agencies.

Housing

DSDIP requested that the housing action plan address the following issues and be submitted to DSDIP before commencement of the project

- type of housing provision to be provided and which employees/contractors would be provided
- volume and location of housing to be provided
- timeframes for bringing on line housing provision and the length of time each type will be utilised
- housing strategies for early works, affordable housing and all workforce types including employees, contractors and for non-resident (FIFO, BIBO and DIDO) construction and operational workforce.

The proponent provided an updated workforce accommodation strategy (SREIS section 3 Project description) that further addressed these issues. The construction phase was stated as not likely to require local housing outside proponent contracted worker accommodation villages. The proponent committed to monitor the impacts of the project on housing availability and affordability for decisions on the need for investment in housing in relevant towns for the operational phase. Variables would include the recent downturn in the coal industry.

The proponent committed to using existing workforce accommodation such that the 'pioneer' workforce required to construct accommodation villages would use existing accommodation camps in the area until sufficient capacity proponent accommodation camp sites (TWAF) are established.

CHRC advised that monitoring housing requirements should be subject to nominated key performance indicators. The proponent committed to monitoring the housing requirements of the workforce and reviewing needs on an ongoing basis.

DSDIP and IRC questioned the impacts on affordable housing and recommended further work to better describe and manage the likely impact on low paid households. The proponent provided an updated workforce accommodation strategy and workforce profile (SREIS section 3 Project Description). The proponent also committed to consider investment in the Isaac Affordable Housing Trust if monitoring indicated project related adverse effects on housing affordability in towns affected by the project. Factors would include the unpredictability of the housing market and the impact of programs such as Economic Development Queensland, the Isaac Affordable Housing Trust, and the cumulative impact of other development in the area such as BMA.

DCS, DSDIP and local governments requested further information on the housing strategy to clarify the housing plan during construction and operational overlap phase and for two years of the operational phase following

completion of construction. The proponent referred to EIS Appendix U Social Technical Report showing low risk of direct increase in housing demand and likely low demand for operational workers to relocate to the region. The SREIS section 3 provided a revised project which showed a decrease in the operational workforce required and confirmed that there would be no change to the EIS assessment of housing demand.

Health and safety

DCS and DSDIP wanted details on service delivery impacts. The strategies included in the EIS SIMP Action Plan related to the workforce without focussing on impacts to the community services in the area. Commitments are required for inclusion in the SIMP on management strategies for emergency services such as volume of work associated with traffic movements, emergency procedures, health and safety, increased anti-social behaviour, health outbreaks.

The proponent committed to implementing a range of management measures on community services including engagement with Department of Community Safety, Queensland Health and the Queensland Police Service health and safety service delivery. SREIS Appendix N draft SIMP includes this range of measures.

4.17.6 Conclusion and recommendations

The EIS documents have adequately met the requirements of the TOR in relation to social impacts. In particular, the EIS documents have adequately described, at a project scale, the exiting social environment of the project area, provided qualitative predictions on the impacts of the project and outlined broad strategies to minimise social impacts of the project. Successful mitigation of impacts will be dependent on The proponent applying the commitments outlined in the EIS documents (with amendments) including conducting localised social assessments and developing and implementing more detailed mitigation strategies that are adaptive to changing social conditions over the life of the project.

Recommendation – further develop social impact management plan (SIMP)

In consultation with relevant local and state government departments, non-government organisations and communities the proponent should further develop the SIMP to address the commitments made and the issues not fully addressed in the EIS documents including social impact management actions and targets not included in SREIS Appendix O dealing with

- the Housing and Accommodation Strategy
- local employment in operations workforce
- employment and training
- indigenous issues
- emergency management
- ongoing stakeholder engagement
- integration of worker camps and local communities.

Recommendation – State agency advice on the SREIS

The proponent should address State agency advice (DSDIP, DCS and DETE) including

- consult with DETE on the recommended 500m buffer of placement of wells and other infrastructure from schools rather than the proposed 200m buffer from schools.
- consider the new policy directions, *Managing the Impacts of Major Projects in Resource Communities and Regional And Resource Town Action Plan* (available on the DSDIP website) to assist in negotiating and agreeing mitigation and management strategies
- commit to developing a Housing and Accommodation Strategy (eg include statements in SREIS Appendix O) that addresses
 - housing types
 - volume and location of housing
 - timeframes for housing provision
 - workforce to be provided housing
- develop a management plan for local employment
- confirm how contractors would apply the proposed workforce management plan
- include all training and employment, health, emergency services, Emergency Management Plan, indigenous issues strategies in the list of project commitments (SREIS Appendix O)
- discuss rating for local industry participation with DSDIP and revise SIMP to include reasons for low opportunity
- develop a stakeholder engagement strategy that includes dispute resolution processes and ongoing stakeholder engagement
- local, non-local, and overseas worker requirements
- detail how workers in TWAF facilities would be integrated with local communities

- include a monitoring strategy with social impact action plan (such as KPIs, timing, reporting methods, parties responsible)
- include economic assessment commitments within the SIMP and SREIS Appendix O and consult with DSDIP on consultation with stakeholders for the economic assessment commitments (Social Impact Assessment Unit OCG).

Recommendation – key performance indicators (KPIs)

With each social impact action plan the proponent should include a monitoring framework including KPIs, timing, reporting methods, and parties responsible.

Recommendation – commitments

The proponent's social impact commitments outlined in the EIS (SREIS Appendix O) should be implemented where they do not conflict with approval conditions and the recommendations of this assessment report.

4.18 Indigenous cultural heritage

EIS section 25 provided a description of the Indigenous cultural heritage values within the project area and assessed the potential for these values to be affected by direct and indirect impacts of the project. EIS Appendix W Aboriginal Cultural Heritage Impact Assessment Study presented a detailed assessment of the project's indigenous cultural heritage impacts and management strategies.

4.18.1 Methodology

The Indigenous cultural heritage assessment comprised a desktop study, consultation and impact assessment. The desktop assessment included; the indigenous cultural heritage register and database (ICHRaD), the Queensland Heritage register and the cultural heritage information management system (CHIMS), investigation of heritage registers including the lists of heritage places throughout Australia, searchable web-based systems relevant to heritage values of individual places on various databases, lists and registers and a review of material held in a range of publicly available archives, collections and publication of Aboriginal cultural heritage information. A qualitative risk assessment was used to assess the likelihood of harm to cultural heritage sites. No field surveys were conducted.

4.18.2 Existing environment

Registered Native title claimants whose country falls within the project area include the Barada Barna, Birri, Jangga and Wirri peoples. The proponent has settled Indigenous Landuse Agreements (ILUAs) with all of these parties. The Kangoulu people had their Native Title claim deregistered in 2010 and this group remains an Aboriginal party with which the proponent is seeking to settle an ILUA.

Key values that were identified in the assessment are associated with either archaeological significance or cultural significance and included places with identified Indigenous values listed on the ICHRaD and CHIMS registers and places identified during previous EIS studies.

The EIS identified the following indigenous cultural heritage values

- known Indigenous sites: two spheres were identified - those related to traditional and spiritual association and those resulting from everyday use and occupation of that landscape. Watercourses and waterholes form part of the living traditional knowledge-base. A substantial number of historical significant places would be present in the project area. A wide range of archaeological sites have been recorded especially stone artefacts and scatters. These scatters would include numerous backed blades and other microliths; possibly dating back up to 4500 years ago. There are also a number of rock shelters with stencils of several colours. Numerous scarred trees have been recorded from the project area with functions ranging from extraction of food resources and ritual markings. Hearths and related cultural material were also recorded. Flora and fauna constitute another important element in the cultural landscape as valued food resources or because of social or ritual significance.
- unknown Indigenous sites: further aboriginal cultural heritage may be found throughout the project area.

4.18.3 Impacts

EIS section 25 summarised the pre-mitigated and residual impacts of the project on Indigenous cultural heritage. The EIS stated that without the implementation of appropriate management controls, particularly clearing activities and ground disturbance, the project had the potential to impact on Indigenous cultural heritage values through encroachment upon, or disturbance of, known or unknown places of cultural heritage to Indigenous persons and/or accidental destruction, damage or disturbance of physical objects.

The EIS stated that the proactive implementation of cultural heritage arrangements described in ILUAs and CHMPs would minimise the likelihood of impact. With proactive assessment, the potential for accidental direct destruction, damage or disturbance to unknown sites would be unlikely.

4.18.4 Avoidance and mitigation measures

The EIS described a cultural heritage management strategy to avoid impacts on known or unknown Indigenous cultural heritage within the project area. The EIS stated that compliance with the *Aboriginal Cultural Heritage Act 2003* (ACH Act) would be achieved using the strategy described. The EIS stated a series of commitments to minimise impacts on Indigenous cultural heritage (see SREIS Appendix O).

EIS section 25.6 stated a number of principles that the proponent would adopt for the project with respect to a range of avoidance, mitigation and management measures to cultural heritage management. Through ILUAs with Native Title claimants whose country falls within the project area, the proponent developed a set of arrangements

for the management of Aboriginal cultural heritage as agreed between the parties (as a separate schedule of the ILUA). These ILUA arrangements would ensure compliance with Part 7 of the Aboriginal Cultural Heritage Act.

For a significant portion of the project area, where the Native Title landscape remains unsettled and where an ILUA could not be successfully finalised, the proponent would move to develop a Cultural Heritage Management Plan (CHMP). The proponent would develop and implement a CHMP negotiated with the Aboriginal parties, or the nominees of the endorsed parties as per s102 (2) of the ACH Act.

The proponent committed to implement best practice for management measures, compliance with legislation, and to work with the Aboriginal ILUA or endorsed parties to develop key performance indicators. While the proponent acknowledged that the database of sites of Indigenous cultural heritage remains the property of the Aboriginal ILUA or endorsed parties, the proponent would require data to clarify the constraints or management requirements with which the proponent must comply to implement the agreed management strategy.

The proponent accepted the requirement for formal cultural heritage induction for all project personnel to become aware of cultural heritage values associated with the project, and their responsibilities. Where possible the proponent would ensure that the Aboriginal ILUA or endorsed parties or nominees would assist with the development of the project. The proponent would implement and participate in cultural heritage induction processes and including cultural awareness training.

4.18.5 Submissions

The Department of Aboriginal and Torres Strait Islanders and Multicultural Affairs (DATSIMA) referred to the final terms of reference requiring 'adequate provision of education, training and employment for women, people with disability and indigenous peoples'. The proponent stated that the Social Impact Management Plan addressed the terms of reference including links to the Aboriginal and Torres Strait Islander Action Plan.

DATSIMA stated that the action plan did not negate the need for specific actions that would ensure the adequate provision of education, training and employment for Aboriginal and Torres Strait Islander peoples. The proponent responded by outlining ongoing efforts and commitments to provide employment, education and training opportunities to indigenous people and communities since the EIS was completed. The proponent referred to commitments to prepare CHMPs in accordance with *Aboriginal Cultural Heritage Act 2003* and enter into ILUAs for the project area to address aboriginal involvement in the management of aboriginal cultural heritage.

DATSIMA submitted further advice on the SREIS with requirements for a specific Indigenous Participation plan. The proponent response referred to the development of an Australian Industry Participation Plan that incorporates Indigenous participation as a fundamental component. The proponent stated that the plan would provide a full, fair and reasonable opportunity for the participation of capable and competitive local (including Indigenous) businesses to provide goods, equipment and services.

4.18.6 Conclusion and recommendations

The EIS adequately met the requirements of the TOR with respect to Indigenous cultural heritage. It adequately described, at a project scale, existing Indigenous cultural heritage values and broadly considered the likelihood of unknown Indigenous cultural heritage values.

To avoid impacts on, or reduce the likelihood of impacts on known or unknown Indigenous cultural heritage within the project area, the proponent has developed ILUAs with most Aboriginal peoples whose country falls within the project area and within each ILUA is a schedule with a set of arrangements for the management of Aboriginal cultural heritage. There is one party that the proponent has not negotiated an ILUA with and it is recommended that the proponent prepare a Cultural Heritage Management Plan in consultation with the Kangoulu people if an ILUA cannot be negotiated.

Recommendation - commitments

The proponent should implement the commitments outlined in SREIS Appendix O Table 1 dealing with Indigenous cultural heritage.

Recommendation – action plan

The proponent should further develop and implement the Reconciliation Action Plan for 2013-14 which supports initiatives to protect Indigenous cultural heritage as well as support employment, training, education and business opportunities for Aboriginal and Torres Strait Islander people.

4.19 Non-Indigenous cultural heritage

EIS section 26 provided a description of the non-Indigenous cultural heritage values within the project area and assessed the potential for these values to be affected by direct and indirect impacts associated with the project. EIS Appendix X Non-Indigenous heritage report, presents a detailed non-Indigenous cultural heritage assessment of the project area.

4.19.1 Assessment methodology

The non-Indigenous cultural heritage assessment comprised archival research, a desktop study and consultation. The desktop study involved a literature review, research and investigation of international, national and state heritage registers, including the following – research from primary and secondary sources; verification and usage of information from previous environmental impact studies; Australian Heritage places inventory; Queensland Heritage register; relevant planning scheme heritage overlays; National Trust of Queensland register and database; and local historical societies and archives. No field survey was undertaken.

4.19.2 Existing environment

The region in which the project area is located has had been visited by non-Indigenous people from the mid-nineteenth century, with the arrival of the earliest explorers, followed by pastoralists. Many known heritage places within the project area are associated with early settlement, including pastoral stations, roads and stock routes, towns, railway infrastructure and contact places. There are remnants of early mining ventures. All known sites originate either in the mining or pastoral industries. Collectively they provide physical evidence of human activities in the region over the last 160 years and complement the historical records that describe the events that occurred in the region.

No sites of national or of world heritage significance were identified. The Bedford Weir, river crossing and historic murder site was a site identified on the National Trust of Queensland database. Twenty one places, including several of potential regional or state significance, were identified. Seven graves, whose exact locations are unknown, are listed in early burial records. Also identified was a reported World War II internment camp on Redhill station, however the exact location of the camp is presently unknown.

4.19.3 Impacts

The project would potentially impact on non-Indigenous cultural heritage sites through direct ground disturbance activities and indirect disturbance through encroachment on sites during construction, operations and decommissioning.

Potential impacts to non-Indigenous places may occur through chance-find discoveries of previously unknown sites that are uncovered during construction activities. These impacts potentially could be long term with disturbance or degradation to sites being difficult to restore or return to original condition.

4.19.4 Avoidance and mitigation measures

The proponent stated that the conservation objective would be to avoid or minimise disturbance from project related activities to non-Indigenous cultural heritage sites and places. The proponent stated that management strategies would be implemented to avoid known cultural heritage sites, including through site selection. The proponent would develop a Cultural Heritage Management Plan in consultation with the stakeholders and State and local government prior to commencement of ground disturbance. This plan would form the basis of mitigation and management of potential impacts on non-Indigenous cultural heritage sites.

The proponent committed to

- undertaking pre-clearance surveys to identify the presence of heritage sites
- notify the Queensland Heritage Office of any cultural heritage sites that are uncovered in construction
- ensure buffers are adequately delineated where significant heritage sites are located within 500m of proposed wells, pipelines or other infrastructure
- develop a chance-find procedure
- consult the local community with respect to the management of historic sites; to incorporate cultural heritage awareness into site induction procedures and to maintain a database of all sites where non-Indigenous cultural is known or found in the course of investigations and works.

4.19.5 Submissions

No submissions were received in relation to non-Indigenous cultural heritage values in the project area.

4.19.6 Conclusion and recommendations

The EIS met the requirements of the TOR with respect to non-Indigenous cultural heritage. The non-Indigenous cultural heritage values were adequately described at the project scale, and the unknown non-Indigenous cultural heritage values were broadly considered.

Recommendations

The proponent should

- implement commitments outlined in SREIS Appendix O Table 1 that pertain to non-Indigenous cultural heritage
- develop a Cultural Heritage Management Plan prior to commencement of ground disturbance works for mitigating and minimising potential impacts on non-Indigenous cultural heritage sites
- consult with the community and landholders regarding the occurrence of non-built heritage sites relating to the history of the area and consider such values in the development and implementation of the Cultural Heritage Management Plan, 'chance-finds' and site induction procedures and other mitigation tools aimed at minimising impacts of the project on non-Indigenous cultural heritage values.

4.20 Waste management

Waste management was discussed in EIS section 28 Waste management. This provided a cross-reference to other sections of the EIS containing further detail on specific waste generation and management measures. A supplementary waste management assessment which addressed changes to the project and relevant legislation following submission of the EIS, and submissions on the EIS relating to waste management was provided in SREIS section 16 Waste management.

EIS Appendix AA Coal seam gas water management strategy, presented the proposed management framework for coal seam gas (CSG) water and salt to meet legislative and policy requirements. SREIS Appendix D, CSG water and salt management strategy, presented a revised management framework for CSG water and salt.

4.20.1 Assessment methodology

The waste assessment was comprised of a desktop study to identify

- potential waste streams associated with the construction, operation and decommissioning of the project, including information on waste generated by existing gas production facilities operated by the proponent
- likely impacts associated with waste streams generated during each phase of the project
- management options for waste minimisation and disposal.

4.20.2 Waste characterisation and quantification

Waste generation and management from the following activities were assessed

- construction of production wells
- construction of gas and water gathering systems, gas processing facilities, and power generation facilities
- gas field operation
- decommissioning and rehabilitation.

Typical waste streams and estimated quantities of waste to be generated by the project were provided in EIS section 28 Table 28.2, along with proposed methods of management and disposal. The EIS stated that the type, quantity and management of wastes may vary following detailed design and planning prior to construction.

Waste associated with construction of production wells

Production well construction would involve site preparation, drilling, cementing and casing and could typically generate the following wastes

- solid wastes comprised of general trash, scrap metal, cleared vegetation, cut and fill material, empty drums and containers, timber, drill cuttings, cardboard and other packaging materials, wood pallets, soil contaminated with chemicals / oils
- liquid wastes comprised of drill fluids, residual drilling mud, coal seam water, filters and filter media, used lubricating oil and filters, acids and caustics, unused or spent chemicals / oils / solvents, grey water, stormwater)
- gaseous waste comprised of coal seam gas and engine emissions.

Approximately 200m³ of drilling fluid (typically comprised of water, salts (calcium chloride, calcium sulphate, potassium sulfate, and potassium chloride), bentonite, biocide, viscosifier, foaming agent and fluid loss prevention agent) would be used to drill a production well and result in approximately 10m³ to 75m³ of potential waste material per well.

Waste associated with construction of gas and water gathering system, gas processing facilities, and power generation facilities

Waste generated from the construction of gas, water treatment and power generation facilities would typically include

- solid wastes comprised of cleared vegetation, excess trench soils and rock, general trash, scrap metal, empty drums and containers, timber, plastic sheeting and pipe offcuts, cardboard and other packaging materials, contaminated soil, filter cartridges, batteries, concrete, general trash, scrap metal, cleared vegetation, cut and fill material, empty drums and containers, timber, plastic pipe, plastic sheeting, sandblast grit, cardboard and other packaging materials, wood pallets, oily rags and sorbents, electrical cable and tyres
- liquid wastes comprised of domestic cleaners, fuel, greases, lube oils, glycol, paint waste, wash-out liquids, hydro-test water, sewage from amenity blocks, contaminated stormwater runoff, wastes from integrity testing, pesticides and herbicides, hydrostatic-test water, filters and filter media, used lubricating oil and filters, unused or spent chemicals / oils / solvents, paints, paint wastes and wastewater
- gaseous waste comprised of vehicle, equipment and generator emissions.

Gas field and facility operation

Wastes generated during operation of the gas field and associated facilities would typically include

- solid wastes comprised of filter cartridges, batteries, concrete, general trash, scrap metal, cleared vegetation, cut and fill material, empty drums and containers, timber, plastic pipe, plastic sheeting, sandblast grit, cardboard and other packaging materials, wood pallets, oily rags and sorbents, electrical cable and tyres
- liquid wastes comprised of domestic cleaners, fuel, greases, lube oils, glycol, paint waste, wash-out liquids, hydro-test water, sewage from amenity blocks, contaminated stormwater runoff, wastes from integrity testing, pesticides and herbicides
- gaseous waste comprised of vehicle, machinery and generator emissions.

Large volumes of CSG water would also be extracted from production wells and treatment of this water using reverse osmosis technology would produce large volumes of salt brine.

Decommissioning and rehabilitation

The EIS provided little information on decommissioning related wastes but indicated that much of the potential waste would be recyclable.

4.20.3 Avoidance and mitigation measures

The EIS proposed avoidance, reuse, recycling, treatment and disposal options for wastes. EIS Table 28.2 stated the proponent's commitments to the waste management measures proposed for each waste type. Proposed management of significant waste streams included the following.

Drilling fluids and cuttings

Drilling fluids would typically be directly re-used, or transferred to an authorised treatment facility prior to reuse or recycling. Where reuse or recycling of drilling fluids was not practicable, the fluids may be disposed of to a suitable licensed disposal facility. Drill cuttings would be reused or recycled where possible, with direct disposal to licenced landfill where no other practical alternative was available. The proponent committed to developing a drilling waste management plan.

Hydrostatic test water

Hydrostatic test water (used to pressure test pipelines), estimated at 100ML per gas field, would be reused, or disposed of through the CSG water management system.

Greywater and sewage

Wastewater, estimated at 5ML per eight month period for each FCF, 12ML per year for each CGPF, and 12ML per year for each IPF, would be treated onsite or transported offsite to a municipal treatment facility.

CSG water and brine management

The EIS stated that management of the estimated 5.4 gigalitres per year of CSG water would be challenging due to variable quality and volumes, and that elevated concentrations of salts would commonly make the associated water unsuitable for release to the environment, or for many beneficial uses, without prior treatment. The proponent committed to employing beneficial use options for CSG water wherever possible and stated a preference for beneficial use of brine resulting from treatment of the CSG water (estimated at 4.5 tonne of salt per megalitre of CSG water).

EIS section 4.7.4 Water treatment and storage facilities, provided an overview of options for CSG water management. EIS Figure 4.14 illustrated the preferred and potential management options for CSG water and associated brine/salt, including treatment, storage, beneficial use and disposal.

A high level water management strategy was presented in EIS Appendix AA, Coal seam gas water and salt management strategy, which outlined

- the current regulatory framework relevant to CSG water management
- the management options for treated and untreated CSG water
- general storage dam and pipeline requirements to manage the production, treatment and distribution of CSG water
- the preferred treatment technology for the project (reverse osmosis).

CSG water use options under consideration included irrigation, other agricultural uses, industrial, urban water supply, injection into groundwater aquifers, discharge to watercourses, and ocean outfall.

Brine and salt management options under consideration included salt recovery (sodium chloride, carbonate and bicarbonate), brine injection into suitable underground aquifers, ocean outfall and disposal to licenced landfill.

The actual treatment and disposal of CSG water resulting from the project was not defined.

4.20.4 Major issues raised

References to agencies and organisations in the following text are based on submissions made on the publicly released EIS. The proponent responded to each submission with explanatory material and information where required.

EHP noted that landfill facilities listed in EIS Table 28.1 (Existing licensed waste management facilities near the project) did not include any facility with the capacity to accept the volume of brine (41,000 tonne/annum average) estimated to be produced by the project, and that new technologies to make use of the brine may be slow to develop. Several submissions (including from Isaac Regional Council and Queensland Health) also questioned the suitability and capacity of landfill sites to accommodate the estimated waste streams.

The proponent stated that, due to the relatively low quantity of salt that could be produced by the project, beneficial use was considered to be not economically viable and the residual salt concentrate would be disposed of to a suitably licensed landfill. Stuart Landfill, operated by Townsville City Council and licensed to receive up to 200,000 tonnes per year of regulated waste or a combination of regulated waste and general waste, was identified as potentially suitable to receive the residual regulated and general waste streams from the project, although landfill sites located closer to the project area were preferred.

The proponent stated that waste salt concentrate (brine) disposal to landfill was not expected to commence until approximately 30 years after commencing CSG water production and it was expected that a third party landfill operator would take advantage of the commercial opportunity to develop and operate a suitable regulated waste facility close to the project water treatment facilities. SREIS Table 16.3 identified additional waste facilities in proximity to the project area and identified the type of waste accepted and the annual capacity based on the current EA.

Submissions (including from the Department of Agriculture, Fisheries and Forestry, the Department of Energy and Water Supply, Queensland Health, Isaac Regional Council, and Fitzroy Basin Association) requested more detail on the management, treatment (including treated water quality suitability for use) and disposal of CSG water and salt, and the basis on which the actual methods used would be determined. In response, the proponent referred to the revised CSG water and salt management strategy provided in SREIS Appendix D which detailed the options under consideration for the stated volumes and type of waste.

Concerns were raised by rural landowners that water used for stock could be contaminated. In response, the proponent stated that all water and brine storage dams would be constructed, operated and decommissioned in accordance with the EHP 2013 guideline Manual for assessing consequence categories and hydraulic performance of structures, and the relevant environmental authority. The proponent also referred to flood modelling presented in the SREIS for areas under consideration as potential sites for CGPFs and WTFs, including CSG water and brine dams, and stated that further modelling would be undertaken at the detailed design stage to ascertain the flood risks for confirmed infrastructure locations.

EHP noted EP Act requirements for CSG water management plans and site specific management measures. The coal seam gas water and salt management strategy presented in EIS Appendix AA contained overarching and general measures and did not meet all of the legislative requirements for environmental authorities as outlined in s126 of the EP Act. EHP stated that site-specific details of CSG water management would be required to form part of any future application for an environmental authority, including

- expected water quality changes during the undertaking of different water management activities
- expected holding times for untreated and treated CSG water in the various water storage infrastructure required within the development areas
- measurable criteria (management criteria) to be developed to determine the success and effectiveness of the CSG water management measures
- actions to be taken if the management criteria were not met.

EHP stated that, if discharge to watercourses was proposed, information would be required on proposed controlled discharges, including:

- stream flow data and information on discharge water quality in combination with proposed discharge rates to estimate in-stream dilution and water quality
- options for controlled discharge under times of natural stream flow to ensure that adequate flushing of waste water would be achieved
- an assessment of the available assimilative capacity of the receiving water given existing background water quality and other potential point source discharges in the catchment.

In responding to EHP concerns relating to CSG water management and potential discharge of CSG water to

watercourses, the proponent referred to SREIS Appendix F Surface water technical report, and a revised version of the CSG water and salt management strategy contained in SREIS Appendix D, which further outlined CSG water and salt disposal options and associated mitigation measures. The SREIS identified two areas for potential location of water treatment facilities and reaches of the Isaac River where treated or untreated CSG water could be discharged, and provided information on the condition of the Isaac River relevant to determining potential impacts of CSG water discharges. The proponent noted that an application for any environmental authority involving discharge would need to address legislative requirements relevant to the management of CSG water.

EHP requested details of the expected number of temporary water storage dams associated with exploration activities, holding times for water in the dams, estimated evaporative losses and the principles and design criteria used. The proponent advised that exploration activities were not part of the scope of the EIS but were subject to current environmental authorities and would be subject to future applications for environmental authorities relevant to exploration activities.

EHP also requested detailed information on the estimated holding time of production CSG water in dams and the predicted evaporative loss of CSG water from storage dams. In response, the proponent referred to the methodology outlined in the CSG water and salt management strategy contained in SREIS Appendix D. No actual estimates of holding time or evaporative losses were provided.

EHP requested further information on the effect of extreme climate events on CSG water management, including the capacity of dams to retain contaminants, the structural integrity of the containing walls, the quality of water contained in storages, and the flows and quality of water discharged. In response, the proponent referred to the findings of a flood investigation for the proposed water treatment facility locations contained in SREIS Appendix G Hydrology and geomorphology technical report, and noted that a sensitivity analysis was undertaken to estimate the potential impact of climate change on flooding in the area. The proponent also stated that a more detailed analysis of the water quality and flow regime associated with potential CSG water release scenarios was provided in SREIS Appendix F Surface water technical report.

EHP requested further detail on the potential contaminants that could be present in CSG water at levels sufficient to cause impacts on aquatic organisms, irrigated plants, stock or humans (such as polycyclic aromatic hydrocarbons, metals, nutrients, radioactive compounds, and additives in drilling mud and hydraulic fracturing fluid) and a CSG water sampling and analysis plan listing sampling locations and analytes. In response, the proponent stated that an updated water quality monitoring program was included in SREIS Appendix F Surface water quality technical report, and that detailed water quality monitoring information would be provided with any application for an environmental authority.

Isaac Regional Council requested a long-term recycling strategy for project wastes, including an economic assessment. In response, the proponent referred to the waste strategy outlined in SREIS section 16, including Table 16.2 which identified the waste streams expected to be generated and their respective management measures. The proponent stated that potential waste materials would be reused or recycled where possible, with residual waste sent to a licensed waste processing or disposal facility, and that a waste management plan would be developed.

4.20.5 Waste assessment for changed project

A number of changes were made to the project description after submission of the EIS. SREIS section 16 provided updated information on waste management to address changes in the project description and associated waste types and quantities, changes in legislation and policy, and in response to submissions on the EIS.

SREIS Table 16.3 of the SREIS provided an updated list of the existing licensed waste management facilities located in proximity to the project area. Stuart Landfill in Townsville was identified as a facility that may be suitable to receive residual regulated and general waste streams from the project. The following waste disposal facilities located closer to the project area were identified as being licensed to receive up to 50,000 tonnes of regulated waste

- Rolleston landfill and Springsure landfill operated by Central Highlands Regional Council
- Kelsey Creek Road landfill and Bowen landfill operated by Whitsunday Regional Council.

An alternative option proposed for disposal of waste generated by the project was development and operation of a new landfill.

SREIS Table 16.4 (Estimated waste generated and proposed management strategies) provided a revised indicative list of the types of waste potentially generated by project, the class of waste (general, regulated, recyclable), the estimated quantity likely to be produced (unchanged from the EIS), and the proponent's commitments to the waste management measures for each waste type. This table is reproduced in Appendix 2 of this assessment report.

SREIS Table 16.6 provided a revised list of avoidance, mitigation and management measures for waste in order to

reflect changes to the project description and to clarify the intent of commitments.

An updated CSG water management strategy was provided in SREIS Appendix D, Coal seam gas water and salt management strategy, confirming reverse osmosis as the preferred treatment technology and the preference for beneficial use of CSG water and brine. The actual treatment and disposal of CSG water, and brine produced by treatment of CSG water, remained undefined.

4.20.6 Conclusions and recommendations

The EIS adequately described the general waste potentially generated over the life of the project and outlined how the waste hierarchy preference to avoid waste generation, reuse, recycle and as a last option dispose of the material would be applied. The commitment to apply and implement waste management principles in accordance with applicable legislation has been adequately demonstrated for waste other than CSG water and associated salt.

The waste hierarchy was appropriately identified, generally adopted for identified waste streams, and reflected in generic and specific management measures. More specific and detailed waste management measures would need to be developed to ensure that the waste hierarchy would be effectively implemented. The proponent committed to develop and implement waste management plans and procedures in accordance with the *Queensland Waste Reduction and Recycling Act 2011*.

As feasibility studies for the CSG water management options were incomplete, and the options to be used for the project were not defined and/or detailed, the requirements of the Queensland Government Coal Seam Gas Water Management Policy (2012) have not been adequately addressed. While the proponent has provided a commitment to employing beneficial use options for CSG water wherever practicable, the options proposed with some level of certainty involve discharge of treated and/or untreated CSG water to watercourses and disposal of brine in a suitable licenced landfill.

Appropriate conditions for waste management are included in the recommendations for EA conditions in Appendix 3 of this assessment report.

Recommendations – EA conditions and information requirements

Section 126 of the EP Act requires specific details about the management of CSG water to be provided in support of any application for an EA, or EA amendment, including

- the quantity of CSG water expected to be generated
- the expected flow rate of generated CSG water
- the quality of the CSG water including expected changes in quality
- the proposed management of CSG water with beneficial use priority
- measurable criteria for monitoring and assessing the effectiveness of the management
- corrective actions to be implemented should compliance with the measurable criteria not be achieved.

In addition, any applications that include a request for beneficial reuse of CSG water should include the information required to assess and condition any beneficial use agreement. Details of requirements are set out in the EHP Guideline 'Application requirements for petroleum activities (EM705)', section 3.7 Waste.

5 Matters of national environmental significance

5.1 Introduction

This section of the report addresses the requirements of the Queensland Government's assessment as specified by Schedule 1 of the bilateral agreement between the Australian Government and the Queensland Government relating to environmental assessment, section 59 of the *Environmental Protection Act 1994* (EP Act) and Section 9 of the EP Regulation.

The SREIS Appendix J Matters of National Environmental Significance Report, provided an evaluation of the potential impacts of the project on MNES determined by the Australian Government to be controlling provisions under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and should be read in conjunction with sections 11 and 23 of the Bowen Gas Project SREIS supporting section 17 and Appendix P of the EIS addressing the controlled action Referral No. EPBC 2012/6377.

5.2 Controlling provisions

On 8 May 2012, the proponent referred the Bowen Gas Project (EPBC 2012/6377) to the Australian Government Minister for the former DSEWPaC, now the Department of Environment (DOE) (hereafter referred to as the Australian Government Environment Minister) for a determination as to whether the project would constitute a 'controlled action' with respect to potential impacts on MNES under sections 75 and 87 of the EPBC Act.

On 15 June 2012, the delegate of the Australian Government Environment Minister determined the project to be a 'controlled action' pursuant to section 75 of the EPBC Act. The relevant controlling provisions for the project were determined as being:

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

Revisions have been made to the schedules of the EPBC Act for a number of species relevant to the project since the project was declared a controlled action. The MNES assessment for the project is not affected by additions to the lists of species, or up-listing of a threatened species status, made after the Australian Government Environment Minister decided the project was a controlled action. Where a species has been removed from the list after the controlled action decision is made, no assessment is required under the EPBC Act. However, these species have been included in the MNES assessment by the proponent and are described in the SREIS.

Changes made to the threatened species list since March 2010 relevant to the project are as follows

- Brigalow scaly-foot (*Paradelma orientalis*) delisted (previously vulnerable)
- Stripe-tailed delma (*Delma labialis*) delisted (previously vulnerable)
- Wardell's wattle (*Acacia wardellii*) delisted (previously vulnerable)
- *Acacia ramiflora* delisted (previously vulnerable)
- *Croton magneticus* delisted (previously vulnerable)
- Finger Panic grass (*Digitaria porrecta*) delisted (previously endangered)
- *Leucopogon cuspidatus* delisted (previously vulnerable)
- *Trigonostemon inopinatus* delisted (previously vulnerable)
- Minute orchid (*Taeniophyllum muelleri*) delisted (previously vulnerable)
- Australian painted snipe (*Rostratula australis*) status listed as endangered (previously vulnerable).

5.2.1 Water trigger

Coal seam gas and large coal mining developments with the potential to have a 'significant impact' on water resources now require referral to and possibly approval from the Commonwealth Environment Minister under the EPBC Act. Under the transitional arrangements for commencement of the amendments to the Act, the project was assessed as to whether the new water trigger would apply. On 17 October 2013 the Commonwealth Minister for the Environment made a final decision that the water trigger applied to the project (controlling provisions 24D and 24E).

The assessment of impacts on all relevant controlling provisions for matters of MNES is detailed in Appendix 4 of this assessment report. A comprehensive assessment of impacts on water resources, including for controlling provisions 24D and 24E, is provided in section 4.9 Groundwater and 4.10 Surface Water of this assessment report.

EHP is of the view that there will not be unacceptable impacts on water resources should the project be implemented in accordance with the EIS recommendations, recommended conditions for any environmental authorities (Appendix 3), recommended conditions for any EPBC approval (Appendix 4), and non-conflicting

proponent commitments (SREIS Appendix O).

5.3 Assessment process

The project was assessed under Part 1 of Chapter 3 of the EP Act and the EP Regulation, in accordance with the bilateral agreement between the Australian Government and the Queensland Government (the bilateral agreement). The controlled action will be considered for approval under section 133 of the EPBC Act once the Australian Government Environment Minister has received this EIS Assessment Report from the delegate under the EP Act.

Potential impacts on MNES have been assessed throughout the EIS process for the project and addressed specifically as a consolidated report in SREIS Appendix J. Water resources were also addressed in the SREIS section 7 Groundwater; section 8 Surface Water; 9 Hydrology and Geomorphology, 10 Aquatic Ecology; Appendix O Commitments Update; and Appendices E, F, G, and H.

DOE was consulted on the evaluation of potential impacts and the adequacy of information with respect to potential impacts and mitigation measures on MNES throughout the EIS process and during the preparation of this report, in accordance with the bilateral agreement.

The Australian Government has established an Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). The IESC provides scientific advice to decision-makers on the impact that CSG and large coal mining development may have on Australia's water resources. The Australian Government Environment Minister must obtain advice from the IESC in coal seam gas and large coal mining development and will consider the IESC's advice for the project in making a decision on whether or not to approve the project under the EPBC Act.

The Bowen Gas Project EIS was referred to the IESC by the Department of Environment and Heritage Protection (EHP) on 22 March 2013. The IESC's advice to the department was dated 24 May 2013. Due to the Commonwealth Minister for the Environment decision to apply the water trigger to the project, the SREIS was referred by the Commonwealth government to the IESC for review and comment on 4 June 2014. The IESC's advice to the Commonwealth was dated 18 July 2014.

The evaluation of potential impacts on MNES presented in this report is based on information contained in the EIS, SREIS and a response by the proponent to an information request from EHP on impacts on MNES (see Appendix 2 of this assessment report). Also considered was advice from DOE in relation to the adequacy of the EIS and SREIS and the advice from the IESC in relation to potential impacts to water resources.

5.4 Description of the proposed action

The proponent is seeking approval to construct, operate and decommission the project, located approximately 850km north of Brisbane and 150 km south-west of Mackay in Queensland's Bowen Basin. The project would form an expansion to the proponent's existing operations in Queensland to cater to growing demand for gas in the Australian and global liquefied natural gas market.

The project area of 8000km² extends north to south from Glenden to Blackwater, follows the Connors Range to the east and on the Denham Range to the west. It incorporates tributaries of the Suttor River and Bowen River catchments in the Burdekin Basin; and the Isaac River, Connors River and the Mackenzie River catchment in the Fitzroy Basin (Figure 2.1).

The proponent is a wholly owned subsidiary of Arrow Energy Holdings Pty Ltd, a 50:50 joint venture between a subsidiary of Royal Dutch Shell plc (Shell) and a subsidiary of PetroChina Company Limited (PetroChina). The EIS stated that the company has interests in more than 65,000km² of petroleum tenures, mostly within Queensland's Surat and Bowen basins but also in the Clarence-Moreton, Coastal Tertiary, Ipswich, Styx and Nagoorin Graben basins. The proponent currently operates existing gas fields, facilities and infrastructure in the Bowen Basin (Moranbah Gas Project) and the Surat Basin near Dalby (Tipton West, Daandine and Kogan North Projects) and supplies gas to the domestic market for power generation and other domestic uses.

Project infrastructure, including up to 4000 CSG production wells and production facilities (including both water treatment and power generation facilities where applicable), would be located throughout the project area but not in towns. Facilities supporting the petroleum development activities, such as depots, stores and offices, may be located in or adjacent to towns.

The gas resources for the project lie within the Bowen Basin which underlies the Duinga and Surat Basins and extends across an area of approximately 160,000 km². The Bowen Basin is one of Australia's major coal producing regions and contains much of the known Permian coal resources in Queensland, which are one of the coal measures targeted by the CSG industry. The Bowen Basin contains 23% of Australia's 2P (proven and probable)

CSG reserves. The target coal seams for the project are the Moranbah Coal Measures and Rangal Coal Measures.

Coal seam gas refers to the methane gas lining the open fractures between the coal and the inside of pores within the coal. Coal seams store both gas and water, with the water, which is under pressure from the weight of overlying material, holding the gas in place. When the water pressure is reduced by pumping from a coal seam, the gas is released and flows to the surface through the well. Gas and water are separated below ground in the well, with water being transferred to centralised collection and treatment points and the gas being piped to production facilities where it is dried, compressed and piped to market.

Coal seam gas production typically requires the extraction of large quantities of groundwater to depressurise coal seams to allow the gas to flow. The proponent has indicated that six months of dewatering would be typically required to allow gas flow, and 18 months of dewatering would be required to reach peak gas production from a well, although it could take several years depending on the characteristics of the coal seam. An estimated 153GL of water would be produced. CSG water production was estimated to average 4.25GL/a over the life of the project (36-40 years), with peak production estimated at 10.4GL/a. Groundwater quality across the development area was determined to be moderately to highly variable. There was no apparent correlation between salinity with respect to depth or location within the Bowen Basin within a geological formation or between formations. Likewise there appears to be no trend in spatial distribution of major ion data and major ion data could not be used to definitively characterise an aquifer. Water quality varied considerably but was typically high in salinity and other dissolved solids and would require management and treatment consistent with the Queensland Government Coal Seam Gas Water Management Policy (EHP, December 2012).

The project is proposed to be developed in 33 drainage areas corresponding to the gas reserves that would supply two central gas processing facilities (CGPF). Each of these drainage areas represent an approximate 6 km radius catchment area for gathering well production (gas and water), and distributing to surface production facilities located at or near the centre of drainage area. These 33 drainage areas would be developed over the project life with seventeen drainage areas proposed to be developed for phase 1 (see Appendix 6 of this assessment report). Two CGPFs would be installed to treat the gas to pipeline specification. One CGPF would service the drainage areas in the north of the project area, and the second would service the drainage areas in the south. Facilities to be constructed within the drainage areas include

- wells
- wellhead facilities
- low pressure water and gas gathering systems
- FCFs (to boost the gas pressure for export to the CGPF)
- WTSs located with each FCF (to pump the water to the WTF)
- raw water trunkline for transport of raw water to the WTFs
- medium pressure infield pipelines (to transport the gas from the FCF to the CGPF)
- infrastructure required for power distribution.

Project phase 1 would target regions with the highest gas production certainty. It is likely that 17 drainage areas would be developed during Phase 1 (year 0 to year 5 of production). In addition, both CGPFs and their co-located water treatment facilities (WTFs) would be constructed in phase 1. A further 11 drainage areas may be developed during Phase 2 (year 6 to year 10 of production) with the remaining five drainage areas and potentially a third WTF (near Blackwater) being developed in Phase 2+ (year 11 onwards).

The SREIS outlines a reference case involving drilling and completion of two well types:

- multi-branched horizontal wells (lateral well) drilled in-seam to intersect a vertical producer (vertical production conduit)
- multi-seam hydraulically stimulated wells: vertical, cased and cemented wells, which are perforated and fracture-stimulated to provide formation access (as presented in the EIS).

About 4000 production wells would be drilled throughout the project area over the approximate 40 year life to maintain gas feed to the LNG plant. Each production well was expected to have an average life of 25 years. The SREIS confirmed information provided in the EIS that up to 25% of the gas production wells may be hydraulically stimulated in the latter stages of the project development.

Additional infrastructure would include

- medium-pressure gas pipelines to transport gas between field compression facilities and central gas processing facilities
- high-pressure gas pipelines to transport gas from central gas processing facilities to the sales gas pipeline
- electricity transmission infrastructure drawing electricity from the grid via third-party substations or from gas-powered electricity generation equipment co-located with production facilities.

The SREIS Section 3 stated that wells would be drilled from both single-well pads and multi-well pads comprised of up to 12 wells. The general configuration of the multi-well pads would be in pairs of wells consisting of one central vertical production well intersected by a lateral (directionally drilled) well.

Arrow has undertaken further works and amendments to the CSG Water and Salt Management Strategy (SREIS Appendix D) since the publication of the EIS, and those revisions relevant to the Project are presented in Section 3.5 of the SREIS Project description Chapter, as well as Section 3.2.5 of the MNES Report (SREIS Appendix J).

Management of CSG water would consist of a combination of management options as presented in SREIS Figure 3.6 section 3 Project Description, and SREIS Appendix J MNES Report Figure 3.4.

The SREIS states that CSG water could be discharged to the Isaac River as required within prescribed quantity and quality limits, when beneficial use options are not available. Discharge to watercourses was proposed as the best management option to address the uncertainty of the viability of a range of other CSG water management options including distribution to existing and new water users for beneficial use and injection into a suitable groundwater aquifer.

The selection of equipment and design of facilities was stated to be subject to ongoing review to maximise efficiency and meet specific gas field development requirements. Disturbance area estimates provided for specific project infrastructure include

- Field compression facilities (FCF) = 200m x 380m (maximum size)
- Central gas processing facilities (CGPF) = 500m x 250m plus up to 0.6 km² for dams (dimensions were provisional)
- Multi branch lateral wells (drilling phase) - estimated multi-well pad area 130m x 175m (4 wells pad), 130m x 235m (8 wells pad) and 130m x 295m (12 wells pad)
- Multi branch lateral wells (operation phase) - estimated operational footprint 100m x 155m (4 well pad), 100m x 215m (8 well pad) and 100m x 275m (12 well pad)
- Multi-seam hydraulically stimulated vertical well drilling phase - each single-well pad may occupy an area of 16,900m² (130m x 130m)

5.5 Places affected by the proposed action

The development area for the project is as shown in Appendix 6 of this assessment report. The proponent has yet to determine the exact locations of production wells, gas processing facilities, water treatment facilities, temporary workers accommodation, and other project infrastructure.

The EIS presented conceptual designs and potential areas for development for the purposes of identifying, describing and assessing the likely impacts. The SREIS presented a significantly reduced development area and revised conceptual design, including identification of the potential localities, to the north and south of Moranbah, preferred for the location of 2 CGPFs and associated WTFs for the treatment of associated water, storage of brine, and temporary storage of treated water. A potential third WTF that may be commissioned in phase 2+ was proposed to be located near Blackwater in drainage area 34. The actual location of infrastructure within these properties was not defined.

The EIS outlined the following key factors as influencing location of project components

- ongoing exploratory drilling and pilot well programs to define viable gas reserves
- consultation with landholders
- environmental and social impact management
- economic and commercial risks that influence the extent and rate of field development
- ongoing refinement of the field development plan over the life of the project
- development of new technologies, standards and practices.

Specific locations for project infrastructure were proposed to be defined as engineering and other studies and consultation progress throughout the life of the project. The EIS presented a planning and management process based on technical studies and defined constraints (referred to as an “environmental framework”) to be used by the proponent to inform site selection and manage the potential impacts of development. This planning approach would also inform locations of infrastructure that would minimise impacts on MNES, particularly TECs and threatened habitat.

5.6 Assessment method

As the actual location of all project facilities and infrastructure were not defined, the potential impacts of the project on MNES were described as being indicative of the scale of impacts that were likely to occur with actual impacts

likely to be significantly reduced. The EIS documents described the likely typical impacts of project activities and outlined the proponent’s internal planning process, known as the environmental framework approach, developed by the proponent to avoid and manage the impacts of CSG development where the location of infrastructure would become known progressively over the life of the project. The environmental framework approach would include environmental controls and constraints that reflect the sensitivity or vulnerability of environmental values at a particular location. Constraints mapping, informed by the EIS documents findings, was proposed to guide the selection of sites and infrastructure routes to avoid and minimise impacts, and was used in conjunction with a conceptual development layout (that included an optimised and grid layout for parts of the project area) to inform the estimates of potential impacts to MNES.

Under the proposed environmental framework approach, the proponent would rely on preclearance and pre-approval surveys to confirm the ecological assessment for a specific site, to provide a basis for site-specific management measures required to avoid or minimise impacts, and to define the actual impacts on MNES within the quantum of estimated impacts which would then be used to determine offset requirements.

The methodology of impact assessment for the initial estimate of maximum potential disturbance to terrestrial ecology was outlined in the EIS section 17 and Appendix P, and in SREIS section 11 and Appendix I including

- assignment of a level of confidence to habitat mapping for flora and fauna species, noting that this was based on an assumption that the mapping of regional ecosystems in the project area was correct
- desktop investigations and targeted field assessment
- qualitative assessment of impacts to define sensitivity of habitats, local flora populations and fauna populations
- qualitative sensitivity assessment and ranking
- impact magnitude ranking
- impact significance assessment and ranking, based on sensitivity and impact magnitude ratings.

The SREIS updated the methodology in response to recommendations made following completion of a third party review of the methodology for impact assessment of terrestrial impacts. The methodology for impact assessment for aquatic ecology followed a similar approach and this is outlined in SREIS Section 10 and Appendix H as well as EIS section 16 and Appendix O.

5.6.1 Threatened ecological community and threatened species habitat

The area of TECs and threatened species habitat within the project area was estimated based on existing regional ecosystem mapping published by the Queensland government, and on revised mapping for parts of the project area based on surveys conducted for the EIS. The accuracy of the estimates was limited by the uncertain accuracy of the regional ecosystem mapping used (except where determined by field survey), inclusion of more than one regional ecosystem in mapped polygons (which would require field survey to resolve), and by assumptions made in correlating TECs and species habitat with regional ecosystems.

5.7 Mitigation measures

Table 5.1 summarises the general measures proposed by the proponent to avoid or mitigate impacts to MNES. Note that numbers in brackets refer to commitments made in the EIS by the proponent (SREIS Appendix O).

Table 5.1 MNES Potential Impacts and Mitigation measures (source: SREIS Appendix J)

Potential Impacts	Mitigation measures
Clearing and fragmentation	<ul style="list-style-type: none"> • Avoid all disturbance within Homevale National Park (Category A ESA) (B142). • Where possible avoid disturbance within the following areas (B131): <ul style="list-style-type: none"> ○ Endangered EPBC Act TECs: Brigalow Ecological community (REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16); Natural Grasslands Ecological Community (RE 11.8.11); Semi-evergreen Vine Thicket Ecological Community (REs 11.5.15, 11.8.3 and 11.8.13); Weeping Myall Woodlands (REs 11.3.2 and 11.3.28); ○ Category B ESAs; ○ Category C ESAs including Arthur’s Bluff State Forest and gazetted nature refuges; ○ Stock routes and state or regionally significant bioregional wildlife corridors; ○ Essential habitat; ○ Core habitat for EVNT species; ○ State forests and resource reserves; and ○ State-listed ‘of concern’ REs. • Conduct pre-construction/pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum (B132): <ul style="list-style-type: none"> ○ Vegetation mapping at a scale suitable for site-specific planning; ○ Identification of core habitats for EVNT species; and

Potential Impacts	Mitigation measures
	<ul style="list-style-type: none"> ○ Identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers). • Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection (B134). • Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts (B135). • Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible (B133). • Deviate access tracks and pipelines around sensitive vegetation where practicable (B140). • Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values (B139). • Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible (B133).
<p>Degradation of terrestrial habitat</p>	<ul style="list-style-type: none"> • Deviate access track and pipelines around sensitive vegetation where practicable (B140). • Retain habitat trees as a priority (B137). • Implement noise control techniques in accordance with the noise and vibration commitments and standard noise suppression techniques (B146). • Design lighting in a manner that limits disruption on landscape character, views and visual amenity and direct lighting into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat (B099). • Use existing roads and designated access tracks, where practicable (B115). • Fell trees away from existing vegetation not identified for removal where practicable (B150). • Avoid damaging trees (e.g. through scraping of tree trunk or breaking of limbs by equipment) not identified by removal where practicable (B151). • Manage impacts to Category A, B and C ESAs through implementation of management buffers. The buffers outlined below are indicative based on current regulatory conditions, however these may be subject to change in future. Buffers that will be implemented for the Project will be in line with the regulatory requirements at the time of implementation. Indicative buffers at this time include disturbance exclusion zones (or management buffers) that will be established and managed during construction and operations to effectively protect ESAs as defined by the project's constraints mapping (outlined in Section 7 and detailed in Constraints Mapping (Appendix BB of the EIS) (B145). • Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates (B156) • Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery (B157). • Woody debris, logs and rocks should be retained for use in rehabilitation. Where practical, these should be piled along the edge of the cleared corridor. However, spreading these features over part or the whole corridor is preferred as it will provide refugia for crossing fauna, Systematic removal of surface debris should be avoided and cleared timber should never be burnt (B161). • Plant species used for rehabilitation are specific to the original ecosystem and local provenance, wherever possible unless the area has been cropped or contains improved pasture to be reinstated (B162). • Regular inspections of pipelines and road alignments will be undertaken to ensure that disturbed surfaces are stable and not subject to concentration of flows or erosion. Repair works will be undertaken proactively to prevent erosion from occurring and worsening (B298). • Suitable topsoil should be re-spread directly onto rehabilitation areas where practicable. Topsoil should be spread, ameliorated (if required), treated with fertiliser and seeded in one consecutive operation to reduce topsoil loss potential to wind and water erosion. Where possible, soil ameliorants will be applied prior to topsoil stripping to ensure adequate mixing (B059). • Implement best practise erosion and sediment control measures during decommissioning works in accordance with the requirements of the International Erosion Control Association (IECA) (2008) <i>Best Practise Erosion and Sediment Control</i> manual (B337). • Prevent subsurface water flows and erosion along the backfilled trench by appropriate means, such as trench blocks and compaction of backfilled soils (B074).
<p>Degradation of aquatic habitat</p>	<ul style="list-style-type: none"> • Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical (B136). • Avoid removing riparian vegetation when directional drilling and reduction of right of ways where practical (B138).
<p>Water resources</p>	<p>Where the tenure is not within a CMA, Arrow undertakes groundwater modelling to evaluate and</p>

Potential Impacts	Mitigation measures
	<p>predict groundwater drawdown as a result of CSG water extraction. The following hierarchy will guide application of groundwater modelling:</p> <ul style="list-style-type: none"> • Collect relevant geological and hydrogeological data from: <ul style="list-style-type: none"> - Existing and future production or exploration wells - Monitoring of Arrow, government and landholder bores - Collaborative sharing of information with other proponents and regulatory authorities. • Construct or update the geological model with relevant data on an ongoing basis, including: <ul style="list-style-type: none"> - Aquifer thicknesses and interfaces between formations - Aquifer properties, e.g. porosity, permeability - The location of sensitive areas, e.g. groundwater discharge springs - Observed responses in monitoring wells that reflect aquifer behaviour during CSG water extraction. • Employ the updated numerical groundwater model (if required) to: <ul style="list-style-type: none"> - Make ongoing predictions regarding changes to groundwater levels and groundwater quality as the project develops - Improve confidence in the understanding of the sensitivity and resilience of the aquifers within the identified groundwater systems - Evaluate water management strategy options by modelling the effectiveness of substitution and/or injection (where conducted) in offsetting impacts of depressurisation. • The complexity of groundwater modelling used to make predictions is consistent with the volume of water production from each tenement. For example, where: <ul style="list-style-type: none"> - Relatively little groundwater is extracted during exploration and appraisal activities, a relatively simple groundwater model is developed to assess the impacts of these activities - Groundwater is extracted during the production phase, the complexity of the groundwater model produced is increased to better predict the impacts of these activities. • Groundwater modelling incorporates historical, current and forecast non-CSG groundwater extraction within the tenure.
Weed and pest fauna invasion and spread	<ul style="list-style-type: none"> • Undertake weed monitoring and targeted weed control measures within sensitive habitat (particularly threatened communities such as brigalow and native grasslands) (B158).
Injury to fauna	<ul style="list-style-type: none"> • Avoid construction activities in waterbodies frequented by migratory species (B141). • Prohibit harassment of wildlife and the unauthorised collection of flora or fauna, unless directed by a suitably qualified and experienced person (B149).

In addition to the general measures listed above, the following species specific measures were proposed

- develop threatened species management procedures as and when project activities were identified as likely to impact on a species
- ensure chemicals or other mechanisms used to eradicate weeds would not have a significant adverse impact on Black Ironbox, *Dichanthium queenslandicum* and *Dichanthium setosum*
- where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor process of any translocation programs in accordance with the relevant translocation management plans.

A detailed assessment of project impacts on individual listed threatened species and communities is at Appendix 4 of this assessment report.

5.8 Estimates of disturbance area for TECs and threatened species habitat

Due to the nature of CSG development and the framework approach proposed by the proponent, the actual construction footprint for the life of the project has yet to be fully defined. Seven sample conceptual footprints were designed for the project and applied to the proposed drainage areas as the basis for calculation of the likely potential maximum disturbance area for the project. The conceptual footprints were used to estimate maximum potential impacts to TECs and to threatened species habitat categories of Core Habitat Known and Core Habitat Possible.

Core Habitat Known was defined generally as habitat in a one kilometre radius around known recent records (since 1980) or confirmed sightings, and may also include remnant or regrowth vegetation contiguous with areas where known sightings have occurred. For Core Habitat Known, the disturbance area comprised the total area of core habitat intersected by the conceptual field layout. Core Habitat Possible was defined as areas of potential habitat with a number of features or values known to contribute to, or be important for the occupation of the species.

It was expected that, given the methodology used, the disturbance limits calculated would represent the maximum potential disturbance and that the actual disturbance, should the project proceed, would be lower. In order to rationalise the potential habitat mapping with inherent inaccuracies contained within mapping data layers and scale, a matrix of likelihood of occurrence and quality of potential habitat mapping was produced and this was used to adjust the estimate of potential maximum impact area for each MNES. The potential habitat mapping confidence matrix assumed one of three levels of confidence

- low confidence for potential habitat mapping based on mapping layers for high value regrowth, remnant vegetation, areas under cultivation, and vegetation patch size
- medium confidence for potential habitat mapping based on remnant regional ecosystems mapping
- high confidence for potential habitat mapping that incorporated LIDAR refinements, watercourse mapping and/or ground truthing.

Appendix 2 of this assessment report includes further detail on the methodology used.

The proponent took a conservative approach with respect to calculating the potential estimated whole of project disturbance impacts. In particular, the proponent assumed impacts to all MNES within the conceptual footprint whereas

- infrastructure was proposed to be located in accordance with constraint mapping informed by information presented in the EIS documents and pre-clearance surveys
- linear infrastructure disturbance was calculated as individual corridors whereas the majority were proposed to be co-located
- a 25m wide construction right of way for all pipelines had been proposed whereas a smaller right of way may be possible
- the conceptual footprint used the maximum number of well pads for the life of the project whereas the number of pads was expected to be further rationalised.

5.8.1 Listed threatened ecological communities

Table TEC Estimates of Impact Area of this assessment report provides a summary of the known or potentially occurring threatened ecological communities within the project area, their estimated extent, and the estimated maximum disturbance area for the total project and for phase 1. The general advice in relation to the accuracy of mapping and estimates of disturbance area should be considered.

Table 5.2 TEC Estimates of Impact Area (source: Arrow Energy Pty Ltd EPBC 2012/6377 Response to request for information, 2014)

Ecological community	EPBC Act status	Area of community within project area (ha)	Rationalised estimated maximum disturbance for phase 1 (ha)	Rationalised estimated maximum disturbance for total project (ha)
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	endangered	57846.81	283.92	781.16
Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	endangered	29246.19	278.4	871.10
Semi – evergreen vine thickets of the Brigalow Belt and Nandewar Bioregions	endangered	5212.53	97.6	107.42
Weeping Myall Woodlands	endangered	29164.14	79.68	198.48

Specific advice on each TEC is included in Appendix 4 to this report.

5.8.2 Listed threatened flora species

Table Threatened Flora Species Estimates of Impact Area of this assessment report provides a summary of the known or potentially occurring threatened flora species, the estimated extent of their habitat within the project area, and the estimated maximum habitat disturbance area for the total project and for phase 1. The general advice in relation to the accuracy of mapping and estimates of impact should be considered.

Table 5.3 Listed Threatened Flora Species Estimates of Impact Area (source: Arrow Energy Pty Ltd EPBC 2012/6377 Response to request for information, 2014)

Common name	Scientific name	EPBC Act status	Estimated Extent of Habitat and Maximum Area of Potential Disturbance (ha)					
			Core Habitat Known (total project)		Core Habitat Possible (total project)		Rationalised Potential Disturbance Footprint	
			Extent	Impact	Extent	Impact	Phase 1	Total Impact
	<i>Aristida annua</i>	vulnerable	0	0	0			0
King blue-grass	<i>Dichanthium queenslandicum</i>	endangered	329.82	27.2	35886.6		429.36	1161.23
Blue-grass	<i>Dichanthium setosum</i>	vulnerable	19.41	0	52898.2		249.84	809.59
Black ironbox	<i>Eucalyptus raveretiana</i>	vulnerable	0	0	18749		21.33	258.32

Specific advice on each the following key species is included in Appendix 4 of this assessment report

- Black ironbox (*Eucalyptus raveretiana*)
- King blue grass (*Dichanthium queenslandicum*)
- Blue grass (*Dichanthium setosum*)
- *Aristida annua*.

Detailed species dossiers, including information on threats, impacts and mitigation and management measures for each flora species were presented in SREIS Appendix J Matters of National Environmental Significance Report (section 9.3).

EHP notes that the Australian government will require offsets for significant residual impacts on listed threatened flora species in accordance with the EPBC Act Environmental Offsets Policy.

5.8.3 Listed threatened fauna species

Table 5.4 Listed Threatened Fauna Species Estimates of Impact Area, of this assessment report provides a summary of the known or potentially occurring listed threatened fauna species, the estimated extent of their habitat within the project development area, and the estimated maximum habitat disturbance area for the total project. The general advice in relation to the accuracy of mapping and estimates of impact should be considered.

Table 5.4 Listed Threatened Fauna Species Estimates of Impact Area (source: Arrow Energy Pty Ltd EPBC 2012/6377 Response to request for information, 2014)

Common Name	Scientific Name	EPBC Act Status	Estimated Extent of Habitat and Maximum Area of Potential Disturbance (ha)					
			Core Habitat Known (total project)		Core Habitat Possible (total project)		Rationalised Potential Disturbance Footprint	
			Extent	Impact	Extent	Impact	Phase 1	Total Impact
Birds								
Australian painted snipe	<i>Rostratula australis</i>	endangered migratory	658.8	5.14	197.9		2.2	5.69
Red Goshawk	<i>Erythrothorichis</i>	vulnerable	0	0	27001.	187.14	49.4	187.14

Common Name	Scientific Name	EPBC Act Status	Estimated Extent of Habitat and Maximum Area of Potential Disturbance (ha)					
			Core Habitat Known (total project)		Core Habitat Possible (total project)		Rationalised Potential Disturbance Footprint	
			Extent	Impact	Extent	Impact	Phase 1	Total Impact
	<i>radiatus</i>				92			
Squatter pigeon (southern)	<i>Geophaps scripta scripta</i>	vulnerable	4324.7 2	74	10148 2.89		313.1	1415.22
Mammals								
South-eastern long-eared bat	<i>Nyctophilus corbeni</i>	vulnerable	0	0	295,64 8.22		618.12	2,282.57
Large-eared pied bat	<i>Chalinolobus dwyeri</i>	vulnerable	0	0	17645 9.61		723.67	1451.44
Northern quoll	<i>Dasyurus hallucatus</i>	endangered	0	0	58.93		0	1.54
Koala	<i>Phascolarctos cinereus</i>	vulnerable	3883.8 1	3.06	16285 7.47		376.59	2466.04
Reptiles								
Ornamental snake	<i>Denisonia maculata</i>	vulnerable	1988.3 7	2.9	59481. 71		296.2	1030.31
Fitzroy river turtle	<i>Rheodytes leukops</i>	vulnerable	0	0	535.2 9		0	0.87
Yakka skink	<i>Egernia rugosa</i>	vulnerable	0	0	0		0	0

Specific advice on each the following species is included in Appendix 4 of this report:

- Northern quoll (*Dasyurus hallucatus*)
- Ornamental snake (*Denisonia maculata*)
- Fitzroy river turtle (*Rheodytes leukops*)
- Squatter pigeon (*Geophaps scripta scripta*)
- Koala (*Phascolarctos cinereus*)
- South-eastern long-eared bat (*Nyctophilus corbeni*)
- Large-eared pied bat (*Chalinolobus dwyeri*)
- Australian painted snipe (*Rostratula australis*)
- Red goshawk (*Erythrorchis radiatus*)
- Yakka skink (*Egernia rugosa*).

Detailed species dossiers for each of these fauna species were presented in the SREIS Appendix J Matters of National Environmental Significance Report (section 9.2), including information on threats, impacts and mitigation and management measures.

EHP notes that the Australian government will require offsets for residual significant impacts on listed threatened fauna species in accordance with the EPBC Act Environmental Offsets Policy.

5.8.4 Migratory species

The following EPBC Act listed migratory species were identified as known or potentially occurring within the project area

• Latham's Snipe, Japanese Snipe (<i>Gallinago hardwickii</i>)	Terrestrial wetland
• Eastern Grey Egret (<i>Ardea modesta</i>)	Marine wetland
• Cattle Egret (<i>Ardea ibis</i>)	Marine wetland
• Rainbow Bea-eater (<i>Merops ornatus</i>)	Terrestrial
• Black-faced Monarch (<i>Monarcha melanopsis</i>)	Terrestrial
• Spectacled Monarch (<i>Symposiachrus trivirgatus</i>)	Terrestrial
• Satin Flycatcher (<i>Myiagra cyanoleuca</i>)	Terrestrial
• Rufous Fantail (<i>Rhipidura rufifrons</i>)	Terrestrial
• Fork-tailed Swift (<i>Apus pacificus</i>)	Marine
• White-tailed Needletail (<i>Hirundapus caudacutus</i>)	Terrestrial
• White-bellied Sea-eagle (<i>Haliaeetus leucogaster</i>)	Terrestrial

Three migratory species were recorded in or near the project area during field surveys

- Eastern great egret (*Ardea modesta* (syn. *Ardea alba*))
- Cattle egret (*Ardea ibis*)
- Rainbow bee-eater (*Merops ornatus*).

Four detailed migratory bird group dossiers (for migratory wetland birds, migratory woodland birds, migratory aerial birds and the white-bellied sea-eagle), including information on threats, impacts and mitigation and management measures for each migratory groups identified were presented in the SREIS Appendix J – Matters of National Environmental Significance Report (section 9.4).

5.8.5 Water resources

A comprehensive assessment of impacts on surface and groundwater from a State perspective is provided in section 4.9 and 4.10 of this assessment report. More detailed information on water is available in the EIS documents. EHP is of the view that there will not be an unacceptable impact on water resources should the project be implemented in accordance with the EIS recommendations, environmental authorities and EPBC approval conditions and non-conflicting proponent commitments (see SREIS Appendix O).

The EIS documents do not specifically address water resources as a matter of national environmental significance. Subsequent to the application of the 'water trigger' controlling provision, the SREIS addressed the potential impacts on water resources in SREIS section 13 and Appendix J. This summarised the findings of studies undertaken as part of the EIS and SREIS (SREIS sections 7, 8, 9 and 10 and Appendices E, F, G and H).

The project has the potential for a number of impacts to both groundwater and surface water resources. Key water-related impacts for the project are groundwater drawdown, interconnectivity of target aquifers with ground and surface water systems; management of saline coal seam gas (CSG) water, surface water quality, discharge water quality and quantity, and issues associated with hydraulic fracturing.

The assessment of impacts on water resources as a matter of national environmental significance is provided at Appendix 4 of this assessment report.

Independent Expert Scientific Committee (IESC) Advice on Coal Seam Gas and Large Coal Mine Development

The IESC advises governments on water-related impacts of coal seam gas and large coal mining proposals.

In May 2013, EHP received the IESC advice on the project EIS. The IESC's advice highlighted the potential for the project to have a number of direct and indirect water-related impacts. EHP's response to the IESC's advice is included in sections 4.9 and 4.10 of this assessment report. In accordance with section 131AB of the EPBC Act, the Minister sought the IESC's advice on water related impacts associated with the project at their meeting of 15-17 July 2014.

DOE received the IESC's advice to the Minister on 18 July 2014. In summary, the IESC raised concerns in relation to changes to groundwater flows associated with interaquifer connectivity; storage and management of co-produced CSG water; cumulative impacts on ground and surface water and potential impacts of hydraulic stimulation and chemical use on aquifer water quality. Further discussion on the IESC's advice is provided in the assessment of impacts to water resources in sections 4.9 and 4.10 and Appendix 4 of this assessment report.

Cumulative impacts

The EIS and SREIS provides a cumulative impact assessment targeted specifically at identifying relevant MNES values that were considered at risk of incurring cumulative impacts and the projects that pose the greatest risk to those values. The SREIS noted that the assessment assumes that mitigation measures would be implemented for other projects to address impacts.

The assessment indicated that a number of listed threatened species and communities had a high potential for cumulative impacts. The SREIS stated that impacts to listed threatened species and communities were best managed at the project scale. However, broader recommendations in respect to regional scale management were also made, including

- collaborative research into species ecology and the effectiveness of mitigation techniques;
- raising awareness of the potential for cumulative impacts and associated management responsibilities; and
- collaborative approach to more strategic approaches to offsetting impacts.

A review of the cumulative effects of coal seam gas development on groundwater formations was provided in the SREIS, including modelling of the cumulative impact of groundwater drawdown with reference to the operating coal mines in the area. The review concluded that groundwater drawdown was generally localised to the mine and surrounding area and limited in time to the period of operations of the mine.

5.9 Major issues raised

References to agencies and organisations in the following text are based on submissions made on the publicly released EIS. The proponent responded in the SREIS documents to each submission with explanatory material and information where required.

DOE requested further detail on when preclearance flora and fauna surveys would be undertaken, proposed methodology, and how these surveys would inform the location of infrastructure and therefore determine the measures needed to avoid, mitigate and offset impacts. The proponent referred to the management approach presented in SREIS section 11 Terrestrial Ecology and stated that field verification of vegetation communities and habitat features would be undertaken prior to construction through preclearance surveys to determine the level of survey effort required, appropriate to each species as outlined in species dossiers within SREIS Appendix I. The proponent noted that further surveys would be required when the actual location of infrastructure within these areas was determined.

DOE and EHP requested more detailed information for a number of listed threatened species and communities. The proponent provided updates to species profiles to further describe the extent of potential habitat within the project area and elaborate on potential impacts. The update was informed by individual species habitat mapping and was presented in the SREIS Appendix J Matters of National Environmental Significance Report. The species profiles include specific assessments in accordance with the criteria set out in the EPBC Act Significant Impact Guidelines.

DOE requested information on management of any impacts on the Fitzroy River turtle from proposed water discharges. The proponent stated that the Fitzroy River turtle species profile (SREIS Appendix J) presented a discussion of how the impact assessment and the proposed mitigation measures were consistent with the objectives and advice provided in threat abatement plans and recovery plans for the species. The proponent also stated that the Fitzroy River turtle Management procedure outlined in the profile would be implemented in line with the proponent's commitment to develop threatened species management procedures as and when project activities were identified as likely to impact upon individuals.

DOE noted the need to consider how any approval could ensure that the proponent's commitments in relation to acceptable impacts to MNES would be implemented and impacts to MNES would be avoided and minimised consistent with commitments stated the EIS. DOE noted the broad scale nature of the project and the inherent inaccuracies of available mapping, as well as the need for confirmation of occurrence and extent of MNES (TECs and threatened species) that would be required during pre-clearance surveys. The proponent confirmed the commitment to undertaking pre-clearance vegetation surveys.

DOE noted the proponent's commitments to develop rehabilitation plans for construction, operation and decommissioning activities and to monitoring programs to focus on sensitive ecological values (SREIS Appendix O). DOE advised that, where EPBC Act listed TEC's would be cleared or impacted indirectly, DOE would require evidence to confirm that the TECs could be re-established to their full suite of species (i.e. consistent with the definition of the TEC under EPBC Act) or would otherwise require an offset for the residual significant impact that provided an environmental gain, in accordance with the EPBC Act environmental offsets policy.

EHP and DOE requested that the biodiversity offset strategy more definitively estimate the impact areas and quantify the impacts to MNES and MSES for phase 1 (comprising drainage areas 1, 2, 4, 8, 12, 19, 20, 22, 28, 29, 30, 31, 36, 38,37, 38, 39, and 40) and for the entire project, with detailed quantification and assessment of phase one offset requirements including condition assessment (either habitat quality assessment or similar), and potential offset areas for all MNES and MSES. The proponent provided additional information to EHP subsequent to the SREIS which satisfactorily addressed the requirement. A summary of this information is provided in Appendix 2 of this assessment report.

DOE advised that the identification of actual disturbance limits for phase 1 would be required at the time of any approval, with a commitment to providing acceptable offsets for phase 1 impacts within an agreed timeframe. The proponent confirmed that this would be the case.

EHP noted a number of issues that should be addressed before any environmental authority for the project could be finalised including

- drilling footprint impact areas for the entire drilling footprint, regardless of rehabilitation of the area outside the operational footprint, should be quantified for offsets consideration
- the Australian painted snipe was likely to occur in the project area in association with wetlands such as farm dams and impacts to this species would need to be considered
- based on the location of the proposed 33 drainage areas and the flora survey sites shown in Figure 17.1 of the EIS (or Figure 5.1 in SREIS Appendix J Matters of National Environmental Significance Report) it appeared that there had been no flora surveys within a number of proposed Phase 1 drainage areas (19, 20, 38, 29, 28 and 30), Phase 2 drainage areas (25, 6, 11, 14 and 15) and Phase 3 drainage areas (16, 32 and 33). Drainage areas 19, 20 and 28 in particular have large areas mapped as brigalow, semi-evergreen vine thicket or natural grassland TEC. Drainage areas 19, 20 and 25 have large areas of threatened regional ecosystems
- based on the location of the proposed 33 drainage areas and fauna survey sites shown in Figure 17.2 (Fauna survey locations) of EIS Section 17 Terrestrial Ecology (or Figure 5.2 of SREIS Appendix J Matters of National Environmental Significance Report) it appeared that there had been no fauna survey work within a number of Phase 1 drainage areas (19, 20, 1, 2, 4, 38, 39, 40, 30 and 29), Phase 2 drainage areas (23, 25, 18, 6, 11, 15 and 14) and Phase 3 drainage areas (21, 16, 32 and 33)
- drainage areas 19 and 20 would partially overlap the proposed national park "Redcliffevale" and it was not clear if the proponent would avoid impacts to this property
- under the *Queensland Environmental Offsets Policy* (2014), threshold regional ecosystems 11.5.15 and 11.4.11 and near-threatened flora and fauna such as Black-chinned honeyeater, Square-tailed kite and Common death adder do not require State offsets
- an analysis of the overlap of the MNES offset requirements and the SSBV state requirements would be required. The offset requirements for some State matters would be satisfied by addressing the MNES offset requirements. For example, the EPBC Act listed brigalow threatened ecological community includes the threatened regional ecosystems 11.3.1, 11.4.8, 11.4.9, 11.5.16 and 11.9.1 which occur within the proposed drainage areas
- the cumulative effects of disturbance, fragmentation, rehabilitation, and weeds across all 33 drainage areas for each MNES.

The proponent provided further advice in the SREIS, and additional information to EHP, on the methodology used to estimate the extent of regional ecosystems and potential species habitat, including the way in which inherent inaccuracies in data and mapping were taken into account in estimating disturbance areas. A summary of the methodology used to estimate the conceptual footprint of the project for the purpose of estimating disturbance areas for MNES and SSBVs, and method used to rationalise potential habitat mapping is contained in Appendix 2 of this assessment report.

To address concerns raised by DOE and EHP about how terrestrial disturbance calculations were estimated, the proponent sought a third party review of their methodology. The review found the methodology to be a valid approach. A summary of this review can be found in Appendix 2. Additionally, the proponent provided a summary of the disturbance calculation methodology which is also presented in Appendix 2.

Isaac Regional Council requested information on how the unpredicted occurrence of TECs and threatened species would be addressed. The proponent advised that pre-construction and pre-clearance surveys would be undertaken to confirm vegetation communities present and re-iterated that impact management would be undertaken to avoid, mitigate, rehabilitate or offset impacts as per the hierarchy of mitigation measures outlined in the EIS.

Isaac Regional Council also requested information on how the potential impact from site discharges on the Isaac and Fitzroy river catchments and the Great Barrier Reef would be mitigated. The proponent stated that project impacts on the hydrology, morphology or functions of the river systems and marine areas downstream were not expected and referred to commitments in relation to mitigation of surface water impacts presented in SREIS section 8.

Fitzroy Basin Association requested further information on the cumulative impact on wildlife corridors and fragmentation of the habitat of threatened species and ecological communities. The proponent responded that habitat fragmentation was a potential direct impact within the project area through vegetation clearing and referred to updated information in the SREIS relating to cumulative impacts.

5.10 Conclusions and recommendations

DOE and EHP consider that, given the framework approach to the project discussed above, adequate survey effort was carried out by the proponent to determine the likely presence of EPBC Act listed communities and species. Pre-clearance surveys to be undertaken by the proponent for each phase of the project would refine the estimated impacts to listed threatened species and communities and allow for ongoing reconciliation with estimated maximum disturbance areas for each TEC and listed species. DOE and EHP also consider that water related impacts have been adequately considered, including additional investigations undertaken in response to advice from the IESC to further substantiate the assessment of project impacts.

DOE and EHP are of the view that the project, if implemented in accordance with both the recommendations for the environmental authority and the recommended EPBC approval conditions, and the proponent's commitments (SREIS Appendix O), will not result in unacceptable impacts on EPBC listed threatened species and communities, listed migratory species and water resources.

Refer to recommendations for conditions at Appendix 3 (for any environmental authority) and 4 (for any EPBC approval) respectively of this assessment report.

Recommendation – pre-clearance surveys

- Where disturbance to potential habitat for MNES species cannot be avoided, the proponent must undertake pre-clearance surveys targeted at MNES species that could be present based on the suitability of habitat. These surveys should be consistent with EPBC survey guidelines listed below or as approved by the administering authority:
 - Survey guidelines for Australia's threatened mammals. EPBC Act survey guidelines 6.5
 - Survey Guidelines for Australia's Threatened Birds. EPBC Act survey guidelines 6.2
 - Survey Guidelines for Australia's Threatened Bats. EPBC Act survey guidelines 6.1
 - Survey guidelines for Australia's threatened reptiles. EPBC Act survey guidelines 6.6
- The proponent should complete flora surveys of the currently unsurveyed drainage areas (see above) to ascertain the values and their condition. The proponent should complete fauna surveys in the currently unsurveyed drainage areas which have relatively intact remnant habitat and are likely to be areas with significant fauna habitat value, and likely to be impacted by the project footprint. The drainage areas 19, 20, 23, 25, 18, 1, 6 and 40 are very likely to contain significant biodiversity values.

Recommendation – proponent's commitments on MNES

Where the proponent's commitments outlined in Appendix O of the SREIS do not conflict with any subsequent approval conditions and any EIS recommendations of this assessment report, the proponent should implement the commitments as stated.

Recommendation – management of impacts to MNES

It is recommended that the proponent develop threatened species management procedures to be implemented for the life of the project to avoid impacts to listed threatened species, including during vegetation clearing.

Recommendation – pre-clearance surveys and offsets for unanticipated species

Should any EPBC Act listed species, not listed as known or possible to occur in the project area, be found in a pre-clearance survey, the proponent should propose measures for avoiding or mitigating any disturbance to the species and their habitat. In addition, where significant residual impact is considered likely to occur, an offset must be provided for the unanticipated impact in accordance with EPBC Act environmental offsets policy. Applicable species may include Red goshawk, Fitzroy river turtle and Yakka skink.

Recommendation – EPBC Offset requirements

The proponent should ensure that required offsets for impacts to threatened species and communities comply with the principles of the EPBC Act Environmental Offsets Policy (2012) to ensure the conservation and protection of MNES values.

Recommendation – water discharge, water discharge locations

Where discharge of CSG water to the environment is proposed, a discharge strategy should be developed that considers water quality and the flow requirements of water related assets. The discharge strategy should also mitigate potential impacts to the Fitzroy river turtle and Black ironbox in accordance with the relevant State approval.

Recommendation – surface water

The proponent should implement the EIS commitments as stated in SREIS Appendix O, including baseline surface water quality monitoring. The recommendations for conditions at Appendix 3 should be considered in developing the EPBC approval conditions to be applied.

Recommendation – groundwater

The proponent should implement a groundwater monitoring program to determine a baseline for ongoing impact assessment and management. The existing groundwater model should be reviewed to predict impacts and inform management responses. The recommendations for conditions at Appendix 3 should be considered in developing the conditions of approval under the EPBC Act.

Recommendation – hydraulic fracturing

The proponent should provide details of a chemical risk assessment and monitoring and control measures proposed. The recommendations for conditions at Appendix 3 should be considered in developing the conditions of approval under the EPBC Act.

Recommendation – conditions for any environmental authority

The recommendations for conditions at Appendix 3 of this assessment report should be considered in developing any environmental authorities for the project.

Recommendation – conditions for any EPBC approval

The recommendations for conditions at Appendix 3 and Appendix 4 of this assessment report should be considered in developing the conditions of approval under the EPBC Act.

Recommendation – State offsets

The proponent should develop an offset management plan that includes the staged quantification of impacts to MNES and MSES (that are not overlapped by MNES values) for the life of the project. The plan should address

- detailed staged quantification of all MNES and MSES impacts and offsets
- the stages for field assessments and reconciliation of predicted impacts with actual impacts.
- desktop assessment of offset availability by tenure with focus on the EHP's Galilee Basin Offset Strategy in order to ensure viable long-term landscape conservation outcomes
- co-located offsets for both MNES and State biodiversity assets on the same land parcel with preliminary desktop assessment of where these land parcels can be found
- desktop analysis to identify areas of overlap between Commonwealth and State offset requirements to clearly define offset requirements in a Biodiversity Offset Strategy and identify potential offset areas for all matters.

6 Environmental management plan

EIS Section 32 and Appendix Z presented an Environmental Management Plan intended to meet the requirements of section 6 of the TOR, and section 310D of the *Environment Protection Act 1994*. The SREIS did not revise the document as an EM Plan is no longer required for EA applications. EHP and advisory body submissions to the EIS identified improvements to the EM Plan and the proponent's commitments particularly in relation to:

- the location of infrastructure and particularly major infrastructure such as gas processing plants, water treatment plants, and quarries
- spatial analysis of impacts including cumulative impacts
- constraints mapping and application of constraints to avoid and mitigate impacts
- management of CSG water
- management of potential impacts to cropping land
- rehabilitation
- monitoring.

The proponent committed to provide information in accordance with the EHP Guideline Application requirements for petroleum activities to accompany the application for an environmental authority or amendment.

EHP noted that, while environmental management plans are no longer required under the amended EP Act (as also identified in the SREIS), the content and structure of the EIS Environmental Management Plan would be partly transferable into a document suitable for submission with an application for an environmental authority. EHP recommended that the proponent ensure that the information provided with the application meets the requirements of sections 125 and 126 of the EP Act.

The matters required for incorporation in the EM Plan (Schedule 1 EP Regulation) have been addressed in the EIS documents and as summarised in the relevant section of Section 4 of this assessment report.

Recommendation – EM Plan

Any EM Plan intended by the proponent for the environmental management of this project should be consistent with the findings and recommendations of this assessment report.

7 Report Certification

The EIS process is completed when this EIS assessment report is approved by the delegate for the chief executive and given to Arrow Energy Pty Ltd.

L Delzoppo

8 September 2014

Signature

Date

Lindsay Delzoppo
Director, Statewide Environmental Assessments
Environmental Performance and Coordination
Environmental Services and Regulation Division
Department of Environment and Heritage Protection
Delegate of the chief executive
Environmental Protection Act 1994

Enquiries:
Statewide Environmental Assessments
Ph: (07) 3330 5602
Fax: (07) 3330 5875

Appendix 1 Summary of changes to Queensland and Commonwealth Government departments

Former departments	New department(s) (as of 3 April 2012) ¹
Department of Employment, Economic Development and Innovation	Department of State Development, Infrastructure and Planning Queensland Treasury and Trade Department of Agriculture, Fisheries and Forestry Department of Water Supply
Department of Environment and Resource Management	Department of Environment and Heritage Protection Department of Natural Resources and Mines Department of Energy and Water Supply Department of Science, Information Technology, Innovation and the Arts Department of National Parks, Recreation, Sport and Racing
Department of Education and Training	Department of Education, Training and Employment
Department of Local Government and Planning	Department of Local Government, Community Recovery and Resilience)
Department of Communities	Department of Communities, Child Safety and Disability Services
Department of Public Works	Department of Housing and Public Works
No changes: Department of Transport and Main Roads Department of Community Safety Queensland Police Service Queensland Health	
New departments:	Department of Housing and Public Works Department of Aboriginal and Torres Strait Islander and Multicultural Affairs Tourism, Major Events, Small Business and the Commonwealth Games

¹Based on The Public Service Departmental Arrangements Notice (No.4) 2012, Queensland Government.

Appendix 2 Proponent information provided post SREIS

This appendix contains documents and summaries of documents submitted by the proponent in response to EHP information requests post submission of the SREIS. The materials were considered and used in its assessment of the project and include

1. Conceptual disturbance footprint estimation method (submitted 4 July 2014)
2. Boobook peer review of Bowen Gas Project habitat mapping (submitted 4 July 2014)
3. Bowen Gas Project Offsets Management Plan (submitted 18 July 2014)

1 Conceptual Disturbance Footprint Estimation Method

The following information provided by the proponent describes how the conceptual footprint of the project was estimated. This information relies on information from the SREIS including the use of LiDAR, habitat mapping and habitat mapping rules that can be found in the following sections - Environmental Offsets Strategic Management Plan, Terrestrial Ecology Technical Report and Matters of National Environmental Significance Report.

Arrow have based the estimated maximum disturbance footprint for the life of Project on a conceptual layout built from seven representative Drainage Areas. There are 33 drainage areas proposed for the entire project. Given the nature and timeframes associated with CSG development, the specific construction footprint for many of the drainage areas within the Project Area is still to be determined. The disturbance limits calculated are a conservative maximum disturbance estimate and it is expected that the likely actual disturbance during the Project will be lower than those impacts estimated. The methodology used for determining the entire Project disturbance is outlined.

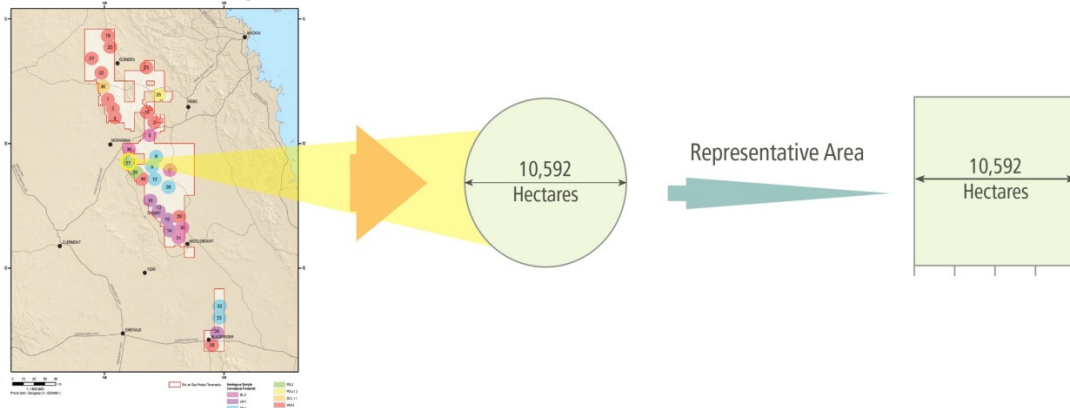
Methodology

The disturbance calculation methodology involves

Step 1) The full project area conceptual development footprint was developed from seven representative drainage areas based on known available gas resource, and the subsequent infrastructure intensity designed to harvest this gas. The seven representative conceptual footprints are based on a broad range of field variables and requirements of the Project Area. All infrastructure is included in the conceptual development footprint.

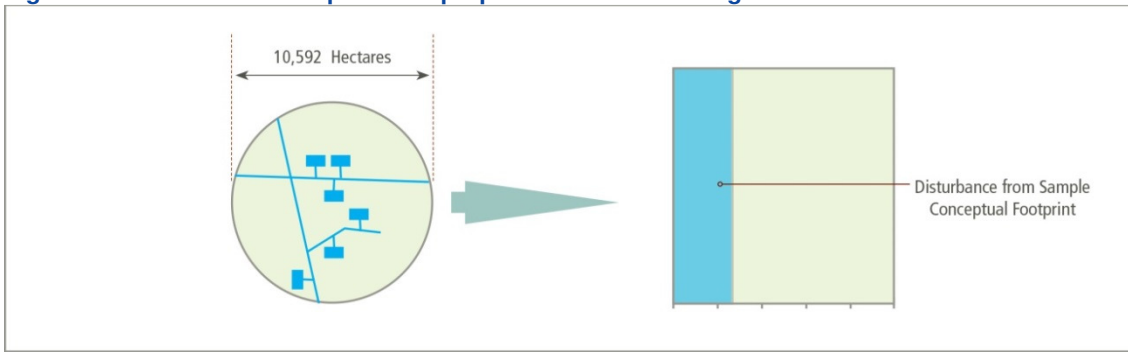
Step 2) The surface area of each of the 33 drainage areas for the SREIS Project Description was calculated as shown by the example in Figure 1-1. Each drainage area has a nominal radius of 6km.

Figure 1-1 Surface area of a drainage circle



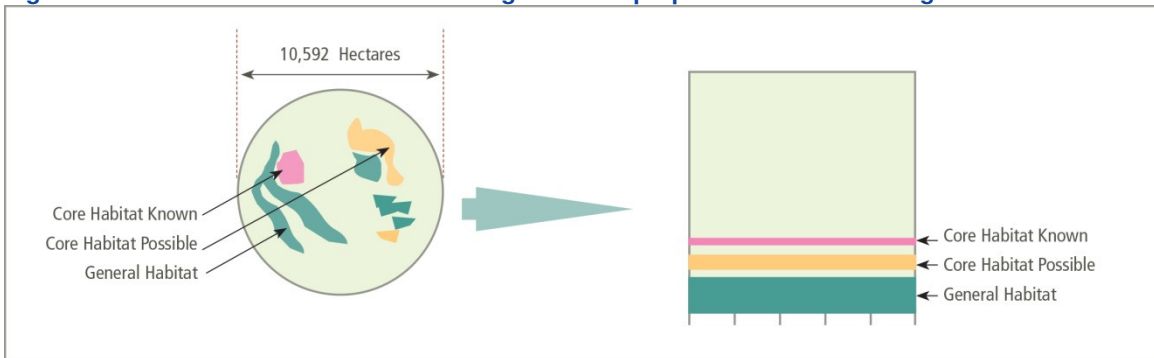
Step 3) Each of the seven representative development footprint areas were then calculated as a proportion of each drainage area's surface area as shown in the example in Figure 1-2. The seven representative footprints were then applied individually to best reflect the expected infrastructure intensity across each of the remaining drainage areas. An optimal layout to maximise coal seam gas drainage would normally, at this stage of a CSG project, use a grid style layout of wells. However Arrow's progressive approach is based on a layout of seven drainage areas representing infrastructure at different densities which are then extrapolated to match drainage areas of corresponding density.

Figure 1-2 Construction footprint as a proportion of total drainage circle surface area.



Step 4) The surface area of each habitat category (core habitat known, core habitat possible and general habitat) was calculated within each of the 33 drainage areas for all relevant environmental value's, and calculated as a proportion of the each drainage area's surface area, as shown in the example in Figure 1-3.

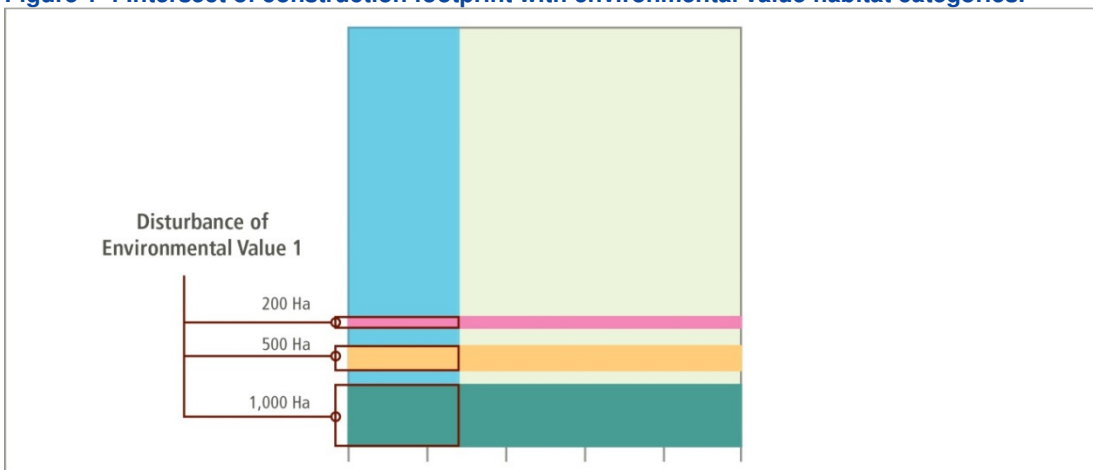
Figure 1-3 Environmental value habitat categories as a proportion of total drainage circle surface area.



Step 5) The disturbance footprint is then applied to all environmental values, even though they may not be intersected, which ensures that all environmental values are assigned an estimated maximum potential disturbance limit.

As shown in the example in Figure 1-4, the extent of intersect of the development footprint surface area and the extent of intersect of the environmental value surface area (i.e. the percentage of the footprint surface area as a percentage of impact to the environmental value surface area) establishes an estimated maximum potential disturbance for each environmental value.

Figure 1-4 Intersect of construction footprint with environmental value habitat categories.



Step 6) The process was repeated for each environmental value, MNES (listed species & TECs) and SSBV's (Listed species, REs of conservation significance etc), within the project area, across all 33 Project Drainage areas.

Step 7) The estimated potential impact caused by linear infrastructure connecting drainage areas (e.g. power lines, trunk lines), was also calculated by adding direct intersects of the proposed development footprint on each environmental value.

Step 8) The total potential maximum disturbance footprint for the entire project area was then calculated as a sum of the potential disturbance footprint from each drainage area together with the connecting linear infrastructure.

Rationalisation of potential habitat mapping impact areas

While the quality and reliability of potential habitat mapping has been improved through the application of LiDAR, and refinement of mapping rules through the use of additional data and information, the mapping produced is still an indication of *potential* habitat and does not necessarily mean that a particular species will inhabit an area indicated by the mapping.

In order to rationalise the potential habitat mapping with inherent inaccuracies contained within mapping data layers and scale, a matrix of likelihood of occurrence and quality of potential habitat mapping has been produced.

The matrix for potential habitat area rationalisation is outlined below in Table 2-1 and 2-2. The assessment criteria for potential habitat mapping confidence is as follows:

High Confidence: Potential habitat rules include incorporation of LiDAR refinements, watercourse mapping and/or ground truthing.

Medium confidence: Potential habitat rules are predominantly based on remnant RE mapping that hasn't been ground truthed.

Low confidence: Based on mapping layers other than those listed above, such as high value regrowth, remnant vegetation (not accounting for REs), areas under cultivation and vegetation patch size. (NB: This level of confidence only applied to one species).

Likelihood of occurrence assessment for all species has been established in either the MNES or terrestrial ecology reports of the SREIS. Where a species appears in both reports, the MNES status is used. Areas less than ten hectares were not reduced.

Species that rated a 'likelihood of Moderate / Possible' or above were the subject of species profiles and habitat mapping in the MNES report. Species of a 'low' or 'highly unlikely' rating of occurrence were not subject to habitat mapping and so these categories of likelihood are considered in the rationalisation of mapping extents below.

Table 2-1 Percentage rationalisation matrix for MNES species

Potential Habitat Mapping Confidence	High	Medium	Low
Recorded occurrence	90%	80%	70%
High likelihood of occurrence	85%	60%	35%
Moderate likelihood of occurrence	75%	40%	10%

Table 2-2 Percentage rationalisation matrix for NC Act species

Potential Habitat Mapping Confidence	High	Medium	Low
Known likelihood	80%	65%	40%
Likely likelihood	70%	50%	30%
Possible likelihood	60%	30%	10%

Table 2-3 Percentage rationalisation of MNES and SSBV potential ‘Core Habitat Possible’ areas

Species/community	Likelihood of occurrence	Mapping confidence	Percentage rationalisation	Estimated disturbance (ha)
TEC				
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) (includes remnant and HVR vegetation)	Recorded	Medium	80%	781
Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	Recorded	Medium	80%	871
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Recorded	Medium	80%	107
Weeping Myall Woodlands	Moderate	Medium	60%	198
MNES Flora Species				
<i>Aristida annua</i>	Moderate	Medium	60%	0

Species/community	Likelihood of occurrence	Mapping confidence	Percentage rationalisation	Estimated disturbance (ha)
<i>Dichanthium queenslandicum</i>	Recorded	Medium	80%	1,134
<i>Dichanthium setosum</i>	High	Medium	60%	810
<i>Eucalyptus raveretiana</i>	Recorded	High	90%	258
MNES Fauna				
<i>Geophaps scripta scripta</i>	Recorded	Medium	80%	881
<i>Rostratula australis</i>	Moderate	High	75%	5
<i>Dasyurus hallucatus</i>	Moderate	Medium	40%	2,433*
<i>Phascolarctos cinereus</i>	High	High	85%	116
<i>Nyctophilus corbeni</i>	Moderate	Medium	40%	2,268
<i>Chalindlobus dwyeri</i>	Moderate	High	75%	2
<i>Denisonia maculata</i>	Recorded	High	90%	1,193
<i>Rheodytes leukops</i>	Low*	High	90%	1
<i>Erythrorhynchus radiatus</i>	Moderate	Medium	40%	187
<i>Egernia rugosa</i>	Moderate	Medium	40%	0
NC Act Fauna				
<i>Acanthopis antarcticus</i>	Known	Low	40%	2,274
<i>Accipiter novaehollandiae</i>	Possible	Medium	30%	267
<i>Calyptorhynchus lathamii</i>	Possible	Medium	30%	191
<i>Chalindlobus picatus</i>	Known	Medium	65%	3,954
<i>Ephippiorhynchus asiaticus</i>	Known	High	80%	5
<i>Jalmenus subulbus</i>	Possible	Medium	30%	191
<i>Lophoictinia isura</i>	Possible	Medium	30%	157
<i>Melithreptus gularis</i>	Known	Medium	65%	1585
<i>Nettapus</i>	Known	High	80%	5

Species/community	Likelihood of occurrence	Mapping confidence	Percentage rationalisation	Estimated disturbance (ha)
<i>coromandelianus</i>				
<i>Paradelma orientalis</i>	Known	Medium	65%	648
NC Act Flora				
<i>Bertya pedicellata</i>	Known	Medium	65%	156
<i>Capparis humistrata</i>	Likely	Medium	50%	2
<i>Cerbera dumicola</i>	Known	Medium	65%	9
<i>Croton magneticus</i>	Possible	Medium	30%	5
<i>Cyperus clarus</i>	Possible	Medium	30%	546
<i>Desmodium macrocarpum</i>	Known	Medium	65%	940
<i>Digitaria porrecta</i>	Known	Medium	65%	1,208
<i>Euphorbia sarcostemmaoides</i>	Known	Medium	65%	363
<i>Graptophyllum ilicifolium</i>	Unlikely**	Medium	30%	102
<i>Macropteranthes leiocaulis</i>	Known	Medium	65%	4
<i>Paspalidium scabrifolium</i>	Known	Medium	65%	153
<i>Peripleura scabra</i>	Likely	Medium	50%	0
<i>Solanum adenophorum</i>	Possible	Medium	30%	224
<i>Solanum elachophyllum</i>	Known	Medium	65%	618
<i>Trioncinia retroflexa</i>	Possible	Medium	30%	271

* Although listed as low likelihood of occurrence, species have been previously recorded upstream from the project area and has been included in the project MNES species assessment. The occurrence applied in the matrix was "recorded".

** Included as a result of submission responses to the EIS. The occurrence applied in the matrix was "possible".

Mapping rules only delineate general habitat, therefore general habitat has been shown here.

Conservative Approach for Impact

A conservative approach has been taken towards calculating the potential estimated disturbance for the project. The conservative nature of the disturbance estimates is demonstrated by the following factors that have been incorporated into the estimated disturbance calculations:

- The disturbance calculation methodology applies a disturbance footprint across all environmental values, even though they may not be intersected, which ensures that all environmental values are assigned an estimated maximum potential disturbance limit.
- A disturbance calculation approach that assumes impacts to all environmental values (excluding identified no-go areas such as wetlands, and associated buffers), however it is expected that Arrow will avoid environmental values where possible. Initially infrastructure is located for optimal field design based on the resource, however

once detailed design is undertaken, infrastructure will be positioned in accordance with constraints mapping, pre-clearance surveys and ground truthing.

- Linear infrastructure such as power lines, tracks, and gathering pipelines have been calculated as individual disturbance corridors adjacent each other when it is expected, where possible and in most cases, they will be co-located where possible and will also utilise existing disturbed areas where possible.
- A 25 m wide construction right of way for all pipelines has been assumed, when it has been identified that a smaller right of way is expected to be possible in places due to innovative construction techniques, such as ploughing-in gathering lines.
- The maximum disturbance footprint for each element of infrastructure has been incorporated, when it will be possible in some circumstances to reduce the disturbance footprint.
- The representative conceptual footprint uses the maximum number of wells and well pads for the life of the project, when this number is expected to be further rationalised.
- The mapping rules used to determine the potential habitat for environmental values are conservative in defining potential habitat areas. The rules are generally broad in scope and identify large areas of potential habitat in three categories (core habitat known, core habitat possible and general habitat). While these areas may contain habitat features, it is highly unlikely that all areas mapped will be suitable as habitat for the species.
- The potential habitat mapping rules do not exclude heterogeneous polygons or attempt to separate the unlisted REs contained within heterogeneous polygons out of the potential habitat mapping.
- Implementing the precautionary principle by including potential habitat features when determining habitat areas.
- Ground truthing of regional ecosystems and habitat areas prior to commencement of construction. After a site has been ground truthed and a listed environmental value is found, the value will be avoided if possible.

2 Boobook peer review of Bowen Gas Project habitat mapping

A third party technical review of the methodologies and subsequent results as outlined for the terrestrial ecology components of the SREIS was commissioned by the proponent and undertaken by consultants 'Boobook'. The review findings are in Review of Arrow Bowen Gas Project SREIS Habitat mapping. Boobook was requested by the proponent to undertake a review of the habitat mapping methodology, habitat mapping rules, habitat maps, disturbance calculation methodology and their disturbance calculations.

Habitat mapping methodology

The review found that the habitat mapping methodology used a well-defined and straightforward process. This methodology incorporated the application of habitat mapping rules (based on the attributes of known species) with EIS information (including some field survey), LiDAR and state mapping datasets. The review found the methodology to be robust, adequate and acceptable. The methodology acknowledged the inherent inaccuracies of the state regional ecosystem and wetland mapping datasets, and attempted to correct for these using field data and LiDAR application. The review determined that the methodology was appropriate for the quantification of broadscale impacts to Matters of National Environmental Significance (MNES) and State Significant Biodiversity Values (SSBV). The review found that the habitat maps would identify potential habitat and could be used to prioritise survey effort. The review concluded that for the actual disturbance areas, detailed pre-disturbance on-ground assessments would be required to quantify the presence of MNES and SSBVs.

The review identified that the habitat mapping methodology had not addressed wetland bird habitat associated with ephemeral and livestock waters well. The review also acknowledged that some species distribution were poorly known, with limited knowledge due to a lack of survey effort in the northern Brigalow Belt bioregion, cryptic species, and the age and imprecision of existing records.

Habitat mapping rules

The habitat mapping rules were found to be generally comprehensive demonstrating the analysis of the habitat requirements from multiple datasets and record types. The review observed that the mapping rules would likely lead to an over-estimation of available habitat when defining potential habitat areas as not all potential habitat will

contain the microhabitat features that influence whether a threatened species is present at a particular location. The review determined that ground-truthing will be required to establish whether critical microhabitat features are present in order to ensure that potential impacts to threatened fauna and flora are avoided or minimised.

Additionally, the review recommended that habitat mapping rules would be enhanced by the incorporation of a list of references, because the habitat mapping rules that apply to MNES species were broadly linked to habitat descriptions on the DOE SPRAT database which do not often contain recent advances in knowledge of some species distribution and habitat preferences.

The review provided specific comments on habitat associations listed within the habitat mapping rules in relation to specific species, namely – large-eared pied bat, northern quoll, ornamental snake, squatter pigeon (southern), south-eastern long-eared bat, koala, Australian painted snipe, pale imperial hairstreak, black-chinned honeyeater, cotton pygmy-goose, brigalow scaly-foot, *Cyperus clarus*, *Solanum elaeagnifolium*, and Weeping myall TEC. The review also recommended the inclusion of several MNES and SSBV species based on very low likelihood of occurrence within the project area, namely: glossy black-cockatoo, square-tailed kite, grey goshawk, red goshawk and yakka skink.

Habitat maps

The review of the habitat maps determined the maps to be well presented and that the scale of 1:1,500,000 avoided the problem of data interpretation at smaller scales. The review re-iterated the paucity of information available for some species, the need for field inspection to establish the presence or absence of microhabitat features and the need for further field survey to target poorly-known threatened species.

Disturbance calculation methodology and disturbance calculations

The disturbance calculations methodology and the resultant disturbance calculations were found valid. The assumptions of the methodology which uses the estimated maximum impact footprint for all infrastructure, taking into account impacts to all environmental values (excluding no-go areas) and including separate calculations of linear infrastructure is a valid approach to quantify disturbances where the potential footprint can change.

Update and review process for habitat mapping

The review also noted that no procedure was identified in the methodology to improve analyses through updated rules and mapping as new information becomes available. The review states that one of the purposes of the habitat mapping is to predict future environmental risk and therefore protocol for revisions, updating habitat mapping datasets and a review process needs to be in place to address changing knowledge and operational circumstances.

3 Offsets Management Plan

Summary of Bowen Gas Project – Offsets Management Plan Rev 0

An Offsets Management plan was provided to EHP on the 18th July 2014. This offsets management plan was produced as a standalone document to progress the assessment of environmental offset requirements for the project and is additional to Bowen Gas Project Environmental Offsets Strategic Management plan provided as Appendix P of the SREIS. This plan was produced to address the offset requirements under the EPBC Act 1999 environmental offsets policy and the Queensland environmental offsets policy.

The scope of the plan covers the life of project offset requirements, offset delivery options, the proposed staged offset approach including the presentation of the offset requirements for stage one of the project, the results of a desktop analysis of the relationship and potential for co-location between MNES and MSES for stage 1, the proposed monitoring and reporting on offset delivery and future steps necessary for the securement of offsets.

The plan presents the life of project impacts for Matters of National Environmental Significance (MNES) and the Matters of State Environmental Significance (MSES). In the SREIS, the proponent presented the results of further work to identify and refine potential habitat areas of MNES species, threatened ecological communities, and MSES

across the project area (using LiDAR). Additionally in the SREIS, Arrow also refined the field development plan and conceptual design for the project. As a result of ongoing exploration, Arrow’s understanding of the gas resource has improved and consequently Arrow’s planning and project development has evolved. Therefore, together both the updated habitat mapping and field development plan were used to revise the environmental impact assessment and identify the potential residual impacts to MNES and MSES.

Four habitat classifications are used to identify disturbance to threatened species, namely; ‘core habitat known’, ‘core habitat possible’, ‘general habitat’ and ‘absence suspected’. For the purposes of estimating the residual impacts to MNES and MSES species 100% of ‘core habitat known’ and a rationalised percentage to ‘core habitat possible’ was applied. The rationalised percentage is based on the data used to identify the potential habitat area and the expected level of accuracy of the data used (see Appendix 2 b of this assessment report - Table 4-5 Percentage rationalisation of MNES and SSBV potential ‘Core Habitat Possible’ areas).

The proponent described their ‘living’ constraints mapping as an integral part of their Environmental Framework that guides site and route selection with the aim to avoid and minimise environmental impacts.

Estimates of life of project and stage one impacts are based on refined habitat mapping and the latest conceptual field layout. Arrow presents a table that identified all the MSES values that will be offset under the EPBC Act. The estimated MSES offset requirements for stage one and the life of the project that would be outstanding to those addressed by EPBC offset requirements are presented in Table 1 below. Eight threatened flora under the NCA are potentially located within the project area (based on known records and the presence of suitable habitat). The proponent proposed that these eight species are identified during pre-clearance surveys. It is proposed that where the species cannot be practically avoided, offsets would be proposed and EHP notified prior to impact.

Table 1 – MSES values that are not addressed by EPBC offset requirements

MSES	Status (VMA/NCA)	Stage 1 estimated disturbance (ha)	Maximum Area of estimated disturbance (ha)
RE 11.5.17	Endangered	0	0.57 [#]
RE 11.8.15	Endangered	1.8	18.29
RE 11.3.2*	Of Concern	124.1	289.02
RE 11.3.3	Of Concern	2.9	27.66
RE 11.3.4	Of Concern	3.7	107.03
RE 11.3.36	Of Concern	0	0.01 [#]
RE 11.4.2	Of Concern	4.1	82.84
RE 11.5.18	Of Concern	0	6.62
RE 11.7.1 ^o	Of Concern	0	2.53 [#]
RE 11.8.14	Of Concern	0	0.66 [#]
RE 11.9.7	Of Concern	0.3	285.55
RE 11.9.10	Of Concern	11.5	35.18
RE 11.9.13	Of Concern	8.8	36.21
RE 11.10.8	Of Concern	0	10.45
Watercourses	Stream order 1	24.7	316.92
	Stream order 2	11.2	138.5
	Stream order 3	20.5	178.53
	Stream order 4	4.6	66.89
	Stream order 5 and greater	7.2	145.83
Brigalow scaly-foot	Vulnerable	207.22	648.91
Pale imperial hairstreak	Vulnerable	75.84	191.06
<i>Capparis humistrata</i>	Endangered	Proponent is not proposing to offset these flora species as they have not been confirmed in the field. If confirmed present and Arrow cannot	2.31
<i>Croton magneticus</i>	Vulnerable		4.67
<i>Cyperus clarus</i>	Vulnerable		546.12
<i>Euphorbia sarcostemmoides</i>	Vulnerable		363.6
<i>Graptophyllum ilicifolium</i>	Vulnerable		101.87
<i>Solanum adenophorum</i>	Endangered		224.27

<i>Solanum elachophyllum</i>	Endangered	avoid species, offsets will then be proposed.	618.17
<i>Trioncinia retroflexa</i>	Endangered		271.04
Connectivity	To be determined		

*this ecosystem has EPBC listed Weeping Myall woodland TEC within it.

these impacts are not significant and therefore do not require offsets

Currently, Arrow is proposing to deliver Stage 1 offset requirements as land-based offsets with the co-location of as many MNES and MSES values as possible on strategically located properties. Co-location will reduce duplication and achieve maximum conservation benefits and efficiencies in processes. However, Arrow would like to retain flexibility of options for delivery of offset requirements for future stages of the project.

To determine the size of the offsets needed under the EPBC Act offsets policy, the proponent is required to use the 'Offsets Assessment Guide' and supporting calculator, which involves an assessment of the impact to threatened species and communities and offset areas required to deliver an overall conservation outcome. This information was not presented in this offset management plan.

Arrow is proposing to stage the delivery of both EPBC and State environmental offsets requirements over the life of the project. Staging provides an inherent incentive to Arrow to reduce its residual impacts in line with progressive design and development. Additionally, staging will result in more accurate impact estimates being used to assess future stage offset requirements as more detailed design and ecological studies are progressively undertaken.

The offset stages are proposed to align with key development phases and infrastructure, including gas drainage areas and compression facilities. Stage 1 is expected to be from year one to year five of construction and with Stage 1 offset requirements presented in the Offsets management plan. Stage one offsets are proposed to be finalised within 12 months of project commencement.

Arrow has developed principles and steps for the implementation of a staged offset approach, with the offset delivery plan to be approved by DOE and EHP prior to the commencement of activities for the defined stage. The results of pre-clearance surveys will be collated and form the basis of regular reconciliation and recording against the stage estimate and life of project disturbance limit. If actual residual impacts are less than the estimated, Arrow will apply for a 'credit' from estimates in future offset stage. Where additional MNES and MSES values are identified to those already estimated for a particular stage, and it is determined a 'significant residual impact' cannot be avoided, Arrow will prepare and submit an 'issue-specific offset proposal' to DOE prior to the impact occurring. Arrow proposed that the offset proposal be approved to allow the project works to continue in a timely manner and the offset requirement be delivered in the next offset stage.

Arrow justifies a stage approach as allowing minimal time-lag from impacts occurring to offset delivery with offset sites identified and approved prior to impacts occurring. The staged approach allows Arrow the opportunity to identify and secure larger strategic offset sites that may acquit a larger proportion of the project's total offset requirements. Arrow states that it is likely that the first two offset stages will provide a substantial proportion of the overall projects offset requirements due to a larger construction footprint including CGPF's occurring in the first two stages.

The offset management plan presents a section that identifies an analysis of the remaining MSES values and how they could be co-located with MNES values with the intent of identifying offset properties and vegetation that can maximise co-location of MNES and MSES to reduce the total offset area needed and total number of offset sites. Where co-located offsets are deemed impracticable, or where there are gaps of MSES post-ground-truthing, Arrow will consider alternative delivery options for the remaining State offset requirements, such as the financial settlement option.

The plan presents an analysis of offset availability for stage one MNES and MSES offset requirements undertaken within 150km of the project development area in the Brigalow Belt bioregion. To model the potential distribution of an offset value and evaluate the availability of suitable site, the following spatial datasets were used:- foliage projective cover, pre-clearing regional ecosystem mapping, remnant regional ecosystem mapping, mining tenure

and the digital cadastral database. This analysis demonstrated abundant availability of all MNES and MSES values.

During each stage, Arrow will undertake regular monitoring and reporting activities to reconcile what is actually disturbed on the ground versus what was predicted during the EIS process.

Post approval under the EPBC Act, and issue of an EA for the project, Arrow is proposing to identify preferred offset areas for Stage one, prioritising for co-location of values and location within strategic offset investment corridors. Arrow will then engage with landholders to carry out field surveys, quantify the offset areas required for MNES and MSES with the use of EPBC guide and calculator, guide to determining habitat quality for MSES, and then prepare an Offset Delivery (Management) Plan for stage one for approval to DOE and EHP at least three months prior to activity commencing.

Appendix 3 Recommended conditions for an environmental authority

(to be finalised by EHP through the application process)

Note: At the time of writing, current environmental authorities are in place for Authorities to Prospect (ATP) 742, 749, 759, 1025, 1031 and 1103. The recommended conditions provided below reflect only what was proposed for the Bowen Gas Project as presented in the Environmental Impact Statement and Supplementary Report to the Environmental Impact Statement for this project. The recommended conditions below do not include the activities that are already authorised within these tenements.

Conditions for an Environmental Authority, Environmental Protection Act 1994

Streamlined Conditions—General Environmental Protection

Authorised activities⁵

Note: Conditions (General 1.) to (General 3.) regarding the scope and relevant thresholds of activities authorised under the environmental authority will be determined during the application and assessment of the subsequent environmental authority application(s).

Monitoring standards

General 4. **(PESCD⁶ 1.)**

All monitoring must be undertaken by a suitably qualified person.

General 5.

If requested by the administering authority in relation to investigating a complaint, monitoring must be commenced within 10 business days.

General 6.

All laboratory analyses and tests must be undertaken by a laboratory that has NATA accreditation for such analyses and tests.

General 7.

Notwithstanding condition (General 6), if there are no NATA accredited laboratories for a specific analyte or substance, then duplicate samples must be sent to at least two separate laboratories for independent testing or evaluation.

General 8.

Monitoring and sampling must be carried out in accordance with the requirements of the following documents (as relevant to the sampling being undertaken), as amended from time to time:

⁵ Advice statements for the environmental authority:

- a) It is an offence under section 426 of the *Environmental Protection Act 1994* for a person to carry out an environmentally relevant activity unless the person holds, or is acting under, an environmental authority for the activity.
- b) The environmental authority does not authorise a relevant act to occur in carrying out an authorised relevant activity unless a condition of this environmental authority expressly authorises the relevant act to occur.
- c) The environmental authority does not authorise environmental harm unless a condition contained within the authority explicitly authorises that harm. Where there is no condition, the absence of a condition shall not be construed as authorising harm.

⁶ Conditions that include 'SC' are an existing approved and published standard condition.

- (a) for waters and aquatic environments, the Queensland Government's *Monitoring and Sampling Manual 2009 – Environmental Protection (Water) Policy 2009*
- (b) for groundwater, *Groundwater Sampling and Analysis – A Field Guide* (2009:27 GeoCat #6890.1)
- (c) for noise, the *Environmental Protection Regulation 2008*
- (d) for air, the *Queensland Air Quality Sampling Manual* and/or Australian Standard 4323.1:1995 *Stationary source emissions method 1: Selection of sampling positions*, as appropriate for the relevant measurement
- (e) for soil, the *Guidelines for Surveying Soil and Land Resources, 2nd edition* (McKenzie *et al.* 2008), and/or the *Australian Soil and Land Survey Handbook, 3rd edition* (National Committee on Soil and Terrain, 2009)
- (f) for dust, Australian Standard AS3580.

Notification

General 9.

In addition to the requirements under Chapter 7, Part 1, Division 2 of the *Environmental Protection Act 1994*, the administering authority must be notified through the Pollution Hotline and in writing, as soon as possible, but within 48 hours of becoming aware of any of the following events:

- (a) any unauthorised significant disturbance to land
- (b) potential or actual loss of structural or hydraulic integrity of a dam
- (c) when the level of the contents of any regulated dam reaches the mandatory reporting level
- (d) when a regulated dam will not have available storage to meet the design storage allowance on 1 November of any year
- (e) potential or actual loss of well integrity
- (f) when the seepage trigger action response procedure required under condition (Water 14(g)) is or should be implemented
- (g) unauthorised releases of any volume of prescribed contaminants to waters
- (h) unauthorised releases of volumes of contaminants, in any mixture, to land greater than:
 - i. 200 L of hydrocarbons; or
 - ii. 200 L of stimulation additives; or
 - iii. 500 L of stimulation fluids; or
 - iv. 1 000 L of brine; or
 - v. 5 000 L of untreated coal seam gas water; or
 - vi. 5 000 L of raw sewage; or
 - vii. 10 000 L of treated sewage effluent.
- (i) the use of restricted stimulation fluids
- (j) groundwater monitoring results from a landholder's active groundwater bore monitored under the stimulation impact monitoring program which is a 10% or greater increase from a previous baseline value for that bore and which renders the water unfit for its intended use
- (k) monitoring results where two out of any five consecutive samples do not comply with the relevant limits in the environmental authority.

Financial assurance

General 10.

(PESCB 1.)

Petroleum activities that cause significant disturbance to land must not be carried out until financial assurance has been given to the administering authority as security for compliance with the environmental authority and any costs or expenses, or likely costs or expenses, mentioned in section 298 of the *Environmental Protection Act 1994*.

General 11.

Prior to any changes in petroleum activities which would result in an increase to the maximum significant disturbance since financial assurance was last given to the administering authority, the holder of the environmental authority must amend the financial assurance and give the administering authority the increased amount of financial assurance.

General 12.

If the amount of financial assurance held by the administering authority has been discounted and either the nominated period of financial assurance has ended, or an event or change in circumstance has resulted in the holder of the environmental authority no longer being able to meet one or more of the mandatory pre-requisites or applicable discount criteria, the holder of the environmental authority must amend the financial assurance and give the administering authority the increased amount of financial assurance as soon as practicable.

Contingency procedures for emergency environmental incidents

General 13.

Petroleum activities involving significant disturbance to land cannot commence until the development of written contingency procedures for emergency environmental incidents which include, but are not necessarily limited to:

- (a) a clear definition of what constitutes an environmental emergency incident or near miss for the petroleum activity.
- (b) consideration of the risks caused by the petroleum activity including the impact of flooding and other natural events on the petroleum activity.
- (c) response procedures to be implemented to prevent or minimise the risks of environmental harm occurring.
- (d) the practices and procedures to be employed to restore the environment or mitigate any environmental harm caused.
- (e) procedures to investigate causes and impacts including impact monitoring programs for releases to waters and/or land.
- (f) training of staff to enable them to effectively respond.
- (g) procedures to notify the administering authority, local government and any potentially impacted landholder.

Maintenance of plant and equipment

General 14.

(PESCC 4.)

All plant and equipment must be maintained and operated in their proper and effective condition.

General 15.

The following infrastructure must be signed with a unique reference name or number in such a way that it is clearly observable:

- (a) regulated dams and low consequence dams
- (b) exploration, appraisal and development wells
- (c) water treatment facilities
- (d) sewage treatment facilities
- (e) specifically authorised discharge points to air and waters
- (f) any chemical storage facility associated with the environmentally relevant activity of chemical storage
- (g) field compressor stations
- (h) central compressor stations
- (i) gas processing facilities; and
- (j) pipeline compressor stations.

General 16.

Measures to prevent fauna being harmed from entrapment must be implemented during the construction and operation of well infrastructure, dams and pipeline trenches.

Erosion and sediment control

General 17.

For activities involving significant disturbance to land, control measures that are commensurate to the site-specific risk of erosion, and risk of sediment release to waters must be implemented to:

- (a) allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities
- (b) minimise soil erosion resulting from wind, rain, and flowing water
- (c) minimise the duration that disturbed soils are exposed to the erosive forces of wind, rain, and flowing water
- (d) minimise work-related soil erosion and sediment runoff; and
- (e) minimise negative impacts to land or properties adjacent to the activities (including roads).

Complaints

General 18.

Petroleum activities must not cause environmental nuisance at a sensitive place, other than where an alternative arrangement is in place.

Documentation

General 19.

A certification must be prepared by a suitably qualified person within 30 business days of completing <documents to be defined> required to be developed under this environmental authority, which demonstrates that:

- (a) relevant material, including current published guidelines (including any current published guidelines) have been considered in the written document
- (b) the content of the written document is accurate and true; and
- (c) the document meets the requirements of the relevant conditions of the environmental authority.

General 20.

All plans, procedures, programs, reports and methodologies required under this environmental authority must be written and implemented.

General 21.

All documents required to be developed under this environmental authority must be kept for five years.

General 22.

All documents required to be prepared, held or kept under this environmental authority must be provided to the administering authority upon written request within the requested timeframe.

General 23.

A record of all complaints must be kept including the date, complainant's details, source, reason for the complaint, description of investigations and actions undertaken in resolving the complaint.

Streamlined Conditions—Waste Management

General waste management

Waste 1.

(PESCC 24.)

Measures must be implemented so that waste is managed in accordance with the waste and resource management hierarchy and the waste and resource management principles.

Waste 2.

Waste, including waste fluids, but excluding waste used in closed-loop systems, must be transported off-site for lawful re-use, remediation, recycling or disposal, unless the waste is specifically authorised by conditions (Waste 4), (Waste 5), (Waste 6), (Waste 7), (Waste 8), (Waste 9), (Waste 11), (Waste 13) or (Waste 16) to be disposed of or used on site.

Waste 3.

Waste fluids, other than flare precipitant stored in flare pits, or residual drilling material or drilling fluids stored in sumps, must be contained in either:

- (a) an above ground container; or
- (b) a structure which contains the wetting front.

Waste 4.

Green waste may be used on-site for either rehabilitation or sediment and erosion control, or both.

Waste 5.

Vegetation waste may be burned if it relates to a state forest, timber reserve or forest entitlement area administered by the *Forestry Act 1959* and a permit has been obtained under the *Fire and Rescue Service Act 1990*.

Pipeline wastewater

Waste 6.

Pipeline waste water, may be released to land provided that it:

- (a) can be demonstrated it meets the acceptable standards for release to land; and
- (b) is released in a way that does not result in visible scouring or erosion or pooling or run-off or vegetation die-off.

Authorised uses of produced water for petroleum activities

Waste 7.

Produced water may be used in:

- (a) drilling, well maintenance and well hole activities; or
- (b) stimulation activities.

Waste 8.

Produced water may be used for dust suppression provided the following criteria are met:

- (a) the amount applied does not exceed the amount required to effectively suppress dust; and
- (b) the application:
 - i. does not cause on-site ponding or runoff
 - ii. is directly applied to the area being dust suppressed
 - iii. does not harm vegetation surrounding the area being dust suppressed; and
 - iv. does not cause visible salting.

Waste 9.

Produced water may be used for construction purposes provided the use:

- (a) does not result in negative impacts on the composition and structure of soil or subsoils
- (b) is not directly or indirectly released to waters
- (c) does not result in runoff from the construction site; and
- (d) does not harm vegetation surrounding the construction site.

Waste 10.

If there is any indication that any of the circumstances in condition (Waste 8)(b)(i) to (Waste 8)(b)(iv)) or (Waste 9)(a) to (Waste 9)(d)) is occurring, the use must cease immediately and the affected area must be remediated without delay.

Sewage treatment

Waste 11.

Treated sewage effluent or greywater can be released to land provided it:

- (a) meets or exceeds secondary treated class B standards for a treatment system with a daily peak design capacity of between 150 EP and 1500 EP; or
- (b) meets or exceeds secondary treated class C standards for a treatment system with a daily peak design capacity of less than 150 EP.

Waste 12.

The release of treated sewage effluent or greywater authorised in condition (Waste 11) must:

- (a) be to a fenced and signed contaminant release area(s)
- (b) not result in pooling or run-off or aerosols or spray drift or vegetation die-off
- (c) be to a contaminant release area(s) that is kept vegetated with groundcover, that is:
 - i. not a declared pest species
 - ii. kept in a viable state for transpiration and nutrient uptake; and
 - iii. grazed or harvested and removed from the contaminant release area as needed, but not less than every three months.

Waste 13.

Notwithstanding condition (Waste 11), treated sewage effluent that meets or exceeds secondary treated class A standards may be used for dust suppression or construction activities, provided the use meets the criteria in condition (Waste 8) or (Waste 9), as relevant to the use.

Waste 14.

Sewage pump stations must be fitted with a:

- (a) stand-by pump; and
- (a) high level alarm to warn of imminent pump station overflow, that operates without mains power or with a back-up power source that starts automatically in the event of a power failure.

Residual drilling material

Waste 15.

If sumps are used to store residual drilling material or drilling fluids, they must only be used for the duration of drilling activities.

Waste 16.

Residual drilling material can only be disposed of on-site:

- (a) by mix-bury-cover method if the residual drilling material meets the approved quality criteria; or
- (b) if it is certified by a suitably qualified third party as being of acceptable quality for disposal to land by the proposed method and that environmental harm will not result from the proposed disposal.

Waste 17.

Records must be kept to demonstrate compliance with condition (Waste 15) and (Waste 16).

Onsite waste disposal—General waste

Waste 18.

Dedicated landfill facilities for the disposal of general waste are not authorised under this approval.

Streamlined Conditions—Protecting Acoustic Values

Noise 1.

Notwithstanding condition (General 21), noise from the petroleum activity(ies) at sensitive receptors at levels less than those specified in **Protecting acoustic values, Table 1—Noise nuisance limits** are not considered to be environmental nuisance.

Protecting acoustic values, Table 1—Noise nuisance limits⁷

Time period	Metric	Short term noise event	Medium term noise event	Long term noise event
7:00am—6:00pm	$L_{Aeq,adj,15\ min}$	45 dBA	43 dBA	40 dBA
6:00pm—10:00pm	$L_{Aeq,adj,15\ min}$	40 dBA	38 dBA	35 dBA
10:00pm—6:00am	$L_{Aeq,adj,15\ min}$	28 dBA	28 dBA	28 dBA
	$Max\ L_{pA, 15\ mins}$	55 dBA	55 dBA	55 dBA

⁷ The noise limits in Table 1 have been set based on the following deemed background noise levels (L_{ABG}):

- 7:00am—6:00 pm: 35 dBA
- 6:00pm—10:00 pm: 30 dBA
- 10:00pm—6:00 am: 25 dBA
- 6:00am—7:00 am: 30 dBA

6:00am—7:00am	$L_{Aeq,adj,15\ min}$	40 dBA	38 dBA	35 dBA
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Noise 2.

If the noise subject to a *valid complaint* is tonal or *impulsive*, the adjustments detailed in **Protecting acoustic values, Table 2—Adjustments to be added to noise levels at sensitive receptors** are to be added to the measured noise level(s) to derive $L_{Aeq, adj, 15\ min}$.

Protecting acoustic values, Table 2—Adjustments to be added to noise levels at sensitive receptors

Noise characteristic	Adjustment to noise
Tonal characteristic is just audible	+ 2 dBA
Tonal characteristic is clearly audible	+ 5 dBA
Impulsive characteristic is detectable	+ 2 to + 5 dBA

Noise 3.

Notwithstanding condition (Noise 1), emission of any low frequency noise must not exceed either (Noise 3(a)) and (Noise 3(b)), or (Noise 3(c)) and (Noise 3(d)) in the event of a valid complaint about low frequency noise being made to the administering authority:

- 60 dB(C) measured outside the sensitive receptor; and
- the difference between the external A-weighted and C-weighted noise levels is no greater than 20 dB; or
- 50 dB(Z) measured inside the sensitive receptor; and
- the difference between the internal A-weighted and Z-weighted ($\text{Max } L_{pZ, 15\ min}$) noise levels is no greater than 15 dB.

Noise 4.

(PESCC 21.)

A Blast Management Plan must be developed for each blasting activity in accordance with Australian Standard 2187.

Noise 5.

(PESCC 22.)

Blasting operations must be designed to not exceed an airblast overpressure level of 120 dB (linear peak) at any time, when measured at or extrapolated to any sensitive place.

Noise 6.

PESCC 23.

Blasting operations must be designed to not exceed a ground-borne vibration peak particle velocity of 10mm/s at any time, when measured at or extrapolated to any sensitive place.

Streamlined Conditions—Protecting Air Values**Venting and flaring****Air 1.**

Unless venting is authorised under the *Petroleum and Gas (Production and Safety) Act 2004* or the *Petroleum Act 1923*, waste gas must be flared in a manner that complies with all of (Air 1(a)) and (Air 1(b)) and (Air 1(c)), or with (Air 1(d)):

- an automatic ignition system is used, and
- a flame is visible at all times while the waste gas is being flared, and
- there are no visible smoke emissions other than for a total period of no more than 5 minutes in any 2 hours.

Fuel burning and combustion facilities—authorised point sources**Air 2.**

A fuel burning or combustion facility must not be operated unless it is listed in **Protecting air values, Table 1—Authorised point sources**.

Air 3.

If a fuel burning or combustion facility is listed in **Protecting air values, Table 1—Authorised point sources**, the fuel burning or combustion facility must be operated so that the releases to air do not exceed the limits specified in **Protecting Air Values, Table 1—Authorised point sources** at the specified release point reference.

Protecting air values, Table 1—Authorised point sources

Resource Authority	Facility	Release Point Reference	Equipment Description	Minimum Release Height (m)	Minimum Efflux Velocity (m / sec)	NOx as Nitrogen Dioxide		Carbon Monoxide	
						Maximum concentration (mg / Nm ³)	Maximum Mass emission rate (g / sec)	Maximum concentration (mg / Nm ³)	Maximum Mass emission rate (g / sec)
XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

Point source air monitoring

Air 4.

Point source air monitoring for each fuel burning or combustion facility listed in **Protecting air values, Table 1—Authorised point sources** must:

- (a) be undertaken once:
 - i. in the first three months after each facility is first commissioned, and then
 - ii. every year thereafter
- (b) be carried out when the facility the subject of the sampling is operating under maximum operating conditions for the annual period; and
- (c) demonstrate compliance with the limits listed in **Protecting air values, Table 1—Authorised point sources** at each release point reference.

Streamlined Conditions—Protecting Land Values

General

Land 1.

Contaminants must not be directly or indirectly released to land except for those releases authorised by conditions (Waste 4), (Waste 5), (Waste 6), (Waste 7), (Waste 8), (Waste 9), (Waste 11), (Waste 13) or (Waste 16).

Top soil management

Land 2.

Top soil must be managed in a manner that preserves its biological and chemical properties.

Land management

Land 3.

Land that has been significantly disturbed by the petroleum activities must be managed to ensure that mass movement, gully erosion, rill erosion, sheet erosion and tunnel erosion do not occur on that land.

Acid sulfate soils

Land 4.

Acid sulfate soils must be treated and managed in accordance with the latest edition of the *Queensland Acid Sulfate Soil Technical Manual*.

Chemical storage

Land 5.

Chemicals and fuels stored, must be effectively contained and where relevant, meet Australian Standards, where such a standard is applicable.

Pipeline operation and maintenance

Land 6.

Pipeline operation and maintenance must be in accordance, to the greatest practicable extent, with the relevant section of the APIA Code of Environmental Practice: Onshore Pipelines (2009).

Pipeline reinstatement and revegetation

Land 7.

(PPSCE 17.)

Pipeline trenches must be backfilled and topsoils reinstated within three months after pipe laying.

Land 8.

Reinstatement and revegetation of the pipeline right of way must commence within 6 months after cessation of petroleum activities for the purpose of pipeline construction.

Land 9.

Backfilled, reinstated and revegetated pipeline trenches and right of ways must be:

- (a) a stable landform
- (b) re-profiled to a level consistent with surrounding soils
- (c) re-profiled to original contours and established drainage lines; and
- (d) either:
 - i. vegetated with groundcover consistent with the surrounding area which is not a declared pest species, and which is established and growing, or
 - ii. effectively stabilised with an alternative soil stabilisation methodology.

Streamlined Conditions—Protecting Biodiversity Values

Confirming biodiversity values

Biodiversity 1.

Prior to undertaking activities that result in significant disturbance to land in areas of native vegetation, confirmation of on-the-ground biodiversity values of the native vegetation communities at that location must be undertaken by a suitably qualified person.

Biodiversity 2.

A suitably qualified person must develop and certify a methodology so that condition (Biodiversity 1) can be complied with and which is appropriate to confirm on-the-ground biodiversity values.

Biodiversity 3.

Where mapped biodiversity values differ from those confirmed under conditions (Biodiversity 1) and (Biodiversity 2), petroleum activities may proceed in accordance with the conditions of the environmental authority based on the confirmed on-the-ground biodiversity value, subject to compliance with conditions (Biodiversity 7), (Biodiversity 8) and (Biodiversity 9).

Planning for land disturbance

Biodiversity 4.

The location of the petroleum activity(ies) must be selected in accordance with the following site planning principles:

- (a) maximise the use of areas of pre-existing disturbance
- (b) in order of preference, avoid, minimise or mitigate any impacts, including cumulative impacts, on areas of native vegetation or other areas of ecological value
- (c) minimise disturbance to land that may result in land degradation
- (d) in order of preference, avoid then minimise isolation, fragmentation, edge effects or dissection of tracts of native vegetation; and
- (e) in order of preference, avoid then minimise clearing of native mature trees.

Planning for land disturbance—linear infrastructure

Biodiversity 5.

Linear infrastructure construction corridors must:

- (a) maximise co-location
- (b) be minimised in width to the greatest practicable extent; and
- (c) for linear infrastructure that is an essential petroleum activity authorised in an environmentally sensitive area or its protection zone, be no greater than 40m in total width.

Authorised disturbance to Environmentally Sensitive Areas

Biodiversity 6.

Where petroleum activities are to be carried out in environmentally sensitive areas or their protection zones, the petroleum activities must be carried out in accordance with **Protecting Biodiversity Values, Table 1—Authorised petroleum activities in environmentally sensitive areas and their protection zones**. <table to be finalised by EHP through the EA application process>

Protecting Biodiversity Values, Table 1—Authorised petroleum activities in environmentally sensitive areas and their protection zones

Environmentally sensitive area	Within the environmentally sensitive area	<u>Primary protection zone</u> of the environmentally sensitive area	<u>Secondary protection zone</u> of the environmentally sensitive area
Category A environmentally sensitive areas	No petroleum activities permitted.	Only <u>low impact petroleum activities</u> permitted.	Only essential petroleum activities permitted.
Category B environmentally sensitive areas that are other than 'endangered' regional ecosystems	Only low impact petroleum activities permitted.	Only low impact petroleum activities permitted.	Only essential petroleum activities permitted.
Category B environmentally sensitive areas that are 'endangered' regional ecosystems	Only low impact petroleum activities permitted.	Only essential petroleum activities permitted.	Only essential petroleum activities permitted.
Category C environmentally sensitive areas that are 'nature refuges' or 'koala habitat'	Only low impact petroleum activities permitted.	Only low impact petroleum activities permitted.	
Category C environmentally sensitive areas that are 'essential habitat', 'essential regrowth habitat', or 'of concern' regional ecosystems	Only low impact petroleum activities permitted.	Only essential petroleum activities permitted.	
Category C environmentally sensitive areas that are 'regional parks' (previously known as 'resources reserves') and conservation parks	Only essential petroleum activities permitted.	Only essential petroleum activities permitted.	
Category C environmentally sensitive areas that are 'state forests' or 'timber reserves'	Only essential petroleum activities permitted.	Petroleum activities permitted.	

Biodiversity 7.

Despite condition (Biodiversity 6), petroleum activities may be carried out in areas containing matters of State environmental significance subject to environmental offset conditions (Biodiversity 8), (Biodiversity 9), (Biodiversity 10), (Biodiversity 11) and (Biodiversity 12).

Impacts to matters of State environmental significance

Biodiversity 8.

Significant residual impacts to prescribed matters of State environmental significance must not exceed the maximum authorised significant residual impact area listed for that matter in Protecting Biodiversity Values, Table 2 – Matters of State Environmental Significance.

Note: Deemed conditions in sections 18, 22, 24 and 25 of the Environmental Offsets Act 2014 are taken to be conditions of this authority.

Protecting Biodiversity Values, Table 2 – Matters of State Environmental Significance

Matter of State Environmental Significance	Estimated maximum extent of impact (ha) #

to be updated when required through condition Biodiversity 10

Biodiversity 9.

Significant residual impacts are not authorised on any prescribed environmental matters not identified in Protecting Biodiversity Values, Table 2 – Matters of State Environmental Significance.

Biodiversity 10.

The authority holder may carry out the prescribed activity in stages and deliver an environmental offset for each stage of the activity’s impact on prescribed environmental matters.

Biodiversity 11.

At least three months prior to the commencement of activities for each stage referred to in condition (Biodiversity 10), the following analysis of impacts must be provided to the administering authority:

- a) the anticipated extent of impact on matters of State environmental significance for that stage
- b) the actual extent of disturbance of matters of State environmental significance resulting from the previous stage.

Biodiversity 12.

The authority holder must provide to the administering authority, no more than three months after completion of the final stage undertaken in accordance with Biodiversity 10, an analysis of the following impacts:

- a) the anticipated extent of impact on matters of State environmental significance resulting from the previous stage
- b) where relevant, a notice of election to address any outstanding offset debit for the authorised activity.

Streamlined Conditions—Protecting Water Values

Authorised impacts to waters

Water 1.

<< Insert site-specific conditions authorising impacts to waters, if approved >>

Authorised impacts to wetlands

Water 2.

The extraction of groundwater as part of the petroleum activity(ies) from underground aquifers must not directly or indirectly cause environmental harm to a wetland.

Authorised activities in waters

Water 3.

Petroleum activities must not occur in or within 200m of a:

- (a) wetland of high ecological significance
- (b) Great Artesian Basin Spring
- (c) subterranean cave GDE

Water 4.

Only construction or maintenance of linear infrastructure is permitted in any wetland of other environmental value or in a watercourse.

Water 5.

The construction or maintenance of linear infrastructure in a wetland of other environmental value must not result in the:

- (a) clearing of riparian vegetation outside of the minimum area practicable to carry out the works; or
- (b) ingress of saline water into freshwater aquifers; or
- (c) draining or filling of the wetland beyond the minimum area practicable to carry out the works.

Water 6.

After the construction or maintenance works for linear infrastructure in a wetland or other environmental value are completed, the linear infrastructure must not:

- (a) drain or fill the wetland
- (b) prohibit the flow of surface water in or out of the wetland
- (c) lower or raise the water table and hydrostatic pressure outside the bounds of natural variability that existed before the activities commenced
- (d) result in ongoing negative impacts to water quality
- (e) result in bank instability; or
- (f) result in fauna ceasing to use adjacent areas for habitat, feeding, roosting or nesting.

Water 7.

The construction or maintenance of linear infrastructure activities in a watercourse must be conducted in the following preferential order:

- (a) firstly, in times where there is no water present
- (b) secondly, in times of no flow
- (c) thirdly, in times of flow, providing a bankfull situation is not expected and that flow is maintained.

Water 8.

The construction or maintenance of linear infrastructure authorised under condition (Water 4) must comply with the water quality limits as specified in **Protecting Water Values, Table 1—Release limits for construction or maintenance of linear infrastructure**.

Protecting Water Values, Table 1—Release limits for construction or maintenance of linear infrastructure

Water quality parameters	Units	Water quality limits
Turbidity	Nephelometric Turbidity Units (NTU)	For a wetland of other environmental value, if background water turbidity is above 45 NTU, no greater than 25% above background water turbidity measured within a 50m radius of the construction or maintenance activity. For a watercourse, if background water turbidity is above 45 NTU, no greater than 25% above background water turbidity
		For a wetland of other environmental value, if background water turbidity is equal to, or below

		45 NTU, a turbidity limit of no greater than 55 NTU applies, measured within a 50m radius of the construction or maintenance activity. For a watercourse, if background water turbidity is equal to, or below 45 NTU, a turbidity limit of no greater than 55 NTU applies, measured within 50m downstream of the construction or maintenance activity.
Hydrocarbons	-	For a wetland of other environmental value, or watercourse, no visible sheen or slick

Water 9.

Monitoring must be undertaken at a frequency that is appropriate to demonstrate compliance with condition (Water 8).

Register of activities in wetlands and watercourses

Water 10.

A register must be kept of all linear infrastructure construction and maintenance activities in a wetland of other environmental value and watercourses, which must include:

- (a) location of the activity (e.g. GPS coordinates (GDA94) and watercourse name)
- (b) estimated flow rate of surface water at the time of the activity
- (c) duration of works, and
- (d) results of impact monitoring carried out under condition (Water 9).

Activities in Floodplains

Water 11.

Petroleum activity(ies) on floodplains must be carried out in a way that does not:

- (a) concentrate flood flows in a way that will or may cause or threaten a negative environmental impact; or
- (b) divert flood flows from natural drainage paths and alter flow distribution; or
- (c) increase the local duration of floods; or
- (d) increase the risk of detaining flood flows.

Seepage monitoring program

Water 12.

A seepage monitoring program must be developed by a suitably qualified person which is commensurate with the site-specific risks of contaminant seepage from containment facilities, and which requires and plans for detection of any seepage of contaminants to groundwater as a result of storing contaminants by << *Insert the specified date no longer than 3 months from date of grant of this environmental authority* >>.

Water 13.

The seepage monitoring program required by condition (Water 12) must include but not necessarily be limited to:

- (a) identification of the containment facilities for which seepage will be monitored
- (b) identification of trigger parameters that are associated with the potential or actual contaminants held in the containment facilities
- (c) identification of trigger concentration levels that are suitable for early detection of contaminant releases at the containment facilities
- (d) installation of background seepage monitoring bores where groundwater quality will not have been affected by the petroleum activities authorised under this environmental authority to use as reference sites for determining impacts
- (e) installation of seepage monitoring bores that:
 - i. are within formations potentially affected by the containment facilities authorised under this environmental authority (i.e. within the potential area of impact)

- ii. provide for the early detection of negative impacts prior to reaching groundwater dependent ecosystems, landholder's active groundwater bores, or water supply bores
- iii. provide for the early detection of negative impacts prior to reaching migration pathways to other formations (i.e. faults, areas of unconformities known to connect two or more formations)
- (f) monitoring of groundwater at each background and seepage monitoring bore at least quarterly for the trigger parameters identified in condition (Water 13(b))
- (g) seepage trigger action response procedures for when trigger parameters and trigger levels identified in conditions (Water 13(b)) and (Water 13(c)) trigger the early detection of seepage, or upon becoming aware of any monitoring results that indicate potential groundwater contamination
- (h) a rationale detailing the program conceptualisation including assumptions, determinations, monitoring equipment, sampling methods and data analysis; and
- (i) provides for annual updates to the program for new containment facilities constructed in each annual return period.

Water 14.

A bore drill log must be completed for each seepage monitoring bore in condition (Water 13) which must include:

- (a) bore identification reference and geographical coordinate location
- (b) specific construction information including but not limited to depth of bore, depth and length of casing, depth and length of screening and bore sealing details
- (c) standing groundwater level and water quality parameters including physical parameter and results of laboratory analysis for the possible trigger parameters
- (d) lithological data, preferably a stratigraphic interpretation to identify the important features including the identification of any aquifers; and
- (e) target formation of the bore.

Streamlined Conditions—Rehabilitation

Rehabilitation planning

Rehabilitation 1.

A Rehabilitation Plan must be developed by a suitably qualified person and must include the:

- (a) rehabilitation goals; and
- (b) procedures to be undertaken for rehabilitation that will:
 - i. achieve the requirements of conditions (Rehabilitation 2) to (Rehabilitation 8), inclusive; and
 - ii. provide for appropriate monitoring and maintenance.

Transitional rehabilitation

Rehabilitation 2.

Significantly disturbed areas that are no longer required for the on-going petroleum activities, must be rehabilitated within 12 months (unless an exceptional circumstance in the area to be rehabilitated (e.g. a flood event) prevents this timeframe being met) and be maintained to meet the following acceptance criteria:

- (a) contaminated land resulting from petroleum activities is remediated and rehabilitated
- (b) the areas are:
 - i. non-polluting
 - ii. a stable landform
 - iii. re-profiled to contours consistent with the surrounding landform
- (c) surface drainage lines are re-established
- (d) top soil is reinstated; and
- (e) either:
 - i. groundcover, that is not a declared pest species, is growing; or
 - ii. an alternative soil stabilisation methodology that achieves effective stabilisation is implemented and maintained.

Final rehabilitation acceptance criteria

Rehabilitation 3.

All significantly disturbed areas caused by petroleum activities which are not being or intended to be utilised by the landholder or overlapping tenure holder, must be rehabilitated to meet the following final acceptance criteria measured either against the highest ecological value adjacent land use or the pre-disturbed land use:

- (a) greater than or equal to 70% of native ground cover species richness
- (b) greater than or equal to the total per cent of ground cover
- (c) less than or equal to the per cent species richness of declared plant pest species; and
- (d) where the adjacent land use contains, or the pre-clearing land use contained, one or more regional ecosystem(s), then at least one regional ecosystem(s) from the same broad vegetation group, and with the equivalent biodiversity status or a biodiversity status with a higher conservation value as any of the regional ecosystem(s) in either the adjacent land or pre-disturbed land, must be present.

Final rehabilitation acceptance criteria in environmentally sensitive areas

Rehabilitation 4.

Where significant disturbance to land has occurred in an environmentally sensitive area, the following final rehabilitation criteria as measured against the pre-disturbance biodiversity values assessment (required by conditions (Biodiversity 1) and (Biodiversity 2)) must be met:

- (a) greater than or equal to 70% of native ground cover species richness
- (b) greater than or equal to the total per cent ground cover
- (c) less than or equal to the per cent species richness of declared plant pest species
- (d) greater than or equal to 50% of organic litter cover
- (e) greater than or equal to 50% of total density of coarse woody material; and
- (f) all predominant species in the ecologically dominant layer, that define the pre-disturbance regional ecosystem(s) are present.

Continuing conditions

Rehabilitation 5.

Conditions (Rehabilitation 2), (Rehabilitation 3) and (Rehabilitation 4) continue to apply after this environmental authority has ended or ceased to have effect.

Remaining dams

Rehabilitation 6.

Where there is a dam (including a low consequence dam) that is being or intended to be utilised by the landholder or overlapping tenure holder, the dam must be decommissioned to no longer accept inflow from the petroleum activity(ies) and the contained water must be of a quality suitable for the intended on-going uses(s) by the landholder or overlapping tenure holder.

Conditions—Well construction, maintenance and stimulation activities

Drilling activities

Well activities 1.

Oil based or synthetic oil-based drilling muds must not be used in the carrying out of the petroleum activity(ies).

Well activities 2.

Drilling activities must not result in the connection of the target gas producing formation and another aquifer.

Well activities 3.

Practices and procedures must be in place to detect, as soon as practicable, any well integrity issues that have or may result in the connection of a target formation and another aquifer as a result of drilling activities.

Stimulation activities

Well activities 4.

Polycyclic aromatic hydrocarbons or products that contain polycyclic aromatic hydrocarbons must not be used in stimulation fluids in concentrations above the reporting limit.

Well activities 5.

Stimulation activities must not negatively affect water quality, other than that within the stimulation impact zone of the target gas producing formation.

Well activities 6.

Stimulation activities must not cause the connection of the target gas producing formation and another aquifer.

Well activities 7.

The internal and external mechanical integrity of the well system prior to and during stimulation must be ensured such that there is:

- (a) no significant leakage in the casing, tubing, or packer; and
- (b) there is no significant fluid movement into another aquifer through vertical channels adjacent to the well bore hole.

Stimulation Risk Assessment

Well activities 9.

Prior to undertaking stimulation activities, a risk assessment must be developed to ensure that stimulation activities are managed to prevent environmental harm.

Well activities 10.

The stimulation risk assessment must be carried out for every well to be stimulated prior to stimulation being carried out at that well and address issues at a relevant geospatial scale such that changes to features and attributes are adequately described and must include, but not necessarily be limited to:

- (a) a process description of the stimulation activity to be applied, including equipment and a comparison to best international practice
- (b) provide details of where, when and how often stimulation is to be undertaken on the tenures covered by this environmental authority
- (c) a geological model of the field to be stimulated including geological names, descriptions and depths of the target gas producing formation(s)
- (d) naturally occurring geological faults
- (e) seismic history of the region (e.g. earth tremors, earthquakes)
- (f) proximity of overlying and underlying aquifers
- (g) description of the depths that aquifers with environmental values occur, both above and below the target gas producing formation
- (h) identification and proximity of landholder' active groundwater bores in the area where stimulation activities are to be carried out
- (i) the environmental values of groundwater in the area
- (j) an assessment of the appropriate limits of reporting for all water quality indicators relevant to stimulation monitoring in order to accurately assess the risks to environmental values of groundwater
- (k) description of overlying and underlying formations in respect of porosity, permeability, hydraulic conductivity, faulting and fracture propensity
- (l) consideration of barriers or known direct connections between the target gas producing formation and the overlying and underlying aquifers
- (m) a description of the well mechanical integrity testing program
- (n) process control and assessment techniques to be applied for determining extent of stimulation activities (e.g. microseismic measurements, modelling etc.)
- (o) practices and procedures to ensure that the stimulation activities are designed to be contained within the target gas producing formation
- (p) groundwater transmissivity, flow rate, hydraulic conductivity and direction(s) of flow
- (q) a description of the chemical compounds used in stimulation activities (including estimated total mass, estimated composition, chemical abstract service numbers and properties), their mixtures and the resultant compounds that are formed after stimulation

- (r) a mass balance estimating the concentrations and absolute masses of chemical compounds that will be reacted, returned to the surface or left in the target gas producing formation subsequent to stimulation
- (s) an environmental hazard assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after stimulation including:
 - i. toxicological and ecotoxicological information of chemical compounds used
 - ii. information on the persistence and bioaccumulation potential of the chemical compounds used; and
 - iii. identification of the chemicals of potential concern in stimulation fluids derived from the risk assessment
- (t) an environmental hazard assessment of use, formation of, and detection of polycyclic aromatic hydrocarbons in stimulation activities
- (u) identification and an environmental hazard assessment of using radioactive tracer beads in stimulation activities
- (v) an environmental hazard assessment of leaving chemical compounds in stimulation fluids in the target gas producing formation for extended periods subsequent to stimulation
- (w) human health exposure pathways to operators and the regional population
- (x) risk characterisation of environmental impacts based on the environmental hazard assessment
- (y) potential impacts to landholder bores as a result of stimulation activities
- (z) an assessment of cumulative underground impacts, spatially and temporally of the stimulation activities to be carried out on the tenures covered by this environmental authority; and
- (aa) potential environmental or health impacts which may result from stimulation activities including but not limited to water quality, air quality (including suppression of dust and other airborne contaminants), noise and vibration.

Water quality baseline monitoring

Well activities 11.

Prior to undertaking any stimulation activity, an assessment must be undertaken of the water quality of:

- (a) all landholder's active groundwater bores (subject to access being permitted by the landholder) that are spatially located within a two (2) kilometre horizontal radius from the location of the stimulation initiation point within the target gas producing formation; and
- (b) all landholders' active groundwater bores (subject to access being permitted by the landholder) in any aquifer that is within 200m above or below the target gas producing formation and is spatially located with a two (2) kilometre radius from the location of the stimulation initiation point; and
- (c) any other bore that could potentially be adversely impacted by the stimulation activities in accordance with the findings of the risk assessment required by conditions (Well activities 9) and (Well activities 10).

Well activities 12.

Prior to undertaking stimulation activities at a well, there must be sufficient water quality data to accurately represent the water quality in the well to be stimulated. The data must include as a minimum the results of analyses for the parameters in condition (Well activities 13).

Well activities 13.

Water quality assessments required by conditions (Well activities 12) and (Well activities 13) must include relevant analytes and physico-chemical parameters to be monitored in order to establish baseline water quality and must include, but not necessarily be limited to:

- (a) pH
- (b) electrical conductivity [$\mu\text{S}/\text{m}$]
- (c) turbidity [NTU]
- (d) total dissolved solids [mg/L]
- (e) temperature [$^{\circ}\text{C}$]
- (f) dissolved oxygen [mg/L]
- (g) dissolved gases (methane, chlorine, carbon dioxide, hydrogen sulfide) [mg/L]
- (h) alkalinity (bicarbonate, carbonate, hydroxide and total as CaCO_3) [mg/L]
- (i) sodium adsorption ratio (SAR)
- (j) anions (bicarbonate, carbonate, hydroxide, chloride, sulphate) [mg/L]

- (k) cations (aluminium, calcium, magnesium, potassium, sodium) [mg/L]
- (l) dissolved [$\mu\text{g/L}$] and total [mg/L] metals and metalloids (including but not necessarily being limited to: aluminium, arsenic, barium, borate (boron), cadmium, total chromium, copper, iron, fluoride, lead, manganese, mercury, nickel, selenium, silver, strontium, tin and zinc) [$\mu\text{g/L}$]
- (m) total petroleum hydrocarbons
- (n) BTEX (as benzene, toluene, ethylbenzene, ortho-xylene, para- and meta-xylene, and total xylene) [$\mu\text{g/L}$]
- (o) polycyclic aromatic hydrocarbons (including but not necessarily being limited to: naphthalene, phenanthrene, benzo[a]pyrene) [$\mu\text{g/L}$]
- (p) sodium hypochlorite [mg/L]
- (q) sodium hydroxide [mg/L]
- (r) formaldehyde [mg/L]
- (s) ethanol [mg/L]; and
- (t) gross alpha + gross beta or radionuclides by gamma spectroscopy [Bq/L].

Stimulation Impact Monitoring Program

Well activities 14.

A Stimulation Impact Monitoring Program must be developed prior to the carrying out of stimulation activities which must be able to detect adverse impacts to water quality from stimulation activities and must consider the findings of the risk assessment required by conditions (Well activities 10) and (Well activities 11) that relate to stimulation activities and must include, as a minimum, monitoring of:

- (a) the stimulation fluids to be used in stimulation activities at sufficient frequency and which sufficiently represents the quantity and quality of the fluids used
- (b) flow back waters from stimulation activities at sufficient frequency and which sufficiently represents the quality of that flow back water
- (c) flow back waters from stimulation activities at sufficient frequency and accuracy to demonstrate that 150% of the volume used in stimulation activities has been extracted from the stimulated well; and
- (d) all bores in accordance with condition (Well activities 11).

Well activities 15.

The Stimulation Impact Monitoring Program must provide for monitoring of:

- (a) analytes and physico-chemical parameters relevant to baseline bore and well assessments to enable data referencing and comparison including, but not necessarily being limited to the analytes and physico-chemical parameters in condition (Well activities 13); and
- (b) any other analyte or physico-chemical parameters that will enable detection of adverse water quality impacts and the inter-connection with a non-target aquifer as a result of stimulation activities including chemical compounds that are actually or potentially formed by chemical reactions with each other or coal seam materials during stimulation activities.

Well activities 16.

The Stimulation Impact Monitoring Program must provide for monitoring of the bores in condition (Well activities 14(d)) at the following minimum frequency:

- (a) monthly for the first six (6) months subsequent to stimulation activities being undertaken; then
- (b) annually for the first five (5) years subsequent to stimulation being undertaken or until analytes and physico-chemical parameters listed in conditions (Well activities 13(a)) to (Well activities 13(t)) inclusive, are not detected in concentrations above baseline bore monitoring data on two (2) consecutive monitoring occasions.

Well activities 17.

The results of the Stimulation Impact Monitoring Program must be made available to any potentially affected landholder upon request by that landholder.

Conditions—Dams

Assessment of consequence category

Dams 1.

The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635) at the following times:

- (a) prior to the design and construction of the structure, if it is not an existing structure; or
- (b) if it is an existing structure, prior to the adoption of this schedule; or
- (c) prior to any change in its purpose or the nature of its stored contents.

Dams 2.

A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.

Dams 3.

Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

Design and construction⁸ of a regulated structure

Dams 4.

Condition (Dams 5.) to (Dams 9.) inclusive do not apply to existing structures.

Dams 5.

All regulated structures must be designed by, and constructed⁹ under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

Dams 6.

Construction of a regulated structure is prohibited unless the holder has submitted a consequence category assessment report and certification to the administering authority has been certified by a suitably qualified and experienced person for the design and design plan and the associated operating procedures in compliance with the relevant condition of this authority.

Dams 7.

Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*, and must be recorded in the Regulated Dams/Levees register.

Dams 8.

Regulated structures must:

- (a) be designed and constructed in accordance with and conform to the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635);
- (b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of:
 - i. floodwaters from entering the regulated dam from any watercourse or drainage line; and
 - ii. wall failure due to erosion by floodwaters arising from any watercourse or drainage line.

⁸ Construction of a dam includes modification of an existing dam—refer to the definitions.

⁹ Certification of design and construction may be undertaken by different persons.

- (c) [Insert only in environmental authorities for regulated dams that are dams associated with a failure to contain - seepage] have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.

Dams 9.

Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that:

- (a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure;
- (b) construction of the regulated structure is in accordance with the design plan.

Operation of a regulated structure

Dams 10.

Operation of a regulated structure, except for an existing structure, is prohibited unless:

- (a) the holder has submitted to the administering authority:
 - i. one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with condition (Dams 9), and
 - ii. a set of 'as constructed' drawings and specifications, and
 - iii. certification of those 'as constructed drawings and specifications' in accordance with condition (Dams 9) and
 - iv. where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan.
 - v. the requirements of this authority relating to the construction of the regulated structure have been met;
 - vi. the holder has entered the details required under this authority, into a Register of Regulated Dams; and
 - vii. there is a current operational plan for the regulated structures.

Dams 11.

For existing structures that are regulated structures:

- (a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the holder must submit to the administering authority within 12 months of the commencement of this condition a copy of the certified system design plan including that structure; and
- (b) there must be a current operational plan for the existing structures.

Dams 12.

Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.

Mandatory reporting level

Dams 13.

Conditions (Dams 14) to (Dams 17) inclusive only apply to regulated Structures which have not been certified as low consequence category for 'failure to contain – overtopping'.

Dams 14.

The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.

Dams 15.

The holder must, as soon as practical and within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.

Dams 16.

The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.

Dams 17.

The holder must record any changes to the MRL in the Register of Regulated Structures.

Design storage allowance

Dams 18.

The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year.

Dams 19.

By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).

Dams 20.

The holder must, as soon as possible and within forty-eight (48) hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, notify the administering authority.

Dams 21.

The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.

Annual inspection report

Dams 22.

Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.

Dams 23.

At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure.

Dams 24.

The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

Dams 25.

The holder must:

- (a) Within 20 business days of receipt of the annual inspection report, provide to the administering authority:
 - i. The recommendations section of the annual inspection report; and
 - ii. If applicable, any actions being taken in response to those recommendations; and
- (b) If, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the holder, provide this to the administering authority within 10 business days¹⁰ of receipt of the request.

¹⁰ Please note that for some model conditions, such as model conditions for dams associated with a resource activity - non mining activity, the notification requirements may be located in a separate part of the conditions of an environmental authority (e.g. under notification requirement conditions).

Transfer arrangements – Resource activity only

Dams 26.

The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.

Decommissioning and rehabilitation

Dams 27.

Dams must not be abandoned but be either:

- (a) decommissioned and rehabilitated to achieve compliance with condition (Dams 28.); or
- (b) be left in-situ for a beneficial use(s) provided that:
 - iii. it no longer contains contaminants that will migrate into the environment; and
 - iv. it contains water of a quality that is demonstrated to be suitable for its intended beneficial use(s); and
 - v. the administering authority, the holder of the environmental authority and the landholder agree in writing that the dam will be used by the landholder following the cessation of the environmentally relevant activity(ies).

Dams 28.

After decommissioning, all significantly disturbed land caused by the carrying out of the environmentally relevant activity(ies) must be rehabilitated to meet the following final acceptance criteria:

- (a) the landform is safe for humans and fauna;
- (b) the landform is stable with no subsidence or erosion gullies for at least three (3) years;
- (c) any contaminated land (e.g. contaminated soils) is remediated and rehabilitated;
- (d) not allowing for acid mine drainage; or
- (e) there is no ongoing contamination to waters (including groundwater);
- (f) rehabilitation is undertaken in a manner such that any actual or potential acid sulfate soils on the area of significant disturbance are treated to prevent or minimise environmental harm in accordance with the Instructions for the treatment and management of acid sulfate soils (2001);
- (g) all significantly disturbed land is reinstated to the pre-disturbed soil suitability class;
- (h) for land that is not being cultivated by the landholder:
 - i. groundcover, that is not a declared pest species is established and self-sustaining
 - ii. vegetation of similar species richness and species diversity to pre-selected analogue sites is established and self-sustaining, and
 - iii. the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance caused by carrying out the petroleum activity(ies).
- (i) for land that is to be cultivated by the landholder, cover crop is revegetated, unless the landholder will be preparing the site for cropping within 3 months of petroleum activities being completed.

Register of Regulated Dams

Dams 29.

A Register of Regulated Dams must be established and maintained by the holder for each regulated dam:

Dams 30.

The holder must provisionally enter the required information in the Register of Regulated Dams when a design plan for a regulated dam is submitted to the administering authority.

Dams 31.

The holder must make a final entry of the required information in the Register of Regulated Dams once compliance with conditions (Dams 10.) and (Dams 11.) has been achieved.

Dams 32.

The holder must ensure that the information contained in the Register of Regulated Dams is current and complete on any given day.

Dams 33.

All entries in the Register of Regulated Dams must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.

Dams 34.

The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Dams, in the electronic format required by the administering authority.

Transitional arrangements

Dams 35.

All existing structures that have not been assessed in accordance with either the Manual or the former Manual for Assessing Hazard Categories and Hydraulic Performance of Dams must be assessed and certified in accordance with the Manual within 6 months of amendment of the authority adopting this schedule.

Dams 36.

All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in Table 1 (Transitional requirements for existing structures), depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.

Dams 37.

Table 1 ceases to apply for a structure once any of the following events has occurred:

- (a) It has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or
- (b) It has been decommissioned; or
- (c) It has been certified as no longer being assessed as a regulated structure.

Dams 38.

Certification of the transitional assessment required by conditions (Dams 35.) and (Dams 36.) (as applicable) must be provided to the administering authority within 6 months of amendment of the authority adopting this schedule.

Dams, Table 1— Transition period required for existing structures to achieve the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Dams

Compliance with criteria	High	Significant	Low
>90% and a history of good compliance performance in last 5 years	No transition required	No transition required	No transitional conditions apply. Review consequence assessment every 7 years.
>70%-≤90%	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 10 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	No transitional conditions apply. Review consequence assessment every 7 years.
>50-≤70%	Within 5 years unless otherwise agreed with the administering authority, based on no history of unauthorised	Within 7 years unless otherwise agreed with the administering authority, based on no history of unauthorised	Review consequence assessment every 7 years.

	releases.	releases.	
≤50%	Within 5 years or as per compliance requirements (e.g. TEP timing)	Within 5 years or as per compliance requirements (e.g. TEP timing)	Review consequence assessment every 5 years.

DEFINITIONS

acceptable standards for release to land	means wastewater of the following quality as determined by monitoring results or by characterisation: (a) electrical conductivity (EC) not exceeding 3000µS/cm (b) sodium adsorption ratio (SAR) not exceeding 8 (c) pH between 6.0 and 9.0 (d) heavy metals (measured as total) meets the respective short term trigger value in section 4.2.6, Table 4.2.10—Heavy metals and metalloids in Australian and New Zealand Guidelines for Fresh and Marine Water Quality (e) does not contain biocides.
acid sulfate soil(s)	means a soil or soil horizon which contains sulfides or an acid soil horizon affected by oxidation of sulfides.
adjacent land use(s)	means the ecosystem function adjacent to an area of significant disturbance, or where there is no ecosystem function, the use of the land. An adjacent land use does not include an adjacent area that shows evidence of edge effect.
administering authority	means: (a) for a matter, the administration and enforcement of which has been devolved to a local government under section 514 of the <i>Environmental Protection Act 1994</i> —the local government; or (b) for all other matters—the Chief Executive of the Department of Environment and Heritage Protection; or (c) another State Government Department, Authority, Storage Operator, Board or Trust, whose role is to administer provisions under other enacted legislation.
affected person	is someone whose drinking water can potentially be impacted as a result of discharges from a dam or their life can be put at risk due to dwellings or workplaces being in the path of a dam break flood.
air shed	TBC
alternative arrangement	means a written agreement about the way in which a particular environmental nuisance impact will be dealt with at a sensitive place, and may include an agreed period of time for which the arrangement is in place. An alternative arrangement may include, but is not limited to, a range of nuisance abatement measures to be installed at the sensitive place, or provision of alternative accommodation for the duration of the relevant nuisance impact.
analogue site(s)	means an area of land which contains values and characteristics representative of an area to be rehabilitated prior to disturbance. Such values must encompass land use, topographic, soil, vegetation, vegetation community attributes and other ecological characteristics. Analogue sites can be the pre-disturbed site of interest where significant surveying effort has been undertaken to establish benchmark parameters.
annual exceedance probability or AEP	the probability that at least one event in excess of a particular magnitude will occur in any given year.
annual inspection	means an assessment prepared by a suitably qualified and

report	<p>experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan);</p> <p>(a) against recommendations contained in previous annual inspections reports;</p> <p>(b) against recognised dam safety deficiency indicators;</p> <p>(c) for changes in circumstances potentially leading to a change in consequence category;</p> <p>(d) for conformance with the conditions of this authority;</p> <p>(e) for conformance with the 'as constructed' drawings;</p> <p>(f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems);</p> <p>(g) for evidence of conformance with the current operational plan.</p>																								
annual return period	means the most current 12-month period between two anniversary dates.																								
appraisal well	means a petroleum well to test the potential of one (1) or more natural underground reservoirs for producing or storing petroleum. For clarity, an appraisal well does not include an exploration well.																								
approved quality criteria	<p>for the purposes of residual drilling materials, means the residual drilling material meet the following quality standards:</p> <p>Part A In all cases:</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Maximum concentration</th> </tr> </thead> <tbody> <tr> <td>pH</td> <td>6-10.5 (range)</td> </tr> <tr> <td>Electrical Conductivity</td> <td>20 dS/cm (20,000 µs/cm)</td> </tr> <tr> <td>Chloride*</td> <td>8000 mg/L</td> </tr> </tbody> </table> <p>*Chloride analysis is only required if an additive containing chloride was used in the drilling process</p> <p>The limits in Part A must be measured in the clarified filtrate of oversaturated solids prior to mixing.</p> <p>Part B If any of the following metals are a component of the drilling fluids, then for that metal:</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Maximum concentration</th> </tr> </thead> <tbody> <tr> <td>Arsenic</td> <td>20 mg/kg</td> </tr> <tr> <td>Selenium</td> <td>5 mg/kg</td> </tr> <tr> <td>Boron</td> <td>100 mg/kg</td> </tr> <tr> <td>Cadmium</td> <td>3 mg/kg</td> </tr> <tr> <td>Chromium (total)</td> <td>400 mg/kg</td> </tr> <tr> <td>Copper</td> <td>100 mg/kg</td> </tr> <tr> <td>Lead</td> <td>600 mg/kg</td> </tr> </tbody> </table> <p>The limits in Part B and Part C refer to the post soil/by-product mix.</p> <p>Part C If a hydrocarbon sheen is visible, the following hydrocarbon fractions:</p>	Parameter	Maximum concentration	pH	6-10.5 (range)	Electrical Conductivity	20 dS/cm (20,000 µs/cm)	Chloride*	8000 mg/L	Parameter	Maximum concentration	Arsenic	20 mg/kg	Selenium	5 mg/kg	Boron	100 mg/kg	Cadmium	3 mg/kg	Chromium (total)	400 mg/kg	Copper	100 mg/kg	Lead	600 mg/kg
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	TPH	Maximum concentration
	C6-C10	170 mg/kg
	C10-C16	150 mg/kg
	C16-C34	1300 mg/kg
	C34-C40	5600 mg/kg
	Total Polycyclic Aromatic Hydrocarbons (PAHs)	20 mg/kg
	Phenols (halogenated)	1 mg/kg
	Phenols (non-halogenated)	60 mg/kg
	Monocyclic aromatic hydrocarbons (Total sum of benzene, toluene, ethyl benzene, xylenes (includes ortho, para and meta xylenes) and styrene)	7 mg/kg
	Benzene	1 mg/kg
areas of pre-existing disturbance	means areas where environmental values have been negatively impacted as a result of anthropogenic activity and these impacts are still evident. Areas of pre-disturbance may include areas where legal clearing, logging, timber harvesting, or grazing activities have previously occurred, where high densities of weed or pest species are present which have inhibited re-colonisation of native regrowth, or where there is existing infrastructure (regardless of whether the infrastructure is associated with the authorised petroleum activities). The term 'areas of pre-disturbance' does not include areas that have been impacted by wildfire/s, controlled burning, flood or natural vegetation die-back.	
assessed or assessment	by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment: (a) exactly what has been assessed and the precise nature of that determination; (b) the relevant legislative, regulatory and technical criteria on which the assessment has been based; (c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and (d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.	
associated water	means underground water taken or interfered with, if the taking or interference happens during the course of, or results from, the carrying out of another authorised activity under a petroleum authority, such as a petroleum well, and includes waters also known as produced formation water. The term includes all contaminants suspended or dissolved within the water.	
associated works	in relation to a dam, means: (a) operations of any kind and all things constructed, erected or installed for that dam; and (b) any land used for those operations.	
Australian Standard 3580	means any of the following publications: • AS3580.10.1 Methods for sampling and analysis of ambient air—	

	<p>Determination of particulate matter—Deposited matter—Gravimetric method.</p> <ul style="list-style-type: none"> AS3580.9.6 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM10 high volume sampler with size-selective inlet—Gravimetric method AS3580.9.9 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM10 low volume sampler—Gravimetric sampler.
authorised resource activities	for this environmental authority means the resource activities authorised to be carried out under condition General 1.
background noise level	means the sound pressure level, measured in the absence of the noise under investigation, as the L A90,T being the A-weighted sound pressure level exceeded for 90% of the measurement time period T of not less than 15 minutes (or LA 90, adj, 15 mins), using Fast response.
bankfull	means the channel flow rate that exists when the water is at the elevation of the channel bank above which water begins to spill out onto the floodplain. The term describes the condition of the channel relative to its banks (e.g. overbank, in-bank, bankfull, low banks, high bank).
bed	<p>of any waters, has the meaning in Schedule 12 of the Environmental Protection Regulation 2008 and—</p> <p>(a) includes an area covered, permanently or intermittently, by tidal or non-tidal waters; but</p> <p>(b) does not include land adjoining or adjacent to the bed that is from time to time covered by floodwater.</p>
being or intended to be utilised by the landholder or overlapping tenure holder	<p>for significantly disturbed land, means there is a written agreement (e.g. land and compensation agreement) between the landholder or the overlapping tenure holder and the holder of the environmental authority identifying that the landholder or the overlapping tenure holder has a preferred use of the land such that rehabilitation standards for revegetation by the holder of the environmental authority are not required.</p> <p>for dams, means there is a written agreement (e.g. land and compensation agreement) between the landholder or the overlapping tenure holder and the holder of the environmental authority identifying that the landholder or the overlapping tenure holder has a preferred use for the dam such that rehabilitation standards for revegetation by the holder of the environmental authority are not required.</p>
biodiversity values	for the purposes of this environmental authority, means environmentally sensitive areas, Matters of State Environmental Significance, and wetlands
BTEX	means benzene, toluene, ethylbenzene, ortho-xylene, para-xylene, meta-xylene and total xylene.
Category A Environmentally Sensitive Area	means any area listed in Schedule 12, Section 1 of the Environmental Protection Regulation 2008.
Category B Environmentally Sensitive Area	means any area listed in Schedule 12, Section 2 of the Environmental Protection Regulation 2008.

<p>Category C Environmentally Sensitive Area</p>	<p>means any of the following areas:</p> <ul style="list-style-type: none"> • nature refuges as defined in the conservation agreement for that refuge under the <i>Nature Conservation Act 1992</i> • koala habitat areas as defined under the <i>Nature Conservation (Koala) Conservation Plan 2006</i> • state forests or timber reserves as defined under the <i>Forestry Act 1959</i> • regional parks (previously known as resource reserves) under the <i>Nature Conservation Act 1992</i> • an area validated as 'essential habitat' from ground-truthing surveys in accordance with the <i>Vegetation Management Act 1999</i> for a species of wildlife listed as endangered or vulnerable under the <i>Nature Conservation Act 1992</i> • 'of concern regional ecosystems' that are remnant vegetation and identified in the database called 'RE description database' containing regional ecosystem numbers and descriptions.
<p>certified or certification</p>	<p>in relation to any matter other than a design plan, 'as constructed' drawings or an annual report regarding dams means, a Statutory Declaration by a suitably qualified person or suitably qualified third party accompanying the written document stating:</p> <ul style="list-style-type: none"> • the person's qualifications and experience relevant to the function • that the person has not knowingly included false, misleading or incomplete information in the document • that the person has not knowingly failed to reveal any relevant information or document to the administering authority • that the document addresses the relevant matters for the function and is factually correct; and • that the opinions expressed in the document are honestly and reasonably held.
<p>certification</p>	<p>in relation to a design plan means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by this Manual, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A)).</p>
<p>certifying, certify or certified</p>	<p>have a corresponding meaning as 'certification'.</p>
<p>clearing</p>	<p>has the meaning in the dictionary of the <i>Vegetation Management Act 2000</i> and for vegetation—</p> <p>(a) means remove, cut down, ringbark, push over, poison or destroy in any way including by burning, flooding or draining; but</p> <p>(b) does not include destroying standing vegetation by stock, or lopping a tree.</p>
<p>closed-loop systems</p>	<p>means using waste on site in a way that does not release waste or contaminants in the waste to the environment.</p>
<p>coal seam gas water</p>	<p>means underground water brought to the surface of the earth, or moved underground in connection with exploring for, or producing coal seam gas.</p>
<p>coal seam gas water concentrate</p>	<p>means the concentrated saline water waste stream from a water treatment process that does not exceed a total dissolved solid</p>

	concentration of 40 000 mg/L.
coal seam gas evaporation dam	is defined as a impoundment, enclosure or structure that is designed to be used to hold coal seam gas water for evaporation.
consequence	in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.
consequence category	means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)</i> .
construction or constructed	in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.
control measure	has the meaning in section 47 of the Environmental Protection Regulation 2008 and means a device, equipment, structure, or management strategy used to prevent or control the release of a contaminant or waste to the environment.
critically limited regional ecosystem	means the regional ecosystems defined and listed in Appendix 5 of the Queensland Biodiversity Offset Policy.
daily peak design capacity	for sewage treatment works, has the meaning in Schedule 2, section 63(4) of the Environmental Protection Regulation 2008 as the higher equivalent person (EP) for the works calculated using each of the formulae found in the definition for EP.
dam(s)	means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and <u>associated works</u> .
dam crest volume	means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).
design plan	is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.
design storage allowance or DSA	means an available volume, estimated in accordance with the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)</i> published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an <u>annual exceedance probability (AEP)</u> specified in that Manual.
designer	for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.
declared pest species	has the meaning in the Land Protection (Pest and Stock Route Management) Regulation 2003 and is a live animal or plant declared to be a declared pest under section 36 (Declaring Pests by Regulation) or section 37(2) (Declaring Pest under Emergency Pest Notice) of that Act and includes reproductive material of the animal or plant.
declared plant pest species	has the meaning in the Land Protection (Pest and Stock Route Management) Regulation 2003 and is a plant declared to be a

	declared pest under section 36 (Declaring Pests by Regulation) or section 37(2) (Declaring Pest under Emergency Pest Notice) of that Act and includes reproductive material of the plant.
design storage allowance or DSA	means an available volume, estimated in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635), published by the administering authority, as amended from time to time, that must be provided in a dam to an annual exceedance probability specified in that Manual.
development wells	means a petroleum well which produces or stores petroleum. For clarity, a development well does not include an appraisal well.
document	has the meaning in the <i>Acts Interpretation Act 1954</i> and means: <ul style="list-style-type: none"> • any paper or other material on which there is writing; and • any paper or other material on which there are marks; and • figures, symbols or perforations having a meaning for a person qualified to interpret them; and • any disc, tape or other article or any material from which sounds, images, writings or messages are capable of being produced or reproduced (with or without the aid of another article or device).
ecologically dominant layer	has the meaning in the Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Version 3.2 August 2012) and means the layer making the greatest contribution to the overall biomass of the site and the vegetation community (NLWRA 2001). This is also referred to as the ecologically dominant stratum or the predominant canopy in woody ecosystems.
ecosystem function	means the interactions between and within living and nonliving components of an ecosystem and generally correlates with the size, shape and location of the vegetation community.
emergency action plan	means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact.
enclosed flare	means a device where the residual gas is burned in a cylindrical or rectilinear enclosure that includes a burning system and a damper where air for the combustion reaction is admitted.
environmental harm	has the meaning in section 14 of the <i>Environmental Protection Act 1994</i> and means any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance. Environmental harm may be caused by an activity— (a) whether the harm is a direct or indirect result of the activity; or (b) whether the harm results from the activity alone or from the combined effects of the activity and other activities or factors.
environmental nuisance	has the meaning in section 15 of the <i>Environmental Protection Act 1994</i> and means unreasonable interference or likely interference with an environmental value caused by— (a) aerosols, fumes, light, noise, odour, particles or smoke; or (b) an unhealthy, offensive or unsightly condition because of

	contamination; or (c) another way prescribed by regulation.
environmentally sensitive area	means Category A, B or C environmentally sensitive areas (ESAs)
equivalent person or EP	has the meaning under section 3 of the Planning Guidelines For Water Supply and Sewerage, 2005, published by the Queensland Government. It is calculated in accordance with Schedule 2, Section 63(4) of the Environmental Protection Regulation 2008 where: <ul style="list-style-type: none"> • $EP = V/200$ where V is the volume, in litres, of the average dry weather flow of sewage that can be treated at the works in a day; or • $EP = M/2.5$ where M is the mass, in grams, of phosphorus in the influent that the works are designed to treat as the inlet load in a day.
essential petroleum activities	means activities that are essential to bringing the resource to the surface and are only the following: <ul style="list-style-type: none"> • low impact petroleum activities • geophysical, geotechnical, geological, topographic and cadastral surveys (including seismic, sample /test / geotechnical pits, core holes) • single well sites not exceeding 1 hectare disturbance and multi-well sites not exceeding 1.5 hectare disturbance • well sites with monitoring equipment (including monitoring bores): <ul style="list-style-type: none"> ○ for single well sites, not exceeding 1.25 hectares disturbance ○ for multi-well sites, not exceeding 1.75 hectares disturbance • well sites with monitoring equipment (including monitoring bores) and tanks (minimum 1 ML) for above ground fluid storage: <ul style="list-style-type: none"> ○ for single well sites, not exceeding 1.5 hectares disturbance ○ for multi-well sites, not exceeding 2.0 hectares disturbance • associated infrastructure located on a well site necessary for the construction and operations of wells: <ul style="list-style-type: none"> ○ water pumps and generators ○ flare pits ○ chemical / fuel storages ○ sumps for residual drilling material and drilling fluids ○ tanks, or dams which are not significant or high consequence dams to contain wastewater (e.g. stimulation flow back waters, produced water) ○ pipe laydown areas ○ soil and vegetation stockpile areas ○ a temporary camp associated with a drilling rig that may involve sewage treatment works that are no release works ○ temporary administration sites and warehouses ○ dust suppression activities using water that meets the quality and operational standards approved under the environmental authority • communication and power lines that are necessary for the undertaking of petroleum activities and that are located within well sites, well pads and pipeline right of ways without increasing the disturbance area of petroleum activities • supporting access tracks • gathering / flow pipelines from a well head to the initial compression facility • activities necessary to achieve compliance with the conditions of

	the environmental authority in relation to another essential petroleum activity (e.g. sediment and erosion control measures, rehabilitation).
existing structure	means a structure that was in existence prior to the adoption of this schedule of conditions under the authority or whose design plan has substantially commenced.
exploration well	means a petroleum well that is drilled to: <ul style="list-style-type: none"> • explore for the presence of petroleum or natural underground reservoirs suitable for storing petroleum; or • obtain stratigraphic information for the purpose of exploring for petroleum. For clarity, an exploration well does not include an appraisal or development well.
extreme storm storage	means a storm storage allowance determined in accordance with the criteria in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)</i> published by the administering authority
flare pit	has the meaning in the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635), and means containment area where any hydrocarbon that is discovered in an over-pressured reservoir during a drilling operation is diverted to, and combusted, The flare pit is only used during the drilling and work over process on a petroleum well.
flare precipitant	means waste fluids which result from the operation of a flare.
floodplains	has the meaning in the <i>Water Act 2000</i> and means an area of reasonably flat land adjacent to a watercourse that— <ul style="list-style-type: none"> • is covered from time to time by floodwater overflowing from the watercourse; and • does not, other than in an upper valley reach, confine floodwater to generally follow the path of the watercourse; and • has finer sediment deposits than the sediment deposits of any bench, bar or in-stream island of the watercourse.
flowable substance	means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.
fuel burning or combustion facility	means a permanent fuel burning or combustion equipment which in isolation, or combined in operation, or which are interconnected, is, or are capable of burning more than 500 kg of fuel in an hour.
GDA	means Geocentric Datum of Australia.
Great Artesian Basin (GAB) spring	means an area protected under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> because it is considered to be a Matter of National Environmental Significance and identified as a: <ul style="list-style-type: none"> • community of native species dependent on natural discharge of groundwater from the Great Artesian Basin; or • Great Artesian Basin spring; or • Great Artesian Basin discharge spring wetland. <p>A GAB spring includes a spring vent, spring complex or watercourse spring and includes the land to which water rises naturally from below the ground and the land over which the water then flows.</p>

	<p><i>Note: The Australian Government’s Protected Matters Search Tool should be used to get an indication of whether the area of interest may contain an MNES spring.</i></p> <p><i>Note: The GAB springs dataset can be requested from the Queensland Government Herbarium</i></p>
green waste	means waste that is grass cuttings, trees, bushes, shrubs, material lopped from trees, untreated timber or other waste that is similar in nature but does not include declared pest species.
greywater	means wastewater generated from domestic activities such as laundry, dishwashing, and bathing. Greywater does not include sewage.
groundwater dependent ecosystem	means ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. For the purposes of the environmental authority, groundwater dependent ecosystems do not include those mapped as “unknown”.
growing	means to increase by natural development, as any living organism or part thereof by assimilation of nutriment; increase in size or substance.
holder	means any person who is the holder of, or is acting under, that environmental authority.
hydraulic integrity	refers to the capacity of a dam to contain or safely pass flowable substances based on its design.
hydraulic performance	means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)</i> .
impulsive (for noise)	means sound characterised by brief excursions of sound pressure (acoustic impulses) that significantly exceed the background sound pressure. The duration of a single impulsive sound is usually less than one second.
incidental activity	for this environmental authority means an activity that is reasonably necessary for carrying out a petroleum activity.
L _{A90} , adj, 15 mins	means the A-weighted sound pressure level, adjusted for tonal character that is equal to or exceeded for 90% of any 15 minutes sample period equal, using Fast response.
L _{Aeq} , adj, 15 mins	means the A-weighted sound pressure level of a continuous steady sound, adjusted for tonal character, that within any 15 minute period has the same square sound pressure as a sound level that varies with time.
land degradation	<p>has the meaning in the <i>Vegetation Management Act 1999</i> and means the following:</p> <ul style="list-style-type: none"> • soil erosion • rising water tables • the expression of salinity • mass movement by gravity of soil or rock • stream bank instability • a process that results in declining water quality.

land-based offset	means direct offsets, indirect offsets, or offset transfers.
landholder's active groundwater bore	means bores that are able to continue to provide a reasonable yield of water in terms of quantity for the bores authorised purpose or use. This term does not include monitoring bores owned by the administering authority of the <i>Water Act 2000</i> .
legally secured	in relation to land-based offsets means any of the following legally binding mechanisms: <ul style="list-style-type: none"> • gazetted as a protected area (e.g., a nature refuge) under the <i>Nature Conservation Act 1992</i> • declaration of an area of high nature conservation values under the <i>Vegetation Management Act 1999</i> • use of a covenant under the <i>Land Title Act 1994</i> or <i>Land Act 1994</i> • other mechanism administered and approved by the State.
levee	means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of <u>water</u> or <u>flowable substances</u> at any other times.
linear infrastructure	means powerlines, pipelines, flowlines, roads and access tracks.
liquid	means a substance which is flowing and offers no permanent resistance to changes of shape.
long term noise event	means a noise exposure, when perceived at a sensitive receptor, persists for a period of greater than five (5) days, even when there are respite periods when the noise is inaudible within those five (5) days.
low consequence dam	means any dam that is not classified as high or significant as assessed using the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures, published by the administering authority, as amended from time to time.
low impact petroleum activities	means petroleum activities which do not result in the clearing of native vegetation, cause disruption to soil profiles through earthworks or excavation or result in significant disturbance to land which cannot be rehabilitated immediately using hand tools after the activity is completed. Examples of such activities include but are not necessarily limited to soil surveys (excluding test pits), topographic surveys, cadastral surveys and ecological surveys, may include installation of monitoring equipment provided that it is within the meaning of low impact and traversing land by car or foot via existing access tracks or routes or in such a way that does not result in permanent damage to vegetation.
mandatory reporting level or MRL	means a warning and reporting level determined in accordance with the criteria in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)</i> published by the administering authority.
manual	means the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)</i> published by the administering authority.
Map of referable wetlands	has the meaning in Schedule 12 of the Environmental Protection Regulation 2008 and means the 'Map of referable wetlands', a document approved by the chief executive on 4 November 2011 and

	published by the department, as amended from time to time by the chief executive under section 144D.
Matters of State Environmental Significance	are those matters listed in Schedule 2 of the Environmental Offsets Regulation 2014.
Max $L_{pA, 15 \text{ min}}$	means the absolute maximum instantaneous A-weighted sound pressure level, measured over 15 minutes.
Max $L_{pZ, 15 \text{ min}}$	means the maximum value of the Z-weighted sound pressure level measured over 15 minutes.
medium term noise event	is a noise exposure, when perceived at a sensitive receptor, persists for an aggregate period not greater than five (5) days and does not re-occur for a period of at least four (4) weeks. Re-occurrence is deemed to apply where a noise of comparable level is observed at the same receptor location for a period of one hour or more, even if it originates from a difference source or source location.
methodology	means the science of method, especially dealing with the logical principles underlying the organisation of the various special sciences, and the conduct of scientific inquiry.
mix-bury-cover method	means the stabilisation of residual drilling solids in the bottom of a sump by mixing with subsoil and which occurs in accordance with the following methodology: <ul style="list-style-type: none"> • the base of the subsoil and residual solid mixture must be separated from the groundwater table by at least one metre of a continuous layer of impermeable subsoil material ($k_w=10-8\text{m/s}$) or subsoil with a clay content of greater than 20%; and • the residual solids is mixed with subsoil in the sump and cover; and • the subsoil and residual solids is mixed at least three parts subsoil to one part waste (v/v); and • a minimum of one metre of clean subsoil must be placed over the subsoil and residual solids mixture; and • topsoil is replaced.
modification or modifying	(see definition of 'construction')
month	has the meaning in the <i>Acts Interpretation Act 1954</i> and means a calendar month and is a period starting at the beginning of any day of one (1) of the 12 named months and ending— <ul style="list-style-type: none"> • immediately before the beginning of the corresponding day of the next named month; or • if there is no such corresponding day—at the end of the next named month.
NATA accreditation	means accreditation by the National Association of Testing Authorities Australia.
operational plan	In relation to dams includes: <p>(a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA allowance);</p> <p>(b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.</p>
petroleum activity	for this environmental authority means an authorised resource

	activity listed under the heading “Petroleum activities” in General Schedule, Table 1 - Authorised Petroleum Activities.
pipeline waste water	means hydrostatic testing water, flush water or water from low point drains.
pre-disturbed land use	means the function or use of the land as documented prior to significant disturbance occurring at that location.
predominant species	has the meaning in the Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Version 3.2 August 2012) and means a species that contributes most to the overall above-ground biomass of a particular stratum.
prescribed contaminants	has the meaning in section 440ZD of the <i>Environmental Protection Act 1994</i> and means: (a) earth; or (a) a contaminant prescribed under section 440ZF.
primary protection zone	means an area within 200m from the boundary of any Category A, B or C ESA.
principal authorised activity	means an authorised activity listed under the heading “Principal authorised activities” in General Schedule, Table 1 - Authorised Petroleum Activities.
produced water	has the meaning in Section 15A of the <i>Petroleum and Gas (Production and Safety) Act 2004</i> and means CSG water or associated water for a petroleum tenure.
project area	for this environmental authority means the following tenures: Authorities to Prospect (ATP) 1103, 1031, 1025, 759; and Authorities to Prospect Applications (ATPA) 742, 749.
protection zone	means the primary protection zone of any Category A, B or C ESA or the secondary protection zone of any Category A or B ESA.
regional ecosystem	has the meaning in the Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Version 3.2 August 2012) and means a vegetation community in a bioregion that is consistently associated with a particular combination of geology, landform and soil. Regional ecosystems of Queensland were originally described in Sattler and Williams (1999). The Regional Ecosystem Description Database (Queensland Herbarium 2013) is maintained by Queensland Herbarium and contains the current descriptions of regional ecosystems.
register of regulated dams	includes: (a) Date of entry in the register; (b) Name of the dam, its purpose and intended/actual contents; (c) The consequence category of the dam as assessed using the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635); (d) Dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the dam; (e) Name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings; (f) For the regulated dam, other than in relation to any levees – i. The dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam; ii. Coordinates (latitude and longitude in GDA94) within five metres at

	<p>any point from the outside of the dam including its storage area</p> <ul style="list-style-type: none"> iii. Dam crest volume (megalitres); iv. Spillway crest level (metres AHD). v. Maximum operating level (metres AHD); vi. Storage rating table of stored volume versus level (metres AHD); vii. Design storage allowance (megalitres) and associated level of the dam (metres AHD); viii. Mandatory reporting level (metres AHD); <ul style="list-style-type: none"> (g) The design plan title and reference relevant to the dam; (h) The date construction was certified as compliant with the design plan; (i) The name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan; (j) Details of the composition and construction of any liner; (k) The system for the detection of any leakage through the floor and sides of the dam; (l) Dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year; (m) Dates when recommendations and actions arising from the annual inspection were provided to the administering authority; (n) Dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.
regulated dam	means any dam in the significant or high consequence category as assessed using the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635), published by the administering authority, as amended from time to time.
Regulated structure	includes land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity.
rehabilitation or rehabilitated	means the process of reshaping and revegetating land to restore it to a stable landform and in accordance with acceptance criteria and, where relevant, includes remediation of contaminated land. For the purposes of pipeline rehabilitation, rehabilitation includes reinstatement, revegetation and restoration.
reinstate or reinstatement	for pipelines, means the process of bulk earth works and structural replacement of pre-existing conditions of a site (i.e. soil surface topography, watercourses, culverts, fences and gates and other landscape(d) features) and is detailed in the Australian Pipeline Industry Association (APIA) Code of Environmental Practice: Onshore Pipelines (2013).
reporting limit	means the lowest concentration that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions. For many analytes, the reporting limit is selected as the lowest non-zero standard in the calibration curve. Results that fall below the reporting limit will be reported as “less than” the value of the reporting limit. The reporting limit is also referred to as the practical quantitation limit or the limit of quantitation. For polycyclic aromatic hydrocarbons, the reporting limit must be based on super-ultra trace methods and, depending on the specific polycyclic aromatic hydrocarbon, will range between 0.005 µg/L–0.02 µg/L.
residual drilling	means waste drilling materials including muds and cuttings or cement

material	returns from well holes and which have been left behind after the drilling fluids are pumped out.
restoration	means the replacement of structural habitat complexity, ecosystem processes, services and function from a disturbed or degraded site to that of a pre-determined or analogue site. For the purposes of pipelines, restoration applies to final rehabilitation after pipeline decommissioning.
restricted stimulation fluids	has the meaning in section 206 of the <i>Environmental Protection Act 1994</i> and means fluids used for the purpose of stimulation, including fracturing, that contain the following chemicals in more than the maximum amount prescribed under a regulation— (o) petroleum hydrocarbons containing benzene, ethylbenzene, toluene or xylene a) (b) chemicals that produce, or are likely to produce, benzene, ethylbenzene, toluene or xylene as the chemical breaks down in the environment.
revegetation or revegetating or revegetate	means to actively re-establish vegetation through seeding or planting techniques in accordance with site specific management plans.
secondary protection zone	in relation to a Category A or Category B ESA means an area within 100 metres from the boundary of the primary protection zone.
secondary treated class A standards	means treated sewage effluent or greywater which meets the following standards: <ul style="list-style-type: none"> • total phosphorous as P, maximum 20mg/L • total nitrogen as N, maximum 30mg/L • 5-day biochemical oxygen demand (inhibited) (e.g. release pipe from sewage treatment plant), maximum 20mg/L • suspended solids, maximum 30mg/L • pH, range 6.0 to 8.5 • e-coli, 80th percentile based on at least 5 samples with not less than 30 minutes between samples, 100cfu per 100mL, maximum 1000cfu per 100mL.
secondary treated class B standards	means treated sewage effluent or greywater which meets the following standards: <ul style="list-style-type: none"> • total phosphorous as P, maximum 20mg/L • total nitrogen as N, maximum 30mg/L • 5-day biochemical oxygen demand (inhibited) (e.g. release pipe from sewage treatment plant), maximum 20mg/L • suspended solids, maximum 30mg/L • pH, range 6.0 to 8.5 • e-coli, 80th percentile based on at least 5 samples with not less than 30 minutes between samples, 1000cfu per 100mL, maximum 10 000cfu per 100mL.
secondary treated class C standards	means treated sewage effluent or greywater which meets the following standards: <ul style="list-style-type: none"> • total phosphorous as P, maximum 20mg/L • total nitrogen as N, maximum 30mg/L • 5-day biochemical oxygen demand (inhibited) (e.g. Release pipe from sewage treatment plant), maximum 20mg/L • suspended solids, maximum 30mg/L • pH, range 6.0 to 8.5 • e-Coli, 80th percentile based on at least 5 samples with not less

	than 30 minutes between samples, 10 000cfu per 100mL, maximum 100 000cfu per 100mL.
sensitive place	<p>means:</p> <ul style="list-style-type: none"> • a dwelling (including residential allotment, mobile home or caravan park, residential marina or other residential premises, motel, hotel or hostel) • a library, childcare centre, kindergarten, school, university or other educational institution • a medical centre, surgery or hospital • a protected area • a public park or garden that is open to the public (whether or not on payment of money) for use other than for sport or organised entertainment • a work place used as an office or for business or commercial purposes, which is not part of the petroleum activity(ies) and does not include employees accommodation or public roads • for noise, a place defined as a sensitive receptor for the purposes of the Environmental Protection (Noise) Policy 2008.
sensitive receptor	is defined in Schedule 2 of the Environmental Protection (Noise) Policy 2008, and means an area or place where noise is measured.
short term noise event	is a noise exposure, when perceived at a sensitive receptor, persists for an aggregate period not greater than eight hours and does not re-occur for a period of at least seven (7) days. Re-occurrence is deemed to apply where a noise of comparable level is observed at the same receptor location for a period of one hour or more, even if it originates from a different source or source location.
significantly disturbed or significant disturbance or significant disturbance to land or areas	has the meaning in Schedule 12, section 4 of the Environmental Protection Regulation 2008. Land is significantly disturbed if— <ul style="list-style-type: none"> (a) it is contaminated land; or (b) it has been disturbed and human intervention is needed to rehabilitate it— <ul style="list-style-type: none"> (a) to a condition required under the relevant environmental authority; or (ii) if the environmental authority does not require the land to be rehabilitated to a particular condition—to the condition it was in immediately before the disturbance.
significant residual impacts	has the meaning defined in section 8 of the <i>Environmental Offsets Act 2014</i> .
species richness	means the number of different species in a given area.
specified relevant activity	for this environmental authority means an activity that: <ul style="list-style-type: none"> (a) but for being carried out as a resource activity, would otherwise be a prescribed ERA; (b) stimulation activities; (c) point source discharge of treated produced water to surface waters; (d) storing waste that is not regulated waste (including coal seam gas water) in a regulated dam; (e) storing coal seam gas water that is not regulated waste in a low hazard / consequence dam; or (f) borrow pits or quarries that extract more than 5000 tonnes of material in the project area.
spillway	means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the dam, normally under flood

	conditions or in anticipation of flood conditions.
stable	has the meaning in Schedule 5 of the Environmental Protection Regulation 2008 and, for a site, means the rehabilitation and restoration of the site is enduring or permanent so that the site is unlikely to collapse, erode or subside.
statement of compliance	for a condition in an environmental authority has the meaning in section 208 of the <i>Environmental Protection Act 1994</i> and is a condition that requires the holder to give the administering authority a statement of compliance about a document or work relating to a relevant activity. The condition must also state— (a) the criteria (the compliance criteria) the document or work must comply with; and (b) that the statement of compliance must state whether the document or work complies with the compliance criteria; and (c) the information (the supporting information) that must be provided to the administering authority to demonstrate compliance with the compliance criteria; and (d) when the statement of compliance and supporting information must be given to the administering authority.
stimulation	means a technique used to increase the permeability of natural underground reservoir that is undertaken above the formation pressure and involves the addition of chemicals. It includes hydraulic fracturing / hydrofracking, fracture acidizing and the use of proppant treatments. This definition is restricted from that in the <i>Petroleum and Gas (Production and Safety) Act 2004</i> in order to only capture the types of stimulation activities that pose a risk to environmental values of water quality in aquifers.
stimulation fluid	means the fluid injected underground to increase permeability. For clarity, the term stimulation fluid only applies to fluid injected down well post-perforation.
stimulation impact zone	means a 100m maximum radial distance from the stimulation target location within a gas producing formation.
structure	means a dam or levee.
subterranean cave GDE	<ul style="list-style-type: none"> • means an area identified as a subterranean cave in the mapping produced by the Queensland Government and identified in the Queensland Government Information System, as amended from time to time; and • means a cave ecosystem which requires access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain its communities of plants and animals, ecological processes and ecosystem services. Subterranean cave GDEs are caves dependent on the subterranean presence of groundwater. Subterranean cave GDEs have some degree of groundwater connectivity and are indicated by either high moisture levels or the presence of stygofauna, or both, referred to in the Queensland Government WetlandsInfo mapping program, as amended from time to time. <p><i>Note: the Subterranean GDE (caves) dataset can be displayed through the Queensland Government WetlandInfo mapping program.</i> <i>Note: the Subterranean GDE (caves) dataset can be obtained from the Queensland Government Information System.</i></p>
suitably qualified	in relation to regulated structures means a person who is a

and experienced person	<p>Registered Professional Engineer of Queensland (RPEQ) under the provisions of the <i>Professional Engineers Act 2002</i>, and has demonstrated competency and relevant experience:</p> <ul style="list-style-type: none"> • for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design. • for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments. <p>Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.</p>
suitably qualified person	means a person who has professional qualifications, training or skills or experience relevant to the nominated subject matters and can give authoritative assessment, advice and analysis about performance relevant to the subject matters using relevant protocols, standards, methods or literature.
suitably qualified third party	<p>means a person who:</p> <p>(a) has qualifications and experience relevant to performing the function including but not limited to:</p> <ol style="list-style-type: none"> i. a bachelor's degree in science or engineering; and ii. 3 years' experience in undertaking soil contamination assessments; and <p>(b) is a member of at least one organisation prescribed in Schedule 8 of the Environmental Protection Regulation 2008; and</p> <p>(c) not be an employee of, nor have a financial interest or any involvement which would lead to a conflict of interest with the holder(s) of the environmental authority.</p>
sump	means a pit in which waste residual drilling material or drilling fluids are stored only for the duration of drilling activities.
synthetic oil-based drilling mud	means a mud where the base fluid is a synthetic oil, consisting of chemical compounds which are artificially made or synthesised by chemically modifying petroleum components or other raw materials rather than the whole crude oil.
system design plan	means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.
top soil	means the surface (top) layer of a soil profile, which is more fertile, darker in colour, better structured and supports greater biological activity than underlying layers. The surface layer may vary in depth depending on soil forming factors, including parent material, location and slope, but generally is not greater than about 300mm in depth from the natural surface.
total density of coarse woody material	means the total length of logs on the ground greater than or equal to 10cm diameter per hectare and number of logs on the ground greater than or equal to 10cm diameter per hectare.
transmissivity	means the rate of flow of water through a vertical strip of aquifer which is one unit wide and which extends the full saturated depth of the aquifer.
underground gas storage	means evaluating, developing and using natural underground reservoirs for petroleum storage or to store prescribed storage gases, including, for example, to store petroleum or prescribed storage gases for others.

valid complaint	means all complaints unless considered by the administering authority to be frivolous, vexatious or based on mistaken belief.
void	means any constructed, open excavation in the ground.
waste and resource management hierarchy	has the meaning provided in section 9 of the <i>Waste Reduction and Recycling Act 2011</i> and is the following precepts, listed in the preferred order in which waste and resource management options should be considered— (a) AVOID unnecessary resource consumption (b) REDUCE waste generation and disposal (c) RE-USE waste resources without further manufacturing (d) RECYCLE waste resources to make the same or different products (e) RECOVER waste resources, including the recovery of energy (f) TREAT waste before disposal, including reducing the hazardous nature of waste (g) DISPOSE of waste only if there is no viable alternative.
waste and resource management principles	has the meaning provided in section 4(2)(b) of the <i>Waste Reduction and Recycling Act 2011</i> and means the: (a) polluter pays principle (b) user pays principle (c) proximity principle (d) product stewardship principle.
waste fluids	has the meaning in section 13 of the <i>Environmental Protection Act 1994</i> in conjunction with the common meaning of “fluid” which is “a substance which is capable of flowing and offers no permanent resistance to changes of shape”. Accordingly, to be a waste fluid, the waste must be a substance which is capable of flowing and offers no permanent resistance to changes of shape.
watercourse	has the meaning in Schedule 4 of the <i>Environmental Protection Act 1994</i> and means: 1) a river, creek or stream in which water flows permanently or intermittently— (a) in a natural channel, whether artificially improved or not; or (b) in an artificial channel that has changed the course of the watercourse. 2) Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.
waters	includes all or any part of a creek, river, stream, lake, lagoon, swamp, wetland, spring, unconfined surface water, unconfined water in natural or artificial watercourses, bed and bank of any waters, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and underground water.
water year	means the 12-month period from 1 July to 30 June.
well integrity	the ability of a well to contain the substances flowing through it.
wet season	means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

wetland	<p>for the purpose of this environmental authority, wetland means:</p> <ul style="list-style-type: none"> • areas shown on the Map of referable wetlands which is a document approved by the chief executive on 4 November 2011 and published by the department, as amended from time to time by the chief executive under section 144D of the Environmental Protection Regulation 2008; and • areas defined under the Queensland Wetlands Program as permanent or periodic / intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six (6) metres, and possess one or more of the following attributes: <ul style="list-style-type: none"> ○ at least periodically, the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle, or ○ the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers, or ○ the substratum is not soil and is saturated with water, or covered by water at some time. <p>The term wetland includes riverine, lacustrine, estuarine, marine and palustrine wetlands; and it does not include a Great Artesian Basin Spring or a subterranean wetland that is a cave or aquifer.</p>
wetland of high ecological significance	means a wetland that meets the definition of a wetland and that is shown as a wetland of 'high ecological significance' or wetland of 'high ecological value' on the Map of referable wetlands.
wetland of other environmental value	means a wetland that meets the definition of a wetland and that is shown as a wetland of 'general environmental significance' or wetland of 'other environmental value' on the Map of referable wetlands.

Applications for an Environmental Authority, *Environmental Protection Act 1994*

Requirements

EHP requires the proponent, prior to submitting an EA application to ensure that the application contains sufficiently detailed information about the project, the impacts and the proposed mitigation measures at a scale suitable for assessment and regulation of the proposed activity.

While there is a substantial body of information in the EIS documents relevant to an application for an environmental authority for carrying out petroleum activities, it would need to be modified and supplemented with detailed activity and site specific information in an application. The EA application would need to provide the detailed information about CSG management in accordance with s126 of the EP Act. The proponent should refer to Part 3 of the EHP guideline "Application requirements for petroleum activities" (EM705) in preparing an EA application.

In the EIS documents, the proponent has committed to providing the following relevant information in its response to comments on the EIS. EHP requires the proponent to provide this information as part of its application under s126 of the EP Act.

Information to be provided would include

- location of major infrastructure, such as gas compression plants, water treatments plants and accommodation camps, and the potential impacts of these locations on environmental values.
- site selection of infrastructure in consideration of:
 - impacts of disturbance on ESAs
 - impacts of power distribution infrastructure on Category C ESAs (State forests)
 - impacts of wells and gathering networks on terrestrial ecology (animal habitat and breeding places, protected plants)

- application of the avoid, minimise, mitigate hierarchy for proposed disturbance
- identification, through ground-truthing where possible, of regional ecosystems to be disturbed
- identification of proposed disturbance to areas of high ecological significance including those protected under the NC Act, EPBC Act and wetlands.
- site-specific CSG water management options including details of proposed beneficial use schemes or releases to watercourses.
- to determine appropriate water quality criteria for the proposed discharge water, either (1) a baseline assessment of receiving water quality, (minimum of 18 data sets from one or two reference sites, or 12 data points from three or more reference sites, over a minimum period of 12 months, ideally under base flow (ambient) conditions) be undertaken to provide a basis for deriving site-specific guideline values for individual surface water quality parameters, or (2) appropriate ANZECC water quality criteria are applied.
- proposed discharge water quality - based on the CSG water quality described in the EIS documents, it is unlikely untreated CSG water would meet the discharge criteria and hence, only treated CSG water would be considered for potential discharge.
- ecological survey data for reaches of watercourses proposed to receive discharges to account for the natural variability in aquatic ecosystems (seasonal and flow related).
- detailed environmental flows assessment informed by water quality monitoring and aquatic ecology assessments, including consideration of the sensitivity of species to variation in hydrology and geomorphology (e.g. cover, water quality, food supply, breeding, movement patterns).
- assessment of proposed CSG water discharge scenarios, using information on natural flow regime, water quality, and expected discharge water quality, to derive expected dilution rates for potential contaminants and the extent of the mixing zone.
- assessment of the overall project water balance to demonstrate that the proposed discharge options assessed, and proposed limits to receiving water quality and flow rate change, could be implemented throughout the life of the project, having regard to potential changes in beneficial use demand (e.g. stakeholder water demand).
- site-specific assessment of the potential ecological impact of changes in water quality (physical and chemical stressors, and toxicants) resulting from discharge of treated and untreated CSG water.
- site-specific assessment of the long-term impacts of flow regime variation, during the operational phase and after decommissioning, on aquatic ecosystems and riparian habitat, including reduced duration or frequency of natural cease to flow events. Particular consideration should be given to: known aquatic conservation values; the life-cycle sensitivities of species of conservation significance; and the response by exotic species to changed conditions.
- identification of reaches vulnerable to bank erosion resulting either directly from the discharge of CSG water, or from altered flow regimes leading to increased susceptibility to flood-induced erosion of channels downstream of discharge points, and proposed site-specific erosion control measures for vulnerable reaches.
- assessment of the potential impact of changes in water quality on downstream water users, including potable water use.
- assessment of the impact of proposed discharges on downstream vehicle and stock crossings and proposed management measures to reduce disruption to existing access arrangements.
- assessment of the potential cumulative impact of CSG water discharges from the project and approved discharges from other CSG and coal mining activities in the catchment, with consideration of changes to hydrology, geomorphology, water quality, and potential impacts to aquatic ecology (aquatic and riparian habitat, native species, exotic species) and water users at a local and catchment scale.
- proposed discharge water quality parameters and limits, location of discharge points, discharge rates, and receiving water quality monitoring parameters, locations, objectives and limits forming part of a strategy for the discharge of CSG water to watercourses in accordance with requirements of the EP Act and the Queensland Government's Coal Seam Gas Water Management Policy.
- site-specific details of the groundwater monitoring program including
 - locations of monitoring wells, including those proposed as leak detection bores around dams
 - frequency of monitoring
 - quality parameters of concern that should be monitored.
- consideration of residual impacts on State Significant Biodiversity Values under the Queensland Biodiversity Offsets Policy and potential provision of offsets.
- site-specific noise and vibration assessment for each proposed infrastructure location.
- details of the proposed management of sewage
- details of the management practices proposed to prevent and minimise environmental harm caused by uncontrolled release of waste
- site-specific air quality assessment for each proposed infrastructure location that describes point source and fugitive emissions.

- consideration of bioaccumulation of chemicals in the environment from discharges of hydrotest water, sewage, CSG water and runoff
- description of the minimisation and management of any waste generated by the activities, including details of the proposed reuse of soils, drill cutting, hydrostatic test water and waste or washout liquids.
- generation and management of hydrostatic test water including quantity, source, quality and additives, storage and disposal.
- details of the proposed ERAs to be included in the project.
- details of the proposed notifiable activities to be included in the project.
- specification of the existing and proposed infrastructure to allow EHP to consider the scale and intensity of the project.
- details of CSG water management infrastructure including identification of beneficial use infrastructure for both CSG water and salt/brine.
- details of a greenhouse gas management strategy including potential impacts of the project on state and national GHG inventories, best practice methods for minimisation of GHG emissions and commitments to continuous improvement of GHG emissions.
- details of existing contaminated land parcels on the Environmental Management or Contaminated Land Registers, and identification of the notifiable activities and locations that will require listing on these registers.
- details of land management strategies including soil and topsoil handling and management, and erosion and sediment control measures.
- identification of sensitive receptors and potential impacts on sensitive receptors including land, water, air, noise, waste and visual amenity.
- identification of flood plains and site selection of infrastructure with regard to minimisation of the impacts of flooding.
- details of discharges/releases of water including:
 - exact location of release point with description including environmental values of the release point and reasoning for site selection based on risk assessment of impacts to environmental values
 - source of release water including quantity and quality
 - proposed monitoring program including parameters, frequency and locations with program review procedures to ascertain effectiveness of the program.
- consideration of impacts on groundwater dependent ecosystems within the project footprint.
- details of site-specific groundwater environmental values, potential impacts on groundwater environmental values and mitigation measures including groundwater monitoring programs for all major infrastructures.
- details of rehabilitation plan including:
 - rehabilitation hierarchy for post-rehabilitation outcome/land use
 - rehabilitation methods including site preparation and revegetation activities
 - rehabilitation goals including establishing final land use in consultation with landholders and EHP, identifying analogue sites to measure rehabilitation success, indicators of rehabilitation success
 - monitoring program
 - progressive rehabilitation and timeframes for commencement of rehabilitation activities.

Appendix 4 MNES Assessment Report - EPBC Act

On 15 June 2012, the proposed Arrow Bowen Gas Project (the project) was determined a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) due to likely significant impacts on

- Listed threatened species and communities (ss 18 & 18A)
- Listed migratory species (ss 20 & 20A).

On 22 June 2013, the *Environment Protection and Biodiversity Conservation Amendment Act 2013* (Cth) (Amendment Act) commenced, introducing a new matter of national environmental significance (MNES) for coal seam gas and large coal mining development that is likely to have a significant impact on a water resource.

On 17 October 2013, the Minister for the Environment determined that there was likely to be a significant impact on water resources as the action involves coal seam gas (CSG) development or large coal mining development (ss 24D & 24E of the EPBC Act) and the project requires assessment and approval for this controlling provision before it can proceed.

Mandatory Considerations – section 136(1)(a) Part 3 controlling provisions

The proposal was determined a controlled action under the following controlling provisions of the EPBC Act

- Listed threatened species and communities (sections 18 and 18A) detailed in Table 1 below
- Listed migratory species (sections 20 and 20A)

The proponent identified the following migratory species as potentially present within the project area

- Lathams Snipe, Japanese Snipe (*Gallinago hardwickii*)
- Australian Painted Snipe (*Rostratula australis*)
- Eastern Great Egret (*Ardea modesta*)
- Cattle Egret (*Ardea ibis*)
- Rainbow Bee-eater (*Merops ornatus*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Spectacled Monarch (*Symposiachrus trivirgatus*)
- Satin Flycatcher (*Myiagra cyanoleuca*)
- Rufous Fantail (*Rhipidura rufifrons*)
- Fork-tailed Swift (*Apus pacificus*)
- White-tailed Needletail (*Hirundapus caudacutus*)
- White-bellied Sea-eagle (*Haliaeetus leucogaster*)

The following migratory bird species, were observed within the project area

- Australian Painted Snipe (*Rostratula australis*)
- Eastern Great Egret (*Ardea modesta*)
- Cattle Egret (*Ardea ibis*); and
- Rainbow Bee-eater (*Merops ornatus*)
- A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).

Species not considered – listed threatened species and communities (section 18 and 18A)

In accordance with section 158A of the EPBC Act, only species and communities listed under the EPBC Act at the time of the controlled action decision (15 June 2012) can be considered in the assessment of project impacts. Due to changes to the threatened species and communities list since the controlled action decision of 15 June 2012 the Australian Government no longer has a role in the protection of the listed threatened species listed below. No assessment of the impacts of the proposed action on these species will be undertaken under the EPBC Act.

- Brigalow scaly-foot (*Paradelma orientalis*) delisted (previously vulnerable)

- Stripe-tailed delma (*Delma labialis*) delisted (previously vulnerable)
- Wardell's wattle (*Acacia wardellii*) delisted (previously vulnerable)
- *Acacia ramiflora* delisted (previously vulnerable)
- *Croton magneticus* delisted (previously vulnerable)
- Finger Panic grass (*Digitaria porrecta*) delisted (previously endangered)
- *Leucopogon cuspidatus* delisted (previously vulnerable)
- *Trigonostemon inopinatus* delisted (previously vulnerable)
- Minute orchid (*Taeniophyllum muelleri*) delisted (previously vulnerable)

Disturbance limits

Due to the nature of the proposed CSG development, the actual construction footprint for the life of the project was not fully defined by the EIS documents. The proponent estimated disturbance limits for potential habitat for listed threatened species and communities based on a proposed field layout, the application of LIDAR, Queensland regional ecosystem (RE) mapping and other relevant desktop sources of habitat information, and an assumption of the level of confidence for all desktop data sources. A conceptual footprint was designed for the project as the basis for calculation of the likely potential whole of project maximum disturbance area for threatened ecological communities (TECs) and the habitat of threatened species in the categories of Core Habitat Known and Core Habitat Possible.

Core Habitat Known: the SREIS has defined Core Habitat Known as known recent records (since 1980) or confirmed sightings, generally buffered by a 1km radius. May also include remnant or regrowth vegetation contiguous with areas where known sightings have occurred.

Core Habitat Possible: the SREIS has defined Core Habitat Possible as areas of potential habitat with a number of features or values known to contribute to, or be important for the occupation of the species.

The SREIS noted that 100% of Core Habitat Known would be retained.

The DOE has requested that a maximum impact scenario is used in estimating whole of project disturbance limits for Core Habitat Possible for listed threatened species and TECs.

Based on surveys and habitat modelling undertaken for the project area, and the conceptual project disturbance area, the proponent estimated potential maximum disturbance to Core Habitat Possible for the following listed threatened species and TECs considered known or likely to occur on the project site.

Table 1 Listed threatened species and communities

Terrestrial species	Maximum disturbance of Core Habitat Known combined with Core Habitat Possible (hectares)
Black Ironbox (<i>Eucalyptus raveretiana</i>)	258.32
Bluegrass (<i>Dichanthium setosum</i>)	809.59
King Bluegrass (<i>Dichanthium queenslandicum</i>)	1161.23
Ornamental Snake (<i>Denisonia maculata</i>)	1030.31
Squatter Pigeon (<i>Geophaps scripta scripta</i>)	1415.22
Red Goshawk (<i>Erythroriorchis radiatus</i>)	187.14
Koala (<i>Phascolarctos cinereus</i>) (combined populations of Queensland, New South Wales and the Australian Capital Territory)	2466.04
Northern Quoll (<i>Dasyurus hallucatus</i>)	1.54
South-eastern long-eared bat (<i>Nyctophilus corbeni</i>)	2282.57
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	1451.44
Australian Painted Snipe (<i>Rostratula australis</i>)	5.69

EPBC Threatened Ecological Communities	Maximum disturbance (hectares)
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	781.16
Weeping Myall Woodlands	198.48
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	871.10
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	107.42

Offsetting approach

DOE and EHP agree to incentivise avoidance through a staged offsetting approach to ensure that maximum disturbance limits would only be reached in a worst case scenario where avoidance and mitigation was not possible, and all residual significant impacts would be compensated for in accordance with the Australian Government's offset policy - *EPBC Act Environmental Offsets Policy* (October 2012) (EPBC Act Offsets Policy) and relevant state policy.

The proponent has developed a 'framework' approach to assessment of the occurrence of threatened ecological communities and threatened species habitat, avoidance and mitigation of impacts, and provision of offsets for residual significant impacts, which would maximise the incentive to avoid actual impacts. The proposed staged approach for the project would involve the provision of an initial offset for the predicted Phase 1 (first five years of the project) disturbance areas. As design and construction progressed through subsequent project phases, offset requirements would be assessed and acquitted using the following general steps

- determination of the estimated area of disturbance using conceptual field development plans and detailed GIS analysis of mapped biodiversity values
- preclearance surveys to detail actual values and likely impacts
- demonstration of avoidance of impact to biodiversity values through comparison of estimated disturbance areas with the actual disturbance areas
- source offsets to meet requirements for the each impacted biodiversity value subject to an offset requirement, and secure the offset.

Offset requirements would be assessed and acquitted in accordance with the proponent's draft Bowen Environmental Offsets Strategic Management Plan, and with methodologies and preferred locations for the provision of offsets proposed to be outlined in a future offset management plan. The offset management plan for Phase 1 impacts of the project would be required to be submitted to the Minister for the Environment for written approval prior to the proponent commencing Phase 1 activities, and to be reviewed and updated prior to the commencement of subsequent project phases.

The following text addresses the controlling provisions in detail.

Listed threatened species and communities (ss 18 and 18A)

Listed threatened ecological communities

1. Brigalow (*Acacia harpophylla* dominant and co-dominant)

EPBC Act listing status: endangered

Description

The brigalow (*Acacia harpophylla* dominant and co-dominant) threatened ecological community (brigalow TEC) is characterised by the presence of brigalow (*Acacia harpophylla*) as one of the three most abundance tree species. Brigalow is usually dominant in the tree layer or co-dominant with other species such as *Casuarina cristata* (belah), other species of acacia or species of eucalyptus. Occasionally belah, or species of acacia or eucalyptus, may be more common than brigalow within the broad matrix of brigalow vegetation. The structure of the vegetation ranges from open forest to open woodland. The height of the tree layer varies from about 9m in low rainfall areas (averaging around 500mm per annum) to around 25m in higher rainfall areas (averaging around 750mm per annum). A prominent shrub layer is usually present.

Brigalow flowers spasmodically and seeds generally remain viable for less than a year with germination and establishment requiring good rainfall during what is traditionally the driest time of the year. Brigalow trees sucker easily from their roots and re-sprout after damage as long as the root stocks remain intact. Brigalow and many of the shrub and tree species associated with brigalow are capable of re-sprouting after low to moderate intensity fire damage. Brigalow and belah are tolerant of saline conditions and brigalow is extremely drought tolerant.

Fauna species associated with the brigalow TEC rely on a range of attributes in the vegetation for habitat. These include litter and woody debris on the forest floor (especially important for reptiles), tree hollows and pockets under the bark of large trees (roost sites for various birds and mammals, including bats), and mistletoes and other sources of nectar, seeds and fruit (food for birds including belah seed for the vulnerable glossy black-cockatoo).

Distribution

The brigalow TEC extends from south of Townsville in Queensland to northern New South Wales. In Queensland, the brigalow TEC occurs predominantly within the Brigalow Belt North, Brigalow Belt South and Southeast Queensland bioregions, with smaller amounts in the Mulga Lands bioregion.

The brigalow TEC has undergone a severe decline in extent due to clearing for agricultural use. At the time of listing under the EPBC Act (April 2001), information supporting the nomination estimated an original extent of 7324560 hectares (7020360ha in Queensland and 304200ha in New South Wales) with approximately 804264ha (661314ha in Queensland and 142950ha in New South Wales) remaining (approximately 10% of original extent).

Survey requirements and survey effort

EPBC survey requirements/techniques

There are no specific guidelines for survey requirements, however brigalow is identifiable at all times of the year.

Project survey effort

Field surveys for the EIS were undertaken in areas mapped as containing regional ecosystems that comprise the brigalow TEC using the methods for survey and mapping of regional ecosystems in Neldner et al. (2005). The regional ecosystems sampled, and the sampling effort applied to sites within each regional ecosystem type, were as follows

- RE 11.3.1 - 5 secondary (including 3 benchmark sites), 3 tertiary, 4 quaternary
- RE 11.4.8 - 3 secondary (including 1 benchmark site), 8 quaternary
- RE 11.4.9 - 7 secondary (including 2 benchmark sites), 13 quaternary
- RE 11.5.16 - 4 secondary, 2 tertiary, 3 quaternary
- RE 11.9.1 - 2 secondary
- RE 11.9.5 - 1 secondary, 11 quaternary.

No field survey work was carried out in drainage areas 12, 19, and 20 (proposed to be developed in Phase 1 of the project) although significant areas of brigalow TEC regional ecosystems are mapped (Queensland government mapping) in these parts of the project site. The proponent has committed to undertaking pre-clearance surveys of areas proposed to be disturbed by project activities.

Occurrence within project area

Brigalow TEC is relatively common in the project area and a number of well-preserved brigalow communities associated with more extensive areas of intact remnant vegetation were surveyed for the EIS. The majority of mapped remnant brigalow communities existed as scattered, poorly preserved fragments. Brigalow TEC within the project area also includes advanced brigalow regrowth communities determined as being more than 15 years old.

Based on existing regional ecosystem mapping, 57847ha of brigalow TEC may occur within the project area, represented by the following regional ecosystems:

- 11.3.1 - *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains
- 11.4.7 - Open forest of *Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* on Cainozoic clay plains
- 11.4.8 - *Eucalyptus cambageana* open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
- 11.4.9 - *Acacia harpophylla* shrubby open forest with *Terminalia oblongata* on Cainozoic clay plains
- 11.5.16 - *Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces
- 11.9.1 - *Acacia harpophylla*-*Eucalyptus cambageana* open forest on Cainozoic fine-grained sedimentary rocks
- 11.9.5 - *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks

Impacts of the proposed action

Potential impacts associated with the proposed project activities would be:

- direct impacts due to vegetation clearing associated with placement of facilities or infrastructure (e.g. gathering lines for water and gas, road widening and road maintenance)
- edge effects associated with increased habitat and landscape fragmentation including loss of native ground cover, exotic species invasion, and changes to surface water flow and sedimentation that affect ecosystem function.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to the brigalow TEC included:

- pre-clearance surveys and mapping of vegetation at a scale suitable for site-specific planning
- avoidance and minimisation of disturbance within areas of brigalow TEC, and avoidance of fragmentation, where possible
- minimising the width of cleared corridors for linear infrastructure and partial rehabilitation of these corridors to reduce edge effects and maintain wildlife movement
- development of management procedures for listed threatened species and TECs
- rehabilitation of available areas to restore habitat consistent with pre-clearing habitat
- monitoring to ensure no unauthorised clearing and to support targeted weed control measures.

The proponent's assessment of the potential project impacts on the brigalow TEC against the significant impact criteria concluded that implementation of proposed measures to avoid disturbance based on constraints mapping, partial rehabilitation of disturbance associated with construction of gathering pipelines, proposed monitoring programs and pest management, would result in 'moderate' impacts on the brigalow TEC.

Residual impact

The proponent estimated that the maximum potential whole of project impact to the brigalow TEC would be 781.16ha. EHP recommends that to manage the impacts associated with the proposed action the conditions of approval for the project should include a requirement that the proponent not clear more than 781.16 ha of brigalow TEC (See summary of recommendations below).

The proposed mitigation and management measures will provide a level of protection to the brigalow TEC, however, DOE considers that residual significant impacts on the brigalow TEC as a result of the proposed action are likely to occur. In addition, EHP considers that the potential impact of the project on the brigalow TEC remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There are twelve other development projects in the northern Brigalow Belt bioregion which would be likely to impact on the brigalow TEC. The proponent has concluded that there would be a high potential for cumulative impacts on the brigalow TEC if these projects were to proceed.

The proponent has undertaken an assessment of the potential cumulative impact of the project in conjunction with other proposed projects in the area and concluded that there would be a high potential for cumulative impacts on the brigalow TEC if these projects were to proceed (Appendix J of the SREIS). The proponent stated that impacts to TECs could best be managed at the individual project scale and proposed specific mitigation measures for project impacts to the brigalow TEC.

Offset

To offset the residual significant impacts of the project on the brigalow TEC, EHP recommends that the proponent protect and enhance a parcel, or parcels, of land containing the brigalow TEC. The offset site(s) and offset management plan proposed would need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval provide for the proponent to carry out the action in stages and to deliver an environmental offset for each project phase. The conditions of approval should require that the offset management plan for Phase 1 of the project be approved by the Minister for the Environment prior to the commencement of Phase 1, and for the offset management plan to be updated and approved by the Minister for the Environment prior to the commencement of each subsequent stage (see recommendations for conditions

below).

The likely success or suitability of the proposed offset would be influenced by the adequacy of the management actions undertaken to improve the habitat on the offset site(s). EHP recommends that the offset management plan provide for comprehensive and long-term management of the offset site(s) to ensure a conservation outcome for the brigalow TEC is achieved.

Consideration of Plans/Agreements/Conservation Advices

Recovery plan: A recovery plan has not been prepared for the brigalow TEC.

Threat abatement plan: There are no threat abatement plans in place for the brigalow TEC.

Conservation advice: Commonwealth Conservation Advice for Brigalow Ecological Community *approved* by the Minister on the 17 December 2013.

The approved conservation advice provides a detailed overview of the description, conservation status, distribution and habitat of the brigalow TEC. The main threats to the brigalow TEC, research priorities and priority conservation actions are listed. The conservation advice identifies that the main threats to the brigalow TEC include factors that may further reduce its extent or cause a decline in condition. The most important threats and risks are clearing, fire, weeds, feral animals and inappropriate grazing regimes.

The conservation advice identifies the priority recovery and threat abatement actions required for the brigalow TEC and these are summarised below:

Threat reduction/control

- protect remnant and regrowth areas and nearby native vegetation including buffer zones and connecting corridors;
- where clearance is unavoidable, mitigate the severity of impacts by: avoiding higher quality areas, avoiding fragmentation, minimising hydrological disruption, minimising the spread of weeds, and by providing offsets relevant to the location and quality of affected patches;
- manage areas of brigalow TEC to reduce threats, including through:
 - fire management that considers brigalow conservation, protection and ecological heterogeneity
 - targeted weed control (e.g. spot application of herbicides, rather than aerial spraying) with a particular focus on high biomass exotic grasses (buffel grass, Rhodes grass, green panic grass)
 - coordinated feral animal control (foxes, cats and pigs)
 - avoiding fertiliser application
 - minimising tree thinning and soil disturbance
 - managing grazing pressure
 - encouraging a shrubby understorey.

Land management

- encourage landholders to balance primary production and the conservation of native flora and fauna within and close to the brigalow TEC through measures such as:
 - managing stocking rates, grazing practices and livestock camp sites to avoid damage to woodland understorey and ground cover
 - leaving trees, or clumps of regrowth, in paddocks to maintain connections between patches of native flora and fauna habitat
 - connecting shade-lines to one another and keeping them as wide as possible (ideally more than 100m)
 - avoiding the application of fertiliser, or the aerial/broad-scale spraying of herbicides
 - leaving dead trees standing and allowing dead timber and leaf litter to rot.
- undertake regeneration of high value regrowth sites and revegetation of degraded sites
- increase the area of brigalow TEC managed for conservation
- establish adequate buffer zones to protect remnants
- develop and implement water management, sediment erosion and pollution control and monitoring plans.

Management for wildlife

- undertake management actions that help to increase the diversity of species and their abundance with consideration of habitat use at various scales, including:
 - retaining fallen timber and leaf litter for small mammals and reptiles
 - retaining standing dead trees or old trees with hollow limbs for nesting sites for birds, mammals and

- reptiles
- re-introducing microhabitat features (e.g. rocks, logs and other woody debris) to disturbed sites
- discouraging species like noisy miners and introduced predators by maintaining large patches of woodland with complex structure
- avoiding clearing remnant vegetation; and retaining areas of brigalow regrowth
- encouraging woodland regeneration close to areas of existing woodland.

The factors in the approved conservation advice have been considered in undertaking this assessment and in making the recommendation that the proposed action be approved. The proponent has proposed to undertake pre-clearance surveys and mapping of vegetation, avoidance and minimisation of disturbance where possible, rehabilitation of available areas consistent with pre-clearing habitat and targeted weed control measures. These measures are reflected in the recommendations below).

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to ecological community Brigalow (*Acacia harpophylla* dominant and co-dominant) and committed to disturbance limits for the project, reflected in the recommendations for conditions below. The proponent must offset residual impacts to the brigalow TEC in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations below.

EHP is of the view that the proposed action will not have an unacceptable impact on the listed threatened ecological community Brigalow (*Acacia harpophylla* dominant and co-dominant).

2. Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

EPBC Act status: endangered.

Description

The natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin threatened ecological community (natural grassland TEC) consists of native grasslands typically composed of perennial native grasses. The grasslands usually occur on flat ground or gently undulating rises with fine-grained, cracking clay soils that are often deep and dark in colour, although soils may be shallower on ridges or sloping land. The soils are derived from basalt or fine-grained sedimentary rocks, or where this material has been transported to form extensive alluvial plains along ancient and flood-prone watercourses.

The natural grassland TEC is mostly dominated by blue-grass (*Dichanthium sericeum*). Tropical three-awned grasses (*Aristida* species) and panic grasses (*Panicum* species) are also a major part of the grasslands. Drier sites may have more Mitchell grasses (*Astrelba* species). Native perennial grass indicator species for this community are *Aristida leptopoda*, *Astrelba elymoides*, *Astrelba squarrosa*, *Eriochloa crebra*, *Panicum queenslandicum*, *Thellungia advena*, *Aristida latifolia*, *Astrelba lappacea*, *Bothriocloa erianthoides*, *Dichanthium sericeum*, *Panicum decompositum* and *Paspalidium globoideum*. Shrubs are typically sparse. However, in some areas the cover of shrubs such as sally wattle (*Acacia salicina*) and mimosa (*Acacia farnesiana*) can be more extensive.

These tussock grasslands are considered to be one of the most threatened ecosystems in Australia. They continue to be threatened by conversion of native pastures to improved pastures, cropping and overgrazing by stock. The grasslands provide habitat for threatened species such as king blue-grass (*Dichanthium queenslandicum*).

Distribution

The natural grassland TEC occurs entirely within Queensland within the Brigalow Belt North and Brigalow Belt South bioregions and within the Fitzroy Basin, Burdekin, South West Qld, Border Rivers Maranoa-Balonne and Desert Channels Natural Resource Management regions. It extends from Collinsville in the north to Carnarvon National Park in the south.

Survey requirements and survey effort

EPBC survey requirements/techniques

- Sites must be assessed during a good season, within two months of cessation of disturbance (fire/grazing/mowing/slashing) and within two months of effective rainfall

- Key diagnostic characteristics for recognising the natural grassland TEC:
 - within the distribution of the TEC
 - tree canopy absent or sparse
 - ground layer dominated by perennial native grasses and contains at least three of the indicator native species listed.

Project survey effort

The field survey was initially conducted over 11 days between 11 October 2011 and 27 October 2011. A second phase of field survey was completed over a period of 17 days between the 4 May 2012 and 20 May 2012. Methods used in the surveys were consistent with those necessary to determine whether or not the surveyed patches achieved the threshold condition according to the EPBC Act listing advice. Species were grouped into broad life-form categories with calculations of mean cover values and species richness utilised. Regional ecosystems analogous to the natural grassland TEC were sampled within the project area using the methods for survey and mapping of regional ecosystems in Neldner et al. (2005) as follows:

- RE 11.8.11 – 15 secondary and 9 quaternary sites
- RE 11.4.4 – 2 secondary sites.

Other REs that correspond with the natural grassland TEC (11.3.21, 11.4.11 and 11.9.3) were not encountered within the project area.

Occurrence within project area

Based on current regional ecosystem mapping 29246.19 ha of natural grassland TEC potentially occurs in the project area. The community consists of REs 11.3.21, 11.4.4, 11.4.11, 11.8.11 and 11.9.3.

Impacts of the proposed action

Potential impacts on the natural grassland TEC associated with the proposed action include:

- direct impacts due to vegetation clearing associated with construction of facilities or infrastructure (e.g. gathering lines for water and gas, road widening and road maintenance)
- fragmentation of large undisturbed tracts of remnant vegetation during placement of access tracks, wells and other petroleum related infrastructure
- edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground cover, exotic species invasion, changes to surface water flow and sedimentation including localised erosion along access tracks that affect ecosystem function
- trampling of grass and compaction of soil in the vicinity of well facilities due to uncontrolled access and poorly defined working areas
- salt scalding through saline groundwater discharge from production well heads.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to the natural grassland TEC include:

- pre-clearance surveys and mapping of vegetation at a scale suitable for site-specific planning
- avoidance and minimisation of disturbance within areas of natural grassland TEC, and avoidance of fragmentation, where possible
- minimising the width of cleared corridors for linear infrastructure and partial rehabilitation to reduce edge effects and maintain wildlife movement
- development of management procedures for threatened species
- dust suppression during construction and clearing activities, particularly during high wind conditions, using water of appropriate quality
- rehabilitation of available areas to habitat consistent with pre-clearing habitat
- monitoring to ensure no unauthorised clearing and to support targeted weed control measures.

The proponents assessment of the potential impacts of the project on the natural grassland TEC against the significant impact criteria concluded that implementation of proposed measures to avoid disturbance based on constraints mapping, partial rehabilitation of disturbance associated with construction of gathering pipelines, proposed monitoring programs and pest management, would result in ‘moderate’ impacts on the natural grassland TEC.

Residual impact

The proponent estimated that the maximum potential impact to the natural grassland TEC would be 871.10ha.

EHP recommends that, to manage the impacts associated with the proposed action, the conditions of approval for the project should include a requirement that the proponent to not clear more than 871.10ha of natural grassland TEC (See recommendations for conditions below).

The proposed mitigation and management measures would provide a level of protection to the natural grassland TEC. However, EHP considers that there is the potential for residual significant impacts on the natural grassland TEC as a result of the proposed action. In addition, EHP considers that the potential impact of the project on the natural grassland TEC remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There are seven other development projects occurring or planned to occur in the Northern Brigalow Belt bioregion that are or will impact on the natural grassland TEC. The proponent has concluded that there is a high potential for cumulative impacts on the natural grassland TEC if these projects were to proceed.

The proponent has undertaken an assessment of the potential cumulative impact of the project in conjunction with other proposed projects and concluded that the natural grasslands TEC in the northern Brigalow Belt bioregion would be particularly prone to cumulative impacts if the currently proposed projects were to proceed (Appendix J of the SREIS). The proponent stated that impacts to TECs could best be managed at the individual project scale and has identified specific mitigation measures for the natural grassland TEC. The proponent stated that, given the high sensitivity of this TEC, project impacts would be closely managed with particular emphasis on avoidance, mitigation and specific management procedures.

Offsets

To offset the residual significant impacts of the project on the natural grassland TEC, EHP recommends that the proponent could protect and enhance a parcel, or parcels, of land containing the natural grassland TEC. The offset site(s) and offset management plan proposed would need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that any conditions of approval provide for the proponent to carry out the action in stages and to deliver an environmental offset for each project phase. The conditions of approval should require that the offset management plan for Phase 1 of the project be approved by the Minister for the Environment prior to the commencement of Phase 1, and for the offset management plan to be updated and approved by the Minister for the Environment prior to the commencement of each subsequent stage, including the reconciliation of actual site disturbance to biodiversity values, following each phase (see recommendations for conditions below).

The likely success or suitability of the proposed offset would be influenced by the adequacy of the management actions undertaken to improve the habitat on the offset site(s). EHP recommends that the offset management plan provide for comprehensive and long-term management of the offset site(s) to ensure a conservation outcome for the natural grassland TEC is achieved.

Consideration of Plans/Agreements/Conservation Advices

Recovery plan: A recovery plan has not been prepared for the natural grassland TEC.

Threat abatement plan: There are no threat abatement plans relevant to the natural grassland TEC.

Conservation advice: Commonwealth Conservation Advice on Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin approved by the Minister on the 15 December 2008.

The approved conservation advice provides a detailed overview of the description, conservation status, distribution and habitat of the natural grassland TEC. The main threats to the natural grassland TEC, research priorities, and priority conservation actions are listed.

The conservation advice identifies that the main threats to the natural grassland TEC include grazing, cropping and pasture improvement; weeds and pest animals; mining activities; construction of roads and other infrastructure. Lack of knowledge about the grasslands and climate change are identified as potential threats.

The conservation advice identifies the priority recovery and threat abatement actions required for the natural grassland TEC and these are summarised below:

Habitat loss, disturbance and modification

- monitor known occurrences to identify key threats or the progress of recovery, including the effectiveness of management actions and the need to adapt actions if necessary
- identify occurrences of high conservation priority

- undertake survey work in potential habitat to locate remnants
- avoid mowing and slashing during peak flowering season from spring to summer
- ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on the ecological community
- ensure road widening and maintenance activities (or other infrastructure or development activities) in areas where the ecological community occurs minimise adverse impacts on known sites
- investigate and implement formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure.

Invasive weeds

- develop and implement management plans for the eradication of weeds such as parthenium (*Parthenium hysterophorus*), parkinsonia (*Parkinsonia aculeata*), prickly acacia (*Acacia nilotica* subsp. *indica*) and buffel grass (*Cenchrus ciliaris*)
- manage sites to prevent introduction of invasive weeds, which could become a threat to the ecological community, using appropriate methods
- implement appropriate protocols to avoid the spread of weeds including good hygiene measures for mowing and grading equipment and appropriate steps to avoid dispersing seeds when moving stock
- maintain a good cover of native perennial grasses and spell the grasslands from grazing to limit the risk of weed invasion.

Trampling, browsing or grazing

- grazing management to maintain a good cover of perennial grasses and legumes, especially the most palatable species, through the driest years
- develop and implement a stock management plan for roadside verges and travelling stock routes
- provide and/or promote incentives for good management
- where possible, use an intermittent grazing regime in preference to burning
- avoid burning, grazing or slashing during peak flowering season (spring to summer).

Animal predation or competition

- Develop and implement management plans for the control of the house mouse (*Mus* spp.).

The factors in the approved conservation advice have been considered in undertaking this assessment and making the recommendation that the proposed action be approved. The proponent has proposed to undertake pre-clearance surveys and mapping of vegetation, avoidance and minimisation of disturbance where possible, rehabilitation of available areas consistent with pre-clearing habitat and targeted weed control measures. These measures are reflected in the recommendations below.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to the ecological community *Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* and committed to disturbance limits for the project, reflected in the recommendations below. The proponent must offset residual significant impacts to the natural grassland TEC in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for conditions.

EHP is of the view that the proposed action will not have an unacceptable impact on the listed threatened ecological community *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin*.

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

EPBC Act status: endangered

Description

Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions ecological community (semi-evergreen vine thickets TEC) is a form of dry seasonal subtropical rainforest characterised by trees with microphyll sized leaves (2.5–7.5cm long), frequent presence of swollen-stemmed “bottle trees” (*Brachychiton australis*, *B. rupestris*), with vines, twining or scrambling plants prominent. Remnants of the semi-evergreen vine thickets TEC, often referred to as softwood scrub or bottle tree scrub, are most common on undulating plains with fine-grained sedimentary rocks (frequently shale), and on basalt hills and plains. They also occur on coastal dunes, Quaternary alluvium, Tertiary clay plains, old loamy and sandy plains, or hills and lowlands on metamorphic rocks.

Many of the tree species found in the semi-evergreen vine thickets TEC are able to re-sprout vegetatively after fire or disturbance, either from stems or roots, although many are sensitive to fire and especially hot or frequent fires. Many canopy and emergent tree species have wind-dispersed seed, while lower canopy and understorey species often have bird or bat dispersed fruit/seed.

Distribution

Semi-evergreen vine thickets are widely scattered within Queensland, New South Wales, the Northern Territory and Western Australia, having a common structure but considerable regional variation in floristic associations. The semi-evergreen vine thickets TEC is distinct from related communities located in other bioregions in northern Australia. Semi-evergreen vine thickets TEC occurs in the Brigalow Belt North, Brigalow Belt South and Nandewar bioregions. In Queensland, more than 50% of remnants occur in the Arcadia, Buckland Basalts, Claude River Downs, Northern Bowen Basin and Southern Downs subregions.

Within the Brigalow Belt bioregions, the semi-evergreen vine thickets TEC has been fragmented, reduced in area and degraded through land clearing and agricultural/grazing practices. The semi-evergreen vine thickets TEC originally covered almost 900,000ha and the total remnant extent in 2003 was less than 150,000ha (17%), with approximately 37,000ha in protected areas. Remnants often occur in small patches in areas of higher soil moisture.

The semi-evergreen vine thickets TEC in Queensland comprises ten regional ecosystems – REs - 11.3.11, 11.4.1, 11.5.15, 11.7.1x, 11.8.3, 11.8.6, 11.8.13, 11.11.18, 11.2.3, 11.9.8 and 11.9.4. The semi-evergreen vine thickets TEC may occur in association with small patches of brigalow TEC.

Survey requirements and survey effort

EPBC Act survey requirements/techniques

There are no EPBC Act survey guidelines in place for the semi-evergreen vine thickets TEC. The methods for the survey and mapping of REs in Queensland are considered suitable for defining this community.

Under the Queensland *Vegetation Management Act 1999* remnant vegetation is defined as 'vegetation where the dominant canopy has >70% of the height and >50% of the cover relative to the undisturbed height and cover of that stratum' and is dominated by species characteristic of the vegetation's undisturbed canopy. Only vegetation that falls within this definition is mapped as a remnant regional ecosystem. Mapped regional ecosystems define vegetation that has not been cleared or has been lightly thinned, and vegetation that has been cleared or heavily thinned but substantially regrown.

Project survey effort

Field surveys for the EIS were undertaken in areas mapped as containing regional ecosystems that comprise semi-evergreen vine thickets TEC using the methods for survey and mapping of regional ecosystems in Neldner et al. (2005). The regional ecosystems sampled, and the sampling effort applied to sites within each regional ecosystem type, were as follows:

- 11.3.11 - 1 quaternary site
- 11.8.13 - 2 secondary and 4 quaternary sites
- 11.8.3 - 1 secondary and 2 quaternary sites
- 11.9.4/11.9.4a - 1 secondary site.

No flora survey work was carried out in drainage areas 36 and 12 where the certified regional ecosystem mapping indicates the largest and most significant areas of the semi-evergreen vine thickets TEC occurs.

Occurrence within project site

A relatively extensive area (total 5212.53 ha) of semi-evergreen vine thickets TEC is identified by Queensland government certified regional ecosystem mapping as occurring in the northern portion of the project area, represented by REs 11.5.15, 11.8.3, 11.8.13 and 11.9.4a. Field surveys confirmed the presence of the community but less extensively than shown in the certified mapping. An area (55 ha) mapped as RE 11.8.13 was found to occur on lateritic escarpments and was consistent with RE 11.7.1x (the same community as RE 11.5.15 except on shallower soils).

Surveys did not find semi-evergreen vine thicket in a significant area mapped as RE 11.5.15 (429 ha). Good quality examples of vine thicket were surveyed on basaltic terrains north of the Newlands Mine site consistent with RE 11.8.13. The identified areas of semi-evergreen vine thickets TEC also included brigalow communities where these occur on basaltic landforms, consistent with the description of RE 11.8.13.

Impacts of the proposed actions

Potential impacts associated with the proposed project activities include:

- direct impacts due to vegetation clearing, particularly for field development activities such as drill pads and access tracks; and
- edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers and exotic species invasion.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to the semi-evergreen vine thickets TEC include:

- preclearance surveys and mapping of vegetation at a scale suitable for site-specific planning
- avoidance and minimisation of disturbance within areas of semi-evergreen vine thickets TEC, and avoidance of fragmentation, where possible
- minimising the width of cleared corridors for linear infrastructure and partial rehabilitation to reduce edge effects and maintain wildlife movement
- development of management procedures for threatened species
- rehabilitation of available habitat areas consistent with pre-clearing habitat
- preclearance surveys for weeds, weed monitoring and targeted weed control measures.

The proponent's assessment of the potential project impacts on the semi-evergreen vine thickets TEC against the significant impact criteria concluded that implementation of proposed measures to avoid disturbance based on constraints mapping, partial rehabilitation of disturbance associated with the construction of gathering pipelines, proposed monitoring programs and pest management, would result in 'moderate' impacts on the semi-evergreen vine thickets TEC. However, EHP considers that the potential impact of the project on the semi-evergreen vine thickets TEC remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Residual Impact

The proponent estimated that the maximum potential impact area to the semi-evergreen vine thickets TEC would be 107.42ha. EHP recommends that, to manage the impacts associated with the proposed action, the conditions of approval for the project should include a requirement that the proponent not clear more than 107.42ha of semi-evergreen vine thickets TEC (see recommendations for conditions below).

The proposed mitigation and management measures would provide a level of protection to the semi-evergreen vine thicket TEC. However, EHP considers that there is the potential for residual significant impacts on the semi-evergreen vine thickets TEC as a result of the project. In addition, EHP considers that the potential impact of the project on the semi-evergreen vine thickets TEC remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There are four other projects that are occurring or planned to occur in the Northern Brigalow Belt bioregion that will impact on semi-evergreen vine thicket TEC and therefore the proponent has concluded that there is a high potential for cumulative impacts to occur to the semi-evergreen vine thicket TEC if these projects were to go ahead.

The proponent has undertaken a cumulative assessment of future projects and concluded that the semi-evergreen vine thicket is particularly prone to cumulative impacts in the region if the currently proposed projects were to proceed (Appendix J of the SREIS). The proponent states that impacts to TECs can best be managed at the individual project scale and has committed to managing its component of cumulative impacts to the TEC with particular emphasis on avoidance, mitigation and specific management measures.

Offsets

To offset the residual significant impacts of the project on the semi-evergreen vine thickets TEC, EHP recommends that the proponent protect and enhance a parcel, or parcels, of land containing the semi-evergreen vine thickets TEC. The offset site(s) and offset management plan proposed would need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval provide for the proponent to carry out the action in stages and to deliver an environmental offset for each project phase. The conditions of approval should require that the offset management plan for Phase 1 of the project be approved by the Minister for the Environment prior to the commencement of Phase 1, and for the offset management plan to be updated and approved by the Minister for the Environment prior to the commencement of each subsequent stage (see recommendations for conditions below).

The likely success or suitability of the proposed offset would be influenced by the adequacy of the management actions undertaken to improve the habitat on the offset site(s). EHP recommends that the offset management plan provide for comprehensive and long-term management of the offset site(s) to ensure a conservation outcome for the semi-evergreen vine thickets TEC is achieved.

Consideration of Plans/Agreements/Conservation Advice

Approved Conservation Advice: There is no approved conservation advice for the *Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions* ecological community.

Threat abatement plan: There are no threat abatement plans relevant to *Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions* ecological community.

Recovery Plan: National Recovery Plan for the Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions ecological community.

The approved National Recovery Plan provides a detailed overview of the description, conservation status, distribution and ecology of the semi-evergreen vine thickets TEC. The main threats to the TEC, research priorities and priority conservation actions are listed. The recovery plan identifies that the most serious threats to the semi-evergreen vine thickets TEC in the northern areas are fire and invasive plant followed by the impact of grazing animals and ongoing clearing and fragmentation.

The priority recovery and threat abatement actions required for the semi-evergreen vine thickets TEC (based on the recovery plan) are listed below:

- complete and refine mapping of remnant semi-evergreen vine thickets TEC;
- determine the extent and condition of areas of the semi-evergreen vine thickets TEC affected by invasive plant species, particularly weeds of national significance e.g. rubber vine and lantana;
- survey poorly known species associated with semi-evergreen vine thickets TEC, especially fungi, herpetofauna and invertebrates;
- monitor selected populations of threatened species across their distribution within the semi-evergreen vine thickets TEC;
- identify key areas of the semi-evergreen vine thickets TEC for addition to the Queensland and NSW conservation reserve systems;
- encourage landholders to enter into conservation agreements over semi-evergreen vine thickets;
- liaise with landholders to develop appropriate burning practices and other procedures to minimize fire damage to remnant areas on private and public lands;
- determine the impact of grazing animals, both domestic and native, on remnant areas of SEVT and develop guidelines and recommendations for fencing;
- develop and implement a pest management program to control or manage feral animals and native animals in semi-evergreen vine thicket remnants;
- encourage landholders through appropriate incentive programs to protect and foster regrowth and associated vegetation in buffer areas;
- research and develop use of semi-evergreen vine thicket species for landscape rehabilitation and encourage mining companies, main road managers and others to use native species in plantings;
- undertake consultation with traditional owner groups to determine the level of indigenous knowledge of and association with the semi-evergreen vine thickets TEC; and
- develop and implement education programs to increase the awareness of government and non-government organisations regarding semi-evergreen vine thickets TEC conservation, and their responsibilities for protection and management.

The factors in the approved conservation advice have been considered in undertaking this assessment and making the recommendation that the proposed action be approved. The proposed action is not inconsistent with the priority recovery and threat abatement actions identified in the national recovery plan. The proponent has proposed to undertake preclearance surveys and mapping of vegetation, avoidance and minimisation of disturbance where possible, rehabilitation of available areas consistent with pre-clearing habitat and targeted weed control measures. These measures are reflected in the recommendations for conditions below.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to the semi-evergreen vine thickets TEC and has committed to disturbance limits for the project, which are reflected in the recommendations for conditions. The proponent must offset residual significant impacts to the TEC in accordance with the EPBC Act Offsets Policy and this is reflected in the recommendations for conditions below.

EHP is of the view that the proposed action will not have an unacceptable impact on the listed threatened ecological community *Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions*.

4. Weeping Myall Woodlands

EPBC Act status: endangered

Description

The weeping myall woodlands threatened ecological community (weeping myall woodlands TEC) occurs in a range of open woodlands to woodlands, generally 4-12 m high, in which weeping myall (*Acacia pendula*) trees are the sole or dominant overstorey species with a shrubby and/or grassy understorey. Other species may include: Western Rosewood (*Alectryon oleifolius subsp. elongatus*); Poplar Box (*Eucalyptus populnea*); or Black Box (*Eucalyptus largiflorens*). The ground layer includes a diversity of grasses and forbs, and varies in species composition and cover depending on grazing regimes and rainfall.

The weeping myall woodlands TEC also provides important habitat for a range of animals such as the Superb Parrot (*Polytelis swainsonii*), Painted Honeyeater (*Grantiella picta*) and the Bush Stone-curlew (*Burhinus grallarius*).

Weeping myall woodlands go through regular cycles of senescence (aging and death) and regeneration, and are also susceptible to defoliation by Bag-shelter Moth (*Ochrogaster lunifer*) caterpillars. The trees are often lopped for stock fodder.

The weeping myall woodlands TEC generally occurs on flat areas, shallow depressions or gilgais on raised (relict) alluvial plains not associated with active drainage channels and rarely if ever flooded. Much of the former range of the ecological community has been cleared for dryland and irrigated cropping or has been significantly modified by heavy grazing. Most areas remaining in good condition are in little-grazed, uncropped sites such as road reserves and stock routes.

Distribution

The weeping myall woodlands TEC is known to occur in Queensland as small patches within regional ecosystems 11.3.2 (*Eucalyptus populnea* woodland on alluvial plains) and 11.3.28 (*Casuarina cristata* +/- *Eucalyptus coolabah* open woodland on alluvial plains). It is not yet possible to estimate the exact proportion of each regional ecosystem that comprises weeping myall woodlands TEC but it is likely to be small, at most 5% of their extent. Most of these patches of weeping myall woodlands are less than 1ha to 2 ha in area. Both of these regional ecosystems are categorised as 'of concern' in Queensland, which means that only 10% - 30% of the original, pre-European extent of the community remains. On the basis of the available information in Queensland, the current extent of the ecological community is at most 31,000 ha and it has undergone a decline of about 75%. The patchy distribution of the community makes mapping of the spatial extent difficult.

Survey requirements and survey effort

EPBC Act survey requirements/techniques

- there are no EPBC Act survey guidelines in place for the weeping myall woodlands TEC. The methods for the survey and mapping of REs in Queensland are adequate.

Project survey effort

- field surveys were undertaken within 'at risk' areas (REs 11.3.2 and 11.3.28). However, no occurrence of weeping myall woodlands TEC was observed.

Occurrence within project site

Within the project area, the weeping myall woodlands TEC is potentially represented by REs 11.3.2 and 11.3.28 which cover 29,164.14ha. No occurrence of weeping myall woodlands TEC was observed during the field survey of the project areas. The distribution of the weeping myall woodlands TEC ranges from 100km north of Clermont, southwards with the eastern-most limit of the TEC coinciding roughly with the western boundary of the project area. With the exception of a small area extending to approximately 75km north of Blackwater, the TEC is not expected to occur within the project area. The weeping myall woodlands TEC does not form communities of sufficient size for consistent separation as a mapable ecosystem. Further survey of REs 11.3.2 and 11.3.28 would be required within project areas potentially containing the TEC.

Impacts of the proposed action

Potential impacts associated with the proposed project activities include:

- direct impacts due to vegetation clearing particularly field development related activities (e.g. drill pads, access tracks)
- edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers and exotic species invasion.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to the weeping myall woodlands TEC included:

- preclearance surveys including: mapping of vegetation at a scale suitable for site-specific planning and identification of site-specific sensitive areas that require avoidance or buffers
- avoidance and minimisation of disturbance within areas of weeping myall woodlands TEC (RE 11.3.2), and avoidance of fragmentation, where possible
- minimising the width of cleared corridors for linear infrastructure and partial rehabilitation to reduce edge effects and maintain wildlife movement
- development of management procedures for threatened species
- rehabilitation of available areas to habitat consistent with pre-clearing habitat
- preclearance surveys for weeds, weed monitoring and targeted weed control measures.

The proponent’s assessment of the potential project impacts on the weeping myall woodlands TEC against the significant impact criteria concluded that implementation of proposed measures to avoid disturbance based on constraints mapping, partial rehabilitation of disturbance associated with the construction of gathering pipelines, proposed monitoring programs and pest management, would result in ‘moderate’ impacts on the weeping myall woodlands TEC.

Residual impact

The proponent estimated that the potential residual impact to the weeping myall woodlands TEC would be 198.48ha. EHP recommends that, to manage the impacts associated with the proposed action, the conditions of approval for the project should include a requirement that the proponent not clear more than 198.48ha of weeping myall woodlands TEC (See recommendations for conditions below).

The proposed mitigation and management measures would provide a level of protection to the weeping myall woodlands TEC. However, EHP considers that residual significant impacts on the weeping myall woodlands TEC as a result of the proposed action are likely to occur. In addition, EHP considers that the potential impact of the project on the weeping myall woodlands TEC remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There is one other project that would have impacts on the weeping myall woodlands TEC in the Northern Brigalow Belt bioregion. The proponent concluded that the potential for cumulative impacts to the weeping myall woodlands TEC would be extremely low.

Offset

To offset residual significant impacts of the project on the weeping myall woodlands TEC, EHP recommends that the proponent could protect and enhance a parcel, or parcels, of land containing the weeping myall woodlands TEC. The offset site(s) and offset management plan proposed would need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval provide for the proponent to carry out the action in stages and to deliver an environmental offset for each project phase. The conditions of approval should require that the offset management plan for Phase 1 of the project be approved by the Minister for the Environment prior to the commencement of Phase 1, and for the offset management plan to be updated and approved by the Minister for the Environment prior to the commencement of each subsequent stage (see recommendations for conditions below).

The likely success or suitability of the proposed offset would be influenced by the adequacy of the management actions undertaken to improve the habitat on the offset site(s). EHP recommends that the offset management plan provide for comprehensive and long-term management of the offset site(s) to ensure a conservation outcome for the weeping myall woodlands TEC is achieved.

Consideration of Plans/Agreements/Conservation Advice

Conservation advice: Commonwealth Conservation Advice on Weeping Myall Woodlands approved by the Minister on 17 December 2008

Threat abatement plan: There are no threat abatement plans relevant to ecological community weeping myall woodlands TEC.

Recovery Plan: No recovery plan has been prepared for the ecological community weeping myall woodlands.

The approved conservation advice provides a detailed overview of the description, conservation status, distribution and ecology of the weeping myall woodlands TEC. The main threats to the TEC, research priorities and priority conservation actions are listed. The conservation advice identifies that the main threats to the TEC are clearing and ongoing degradation. Other threats include overgrazing, weed invasion and herbivory by caterpillars of the Bag-shelter moth.

The priority recovery and threat abatement actions required for the listed ecological community include

- protecting remnants of the listed ecological community through the development of conservation agreements and covenants
- the use of strategic grazing that allows regeneration
- replanting of understory species where they have been depleted
- use of lopping methods that do not result in the death of the dominant tree species
- avoiding the application of fertilisers and herbicides in or near remnants
- protecting remnants from weeds including the speedy eradication of any new invasions
- raising awareness of the ecological community within the community.

The factors in the approved conservation advice have been considered in undertaking this assessment and making the recommendation that the proposed action be approved. The proponent has proposed to undertake pre-clearance surveys and mapping of vegetation, avoidance and minimisation of disturbance where possible, rehabilitation of available areas consistent with pre-clearing habitat and targeted weed control measures. These measures are reflected in the recommendations for the conditions of approval.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to the weeping myall woodland TEC and committed to disturbance limits for the project, reflected in the recommended conditions ([Appendix 4](#)). The proponent must offset residual significant impacts to the TEC in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for conditions.

EHP is of the view that the proposed action will not have an unacceptable impact on the listed threatened Weeping Myall Woodland ecological community.

Listed threatened species

1. Black ironbox (*Eucalyptus raveretiana*)

EPBC Act status: vulnerable

Description

Black ironbox is a medium sized tree growing to a height of about 25m. The bark is rough, slightly furrowed, hard and dark grey on the trunk and the largest branches with other branches smooth, white, grey or pale blue. Branchlets are reported to have glandular pith, unlike any other Queensland eucalypt species. Adult leaves are stalked, lance-shaped, 8–15cm long, 1–3.5cm wide, dark green on upper surface and much paler below. Flowers are formed in terminal clusters, with seven buds per umbel. Flower buds are diamond-shaped, 3–4mm long when mature, on stalks 2–4mm long. Fruit is hemispherical, approximately 2mm long and wide, with three or four fruit valves prominently exerted. Black ironbox has the smallest fruit of any eucalypt.

Black ironbox matures at about five years and flowers from December to March. The fruits mature in late summer and the seeds are expelled within a few weeks. Insects are presumed the primary pollinator and the species is not capable of vegetative reproduction, although it may re-sprout after fire. The seed germinates after fire but does not require fire or smoke to germinate.

Black ironbox typically grows along watercourses, and sometimes on river flats. Soil varies from sand through to heavy clay. Black ironbox does not usually occur in pure stands, but is co-dominant with species such as *Melaleuca leucadendra*, *M. fluviatilis*, *Casuarina cunninghamiana*, *Eucalyptus tereticornis*, *E. camaldulensis*, *Corymbia tessellaris*, and occasionally semi evergreen vine thicket.

Distribution

Black ironbox has a wide but patchy distribution from south of Townsville to Rockhampton along the tributaries of the Fitzroy River (Mackenzie, Isaac and Connors Rivers, and the Funnel, Boothill, Nebo and Denison Creeks), the Suttor River (and its upper tributaries) and the Bowen, Burdekin, Don, Bogie, Broughton, Haughton, O'Connell and Andromache Rivers. The species occurs in State Forest 652, State Forest 658, Dipperu National Park (NP), Eungella NP, Homevale NP and Goodedulla NP.

Survey requirements and survey effort

EPBC survey requirements/techniques

Black ironbox is similar in appearance to Howitt's Box (*E. howittiana*), but is distinguished by the valves of the fruit, which are prominently projecting. Black ironbox has the smallest fruit of any eucalypt. Surveys should target semi-permanent or permanent creeks and rivers. Genetically similar eucalypts are geographically disjunct from black ironbox and the species is not known to hybridise.

Project survey effort

The extensive size of the project area (approximately 8000km²), and diversity of habitats, precluded systematic sampling of all vegetation and habitat types that could contain black ironbox. Field surveys were conducted to document condition, extent and value of vegetation and habitats and inform refinement of habitat maps based on vegetation mapping. Black ironbox was recorded by field surveys for the EIS along a number of watercourses including Bee Creek, Blenheim Creek and Hail Creek.

Occurrence within project site

Black ironbox occurs along Bee Creek, Blenheim Creek and Hail Creek. These habitats are all in the north-east of the project area. Based on the proponent's potential habitat mapping, an estimated 18,479ha of 'core habitat possible' is potentially present within the project area.

Impacts of the proposed action

Potential impacts on black ironbox associated with the proposed project activities include

- loss of individuals through clearing for infrastructure (mostly linear infrastructure) and watercourse diversions
- loss and degradation of habitat through construction of facilities and development and maintenance of access tracks
- habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to black ironbox and its habitat

include

- avoid and minimise disturbance of black ironbox and its habitat (regional ecosystem 11.3.25), and avoidance of fragmentation
- pre-clearance surveys to identify any additional habitat (including core habitat) and develop vegetation mapping at a scale suitable for site-specific planning
- minimising the width of cleared corridors for linear infrastructure and partial rehabilitation to reduce edge effects and maintain wildlife movement
- development of management procedures for black ironbox if project activities are likely to impact on the species
- rehabilitation of available areas consistent with pre-clearing habitat
- monitoring to ensure no unauthorised clearing and to support targeted weed control measures
- consideration of measures such as translocation or propagation and monitor effectiveness of translocation management plans (black ironbox is readily grown from seed)
- preclearance surveys for weeds, weed monitoring and targeted weed control measures.

The proponent assessment of the potential project impacts on black ironbox and its habitat against the significant impact criteria concluded that implementation of proposed measures to avoid disturbance and mitigate potential direct and indirect impacts, would result in 'moderate' impacts to the species.

Residual impact

The proponent estimated that the maximum potential impact to black ironbox would be 258 ha. The proposed mitigation and management measures will provide a level of protection to the species however, DOE considers that there is the potential for residual significant impacts on black ironbox as a result of the proposed action. In addition, EHP considers that the potential impact on the project on black ironbox remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There are four other projects occurring or planned in the Northern Brigalow Belt that will impact on vulnerable black ironbox and therefore the proponent considers that the potential for cumulative impacts on black ironbox is moderate.

The proponent states that impacts to listed threatened species can best be managed at the individual project scale and has committed to managing its component of cumulative impacts to the species with particular emphasis on avoidance, mitigation and specific management measures.

Offsets

To offset the residual significant impacts for Phase 1 of the project, EHP recommends that the proponent be required to protect and enhance a parcel of land containing black ironbox. The offset site and offset management plan proposed will need to demonstrate compliance with EPBC Act Offsets Policy.

EHP recommends that the conditions of approval require the proponent provide a direct offset for disturbance to black ironbox associated with Phase 1 of the project. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for conditions below).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a conservation outcome for black ironbox is achieved.

EHP recommends that to compensate for the residual significant impact on black ironbox, the proposed conditions of approval include the requirement for the development of an offset management plan (the proponent has proposed the Bowen Environmental Offsets Strategic Management Plan) which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the species and conservation of habitat.

Conservation advice, priority recovery and threat abatement actions

Recovery plan: A recovery plan has not been prepared for black ironbox.

Threat abatement plan: There are no threat abatement plans relevant to black ironbox.

Conservation advice: *Commonwealth Conservation Advice on Eucalyptus raveretiana* approved by the Minister on 16 December 2008.

The approved conservation advice provides a detailed overview of the description, conservation status, distribution and habitat for black ironbox. The main threats to the species, research priorities and priority conservation actions are listed. The conservation advice identifies that the main threats to the species are habitat disturbance and by invasion of rubber vine (*Cryptostegia grandiflora*) and large exotic grasses (*Panicum maximum*), and by frequent and/or hot fires. The approved conservation advice lists priority recovery and threat abatement actions which can be done to support the recovery of the black ironbox, including

- identify populations of high conservation priority
- ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on black ironbox
- minimise adverse impacts from land use at known sites, particularly in relation to forest operations and maintenance of stream bank and riparian vegetation integrity
- investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate inclusion in reserve tenure if possible
- implement a pest and weed management plan, particularly for the control of rubber vine and to prevent the introduction of invasive weeds which could threaten the species
- regional and local priority recovery and threat abatement actions
- minimise adverse impacts from land use, particularly in relation to maintenance of stream bank and riparian vegetation integrity
- identify and remove weeds which could become a threat to black ironbox, using appropriate methods; and
- develop and implement a suitable fire management plan.

The factors contained in the approved conservation advice have been considered in undertaking this assessment and designing the proposed conditions. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including management of riparian habitat during construction, the management of invasive weeds, fire control and progressive rehabilitation of disturbed areas. These measures are reflected in the recommended conditions of approval.

In addition, it is recommended that the conditions of approval include the management of discharges of CSG produced water to the Isaac River to further protect the species and its habitat (see recommendations for approval conditions below)

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to black ironbox and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. The proponent must offset residual significant impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions below.

EHP is of the view that the proposed action will not have an unacceptable impact on black ironbox.

2. King blue-grass (*Dichanthium queenslandicum*)

EPBC Act Status: endangered

Dichanthium queenslandicum (King blue-grass) is a perennial grass, growing to 80cm tall. Culms are solitary or rarely branched, erect, glabrous, smooth with a single groove, 4 to 5 noded with nodes prominently hairy. Leaf sheaths are hirsute with the hairs arising from wart-like projections. Inflorescences are single racemes of paired spikelets to 10cm long. Sessile spikelets are bisexual, dorsally compressed, and straw-coloured to pale mauve. Pedicelled spikelets are male and straw-coloured to pale mauve.

Distribution

King blue-grass occurs within the South Eastern Queensland, Brigalow Belt South, Brigalow Belt north, Central Mackay Coast, Desert Uplands, Mitchell Grass Downs and Einasleigh Upland Bioregions; and the South East Queensland, Condamine, Border Rivers Maranoa-Balonne, Burnett Mary, Fitzroy, Burdekin, Mackay Whitsunday, Southern Gulf and Desert Channels Natural Resource Management Regions.

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Weeping Myall woodlands

- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin.

Survey requirements and survey effort

EPBC Act survey requirements/techniques

- There are no specific guidelines for survey timing or requirements, however grasses are best surveyed in the late summer/early autumn following the wet season when grasses are in seed allowing positive identification of species.

Project survey effort

- The species is known to occur in the project area. A targeted survey in late wet season (9 May 2012) within suitable native grassland habitat identified a robust population of the species in Lancewood and Wards Well properties. Within these properties, the species is associated with *Dichanthium sericeum* dominant native grassland habitats and associated woodlands. A single herbarium collection also exists in the north of the project area near Newlands Coal Mine. In the vicinity of the project area, the species is known from scattered collections near Nebo.

Occurrence within the project area

The species is known to occur in the project area. Targeted surveys in the late wet season (May 2012) within suitable native grassland habitats identified a robust population of the species in the Lancewood and Wards Well properties. Within these properties, the species is associated with king blue-grass dominant native grassland habitats and associated woodlands (RE 11.8.11, RE 11.8.5).

Based on the proponent's potential habitat mapping approximately 36,216.43ha of potential habitat is present within the project area including 329.82ha of 'core habitat known' and 35,886.61ha of 'core habitat possible'.

Impacts of the proposed action

Potential impacts associated with the proposed project activities include

- direct loss of individuals during habitat clearing for wells and access tracks
- direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks
- habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

The proponent's assessment of their potential impacts on king blue-grass against the significant impact criteria, concluded that due to their constraints mapping by which they will preferentially avoid the Natural Grassland REs – 11.8.11, 11.8.5, avoidance of vegetation disturbance in their placement of linear infrastructure, partial rehabilitation of gathering lines, monitoring and pest management, they will have 'moderate' impacts on the King blue grass. However, EHP does not consider that there is any certainty of the actual impacts until the whole project is completed due to the lack of survey work, lack of clear definition of the actual footprint and no rehabilitation management plan.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to king blue-grass and its habitat included

- avoidance of disturbance to Natural Grassland TEC
- pre-construction and preclearance surveys to identify any additional areas that need to be avoided including vegetation mapping at a scale suitable for site-specific planning, the identification of core habitats for king blue-grass and identification of site-specific sensitive areas that require avoidance or buffers
- minimisation of vegetation disturbance wherever practical
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- where king blue-grass is identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species, monitoring the progress of any translocation programs in accordance with the relevant translocation management plans
- undertaking preclearance surveys to determine the likelihood of weeds, weed monitoring and targeted weed control measures within sensitive king blue-grass habitats.

Residual impact

The proponent has estimated the maximum potential impact on endangered *Dichanthium queenslandicum* would be 1161.23 ha. The proposed mitigation and management measures will provide a level of protection to the species however DOE considers that there is the potential for residual significant impacts on king bluegrass as a result of the proposed action. In addition, EHP considers that the potential impact on the project on king bluegrass remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

Seven other development projects within the Northern Brigalow Belt bioregion are or will impact on king blue-grass and therefore the proponent has concluded that there is a high potential for cumulative impacts on king blue-grass if these projects were to proceed.

The proponent has undertaken a cumulative assessment of current and future projects and concluded that there is a high potential for cumulative impacts on king blue-grass (Appendix J of the SREIS). The proponent states that impacts to listed threatened species can best be managed at the individual project scale and has identified specific mitigation measures for the species.

Offset

To offset the significant residual impacts for Phase 1 of the project, EHP recommends that the proponent be required to protect and enhance a parcel of land containing king blue-grass. The offset site and offset management plan proposed will need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval require the proponent provide a direct offset for disturbance to king blue-grass associated with Phase 1 of the project. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for conditions below).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a conservation outcome for king blue-grass is achieved.

EHP recommends that to compensate for the residual significant impact on king blue-grass, the proposed conditions of approval include the requirement for the development of an offset management plan (the proponent has proposed the Bowen Environmental Offsets Strategic Management Plan) which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the species and conservation of habitat.

Consideration of Plans/Agreements/Conservation Advice

Recovery plan: A recovery plan has not been prepared for king blue-grass.

Threat abatement plan: There are no threat abatement plans relevant to king blue-grass.

Conservation Advice: *Commonwealth Conservation Advice on Dichanthium queenslandicum (king blue-grass)* approved by the Minister on 20 January 2013.

The approved conservation advice provides a detailed overview of the description, conservation status, distribution and habitat for king blue-grass. The main threats to the species, research priorities and priority conservation actions are listed. The conservation advice identifies that the main threats to the species are loss of habitat through agricultural and mining activities, road construction and other infrastructure developments. Cultivation and crop production, grazing and weed invasion from parthenium and parkinsonia are on-going threats.

The priority actions for king blue-grass (based on the conservation advice) are listed below

Habitat Loss, Disturbance and Modification

- monitor known populations to identify key threats
- monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary
- identify populations of high conservation priority
- ensure there is no disturbance in areas where king blue-grass occurs, excluding necessary actions to manage the conservation of the species/ecological community
- investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate and/or secure inclusion in reserve tenure if possible
- manage any other known, potential or emerging threats, including mining practices, grazing, weed invasion and climate change.

Invasive Weeds

- develop and implement a management plan for king blue-grass for the control of parthenium (*Parthenium hysterophorus*) and parkinsonia (*Parkinsonia aculeata*) in the region; and
- ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on king blue-grass.

Trampling, Browsing or Grazing

- develop and implement a stock management plan for roadside verges and travelling stock routes.

Conservation Information

- raise awareness of king blue-grass within the local community, for example distribute fact sheets/information brochures or conduct field days in conjunction with known industry or community interest groups
- engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions
- enable recovery of additional sites and/or populations
- undertake appropriate seed collection and storage
- investigate options for linking, enhancing or establishing additional populations
- implement national translocation protocols if establishing additional populations is considered necessary and feasible.

The factors included in the approved conservation advice have been considered in undertaking this assessment and in making recommendations for the approval conditions. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive weeds, fire control and progressive rehabilitation of disturbed areas.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to King blue-grass and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. The proponent must offset residual impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions.

EHP is of the view that the proposed action will not have an unacceptable impact on king blue-grass.

3. Bluegrass (*Dichanthium setosum*)

EPBC Act Status: vulnerable

Description

It is an upright perennial grass less than 1m tall. It has mostly hairless leaves about 2-3mm wide. The flowers are densely hairy and clustered together along a stalk in a cylinder shape and appear mostly during summer. The species can form pure swards or occur as scattered clumps.

Dichanthium setosum is associated with heavy basaltic black soils and stony red-brown hard-setting loam with clay subsoil and is found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The extent to which this species tolerates disturbance is unknown.

Distribution

The distribution of this species overlaps with the following EPBC Act –listed threatened ecological communities:

- Semi-evergreen vine thickets of the Brigalow Belt
- the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin
- Bluegrass (*Dichanthium spp.*) dominant grasslands of the Brigalow Belt bioregions
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-yellow box-Blakely red gum grassy woodland and derived native grassland
- Upland wetlands of the New England Tablelands and the Monaro plateau.

In Queensland, it has been reported from the Leichhardt, Morton, North Kennedy and Port Curtis regions.

Survey requirements and survey effort

EPBC Act survey requirements/techniques

- There are no specific guidelines for survey timing or requirements, however grasses are best surveyed in the late summer/early autumn following the wet season when grasses are in seed allowing positive identification of species.

Project survey effort

- Bluegrass was not detected during the field survey.

Occurrence within the project area

The species is known to occur in the project area. It has been recorded from six records (Qld Museum, 2012). The habitats from which the species is recorded are open woodland of *Eucalyptus crebra*, *E. orgadophila*, *Corymbia erythrophloia* including open woodland of *Eucalyptus orgadophila* on black soils, grasslands on flat plains of sandy clay loam, and grassy *Eucalyptus crebra*, *Eucalyptus populnea* woodland on dark brown cracking clays on basalt. Records from outside the project area occur in grasslands and open woodlands on clay plains and alluvium. Potential habitat includes non-remnant grazed grasslands.

Based on the proponent's potential habitat mapping, approximately 52,917.41ha of potential habitat for bluegrass is present within the project areas including 19.41ha of 'core habitat known' and 52,898ha of 'core habitat possible'.

Impacts of the proposed action

Potential impacts associated with the proposed project activities include

- direct loss of individuals during habitat clearing
- direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks
- habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

In the proponent's assessment of their potential impacts on the *Dichanthium setosum* against the significant impact criteria, they concluded that due to their proposed detailed habitat mapping and preclearance survey with which they will avoid vegetation disturbance in their placement of linear infrastructure, partial rehabilitation of gathering lines, monitoring and pest management they will have 'moderate' impacts on vulnerable *Dichanthium setosum*. However, EHP does not consider that there is any certainty of the actual impacts until the whole project is completed due to the lack of survey work, lack of clear definition of the actual footprint and no rehabilitation management plan.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to bluegrass and its habitat include

- avoid disturbance to the following areas
 - endangered EPBC TEC communities: Natural Grassland
 - mapped essential habitat for threatened species
 - core habitat for the species.
- conduct pre-construction/ preclearance surveys to identify any additional areas that need to be avoided, including as a minimum
 - vegetation mapping at a scale suitable for site-specific planning
 - identification of core habitat for the species
 - identification of site-specific sensitive areas that require avoidance or buffers.
- where the species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans.
- undertake preclearance surveys to determine the likelihood of weeds presence, undertake weed monitoring and targeted weed control measures within sensitive habitats.

Residual impact

The proponent has estimated that the maximum potential impact on *Dichanthium setosum* would be 809.59 ha. The proposed mitigation and management measures will provide a level of protection to the species however, DOE considers that there is the potential for residual significant impacts on bluegrass as a result of the proposed action. In addition, EHP considers that the potential impact on the project on bluegrass remains uncertain due to the

limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There are four other development projects in the Northern Brigalow Belt bioregion that are or will have impacts on blue grass. The proponent has undertaken a cumulative impact assessment of current and future projects in the area and is of the view that impacts to listed threatened species can best be managed at the individual project scale and has identified specific mitigation measures for the species.

Offset

To offset the significant residual impacts for Phase 1 of the project, EHP recommends that the proponent be required to protect and enhance a parcel of land containing bluegrass. The offset site and offset management plan proposed will need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval require the proponent provide a direct offset for disturbance to bluegrass associated with Phase 1 of the project. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for approval conditions below).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a conservation outcome for the bluegrass is achieved.

EHP recommends that to compensate for the residual significant impact on bluegrass, the proposed conditions of approval include the requirement for the development of an offset management plan (the proponent has proposed the Bowen Environmental Offsets Strategic Management Plan) which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the species and conservation of habitat.

Consideration of Plans/Agreements/Conservation Advices

Conservation Advice: *Commonwealth Conservation Advice on Dichanthium setosum* approved on 26 March 2008.

Recovery Plan: No recovery plan has been prepared for Bluegrass (*Dichanthium setosum*).

Threat Abatement Plans: There are no threat abatement plans relevant to Bluegrass (*Dichanthium setosum*).

The main threats identified in the approved conservation advice are heavy grazing by domestic stock; loss of habitat through clearing for pasture improvement and cropping, frequent fires, invasion by introduced grasses and road widening.

The priority actions for blue grass (based on the conservation advice) are listed below:

Habitat Loss, Disturbance and Modification

- identify populations of high conservation priority;
- manage threats to areas of vegetation that contain populations/occurrences/remnants of *D. Setosum*;
- ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on *D. Setosum*;
- ensure road widening and maintenance activities (or other infrastructure or development activities as appropriate) in areas where *D. setosum* occurs do not adversely impact on known populations; and
- investigate formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure.

Invasive Weeds

- develop and implement a management plan for the control of introduced grasses, such as Coolatai, African lovegrass and Lippia, in the local region.

Trampling, Browsing or Grazing

- develop and implement a stock management plan for roadside verges and travelling stock routes.

Fire

- develop and implement a suitable fire management strategy for *D. Setosum*
- identify appropriate intensity and interval of fire to promote seed germination

- provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigation measures in bush fire risk management plans, risk register and/or operation maps.

Conservation Information

- raise awareness of *D. setosum* within the local community, particularly among landholders.

The priority management actions identified in the approved conservation advice have been considered in undertaking this assessment and making the recommendation that the proposed action be approved. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive weeds, fire control and progressive rehabilitation of disturbed areas.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to bluegrass and committed to disturbance limits for the project, reflected in the recommended conditions. The proponent must offset residual significant impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions below.

EHP is of the view that the proposed action will not have an unacceptable impact on blue grass.

4. A tufted grass *Aristida annua*

EPBC Act Status: vulnerable

Aristida annua occurs is an annual loosely tufted grass growing to approximately 50 cm in height which flowers between March and June. The species occurs in eucalypt woodland and is restricted to black clay soils, basalt soils and possibly disturbed sites. The species is known to occur in the *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* ecological community.

The species is restricted to central Queensland, in the Emerald and Springsure districts.

Aristida annua was not detected during EIS field surveys on the project site, however suitable habitat in form of black soil plains occurs within the project area. The nearest record is a 1999 collection 25km west of Dysart, adjacent to the Cotherstone road near Peak Range National Park. Potential habitat mapping provided in the SREIS indicates that there is no known or potential core habitat on the project site. The proponent has concluded that no impacts to this species are predicted to occur as a result of the project.

Consideration of Plans/Agreements/Conservation Advices

Conservation Advice: *Approved Conservation Advice for Aristida annua (a tufted grass)* was approved on 11 April 2014.

Recovery Plan: No recovery plan has been prepared for *Aristida annua (a tufted grass)*.

Threat Abatement Plans: There are no relevant threat abatement plans for *Aristida annua (a tufted grass)*

The main threats identified in the conservation advice are conversion of natural grassland to exotic pasture and cultivation of exotic fodder tree – *Leucaena leucophala*. Persistent heavy grazing and mining development in the Bowen basin are additional threats. Priority actions and threat abatement actions identified by the conservation advice are to monitor the known occurrences and identify key threats and progress of their recovery, control pasture improvement at known sites, protect populations through conservation arrangements, manage grazing to only occur outside growing season, intermittent grazing in preference to grazing and raise community awareness of the species within the local community.

The priority management actions identified in the approved conservation advice have been considered in undertaking this assessment.

Conclusion

Where potential habitat cannot be avoided through the planning and design phase, the proponent has committed to undertaking pre-clearance surveys for the species. Following preclearance surveys, disturbance will be minimised in identified core habitat in accordance with the proponent's commitments. In the event that the species is identified on site and residual significant impacts are determined likely, the proponent will be required to provide an offset in accordance with the EPBC Act Offsets Policy (see recommendations for approval conditions below).

Given the lack of records for the species and the avoidance measures proposed by the proponent, a significant

impact on *Aristida annua* as a result of the project is considered unlikely.

5. Northern quoll (*Dasyurus hallucatus*)

EPBC Act Status: endangered

Description

The northern quoll is the smallest of the four Australian quoll species. It has a pointy snout and reddish brown fur, with a cream underside. It has white spots on its back and rump and a long, sparsely-furred, unspotted tail. The tail length ranges between 202 and 345mm. The hind feet have striated pads and five toes. Northern quolls can weigh up to 1.2kg, with the males being larger than the females. It is the most arboreal and aggressive of the four quoll species, and its faeces and body smell strongly.

The northern quoll occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. Northern quoll are also known to occupy non rocky lowland habitats such as beach scrub communities in central Queensland. Northern quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Rocky habitats are usually of high relief, often rugged and dissected but can also include fields or caves in low lying areas. Eucalypt forest or woodland habitats usually have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes. Dens are made in rock crevices, tree holes or occasionally termite mounds. Northern quolls sometimes occur around human dwellings and campgrounds. Northern quolls appear to be most abundant in habitats within 150km of the coast.

Recent surveys throughout Queensland have suggested northern quolls are more likely to be present in high relief areas that have shallower soils, greater cover of boulders, less fire impact and were closer to permanent water.

Distribution

The northern quoll is known to occur as far south as Gracemere and Mt. Morgan, south of Rockhampton, as far north as Weipa in Queensland and extends as far west into central Queensland to the vicinity of Carnarvon National Park. There are occasionally records as far south in Queensland as Maleny on the sunshine coast hinterland. The species is highly fragmented in the state and surveys indicate severe reductions from the species' former distribution.

Survey requirements and survey effort

EPBC Act survey requirements/techniques

Survey guidelines for Australia's threatened mammals. EPBC Act survey guidelines 6.5

- For the purposes of referral and assessment under the EPBC Act, it is recommended that surveys for northern quoll involve an initial reconnaissance survey which aims to identify the need for further investigations through a targeted survey. Where it is not possible to conduct surveys in this manner, failure to detect northern quoll should not be considered indicative of its absence.
 - *Reconnaissance survey* - A reconnaissance survey can be conducted at any time of the year but should be undertaken in the early planning stages of the project. The reconnaissance survey should assess the suitability of habitat for northern quolls, both for denning/shelter and dispersal and foraging purposes. Suitable habitat should be mapped during this survey and habitat areas calculated. Data collected should describe the habitat quality including information on vegetation, microhabitat, fire history, presence of introduced predators, grazing history and landscape condition. A reconnaissance survey may choose to consider the presence or potential presence of the northern quoll by using non-invasive techniques such as active searching for scats and latrine sites, motion sensitive cameras, hair tubes or spotlighting where appropriate.
 - *Targeted survey* - A targeted survey is recommended for any proposal occurring within the modelled distribution of the species where the reconnaissance survey identifies the presence of quolls and/or habitat critical to the survival of northern quoll.
 - The objective of the targeted survey should be to determine the relative abundance and distribution of northern quolls likely to be impacted by the proposed development. The survey protocol should be designed so that the total population of northern quolls in the impact area can be calculated. A targeted survey should be undertaken pre development and during the months of May, June, July or August (primarily to avoid any disturbance during the reproductive period) and involve a trapping program using preferably wire cage traps or large size Elliot traps.
As a minimum, a targeted survey should consider the following:

- carefully configure the trapping program to address project impact and non-impact zones so that results are adequate to inform monitoring programs and project siting options;
- trapping should be concentrated in habitat critical to the survival with some consideration of non-rocky foraging and dispersal habitats;
- where large Elliott traps are the primary trapping technique, a minimum of four cage traps should be used per trap configuration;
- to be considered effective, traps should be baited with oats, sardines and peanut butter. Chicken wings and diced bacon are optional;
- traps should be rebaited at least every second day (baits should be fresh), cleared within 2–3 hours of sunrise and have adequate shade cover during the day. Consideration should be given to closing traps during the day to eliminate by-catch and potential heat stress issues; and
- targeted surveys may be supplemented by one of several non-invasive survey techniques such as latrine searches in habitat critical to the survival, use of motion sensitive cameras and / or hair tubes. These methods should however not be relied upon to demonstrate northern quolls are not present in an area.

Targeted survey effort –

- Trapping effort for a targeted survey should be determined by the formula $y = 50 \times 0.5$, where y is the number of trap-nights and x is the area of potential northern quoll habitat in hectares
- Trapping effort is calculated as the number of traps by the number of nights of trapping (e.g. trap-nights)
- For linear habitat critical to the survival of the species (e.g. gorges, major drainage lines, breakaways less than 100 m wide), 1 trap per 100 linear metres is recommended.

Project survey effort

Habitat assessments were used to evaluate important ecological features that contribute to fauna values including:

- quality and type of ground cover – thick grass, woody debris, rocks, soil cracks etc.;
- abundance of hollows;
- abundance of food resources such as fruit, flowers and seeds;
- abundance of suitable roosting and sheltering habitat, including caves and fissures;
- water sources or possibility for pooling surface water (e.g. gilgai);
- canopy cover, extent and height;
- vegetation structure, density and complexity; and
- edge effects and other disturbance regimes.

The Northern Quoll was not detected during field surveys of the project area.

Occurrence within the project area

Records of northern quolls within the project area and surrounding area are known, though few records exist. The most recent records in proximity to the project area include individuals in Dipperu National Park, Mt Hess, within Homevale National Park and Redcliffevale.

Northern quolls are most likely to be associated with the Kerlong Range, Carborough Range, Redcliffe Tableland and Blackdown Tableland.

From the proponent’s potential habitat mapping the area of Core Habitat Possible within the project area is 58.93ha.

Impacts of the proposed action

The lack of populations within the project area dilutes the project related impacts, which could include

- the loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure;
- death or injury of individuals during construction
- increased risk of vehicle strike
- increased fire frequency related to increased human presence
- increased mortality through predation and cane toad ingestion
- increased competition with introduced predators (e.g. cats)
- lead to a long-term decrease in the size of a population.

In Arrow’s assessment of their potential impacts on northern quoll against the significant impact criteria, they concluded that due to their detailed habitat mapping and pre-clearance survey with which they will avoid vegetation disturbance in placement of linear infrastructure, partial rehabilitation of gathering lines, monitoring and pest

management, they will have 'moderate' impacts on endangered northern quoll. However, EHP does not consider that there is any certainty of the actual impacts until the whole project is completed due to the lack of survey work, lack of clear definition of the actual footprint and no rehabilitation management plan.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to Northern Quoll and its habitat include

- avoid disturbance to the following areas
 - mapped essential habitat for threatened species
 - core habitat for species.
- conduct pre-construction/ preclearance surveys to identify any additional areas that need to be avoided, including as a minimum
 - vegetation mapping at a scale suitable for site-specific planning
 - identification of core habitat for species
 - Identification of site-specific sensitive areas that require avoidance or buffers.
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- data collection, particularly of species identified during pre-clearing surveys, during project related activities, should be ongoing until rehabilitation is complete
- undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery
- where species are identified in proposed development areas, consider mitigation measures such as translocation of fauna species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans
- a detailed pest management plan will be developed to mitigate and manage the potential spread of flora and fauna species
- undertake preclearance surveys to determine likelihood of weeds occurring, weed monitoring and targeted weed control measures within sensitive habitats.

Residual impact

The SREIS states that the potential maximum area of disturbance impact is 1.54ha of northern quoll Core Habitat Possible.

Cumulative impacts

There are two other development projects in the Northern Brigalow Belt bioregion that are or will have impacts on northern quoll habitat and therefore the proponent has concluded that there is moderate potential for cumulative impacts to northern quoll habitat.

The proponent has undertaken a cumulative assessment of current and future projects and states that impacts to listed threatened species can best be managed at the individual project scale and has identified specific mitigation measures for the species.

Consideration of Plans/Agreement/Conservation Advice

Conservation Advice: There is no approved conservation advice for the Northern Quoll

Recovery Plan: *National Recovery Plan For the Northern Quoll Dasyurus hallucatus*

Key threats identified in the recovery plan include cane toads, feral predators, inappropriate fire regimes, habitat degradation, habitat destruction, weeds, disease, hunting and population isolation.

The recovery plan aims to minimise the rate of decline of the northern quoll in Australian, and ensure that viable populations remain in each of the major regions of distribution into the future. Priority actions that relate to the project area include

- foster the recovery of northern quoll sub-populations in areas where the species has survived alongside cane toads
- determine which factors affect survival and recovery of northern quolls in areas with cane toads
- use information to assist surviving populations to recover in sympatry with cane toads
- identify the effect of pastoral land management practises on northern quoll persistence
- interim fire management at potential key quoll populations
- refine models of the current and expected distribution of cane toads and northern quolls, incorporation predictions of climate change
- maintain secure populations and source animals for future reintroductions/introductions, if they become

appropriate

- protection of key secure populations through protection of habitat in National Parks and Conservation Agreements
- reduce the risk of northern quoll populations being impacted by disease
- reduce the impact of feral predators on northern quolls
- implement efforts to protect key northern quoll populations from the impacts of feral predators
- raise public awareness of the plight of northern quolls
- implement a broader public education and awareness campaign on quolls and feral species (particularly cane toads and cats)
- develop and implement public education and awareness campaign on land management threats to quolls.

Threat Abatement Plans: The following threat abatement plans are relevant to the Northern Quoll

- *Threat Abatement Plan for Predation by the European Red Fox*
- *Threat Abatement Plan for Predation by Feral Cats*
- *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads*
- *Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses*

These Threat Abatement Plans focus on the risk to species from feral and pest species. They set out a national framework to guide and coordinate Australia's response to the impacts of cats and foxes on biodiversity to protect affected species and prevent further species being affected.

The objectives of the *Threat Abatement Plan for predation by feral cats* are to prevent feral cats occupying new areas, promote the maintenance and recovery of species affected by feral cats, improve knowledge and understanding, improve effectiveness of control operations and increase awareness.

The objectives of the *Threat Abatement Plan for predation by the European Red Fox* are to prevent red foxes occupying new areas, promote the maintenance and recovery of native species and communities that are affected, improve knowledge and understanding of red fox impacts and interactions with species and ecological processes, improve effectiveness of control options and increase awareness.

The *Threat Abatement Plan for the biological effects, including lethal toxic ingestion, caused by cane toads* is a national strategy to guide investment and effort by the Australian Government, jurisdictions, research organisations and non-government organisations in abating the impacts of cane toads across their known and anticipated range. The aim of the Plan is to identify priority native species and ecological communities (including those that are protected matters under the EPBC Act) at risk from the impact of cane toads; to reduce the impact of cane toads on populations of priority native species and ecological communities; and to communicate information about cane toads, their impacts and the Threat Abatement Plan. The Northern Quoll is identified as a species affected by the cane toad.

The *Threat Abatement Plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses* has been developed to address the key threatening process 'ecosystem degradation, habitat loss and species decline due to invasion of northern Australia by introduced gamba grass (*Andropogon gayanus*), para grass (*Urochloa mutica*), olive hymenachne (*Hymenachne amplexicaulis*), mission grass (*Cenchrus polystachios* syn. *Pennisetum polystachion*) and annual mission grass (*Cenchrus pedicellatus* syn. *Pennisetum pedicellatum*). It provides a framework for prioritising investment in threat abatement and identifies management and other actions required to ensure the long-term survival of native species and ecological communities affected by these grasses.

The key goal of the threat abatement plan is to minimise the adverse impacts of the five listed grasses on affected native species and ecological communities. To achieve this goal, there are six main objectives

- develop an understanding of the extent and spread pathways of infestation by the five listed grasses
- support and facilitate coordinated management strategies through the design of tools, systems and guidelines
- identify and prioritise key assets and areas for strategic management
- build capacity and raise awareness among stakeholders
- implement coordinated, cost-effective on-ground management strategies in high-priority areas
- monitor, evaluate and report on the effectiveness of management programs.

The threats posed by the introduced grasses in this threatening process can be controlled by preventing further spread into new habitats, eradicating weeds and rehabilitating the ecosystems where these weeds have invaded.

The proposed action is not inconsistent with the key recovery actions or the objectives of relevant threat abatement plans. The proponent has committed to the avoidance of Core Habitat Known for the species and to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive

weeds, fire control and progressive rehabilitation of disturbed areas.

Conclusion

Where potential habitat cannot be avoided through the planning and design phase, the proponent has committed to undertaking pre-clearance surveys for the species. Following pre-clearance surveys, disturbance will be minimised in identified core habitat in accordance with the proponent's commitments. In the event that the northern quoll is identified on site and residual significant impacts are determined likely, the proponent will be required to provide an offset in accordance with the EPBC Act Offsets Policy (see recommendations for approval conditions below).

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for pre-clearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified fauna person (see recommendations for approval conditions below).

Given the lack of records for the species on the project site and the avoidance and mitigation measures proposed by the proponent, a significant impact on the northern quoll as a result of the project is considered unlikely.

6. Ornamental snake (*Denisonia maculata*)

EPBC Act Status: vulnerable

Description

The ornamental snake is a brown, grey-brown or black snake growing up to 50cm in length with lighter coloured body scales, often with darker streaks/flecks. The crown of the head is darker brown/black with lighter flecks, it has distinctly barred lips, a white/cream belly with dark spots/flecks on the outer edges, and smooth scales.

Ornamental snake's preferred habitat is within, or close to, habitat that is favoured by its prey – frogs. The species is known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions in Queensland regional ecosystem land zone 4, but also lake margins and wetlands. Gilgai formations are found where deep-cracking alluvial soils with high clay contents occur. Ornamental snake is likely to be found in Brigalow (*Acacia harpophylla*), gidgee (*Acacia cambagei*), Blackwood (*Acacia argyrodendron*) or Coolibah (*Eucalyptus coolabah*) dominated vegetation communities, or pure grassland associated with gulgais.

The most common regional ecosystem in which the species has been recorded is RE 11.4.3, other regional ecosystems where the species has been recorded include: 11.4.6, 11.4.8, 11.4.9, 11.3.3 and 11.5.16. Ornamental snake shelters in logs and under coarse woody debris and ground litter. Sites where ornamental snake have been recorded in abundance share the following habitat characteristics

- located within the lowest part of the catchment. Found in greatest numbers in shallow water where some aquatic vegetation is present, or where fringing groundcover vegetation has been inundated, especially in flooded gulgais where the dominant aquatic macrophyte is *Monochoria cyanea*
- have a diversity of gilgai size and depth
- there are soils of high clay content and deep-cracking characteristics. Water retention capacity increases with an increase in the fine clay particle fraction of soils
- ground timber is usually relatively common
- where burrowing frogs are abundant
- habitat patches are typically greater than 10 ha in area and are within, or connected, to larger areas of remnant vegetation.

Distribution

The species is known only from the Brigalow Belt North and parts of the Brigalow Belt South biogeographical regions. The core of the species' distribution occurs within the drainage system of the Fitzroy and Dawson rivers. Important populations occur in remnant vegetation on, or surrounding, gilgai mounds and depressions.

Survey requirements and survey effort

Survey guidelines for Australia's threatened reptiles. EPBC Act survey guidelines 6.6

EPBC Act survey requirements/techniques

- No survey methods are known to reliably detect the ornamental snake during dry weather/seasons. The species is most likely to be encountered by searching around suitable gilgai habitat while frogs are active. Driving roads at night, particularly after wet weather when frogs are active, may be necessary if wet weather precludes access to suitable (gilgai) habitat. Diurnal searches under sheltering sites (rocks, logs or other large

objects on the ground) could also be employed. Pitfall and funnel trap arrays could be trialled. These methods are all likely to yield low returns.

- It is recommended that all records be photographed and copies lodged with both the state National Parks Service and the Queensland Museum (Brisbane) for confirmation of identification.

Project survey effort

Habitat assessments were used to evaluate important ecological features that contribute to fauna values including

- quality and type of ground cover – thick grass, woody debris, rocks, soil cracks etc
- abundance of hollows
- abundance of food resources such as fruit, flowers and seeds
- abundance of suitable roosting and sheltering habitat, including caves and fissures
- water sources or possibility for pooling surface water (e.g. gilgai)
- canopy cover, extent and height
- vegetation structure, density and complexity
- edge effects and other disturbance regimes.

Active Search

- Habitat searches for amphibians, small mammals, and reptiles included log/rock rolling, inspecting exfoliating bark and raking through leaf litter. Scats, tracks and traces, including droppings and claw marks, were recorded, this method being particularly useful for assessing the presence of koalas.

Incidental Observations

Incidental observations were made in relation to terrestrial vertebrates throughout the survey. Any locations where potentially important fauna values were recognised were geospatially recorded for later use in impact assessment and mapping.

- A total of 334 sites have been assessed for fauna composition including 260 sites subject to active fauna searches during this study with a further 39 sites subject to formalised trapping techniques and 35 sites subject to fauna observation recorded in recent associated studies.

Occurrence within the project area

Possible core habitat within the project area is estimated to be 59481.71ha and core habitat known is 1988.37ha. The species is known only from the Brigalow Belt north and parts of the southern Brigalow Belt bioregions. The core of the species' distribution occurs within the drainage systems of the Fitzroy and Dawson rivers.

During the EIS field survey the ornamental snake was found in woodland of Eucalyptus coolabah woodland with scattered *Casuarina cristata* palustrine wetland with shallow gilgai development and groundcover dominated by *Eleocharis pallens*.

Impacts of the proposed action

Potential impacts associated with the proposed project activities include

- possible death or injury of individual during vegetation clearing. It is possible, depending on the extent of the clearing that displaced animals forced into nearby or adjacent habitats may be unlikely to persist due to increased competition in these areas
- as the species is known to cross artificial corridors, it is highly probable that individuals could become trapped and perish in open trenches
- the species is susceptible to changes in soil structure and hydrology resulting from construction activities such as soil compaction and short-term loss of soil structure development (i.e. cracking), however the species has also been observed in disturbed soils (such as graded road verges and spoil piles) which suggests that the species can tolerate some soil degradation
- edge effects, particularly weed invasion, could significantly modify existing habitats and render them unsuitable for the species. Although the species is known to utilise buffel grass-dominated pasture, the impacts from other weeds such as parthenium is unclear. Therefore weed invasion resulting from clearing has the potential to alter large areas of potential or known habitat, possibly reducing the abundance or extent of the species
- individuals may become entrapped and perish in plastic-lined surface ponds.

In Arrow's assessment of the potential impacts on ornamental snake against the significant impact criteria, they concluded that due to their detailed habitat mapping and pre-clearance survey with which they will avoid vegetation disturbance in their placement of linear infrastructure, partial rehabilitation of gathering lines, monitoring and pest management they will have 'moderate' impacts on endangered ornamental snake. However, EHP does not

consider that there is any certainty of the actual impacts until the whole project is completed due to the lack of survey work, lack of clear definition of the actual footprint and no rehabilitation management plan.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to ornamental snake and its habitat include

- avoid disturbance to mapped essential habitat for the species and core habitat for species
- conduct pre-construction/preclearance surveys to identify any additional areas that need to be avoided, including as a minimum
 - vegetation mapping at a scale suitable for site-specific planning
 - identification of core habitats for species
 - identification of site-specific sensitive area that require avoidance or buffers.
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- data collection, particularly of species identified during pre-clearing surveys, during trench checking or in other project related activities, ongoing until rehabilitation is completed
- undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery
- trenches should be inspected and monitored as per the APIA Code of Environmental Practice
- minimise the time a trench is left open. Construct exit points when construction is within 1km of native vegetation, using appropriate material. Provide fauna refuges, such as sawdust-filled bags, regularly through areas of high fauna activity
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake pre-clearing surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive EVNT habitats.

Residual impact

The maximum project disturbance impact on vulnerable ornamental snake habitat is estimated to be 1030.31 ha of Core Habitat Possible. The proposed mitigation and management measures will provide a level of protection to the species however, DOE considers that there is the potential for residual significant impacts on the ornamental snake as a result of the proposed action. In addition, EHP considers that the potential impact on the project on the ornamental snake remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There are eleven other development projects in the Northern Brigalow Belt bioregion that are or will have impacts on ornamental snake habitat and therefore there is high potential for cumulative impacts to ornamental snake and its habitat.

The proponent has undertaken a cumulative assessment of future projects and concluded that there is a high potential for cumulative impacts on the ornamental snake (Appendix J of the SREIS). The proponent states that impacts to threatened species can best be managed at the individual project scale and has identified specific mitigation measures for the ornamental snake.

Offset

To offset the significant residual impacts of the project, EHP recommends that the proponent be required to protect and enhance a parcel of land containing habitat for ornamental snake. The offset site and offset management plan proposed will need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval require the proponent provide a direct offset for disturbance to ornamental snake associated with Phase 1 of the project. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for approval conditions below).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a conservation outcome for the ornamental snake is achieved.

EHP recommends that to compensate for the residual significant impact on the ornamental snake, the proposed conditions of approval include the requirement for the development of an offset management plan which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the

species and conservation of habitat.

Consideration of Plans/Agreements/Conservation Advice *Conservation Advice: Commonwealth Conservation Advice for Denisonia maculata (Ornamental Snake)* approved 29 April 2014.

The approved conservation advice identifies the main threat to the ornamental snake as the continued legacy of past broadscale land clearing and habitat degradation. Another threat is the destruction of wetland habitat by feral pigs, along with associated destruction of frog habitat and direct competition for their food source (frogs). The ornamental snake is potentially threatened by poisoning from the ingestion of cane toads.

Priority actions identified by the recovery plan that relate to the project area include:

Habitat loss, disturbance and modification

- identify populations of high conservation priority
- investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate inclusion in reserve tenure if possible
- minimise adverse impacts from land use at known sites.

Animal impacts

- control introduced pests such as pigs to manage threats at known sites.
- develop and implement a management plan for the control of cane toads in the region.

Conservation information

- raise awareness of ornamental snake and other reptiles found in the Brigalow Belt bioregion within the local community.

Recovery Plan: No Recovery Plan has been prepared for the ornamental snake.

Threat Abatement Plans: The following threat abatement plans are relevant to the ornamental snake:

- *Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs*
- *Threat Abatement Plan for predation by feral cats*
- *Threat Abatement Plan for Predation by the European Red Fox*

These threat abatement plans focus on the risk to species from feral and pest species. They set out a national framework to guide and coordinate Australia's response to the impacts of cats and foxes on biodiversity to protect affected species and prevent further species being affected.

The objectives of the *Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs* are to prevent feral pigs from establishing in new areas; integrate feral pig management plans; increase awareness and understanding; quantify the impacts on biodiversity; and improve the effectiveness of strategies to manage environmental damage. An adaptive management approach is recommended where feasible.

The broad goals of the Threat Abatement Plan for Feral Pigs is to protect nationally listed threatened species and communities from predation, habitat degradation, competition and disease transmission by feral pigs. The objectives of the Plan are to

- prevent feral pigs from establishing in areas where they do not currently occur or are in low eradicable numbers, and where they would impact on nationally listed threatened species and ecological communities
- integrate feral pig management plans and their implementation into natural resource planning and investment at the regional, state and territory and federal level through consultation and liaison with key stakeholders
- increase awareness and understanding of land managers and the general community about the damage that feral pigs cause and management options
- quantify the impacts that feral pigs have on biodiversity (especially nationally listed threatened species and ecological communities) and determine the relationship between feral pig density and the level of damage
- improve the effectiveness, efficiency and humaneness of techniques and strategies for managing the environmental damage due to feral pigs.

The objectives of the *Threat Abatement Plan for predation by feral cats* are to prevent feral cats occupying new areas, promote the maintenance and recovery of species affected by feral cats, improve knowledge and understanding, improve effectiveness of control operations and increase awareness.

The objectives of the *Threat Abatement Plan for predation by the European Red Fox* are to prevent red foxes occupying new areas, promote the maintenance and recovery of native species and communities that are affected,

improve knowledge and understanding of red fox impacts and interactions with species and ecological processes, improve effectiveness of control options and increase awareness.

The priority management actions identified in the approved conservation advice have been considered in undertaking this assessment and in making the recommendation that the proposed action be approved. The proposed action is not inconsistent with the objectives of relevant threat abatement plans. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive flora and fauna species and progressive rehabilitation of disturbed areas.

Conclusion

The Proponent has proposed a number of mitigation and management measures to reduce the level of impact to the ornamental snake and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. The proponent must offset residual significant impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions.

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for preclearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified Person (see recommendations for approval conditions below).

EHP is of the view that the proposed action will not have an unacceptable impact on the ornamental snake.

7. Fitzroy River turtle (*Rheodytes leukops*)

EPBC Act Status: vulnerable

Description

Rheodytes leukops grows to 25 cm (shell length) and the shell has a medium to dark brown colouring, with some dark spots and blotches on the top of the shell. On the underside surface, the shell is yellow or cream and the skin is an olive-grey colour. The neck of *Rheodytes leukops* is covered with 'large, pointed conical tubercles'. The turtle also has long forelimbs, each with five claws, and a large cloacal bursa.

Rheodytes leukops has adapted to breathe either using its lungs or its cloaca. The turtles are known as 'bottom-breathers' as they can respire by drawing water in and expelling it from the cloaca at a rate of 15-60 times per minute. This function allows the turtle to walk on the streambed and stay underwater without coming to the surface for days or weeks.

Rheodytes leukops is slow to reach sexual maturity, taking up to 15-20 years before reproduction can occur. Nesting takes place between September and October annually, with nests being located in river sandbanks 1-4 m above the water level. Females typically lay between 46-59 eggs annually in three to five clutches.

Rheodytes leukops has a highly diverse diet consisting of algae, macro-invertebrate larvae, macrophytes (including *Vallisneria spp.*), freshwater sponges, terrestrial insects, as well as terrestrial leaves and bark.

Rheodytes leukops is thought to have a limited home range (417-679m), overlapping riffle zones. Turtles have been observed to be active mainly during late afternoon and at night, although they can be largely sedentary staying in the same location for several days.

Rheodytes leukops occurs in rivers with a rock, gravel or sand substrate, with deep pools that are connected by shallow riffle zones. Riffle zones are an important habitat for *Rheodytes leukops* due to the high dissolved oxygen levels in these zones and abundant food sources, including benthic macro-invertebrates and algae.

During the dry season this species retracts into large slow flowing pools and/or non-flowing permanent pools. The species prefers waterways with high water clarity and areas that contain large macrophyte beds, including *Vallisneria spp.* *Rheodytes leukops* has been identified as occurring in the Fitzroy, Connors, Dawson, Isaac and Mackenzie Rivers, as well as Windah Creek and Develin or Marlborough Creek. Since being described in 1980, the distribution of *Rheodytes leukops* is not believed to have significantly changed.

Distribution

Rheodytes leukops is only known to occur within the Fitzroy Basin. It is estimated that this species occurs in a total area of less than 10,000km². Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie river, the Connors river, Daringa, Marlborough creek and Gogango.

Survey requirements and survey effort

EPBC Act survey requirements/techniques

- The Fitzroy River turtle is readily observed in the riffle zones by diving with a face mask and snorkel, or collected by seine netting. However, the presence of saltwater crocodiles *Crocodylus porosus* in the mid to lower reaches of the river presents a hazard to survey work. The effectiveness of drum traps to sample this species is unknown. The partly carnivorous diet of the Fitzroy River turtle reported indicates it might be attracted to meat baits and this methodology should be trialled to determine its suitability for detecting the presence of the species.
- Potential records of the Fitzroy River turtle should be supported by a good quality colour photograph. Photo vouchers should be forwarded to the state fauna authority and appropriate state museum (Queensland Museum) for positive identification and databasing of the record.

Project survey effort

- Habitat assessments were used to evaluate important ecological features that contribute to fauna values including
 - quality and type of ground cover – thick grass, woody debris, rocks, soil cracks etc
 - abundance of hollows
 - abundance of food resources such as fruit, flowers and seeds
 - abundance of suitable roosting and sheltering habitat, including caves and fissures
 - water sources or possibility for pooling surface water (e.g. gilgai)
 - canopy cover, extent and height
 - vegetation structure, density and complexity
 - edge effects and other disturbance regimes.
- Active Search
 - Habitat searches for amphibians, small mammals, and reptiles included log/rock rolling, inspecting exfoliating bark and raking through leaf litter. Scats, tracks and traces, including droppings and claw marks, were recorded, this method being particularly useful for assessing the presence of koalas.
- Incidental Observations
 - Incidental observations were made in relation to terrestrial vertebrates throughout the survey. Any locations where potentially important fauna values were recognised were geospatially recorded for later use in impact assessment and mapping.
- A total of 334 sites have been assessed for fauna composition including 260 sites subject to active fauna searches during this study with a further 39 sites subject to formalised trapping techniques and 35 sites subject to fauna observation recorded in recent associated studies.

Occurrence within the project area

General fauna surveys did not detect this species during EIS field surveys. The core habitat for this species is found to the south-east of the project area. The proponent estimates that there is 535.29ha of core habitat possible present within the project area.

Impacts of the proposed action

Potential impacts associated with the project include

- loss of habitat from construction activities
- loss of movement opportunities from construction activities
- reduction in water quality
- sediment deposition in habitat areas
- spread of riparian weeds.

Appendix J of the SREIS notes that impacts associated with the project also include erosion during construction and contamination of waterways as a result of fuel, oil or chemical spills. The proponent considers that the likelihood of occurrence of the species on the project is low however, has concluded that there is the potential for impacts to downstream habitat if these activities are not managed.

In Arrow’s assessment of their potential impacts on Fitzroy River turtle against the significant impact criteria, they concluded that due to their detailed habitat mapping and pre-clearance survey with which they will avoid vegetation disturbance in their placement of linear infrastructure, partial rehabilitation of gathering lines, monitoring and pest management they will have ‘moderate’ impacts on vulnerable Fitzroy River turtle. However, EHP does not consider that there is any certainty of the actual impacts until the whole project is completed due to the lack of survey work, lack of clear definition of the actual footprint and no rehabilitation management plan.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to Fitzroy River turtle and its habitat include

- avoid disturbance to mapped essential habitat for the species and core habitat for species
- conduct pre-construction/preclearance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for species and site-specific sensitive areas that require avoidance or buffers
- minimise vegetation disturbance. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac river and Suttor creek)
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- data collection, particularly of species identified during pre-clearing surveys, in other project related activities, should be ongoing until rehabilitation is complete
- trenches should be inspected and monitored as per the APIA Code of Environmental Practice
- minimise the time a trench is left open. Construct exit points when construction is within 1km of native vegetation, using appropriate material. Provide fauna refuges, such as sawdust-filled bags, regularly through areas of high fauna activity
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake preclearance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive habitats.

Residual impact

The proponent has estimated that the maximum project disturbance impact on vulnerable Fitzroy River turtle would be 0.87ha of Core Habitat Possible.

Cumulative impacts

There are two other development projects in the Northern Brigalow Belt bioregion that are or will have impacts on Fitzroy River turtle habitat and the proponent has concluded that there is low potential for cumulative impacts on Fitzroy River turtle habitat.

The proponent has undertaken a cumulative assessment of projects in the area and states that impacts to listed threatened species can best be managed at the individual project scale and has identified specific mitigation measures for the Fitzroy River turtle.

Consideration of Plans/Agreements/Conservation Advice

Conservation Advice: *Commonwealth Conservation Advice on Rheodytes leukops (Fitzroy Tortoise)* approved on 3 March 2008.

Recovery Plan: No Recovery Plan has been prepared for the Fitzroy River Turtle.

Threat Abatement Plans: There are no threat abatement plans relevant to the Fitzroy River Turtle.

The main threats identified in the approved conservation advice include loss and disturbance from agriculture (particularly cotton and cattle farming); mining and salinity, damming of rivers and pollution, and siltation of rivers and creek habitats. A significant threat is from the predation of eggs; communal nesting sites are heavily exploited by foxes, pigs, dingos, cats, goannas and water rats (with over 90% of nests being lost to predation). Fishing and recreational boating cause injury or mortality.

The following regional and local priority recovery and threat abatement action are identified by the approved recovery plan.

Habitat Loss, Disturbance and Modification

- identify populations of high conservation priority;
- protect areas of riparian habitat where populations of *Rheodytes leukops* are known or have the potential to occur;
- ensure mining operations and other infrastructure or development activities in areas where *Rheodytes leukops* occurs do not impact on known populations;
- manage, in such a manner that there is no detrimental impact, any changes to hydrology that may result in changes to the water table levels, increased run-off, sedimentation or pollution, particularly from cotton/grazing production; and

- investigate formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure.

Trampling

- develop and implement a stock management plan along riparian habitats and travelling stock routes.

Animal Predation

- develop a management plan to be implemented for the control and eradication of foxes, pigs, dingoes and cats around breeding colonies of the Fitzroy River turtle.

Conservation Information

- raise awareness of *Rheodytes leukops* within the local community, particularly with boat owners to minimise boat strike.

Enable Recovery of Additional Sites and/or Populations

- improve recruitment of hatchling into the population
- Maintain stream flow and the continuity of turtle populations between impoundments.

Local Priority Actions

The following local priority recovery and threat abatement actions can be done to support the recovery of *Rheodytes leukops*

- monitor known populations to identify key threats
- monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary
- control access routes to suitably constrain public access to known sites on public land
- suitably control and manage access to nest sites on private land.

The priority management actions identified in the approved conservation advice have been considered in undertaking this assessment and in making the recommendation that the proposed action be approved. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the implementation of sediment and erosion control measures, weed and pest management and implementation of a water management plan for the proposed discharge of CSG water.

Conclusion

Where potential habitat cannot be avoided through the planning and design phase, the proponent has committed to undertaking preclearance surveys for listed threatened species and communities. Following preclearance surveys, disturbance will be minimised in identified core habitat in accordance with the proponent's commitments. In the event that the Fitzroy River Turtle is identified and residual significant impacts are determined likely, the proponent will be required to undertake management actions and provide an offset in accordance with the EPBC Act Environmental Offsets Policy (see recommendations for approval conditions below).

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for pre-clearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified person (see recommendations for approval conditions). It is also recommended that the conditions of approval include the management of discharges of CSG produced water to the Isaac River to further protect the species and its habitat (See recommendations for approval conditions below).

Given the lack of records for the species on the project site and the avoidance and mitigation measures proposed by the proponent, a significant impact on the Fitzroy River Turtle as a result of the proposed action is considered unlikely

8. Squatter pigeon (southern) (*Geophaps scripta scripta*)

EPBC Act Status: vulnerable

Description

The squatter pigeon (southern) is a medium-sized (approximately 30cm long) ground-dwelling pigeon. Adults of both sexes are mostly grey-brown with black and white stripes on the face and throat, iridescent green or violet patches on the wings, a blue-grey lower breast and white flanks and lower belly. The two identified sub-species

differ in the colouring of the facial skin – *G.s.scripta* has blue-grey orbital skin.

Distribution

The squatter pigeon (southern) occurs on the inland slopes of the Great Dividing Range, with a distribution that extends from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coast from Proserpine to Port Curtis, and south to scattered sites in south-eastern Queensland. The subspecies, which is suspected to occur as a single, contiguous breeding population, mostly inhabits grassy woodlands and open forest dominated by eucalypts. The squatter pigeon (southern) is considered to be resident in at least some parts of its range, but also appears to undertake some local movements.

Survey requirements and survey effort

Survey Guidelines for Australia's Threatened Birds. EPBC Act survey guidelines 6.2

EPBC Act survey requirements/techniques

Desktop assessment

Surveys for the squatter pigeon (southern) should commence with a desktop assessment of the geographical area of potential foraging, breeding or dispersal habitat for the subspecies. The desktop assessment of this study area provides the information necessary to locate and design on-ground habitat assessments, opportunistic surveys and targeted surveys for the subspecies.

A desktop assessment should provide general information about the known distribution of squatter pigeons, where potential habitat and habitat connectivity occurs, and where important populations or habitat critical to the survival of the subspecies may occur in relation to the study area. This preliminary assessment should include searches of squatter pigeon (southern) records in state and non-government databases a review of the scientific literature, and a review of current vegetation mapping and aerial photographs of the study area.

Habitat assessment

Habitat assessments must be conducted by suitably qualified botanists or ecologists with demonstrated skill and experience in squatter pigeon (southern) habitat assessments.

If any vegetation types, which are indicative of the subspecies' foraging, breeding or dispersal habitat, are identified in the desktop assessment, an on-ground habitat assessment will need to be conducted. The distribution of each vegetation type and the quality of potential habitat areas for squatter pigeon foraging, breeding or dispersal should be assessed, as much as practicable, in each vegetation type. With regards to larger study areas, a reconnaissance of each vegetation type and subsequent stratification of the sampling effort will need to be conducted. It is recommended that opportunistic surveys for the subspecies be conducted during habitat assessments, particularly along dusty roads and other patches of bare ground adjacent to areas of native vegetation identified as suitable for the subspecies' foraging, breeding or dispersal.

Targeted surveys

Targeted surveys for the squatter pigeon (southern) are required to detect the subspecies in suitable habitats and to identify how the subspecies may be using those areas of habitat. Surveys must be conducted by suitably qualified zoologists or ecologists with demonstrated skill and experience in conducting squatter pigeon (southern) surveys, and must be undertaken in a manner which maximises the chance of detecting the species.

Optimal conditions

The optimal period of the year to detect the squatter pigeon (southern) is during the mid to late dry season from May to the end of October when the subspecies is most actively foraging for grass seed. The optimal period to observe juvenile squatter pigeons, which will indicate the presence of breeding habitat in the area, is in June.

As a general rule, targeted surveys should not be undertaken during weather conditions which are likely to impair visual detection of the subspecies, such as high windy conditions or during the night. Squatter pigeons are most commonly detected between sunrise and 9 am and between 3:30 pm and sunset. The optimal times of day to detect squatter pigeons are in the first half hour after sunrise and the last half hour before sunset when the birds are most active.

Targeted survey methods

Squatter pigeons are difficult to detect in their natural habitat, but are commonly seen foraging for seed on bare, dusty ground adjacent to natural habitats. The subspecies often occurs around dirt tracks and frequents water bodies or water courses from dawn to the middle of the morning and from the middle of the afternoon to dusk. Close inspection of dirt tracks and waterholes by surveyors tends to increase the chance of detection.

Commencing targeted surveys with slow driving surveys along roads and dusty areas is the most efficient way of detecting the subspecies. Driving in a vehicle at a constant speed (approximately 20 km per hour) along these roads is likely to be 'flush' squatter pigeons from their positions on the ground, which should allow the detection of the subspecies. Two driving surveys should be conducted in the following manner

- along the same route, in the same manner, on consecutive days
- adjacent to areas of natural habitat throughout the study area
- along unsealed roads, tracks and other dusty areas, such as stockyards
- along sealed roads around the perimeter of the study area.

The route to be taken should be designed to

- survey all unsealed roads in the study area during the periods, sunrise to 9 am and from 3:30 pm to sunset (i.e. commence the morning route at sunrise and then allow enough time in the afternoon to complete the afternoon survey by sunset)
- conduct return surveys along each road (i.e. survey a road then come back along the same road before proceeding to another).

It is recommended that waterbody surveys are conducted on the two consecutive days following the driving surveys. Waterbody surveys should target all natural and artificial waterbodies and watercourses which are suitable for use by the Squatter Pigeon (southern), and be conducted during the periods, sunrise to 9 am and from 3:30 pm to sunset.

Individuals tend to drink at the same, preferred location at the edge of a waterbody. It is recommended that observers position themselves so that they have a clear view of the subspecies' preferred drinking location. The observer must also be as still and quiet as possible to not disturb birds as they approach and drink. Therefore, the observer should be in position at the waterbody before birds are likely to arrive.

Project survey effort

Habitat assessments were used to evaluate important ecological features that contribute to fauna values including

- quality and type of ground cover – thick grass, woody debris, rocks, soil cracks etc.
- abundance of hollows
- abundance of food resources such as fruit, flowers and seeds
- abundance of suitable roosting and sheltering habitat, including caves and fissures
- water sources or possibility for pooling surface water (e.g. gilgai)
- canopy cover, extent and height
- vegetation structure, density and complexity
- edge effects and other disturbance regimes.

Active Search

Habitat searches for amphibians, small mammals, and reptiles included log/rock rolling, inspecting exfoliating bark and raking through leaf litter. Scats, tracks and traces, including droppings and claw marks, were recorded, this method being particularly useful for assessing the presence of koalas.

A total of 334 sites have been assessed for fauna composition including 260 sites subject to active fauna searches during this study with a further 39 sites subject to formalised trapping techniques and 35 sites subject to fauna observation recorded in recent associated studies.

Occurrence within the project area

The squatter pigeon was recorded during field surveys undertaken for the EIS. The squatter pigeon (southern) is common and widespread throughout the project area. Based on potential habitat mapping, approximately 105,807.71ha of potential squatter pigeon habitat is present within the project area including 4,324.72ha of 'core habitat known' and 101,482.89ha of 'core habitat possible'.

Impacts of the proposed action

The dispersal and movement patterns of the squatter pigeon (southern) are unlikely to be affected by project activities due to the highly mobile nature of the species and large areas of suitable habitat. Project related impacts are therefore mainly restricted to

- the loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure
- decreased habitat quality due to invading exotic grasses associated with unsuitable revegetation practices or surface soil disturbance

- increased surface water flows and resultant decrease in separation distance between permanent water and foraging habitats, enabling access to these areas for other less mobile species. Due to the mobility of the species, this benefit is likely to be minor or negligible.

In Arrow's assessment of their potential impacts on squatter pigeon (southern) against the significant impact criteria, they concluded that due to the poor condition of much of the existing habitat, the identification of similar habitat in areas adjacent to the project area and the mobile nature of the species that it is unlikely that the project will result in a long-term decrease in the size of an important population and as a consequence they will low impacts on vulnerable squatter pigeon. However, EHP does not consider that there is any certainty of the actual impacts until the whole project is completed due to the lack of survey work, lack of clear definition of the actual footprint and no rehabilitation management plan.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to squatter pigeon (southern) and its habitat include

- avoid disturbance to mapped essential habitat for the species and core habitat for species
- conduct pre-construction/preclearance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for species and site-specific sensitive areas that require avoidance or buffers
- design infrastructure to avoid undisturbed tracts of remnant vegetation. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection
- attempt to located wells, gathering lines and access tracks within previous clearings or non-remnant vegetation
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- data collection, particularly of species identified during pre-clearing surveys, in other project related activities, should be ongoing until rehabilitation is complete
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake preclearance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive habitats.

Residual impact

The project disturbance impact on squatter pigeon Core Habitat Possible is estimated by the proponent to be 1415.22 ha.

The proposed mitigation and management measures will provide a level of protection to the species however, DOE considers that there is the potential for residual significant impacts on squatter pigeon as a result of the proposed action. In addition, EHP considers that the potential impact on the project on squatter pigeon remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There are twelve other development projects within the Northern Brigalow Belt bioregion that are or will have impacts on squatter pigeon (southern) habitat. However, the proponent concludes that given its widespread occurrence and mobile nature, the potential for cumulative impacts to the species is considered to be low.

Offset

To offset the significant residual impacts associated with the project, the EHP recommends that the proponent be required to protect and enhance a parcel of land containing habitat for squatter pigeon (southern). The offset site and offset management plan proposed will need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval require the proponent provide a direct offset for disturbance to squatter pigeon associated with Phase 1 of the project. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for approval conditions).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a conservation outcome for the squatter pigeon (southern) is achieved.

EHP recommends that to compensate for the residual significant impact on the squatter pigeon (southern), the proposed conditions of approval include the requirement for the development of an offset management plan which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the species and conservation of habitat.

Consideration of Plans/Agreement/Conservation advice

Conservation advice: Commonwealth Conservation Advice on *Geophaps scripta scripta* (Squatter Pigeon (southern)) approved 3 July 2008.

Recovery Plan: No recovery plan has been prepared for the Squatter Pigeon (southern).

Threat Abatement Plans: The following threat abatement plans are relevant to the Squatter Pigeon (southern)

- *Threat Abatement Plan for predation by feral cats*
- *Threat Abatement Plan for Predation by the European Red Fox*
- *Threat abatement plan to reduce the impacts of tramp ants on biodiversity in Australia and its territories*

The main threats identified in the approved conservation advice include: ongoing clearance of habitat for farming or development purposes, grazing of habitat by livestock and feral herbivores, and predation by feral cats and foxes.

The following priority recovery and threat abatement actions are identified in the conservation advice to support the recovery of the squatter pigeon:

Habitat Loss, Disturbance and modification

- monitor known populations to identify key threats
- monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary
- identify populations of high conservation priority
- manage threats to areas of vegetation that support important populations of the squatter pigeon (southern)
- protect populations of the listed subspecies through the development of covenants, conservation agreements or inclusion in reserved tenure.

Trampling, browsing or grazing

- develop and implement a stock management plan for key sites
- develop and implement a management plan, or nominate an existing plan to be implemented, for the control and eradication of feral herbivores in areas inhabited by the squatter pigeon (southern).

Animal predation or competition

- implement the appropriate recommendations outlined in the *Threat Abatement Plan for Predation by Feral Cats* and the *Threat Abatement Plan for Predation by the European Red Fox* in areas inhabited by the squatter pigeon (southern).

Conservation Information

raise awareness of the squatter pigeon (southern) within the local community, particularly among land managers. The objectives of the *Threat Abatement Plan for predation by feral cats* are to prevent feral cats occupying new areas, promote the maintenance and recovery of species affected by feral cats, improve knowledge and understanding, improve effectiveness of control operations and increase awareness.

The objectives of the *Threat Abatement Plan for predation by the European Red Fox* are to prevent red foxes occupying new areas, promote the maintenance and recovery of native species and communities that are affected, improve knowledge and understanding of red fox impacts and interactions with species and ecological processes, improve effectiveness of control options and increase awareness.

The *Threat Abatement Plan to reduce the impacts of tramp ants on biodiversity in Australia and its territories* establishes a national framework to guide and coordinate Australia’s response to tramp ants, identifying the research, management, and other actions necessary to ensure the long-term survival of native species and ecological communities affected by tramp ants. The plan contains six objectives, with supporting actions at all stages of the invasion sequence. The objectives are

- increase science-based knowledge and expertise, incorporate Indigenous traditional ecological knowledge, quantify impacts, and improve access to information for priority tramp ant species
- prevent entry and spread of tramp ants by increasing diagnostic capacity, offshore surveillance, inspection, treatment, and national and state and territory surveillance

- prepare for rapid response to tramp ant incursions and spread through risk assessment of tramp ant species and pathways of introduction, and development of contingency plans
- enhance emergency response to tramp ant incursions by improving reporting and response rates, and by developing tools for response and follow-up
- build stewardship by engaging, educating, and informing the Australian community about the impacts of invasive tramp ants and effective means of response
- coordinate Australian Government, state and territory government, and local management activities in Australia and the region.

Impacts from tramp ants range from the displacement of native species to competition and predation resulting in disruption of ecosystem processes, including litter decomposition and changes in pollination and seed dispersal services.

The priority management actions identified in the approved conservation advice have been considered in undertaking this assessment and in making the recommendation that the proposed action be approved. The proposed action is not inconsistent with the objectives of relevant threat abatement plans. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive flora and fauna species and progressive rehabilitation of disturbed areas.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to the squatter pigeon (southern) and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. The proponent must offset residual significant impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions.

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for pre-clearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified person (see recommendations for approval conditions below).

EHP is of the view that the proposed action will not have an unacceptable impact on the squatter pigeon (southern).

9. Koala (*Phascolarctos cinereus*)

EPBC Act Status: vulnerable

Description

Koalas live in a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by eucalypts species. Their distribution is affected by altitude, temperature and leaf moisture particularly at the western and northern ends of their range.

As a leaf-eating specialist, the koala's diet is restricted mainly to foliage of eucalypt species. There are around 120 species of eucalypt in which koalas have been observed sitting in and/or feeding. Whilst koalas are known to feed on the leaves of Eucalyptus related genera, they usually get most of their nutrition from one or a few eucalypt species found at a single site.

Koala habitat critical to the survival of the koala is considered to be areas of forest or woodland where

- primary koala food tree species comprise at least 30% of the over-storey trees
- primary koala food tree species comprise less than 30% of the over-storey trees, but together with secondary food tree species comprise at least 50% of the over-storey trees
- primary food tree species are absent but secondary food tree species along comprise at least 50% of the over-storey trees
- the above qualities may be absent in a forest or woodland but other essential habitat features are present and adjacent to areas exhibiting the above qualities
- a relatively high density of koalas is supported, regardless of the presence of food tree species.

Distribution

For the combined population subject to the listing and the conservation advice, the range extends from approximately the latitude of Cairns to the New South Wales-Victoria border, and includes some island populations. The koala's distribution is not continuous across this range, with populations isolated by cleared land or unsuitable

habitat.

Koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus *Eucalyptus*. The distribution of koalas is also affected by altitude (limited to <800m ASL), temperature and, at the western and northern ends of the range, leaf moisture.

Survey requirements and survey effort

EPBC Act survey requirements/techniques

On-ground surveys

On-ground koala surveys are a useful tool for informing decision-making, where uncertainty or knowledge gaps exist. On-ground surveys may be designed to ground-truth (confirm) habitat/vegetation information and/or assess koala occurrence. A habitat assessment should include an assessment of the vegetation, particularly in relation to vegetation condition and structure, and the types and intensity of existing threats to the koala in your impact area. Surveys must be conducted by a suitably qualified specialist (tertiary educated/trained in ecology or environmental science), with demonstrated skill and experience in conducting koala surveys and must be undertaken in a manner which maximises the chance of detecting the species. Surveys should aim to capture as much relevant data as possible, particularly estimates of the approximate age of any koalas that are observed directly (i.e. whether juveniles or adults).

On-ground koala surveys should ideally be undertaken between August and January when koala activity is at a peak. This is the optimum period to observe resident breeding females with back-young. It is also best to conduct surveys during the drier parts of the year as this is generally when koala faecal pellets will not break down or get washed away with rain (scat surveys can be carried out during wetter periods but it should be noted that detectability is likely to be lower). In the inland context, there may be seasonal differences in the use of habitat and it is recommended that koala surveys that are conducted during dry periods should be centred on riparian areas, upper/mid-slope areas and other potential dry-period refugia. Surveys conducted outside of this period must take into account the potential lower koala activity (detectability) and other relevant seasonal considerations.

Although direct observations of koalas are ideal, indirect methods can provide useful complementary information for assessing the occurrence of koalas in your study area. Faecal pellet searches, for example the Spot Assessment Technique (SAT) or the Regularised Grid-based Spot Assessment Technique (RGB-SAT), are recommended to determine the occurrence of koalas indirectly. These techniques can assist with determining local food tree preferences and identifying koala densities. These techniques are only appropriate where pellet persistence is high (in drier regions). Table 2 outlines some direct observation methods which may be used to assess koala occurrence and gather evidence of breeding.

Table 1: Direct observation methods.

Direct observation method	Comment
Strip transects	Diurnal (daytime) searching recommended for areas <30ha and where the number of koalas is expected to be high.
Nocturnal spotlighting	A good way to commence a survey as eye shine is easy to detect.
Call playback	Optimal during the breeding season (which can vary across the species' range), but may not be appropriate in some areas with a particularly vulnerable local sub-population as it can disrupt natural behavioural patterns (to be considered by the relevant ethics committee).
Remote sensor activated cameras	Strategically placed to record any koala movement within a search plot with faecal evidence.

Baseline monitoring for koala abundance, movement and habitat preference information

A more detailed approach to surveys is recommended for projects where large-scale or long-term impacts on the koala are likely and information on koalas is limited. Examples of such projects could be large-scale mining or forestry operations, major urban, peri-urban or transport developments which remove or fragment habitat critical to the survival of the koala.

For such projects, it is recommended the Department is contacted and also discussions are commenced with local koala experts, local and state government environmental agencies, experienced consultants and other relevant institutions. These discussions should be carried out with a view to developing and implementing a baseline monitoring methodology which evaluates koala abundance, movement and habitat preferences in the area

proposed to be affected by the project. This may involve intensive koala surveys including large scale scat surveys or tracking koalas to understand their movements and preferences in the impact area. These surveys will be important for effective design and implementation of mitigation measures to minimise the action's impacts.

Project survey effort

The field investigation was conducted over an initial period of 11 days (between 17 and 27 October 2011). Conditions during the field survey were generally mild (26 - 30°C) with overcast and windy conditions. The ground cover, particularly cover of perennial native grass species, was robust in the majority of field survey locations, a testament to the extent and duration of rainfall during the previous wet season.

A second phase of field survey subsequently was completed in May over a period of 17 days (between May 4 and May 20), to allow for seasonal variations in floristic and faunal composition of habitats and species seasonality. The latter survey period is consistent with Neldner et al. (2005) as the optimal window for sampling in north Australian savannahs.

For both survey periods, a survey team of two personnel undertook the flora survey and two personnel the fauna habitat assessments making for a total survey effort of 56 survey days for the flora survey and 56 survey days for the fauna habitat assessment. Field surveys were conducted as part of the EIS. Additional survey work was not carried out as part of the Arrow SREIS as development planning hasn't been refined to include detail for targeted sites at this stage of the project development.

Habitat assessments were used to evaluate important ecological features that contribute to fauna values including

- quality and type of ground cover – thick grass, woody debris, rocks, soil cracks etc
- abundance of hollows
- abundance of food resources such as fruit, flowers and seeds
- abundance of suitable roosting and sheltering habitat, including caves and fissures
- water sources or possibility for pooling surface water (e.g. gilgai)
- canopy cover, extent and height
- vegetation structure, density and complexity
- edge effects and other disturbance regimes.

Incidental observations were made in relation to terrestrial vertebrates throughout the survey. Any locations where potentially important fauna values were recognised were geospatially recorded for later use in impact assessment and mapping.

A total of 334 sites have been assessed for fauna composition including 260 sites subject to active fauna searches during this study with a further 39 sites subject to formalised trapping techniques and 35 sites subject to fauna observation recorded in recent associated studies.

Occurrence within the project area

Based upon the proponent's potential habitat mapping, approximately 166,741.28 ha of potential koala habitat is present within the project area including 3,883.81 ha of Core Habitat Known and 162,857.47 ha of Core Habitat Possible. Koalas in this region typically occur in low densities and have large home ranges.

Impacts of the proposed action

While koalas are slow moving, they readily cross short distances through unsuitable landscapes (i.e. cleared land). The isolation of existing populations is therefore unlikely to be a consequence of project-related activities in an already fragmented landscape. Potential impacts associated with the project include

- the loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure;
- invasive species altering ground cover density influencing the ability of the species to move within the environment;
- death or injury of individuals during clearing;
- increased mortality due to capture of individuals in open trenches passing through or adjacent to existing habitats; and
- increased fire frequency and intensity due to increased human presence and modified vegetation composition (i.e. weed invasion).

In Arrow's assessment of their potential impacts on koala against the significant impact criteria, they concluded that due the low koala population density within the project area, their solitary nature and the distributed nature of the project that it is unlikely that the project will result in a long-term decrease in the size of an important population and as a consequence they will have moderate impacts on vulnerable koala. However, the project area is considered to contain regionally important habitat for koalas (Alistair Melzer, pers. comm.) and EHP does not consider that there

is any certainty of the actual impacts until the whole project is completed due to the lack of survey work, lack of clear definition of the actual footprint and no rehabilitation management plan.

Avoidance and mitigation measures

Key mitigation measures proposed by the proponent to address potential impacts to koala and its habitat include

- avoid disturbance to mapped essential habitat for the species and core habitat for EVNT species
- conduct pre-construction/preclearance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for EVNT species and site-specific sensitive areas that require avoidance or buffers
- minimise vegetation disturbance. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac river and Suttor creek). Areas cleared for field development should be as small as practical
- design infrastructure to avoid undisturbed tracts of remnant vegetation. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection
- retain habitat tree where practical
- identify key koala trees, and visually inspect prior to clearing to ensure that they are free of koalas. If koalas are located, the tree should be retained until the animals have moved on, typically overnight
- attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- data collection, particularly of EVNT species identified during pre-clearing surveys, in other project related activities, should be ongoing until rehabilitation is complete
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake preclearance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive EVNT habitats.

Residual impact

The proponent has estimated that the maximum project disturbance impact on Core Habitat Possible for the koala would be 2466.04 ha.

The proponent has determined that any vegetation within 20km of a recent, accurate record is considered as 'core habitat possible' and is generally found in RE 11.3.2.

The proposed mitigation and management measures will provide a level of protection to the species however, DOE considers that there is the potential for residual significant impacts on koala as a result of the proposed action. In addition, EHP considers that the potential impact on the project on koala remains uncertain due to the limited survey work, uncertain location of project infrastructure, and absence of a rehabilitation management plan in the EIS documentation.

Cumulative impacts

There are nine other development projects in the Northern Brigalow Belt bioregion that are or will have impacts on koala habitat.

The proponent has undertaken a cumulative impact assessment of projects in the area and concluded that given the shared boundaries, similarity in impact pathways and temporal scale of operations proposed, there is a high potential for cumulative impacts on the koala. The proponent states that impacts to threatened species can best be managed at the individual project scale and has identified specific mitigation measures for the koala.

Offsets

To offset the significant residual impacts associated with the project, EHP recommends that the proponent be required to protect and enhance a parcel of land containing habitat for koala. The offset site and offset management plan proposed will need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval require the proponent provide a direct offset for disturbance to koala associated with Phase 1 of the project. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for approval conditions below).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a

conservation outcome for the koala is achieved.

EHP recommends that to compensate for the residual significant impact on the koala the proposed conditions of approval include the requirement for the development of an offset management plan which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the species and conservation of habitat.

Consideration of Plans/Agreements/ Conservation advice

Conservation Advice: *Commonwealth Conservation Advice on Phascolarctos cinereus (combined population in Queensland, New South Wales and the Australian Capital Territory)* approved 30 April 2012.

Recovery Plan: no national recovery plan has been approved for the koala.

Threat Abatement Plans: there are no threat abatement plans relevant to the koala.

The main threats identified in the approved conservation advice include the loss and fragmentation of habitat, vehicle strike, disease and predation by dogs. The following priority recovery and threat abatement actions are identified in the conservation advice that would support the recovery of the koala.

Habitat loss, disturbance and modification

- develop and implement a development planning protocol to be used in areas of koala populations to prevent loss of important habitat, koala populations or connectivity options
- development plans should explicitly address ways to mitigate risk of vehicle strike when development occurs adjacent to, or within, koala habitat
- monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary
- identify populations of high conservation priority
- investigate formal conservation arrangements, management agreements and covenants on private land, and for Crown and private land investigate and/or secure inclusion in reserve tenure if possible
- manage any other known, potential or emerging threats such as Bell Miner associated dieback or Eucalyptus rust
- develop and implement options of vegetation recovery and re-connection in regions containing fragmented koala populations, including inland regions in which koala populations were diminished by drought and coastal regions where development pressures have isolated koala populations.

Animal Predation

- develop and implement a management plan to control the adverse impacts of predation on koalas by dogs in urban, peri-urban and rural environments.

Conservation Information

- engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.

The priority threat abatement and recovery actions identified in the approved conservation advice have been considered in undertaking this assessment and in making the recommendation that the project be approved. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive flora and fauna species and progressive rehabilitation of disturbed areas.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to the koala and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. The proponent must offset residual significant impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions.

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for pre-clearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified person (see recommendations for approval conditions below).

EHP is of the view that the proposed action will not have an unacceptable impact on the koala.

10. South-eastern long-eared bat (*Nyctophilus corbeni*)

EPBC Act Status: vulnerable**Description**

The south-eastern long-eared bat is larger in size than other long-eared bats and has a broader skull and jaw. It has a head and body length of about 50-70 mm and a tail length of 35-50 mm. Weight varies between gender with females (14-21 g) heavier than males and males (11-15 g). Little is known about the ecology of this species and most of what is known comes from research outside of Queensland. Roosting has been recorded in hollows of live trees, cracks in tree limbs, occasionally under exfoliating bark and even within foliage. With broad, short wings, the south-eastern long-eared bat is highly manoeuvrable and well-adapted to its cluttered habitat. They fly close to vegetation, often through the canopy and can drop suddenly to almost ground level after prey. Individuals are known to fly more than seven km moving between roosts and foraging areas. Roosts may be changed frequently, with an average of 1.3 days in one study. Mating occurs in autumn and winter. Females are able to store spermatozoa until ovulation and conception in early spring. Two young are usually born in late October to November and lactation continues until January.

The south-eastern long-eared bat (*Nyctophilus corbeni*) is most common in box/ironbark/cypress pine woodland on sandy soils, though it also occurs in bullock (*Allocasuarina luehmannii*), brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) communities, dry sclerophyll forests with *Corymbia citriodora*, and semi-evergreen vine thickets. The species prefers areas with a distinct canopy and a dense understorey. Most records are from large tracts of vegetation (> 5000ha), although the species can be recorded from smaller tracts of 600 ha.

Distribution

The species is largely restricted to the Murray-Darling Basin, with its stronghold in the Pilliga forests of central New South Wales. In Queensland, the species is mainly recorded in Brigalow Belt South, with records from less than 30 locations, extending eastwards to the Bunya Mountains National Park. The distributional limits in Queensland are uncertain. The species is found north to near Duaringa and the Dawson River area may be its northern range limit. However, the most northerly record of the species is from 80 km west of Taroom. Forearm length is used extensively in field identifications of *Nyctophilus* species and there is broad overlap between each species for each sex of *N. corbeni* and *N. gouldi*. Larger individuals of *N. gouldi* are the same general size as *N. corbeni*. It is unknown if possible misidentifications of the species have resulted in the uncertainty attached to its distribution.

Survey requirements and survey effort

Survey Guidelines for Australia's Threatened Bats. EPBC Act survey guidelines 6.1

EPBC Act survey requirements/techniques

The eastern greater long-eared bat should be surveyed using capture techniques.

- **Prior to the survey.** In agricultural or other heavily modified landscapes, digital aerial photography of the study area can be examined to determine the size and pattern of vegetation remnants so that trapping effort can be planned.
- **Passive acoustic detection.** Bat detectors can be used to identify areas used by long-eared bats, even if they cannot be identified to species level. Acoustic detection can then be followed up with an appropriate level of trapping.
- **Trapping.** Mist nets and harp traps should be placed in woodland, mallee and forest, given that the species forages below the tree canopy, often to ground level. Equipment should be placed both in open fly-ways and within cluttered vegetation. If open water bodies (earth dams, fire dams, open top tanks and watercourses) occur in or near the project area, then significant effort should be given to mist-netting or harp trapping over the water. For project sites where there is no surface water, mist nets can be set over temporary water pools specifically constructed for the purpose of the survey.

Survey effort guide

Both harp traps and mist nets are effective for this species, and either can be used although harp traps have been employed successfully on a large scale in the past. For large project areas with landscape complexity, traps and nets should be distributed so as to give good representation in the major habitat types.

In the past, *N. timoriensis* has been captured in harp traps at 33 per cent of sites at a rate less than one capture per 20 trap nights. The species is uncommon in some areas but quite common in others. The recommended effort below might provide a reasonable opportunity to make a capture in the Brigalow Belt South and Nandewar Bioregions and possibly in South Australia, but elsewhere it would likely remain undetected. For this species, it is important to consider that failure to capture will not necessarily mean that a significant population of this species does not occur in the area.

EPBC survey guidelines for the *N. corbeni* recommend the use of harp trap or mist nest for a minimum of five

nights period and a total effort of 20 nights.

Project survey effort

The field investigation was conducted over an initial period of 11 days (between 17 and 27 October 2011).

Conditions during the field survey were generally mild (26 - 30°C) with overcast and windy conditions. The ground cover, particularly cover of perennial native grass species, was robust in the majority of field survey locations, a testament to the extent and duration of rainfall during the previous wet season.

A second phase of field survey subsequently was completed in May over a period of 17 days (between May 04 and May 20), to allow for seasonal variations in floristic and faunal composition of habitats and species seasonality. The latter survey period is consistent with Neldner et al. (2005) as the optimal window for sampling in north Australian savannahs.

For both survey periods, a survey team of two personnel undertook the flora survey and two personnel the fauna habitat assessments making for a total survey effort of 56 survey days for the flora survey and 56 survey days for the fauna habitat assessment. Field surveys were conducted as part of the EIS. Additional survey work was not carried out as part of the Arrow SREIS as development planning hasn't been refined to include detail for targeted sites at this stage of the project development.

Habitat assessments were used to evaluate important ecological features that contribute to fauna values including

- quality and type of ground cover – thick grass, woody debris, rocks, soil cracks etc.
- abundance of hollows
- abundance of food resources such as fruit, flowers and seeds
- abundance of suitable roosting and sheltering habitat, including caves and fissures
- water sources or possibility for pooling surface water (e.g. gilgai)
- canopy cover, extent and height
- vegetation structure, density and complexity
- edge effects and other disturbance regimes.

Incidental observations were made in relation to terrestrial vertebrates throughout the survey. Any locations where potentially important fauna values were recognised were geospatially recorded for later use in impact assessment and mapping.

A total of 334 sites have been assessed for fauna composition including 260 sites subject to active fauna searches during this study with a further 39 sites subject to formalised trapping techniques and 35 sites subject to fauna observation recorded in recent associated studies.

Occurrence within the project area

The species was not detected during field surveys. However, several individuals have been recorded in the south near Blackdown Tablelands and Dawson Range State Forest. Based on the proponent's potential habitat mapping there is 295648.22ha of Core Habitat Possible for south-eastern long-eared bat in the project area.

Impacts of the proposed action

Evidence suggests that this species is absent from small patches of vegetation, occurring most often in patches approximating 5,000 ha. However, the effect of fragmentation and disturbance associated with the construction of tracks and linear clearing is uncertain. Possible project-related impacts include

- potential death or injury of roosting bats caused by diurnal clearing of roosts
- the loss of foraging and roosting habitat due to the construction of infrastructure
- fragmentation of existing large, intact and contiguous habitats. The species does occur in large forests that are traversed by management tracks, suggesting that they could be tolerant of some disturbance
- increased fire frequency associated with increased human activity and machinery
- decreased wildfire extent due to fire breaks along gas gathering lines in otherwise continuous vegetation.

In Arrow's assessment of their potential impacts on South-eastern long-eared bat against the significant impact criteria, they concluded that due survey data that suggests that large, intact remnants of suitable habitat are required to support populations and the remaining large tracts of habitat are primarily restricted to the sandstone range, much of which in the region is within ranges such as Kerlong Range, Carborough Range, Redcliffe Tableland and Blackdown Tableland and as a consequence they will have moderate impacts on South-eastern long-eared bat. However, EHP does not consider that there is any certainty of the actual impacts until the whole project is completed due to the lack of survey work, lack of clear definition of the actual footprint and no rehabilitation management plan.

Avoidance and mitigation measures

Mitigation and management measures proposed by the proponent relevant to the vulnerable south-eastern long-eared bat include

- avoid disturbance to mapped essential habitat for the species and core habitat for species
- conduct pre-construction/preclearance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for species and site-specific sensitive areas that require avoidance or buffers
- minimise vegetation disturbance. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor creek). Areas cleared for field development should be as small as practical
- design infrastructure to avoid undisturbed tracts of remnant vegetation. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection
- assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter and roll them so that the hollows are facing upwards, allowing fauna to escape
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- data collection, particularly of species identified during preclearance surveys, in other project related activities, should be ongoing until rehabilitation is complete
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake preclearance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive habitats.

Residual impacts

The proponent estimates the maximum project disturbance on south-eastern long-eared bat habitat would be 2282.57 ha Core Habitat Possible.

Cumulative impacts

There is one other development project in the Northern Brigalow Belt bioregion that will impact on south-eastern long-eared bat habitat. The proponent's cumulative impact assessment of projects in the area determined that no other projects identified the species as known to occur or as having the potential to occur. Therefore, the proponent has concluded that the potential for cumulative impacts on the species is negligible.

Offsets

To offset the significant residual impacts associated with the project, EHP recommends that the proponent be required to protect and enhance a parcel of land containing habitat for south-eastern long-eared bat. The offset site and offset management plan proposed will need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval require the proponent provide a direct offset for disturbance to the south-eastern long-eared bat associated with Phase 1 of the project. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for approval conditions below).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a conservation outcome for the south-eastern long-eared bat is achieved.

EHP recommends that to compensate for the residual significant impact on the south-eastern long-eared bat the proposed conditions of approval include the requirement for the development of an offset management plan which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the species and conservation of habitat.

Consideration of Plans/Agreements/Conservation Advice

Conservation Advice: There is no approved conservation advice for the south-eastern long-eared bat.

Recovery Plan: No recovery plan has been prepared for the south-eastern long-eared bat.

Threat Abatement Plans: There are no threat abatement plans relevant for the south-eastern long-eared bat.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to the south-eastern long-eared bat and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. The proponent must offset residual significant impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions.

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for pre-clearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified person (see recommendations for approval conditions below).

EHP is of the view that the proposed action will not have an unacceptable impact on the south-eastern long-eared bat.

11. Large-eared pied bat (*Chalinolobus dwyeri*)

EPBC Act Status: vulnerable

Description

The Large-eared pied bat is a medium-sized insectivorous bat with large ears, glossy black dorsal fur and a white band of fur along the sides of the belly adjacent to the wing membrane. As with other *Chalinolobus*, there are lobes extending from the corners of the mouth to the bottom of the ears. Weight 7–12 g, forearm length 37–44.5 mm.

Habitat requirements remain poorly understood. The species is known to roost in mines, caves, and rock overhangs, especially in sandstone outcrops and gorges and also uses fairy martin nests and possibly tree hollows. Recorded from a range of habitats, including wet and dry sclerophyll forest, Cyprus pine dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland, but typically in association with sandstone relief. In south-eastern Queensland, it has been recorded primarily from higher altitude moist tall open forest adjacent to rainforest.

Distribution

The species is known from scattered localities in south-eastern Queensland, and New South Wales (central western NSW, the mid to north-eastern part of the state and as far south as Nowra). In Queensland, records exist from sandstone escarpments in the Carnarvon and Expedition Ranges and Blackdown Tablelands, and from volcanic rock types at Scenic Rim near the New South Wales/Queensland border. It has been recorded more often within New South Wales: from areas of volcanic strata at Coolah Tops, Mt Kaputar and the Warrumbungle National Park, distributed patchily in the sandstone areas of the Sydney Basin and the western slopes and plains including Pilliga Nature Reserve. Populations in north-eastern New South Wales, south-eastern Queensland, Shoalwater Bay and Blackdown Tablelands are likely to be isolated from each other.

Survey requirement and survey effort

Survey Guidelines for Australia's Threatened Bats. EPBC Act survey guidelines 6.1

EPBC Act survey requirements/techniques

The use of electronic bat detectors is the best means of non-invasive survey, and the most efficient in terms of data collection and area coverage. Trapping with harp traps and mist nets, and roost searches in caves, mines, rock overhangs, culverts and crevices could be undertaken to confirm presence or roosting.

Recommended acoustic detection devices include the Anabat ZCA system (recording to CF card), though other frequency-division and time expansion detectors connected to digital recorders could be used.

- **Prior to the survey.** Determine the potential for rocky outcrops, caves and mines to occur in the area by examining topographic and geological maps, and contacting state government mines and forestry departments, Queensland Parks and Wildlife Service, caving groups, bat researchers and local councils. Where appropriate, information on caves and mines may be obtained from local residents.
- **Passive acoustic detection.** A range of potential roost habitats can be examined by passive detection with unattended recorders placed in the vicinity of mines, caves and rocky outcrop, and also in foraging sites such as vegetation corridors and flyways, sandstone gorges, over watercourses, isolated waterholes and in representative vegetation types. Quality search-phase echolocation calls are diagnostic but these may not be recorded from bats emerging from underground roosts if bat detectors are placed at the entrance. Unattended detectors should be left overnight at multiple locations.

- **Active acoustic detection.** For larger project areas, walking or driving transects using hand-held detectors may be used in conjunction with unattended detectors. Transects should begin at dusk.
- **Roost searches.** Where no known roost sites have been identified in the planning stage, several hours may be required to conduct ground-based surveys for caves, mines, rock overhangs and crevices. For large project areas in gorge country, ground-based searching could be expected to take several days. Daytime entry of subterranean structures such as culverts, mines and caves should be undertaken carefully to avoid risking the safety of personnel and disturbance to resting bats. Identification can be made from capture within roosts. Disturbance resulting from capture of bats should be compensated by the collection of unambiguous and verifiable evidence of occupancy – in the form of photographs of the distinctive pelage, and external measurements.
- **Trapping.** Success with trapping is most efficient in the vicinity of potential roosts. Harp traps and mist nets are useful for detecting this species, and can be set overnight in forest flyways, near scarps and cliffs and in riparian zones. Captured individuals should be released only at night, or into roosts during the day if these are known, and bats should be held for the minimum amount of time after being removed from traps and nets. If bats are cleared from harp traps in the early morning, they should be kept at room temperature until the following night. Reference calls should be recorded from individuals released after trapping so that identification information is available for verification.

Survey effort guide

A combination of techniques is recommended. Three techniques recommended include unattended bat detectors, attended bat detectors and harp and/or mistnets for which a total effort of 16, 6 and 16 nights total effort is recommended respectively and for a duration of 4, 3 and 4 nights respectively.

Project survey effort

The field investigation was conducted over an initial period of 11 days (between 17 and 27 October 2011). Conditions during the field survey were generally mild (26 - 30°C) with overcast and windy conditions. The ground cover, particularly cover of perennial native grass species, was robust in the majority of field survey locations, a testament to the extent and duration of rainfall during the previous wet season.

A second phase of field survey subsequently was completed in May 2012 over a period of 17 days (between May 4 and May 20), to allow for seasonal variations in floristic and faunal composition of habitats and species seasonality. The latter survey period is consistent with Neldner et al. (2005) as the optimal window for sampling in north Australian savannahs.

For both survey periods, a survey team of two personnel undertook the flora survey and two personnel the fauna habitat assessments making for a total survey effort of 56 survey days for the flora survey and 56 survey days for the fauna habitat assessment. Field surveys were conducted as part of the EIS. Additional survey work was not carried out as part of the Arrow SREIS as development planning hasn't been refined to include detail for targeted sites at this stage of the project development.

Habitat assessments were used to evaluate important ecological features that contribute to fauna values including

- quality and type of ground cover – thick grass, woody debris, rocks, soil cracks etc.
- abundance of hollows
- abundance of food resources such as fruit, flowers and seeds
- abundance of suitable roosting and sheltering habitat, including caves and fissures
- water sources or possibility for pooling surface water (e.g. gilgai)
- canopy cover, extent and height
- vegetation structure, density and complexity
- edge effects and other disturbance regimes.

Incidental observations were made in relation to terrestrial vertebrates throughout the survey. Any locations where potentially important fauna values were recognised were geospatially recorded for later use in impact assessment and mapping.

A total of 334 sites have been assessed for fauna composition including 260 sites subject to active fauna searches during this study with a further 39 sites subject to formalised trapping techniques and 35 sites subject to fauna observation recorded in recent associated studies.

Occurrence within the project area

It is estimated within the project area to be 295,648.22ha of core habitat possible. In Queensland, records are known from sandstone escarpments in the Carnarvon, Expedition Ranges and Blackdown Tablelands. It is likely that these areas support a high proportion of the Queensland populations, although estimates of the number of

individuals present and their distribution in these areas has not been established. The species has the potential to be present.

Impacts of the proposed action

Evidence suggests that this species is absent from small patches of vegetation, occurring most often in patches approximating 5,000 ha. However, the effect of fragmentation and disturbance associated with the construction of tracks and linear clearing is uncertain. Possible project-related impacts include

- potential death or injury of roosting bats caused by diurnal clearing of roosts
- the loss of foraging and roosting habitat due to the construction of infrastructure
- fragmentation of existing large, intact and contiguous habitats. The species does occur in large forests that are traversed by management tracks, suggesting that they could be tolerant of some disturbance
- increased fire frequency associated with increased human activity and machinery
- decreased wildfire extent due to fire breaks along gas gathering lines in otherwise continuous vegetation.

Avoidance and mitigation measures

Mitigation and management measures proposed by the proponent relevant to the vulnerable south-eastern long-eared bat include

- avoid disturbance to mapped essential habitat for the species and core habitat for species
- conduct pre-construction/preclearance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for species and site-specific sensitive areas that require avoidance or buffers
- minimise vegetation disturbance. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac river and Suttor creek). Areas cleared for field development should be as small as practical
- design infrastructure to avoid undisturbed tracts of remnant vegetation. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection
- assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter and roll them so that the hollows are facing upwards, allowing fauna to escape
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- data collection, particularly of species identified during pre-clearing surveys, in other project related activities, should be ongoing until rehabilitation is complete
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake preclearance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive habitats.

Residual impact

The proponent has estimated that the project disturbance impact on large-eared pied bat habitat is 1451.44 ha of Core Habitat Possible.

Cumulative impacts

There is one other development project in the Northern Brigalow Belt that will impact on large-eared pied bat habitat and therefore there is a low potential for cumulative impacts. The proponent's cumulative impact assessment of projects in the area determined that no other projects identified the species as known to occur or as having the potential to occur. Therefore, the proponent has concluded that the potential for cumulative impacts on the species is negligible.

Offsets

To offset the significant residual impacts associated with the project, EHP recommends that the proponent be required to protect and enhance a parcel of land containing habitat for large-eared pied bat. The offset site and offset management plan proposed will need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that the conditions of approval require the proponent provide a direct offset for disturbance to the large-eared pied bat and habitat associated with Phase 1 of the project, where the impact footprint would cause a significant residual impact. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for approval conditions below).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of

the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a conservation outcome for the large-eared pied bat is achieved.

EHP recommends that to compensate for the residual significant impact on the large-eared pied bat, the conditions of approval include the requirement for the development of an offset management plan which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the species and conservation of habitat.

Consideration of Plans/Agreements/Conservation Advice

Conservation Advice: There is no approved conservation advice for the large-eared pied bat.

Recovery Plan: *National recovery plan for the large-eared pied bat* *Chalinolobus dwyeri*.

Threat Abatement Plans: There are no threat abatement plans relevant to the large-eared pied bat.

Key threats identified by the national recovery plan include: destruction of and interference with maternity and other roosts, mining of roosts, mine induced subsidence of cliff lines, disturbance from human recreational activities, habitat disturbance by other animals, including livestock and feral animals, predation by introduced predators, vegetation clearance in the proximity of roosts, fire in the proximity of roosts and loss of genetic diversity.

Key objectives and recovery actions identified by the recovery plan include

- identify priority roost and maternity sites for protection
 - undertake review of all existing information on the large-eared pied bat
 - identify and map known colonies within NSW and QLD to develop habitat models
 - identify priority colonies and sites for conservation management and protection
 - identify and locate roost structures such as cave systems, old mine sites and geological formations that require surveying
 - undertake targeted surveys for the species to clarify distribution and abundance to identify priority roost sites for management prescriptions
 - produce revised distribution and habitat model and report on findings with recommendations for conservation and threat abatement.
- implement conservation and management strategies for priority sites
 - protection of known roosts and associated foraging habitats and management of threats
 - installation of bat gates and remedial works at site where required
 - establish fire prescriptions for areas around each identified priority roost or maternity sites
 - conduct a program to control introduced species, such as goats, where necessary
 - undertake monitoring to assess the impact of prescribed management strategies.
- educate the community and industry to understand and participate in the conservation of large-eared pied bat
 - initiate education and extension programs to increase the awareness and participation in the recovery plan
 - encourage and assist community and industry groups to be involved in the recovery process
 - develop press releases for media and stakeholder groups to increase awareness and advice of progress.
- research the large-eared pied bat to augment biological and ecological data to enable conservation management
 - develop and implement a research strategy.
- determine the meta-population dynamics throughout the distribution of the large-eared pied bat:
 - collect and analyse genetic material from individuals across geographic range of large-eared pied bat to facilitate analysis of population genetics.

The proposed action is not inconsistent with the objectives of the national recovery plan. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive flora and fauna species and progressive rehabilitation of disturbed areas.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to the long-eared pied bat and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. The proponent must offset residual significant impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions.

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for preclearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified person (see recommendations for

approval conditions below).

EHP is of the view that the proposed action will not have an unacceptable impact on the long-eared pied bat.

12. Australian painted snipe (*Rostratula australis*)

EPBC Act Status: endangered

Description

The Australian Painted snipe is a stocky wading bird around 220-250mm in length with a long pinkish bill. The adult female, more colourful than the male, has a chestnut-coloured head, with white around the eye and a white crown stripe, and metallic green back and wings, barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down its upper back. The adult male is similar to the female, but smaller and duller with buff spots on the wings.

Distribution

The Australian Painted Snipe is usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled. It is a cryptic bird that is hard to see and often overlooked. Usually only single birds are seen, though larger groups of up to 30 have been recorded. It nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats, taking invertebrates, such as insects and worms, and seeds.

Although the Australian Painted Snipe can occur across Australia, the areas of most sensitivity to the species are those wetlands where the birds frequently occur and are known to breed. It has always only occurred in limited numbers in Australia, but substantial declines in numbers have been noted since European settlement, in particular, over the last 30-50 years.

Survey requirement and survey effort

Survey Guidelines for Australia's Threatened Birds. EPBC Act survey guidelines 6.2

EPBC survey requirements/techniques

- Area searches or transects through suitable wetlands; detection by sighting and flushing. Targeted stationary observations at dawn and dusk of suitable foraging locations within wetlands; detection by sighting. Also a brief spotlight search shortly after dusk may detect birds. To date, trials of broadcast (playback) have not been successful. Required survey effort as follows
 - A total of 10 hours of targeted stationary observations over 5 days or
 - 10 hours land-based area or transect searches over 3 days.
- The above survey effort is for an area of 50ha. Some modification is required for larger sites within consideration to be given to the variety of landforms and vegetation types present. Surveys should be conducted when wetlands hold water but are not flooded.

Project survey effort

- General bird surveys within wetlands across the Project area were undertaken as part of the fauna field survey program. The Australian painted snipe was not detected during field surveys.

Occurrence within project area

Given the nomadic nature and extensive range of occurrence of the species, it is difficult to maintain an understanding of the current extent of the population. The species is recorded at scattered sites throughout Australia, and is recorded only infrequently at most sites. Therefore, it is difficult to determine if the presence or absence of the species from a given site is a temporary or permanent change to its distribution.

Based upon the proponents potential habitat mapping there is approximately 856.67 ha of potential Australian painted snipe habitat is present within the Project area that includes 658.8 ha of Core Habitat Known', and 197.9 ha of Core Habitat Possible'.

Impacts of the proposed action

The project area includes identified wetlands and a recognised 'important wetland', Lake Elphinstone, that is not located within the project area but within an enclave that the project area surrounds. Therefore, the loss of wetland habitat or disturbance to nesting sites is considered a potential impact of project activities. Additional potential project related impacts include

- potential death or injury of snipes traversing the project area during movement between habitats
- project facilitated spread of invasive pest flora and fauna species, and subsequent loss or degradation of habitat or increased predation.

Avoidance and mitigation measures

Mitigation and management measures proposed by the proponent relevant to the endangered Australian painted snipe include

- construction activities in water-bodies frequented by migratory species will be avoided. The Australian painted snipe is a migratory bird that has not been recorded within the project area, however suitable wetland habitat has been identified in the project area;
- avoid construction activities in water-bodies frequented by migratory species;
- apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas;
- reduce the impact of CSG water on soil structure and aquatic values, by designing and constructing wells in accordance with the *Code of Practise for Constructing and Abandoning CSG wells in Queensland*;
- design creek crossings to ensure that existing flow regimes are maintained;
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals;
- data collection, particularly of species identified during pre-clearing surveys, in other project related activities, should be ongoing until rehabilitation is complete;
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species; and
- undertake pre-clearing surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive EVNT habitats.

Residual impacts

The proponent has estimated the maximum project disturbance impact on endangered Australian painted snipe Core Habitat Possible would be 5.69 ha.

Cumulative impacts

There are three other development projects in the Northern Brigalow Belt bioregion that may impact on the Australian painted snipe. The proponent concludes that given the distributed nature of many of the impacts of this and other CSG projects in the area and the commitment to avoid the specie's preferred wetland habitats, there is low potential for cumulative impacts to occur to the Australian painted snipe and its habitat.

Consideration of Plans/ Agreement/Conservation Advice

Conservation Advice: *Commonwealth Conservation Advice on Rostratula australis (Australian Painted Snipe)* approved on 30 May 2013.

Recovery Plan: No recovery plan has been prepared for the Australian Painted Snipe.

Threat Abatement Plans: There are no threat abatement plans relevant to the Australian Painted Snipe.

The main threats identified in the approved conservation advice include: loss and degradation of wetlands, through drainage and the diversion of water for agriculture and reservoirs; grazing and the associated trampling of wetland vegetation/nests; and nutrient enrichment and disturbance to substrate by livestock, especially where grazing is concentrated around wetlands during dry seasons. Predation by foxes or cats may also be a threat. Additional threats include: coastal port and infrastructure development, shale oil mining and replacement of native wetland vegetation by invasive weeds.

The following priority recovery and threat abatement actions could support the recovery of the Australian painted snipe:

Habitat loss, disturbance and modification

- develop management guidelines for breeding and non-breeding habitat
- monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary
- ensure there is no disturbance in areas where the species is known to breed, excluding necessary actions to manage the conservation of the species
- control access routes to suitably constrain public access to existing and future breeding sites on public land
- suitably control and manage access on private land and other land tenure
- minimise adverse impacts from land use at known sites

- manage any changes to hydrology that may result in changes to water table levels, run-off, salinity, algal blooms, sedimentation or pollution
- manage any disruptions to water flows
- investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate/secure inclusion in reserved tenure if possible
- manage any other known, potential or emerging threats including inappropriate fire regimes and coastal port/infrastructure development.

Invasive weeds

- implement the parkinsonia strategic plan for the control of this species within the range of the Australian painted snipe
- identify and remove weeds in wetland areas that could become a threat to the Australian painted snipe, using appropriate methods
- ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on the Australian painted snipe.

Trampling, browsing or grazing

- develop and implement a stock management plan for roadside verges and travelling stock routes which include swamps, marshes or wetlands
- if livestock grazing occurs in known Australian painted snips habitats, ensure land owners/managers use an appropriate management regime and density that does not detrimentally affect Australian painted snipe nesting sites
- if appropriate, manage total grazing pressure at important breeding sites through exclusion fencing or other barriers.

Animal predation or competition

- implement the national threat abatement plans for the European red fox and feral cats to control the adverse impacts of foxes (*Vulpes vulpes*) and cats (*Felis catus*) in the species' range
- continue baiting to control population numbers of feral animals.

Fire

- develop and implement a suitable fire management strategy for the habitat of the Australian painted snipe.

Conservation information

- raise awareness of the Australian painted snipe within the local community and the importance of reporting observations to BirdLife Australia, using fact sheets and/or brochures
- advertise and encourage use of Australian painted snipe survey techniques and survey forms
- organise field days with industry and interest groups to raise awareness and share information on the species. These groups may include natural resource management groups, catchment management authorities, Indigenous groups, conservation organisations, local and state governments, and private landholders
- engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions
- raise awareness of banded individuals to increase the likelihood of re-sighting and reporting
- facilitate the exchange of information between interested parties, including sightings, research and management approaches.

The priority threat abatement and recovery actions identified in the approved conservation advice have been considered in undertaking this assessment and making the recommendation that the proposed action be approved. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive flora and fauna species and progressive rehabilitation of disturbed areas.

Conclusion

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to the Australian Painted Snipe and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for pre-clearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified person (see

recommendations for approval conditions below. Given the commitment by the proponent to avoid Core Habitat Known for the species and the small area of Core Habitat Possible potentially impacted by the project, EHP is of the view that a significant impact on the Australian Painted Snipe as a result of the proposed action is unlikely.

13. Red goshawk (*Erythrotriorchis radiatus*)

EPBC Act Status: vulnerable

Description

The red goshawk is a large, swift and powerful rufous-brown hawk, growing to a length of 45–60 cm, with a wingspan of 100–135 cm. The two sexes of this species are quite different in size and appearance. The females weigh approximately 1.1 kg, the males approximately 0.63 kg. The red goshawk is boldly mottled and streaked, with rufous scalloping on the back and upper wings, rufous underparts that are brightest and lack streaking on the thighs, and with massive yellowish legs and feet, and boldly barred underwings. Females are larger, more powerfully built, paler and more heavily streaked below, showing some white on the under body. Juveniles have redder upperparts, and the head and underparts are rich rufous with fine dark streaks. The juvenile's rufous head distinguishes it from adults.

The red goshawk can further be distinguished from other similar raptors by its broad 'six-fingered' wings that are held at slightly angled planes when soaring, the lack of pale markings on upperparts, the heavy and dark streaking on the head and chest, the flat head, the deep bill (female), the broad deep chest, and the long tail which is square-tipped to slightly rounded at the tip. No geographical variation has been observed in red goshawk morphology.

The red goshawk is solitary and very thinly dispersed. It is usually observed singly, and occasionally in pairs or family groups. Red goshawk pairs are believed to remain within the nesting territory all year, but some may expand their home range when not breeding. In the southeast of their range it has been suggested that adults may migrate from the ranges to lowland winter territories. Occasional records of individuals hundreds of kilometres from the known breeding range suggest juvenile dispersal from their natal territories may be extensive.

Distribution

The red goshawk is endemic to Australia. It is very sparsely dispersed across approximately 15% of coastal and sub-coastal Australia, from western Kimberley Division (north of 19°S) to north-eastern NSW (north of 33°), and occasionally on continental islands. It has probably always occurred in central Australia, where three widely-spaced, recent confirmed sightings corroborate earlier, previously doubted records.

The estimated extent of occurrence is likely to be stable at 1 000 000 km². Extent of occurrence was estimated from published maps. There is no clear data to indicate past declines in extent of occurrence, and there is no information available on predicted future changes in extent of occurrence. The red goshawk is suspected to have always had a very large distributional range and extent of occurrence within which it was very sparsely distributed.

The estimated area of occupancy is suspected to be 200 000 km², though the reliability of this estimate is low. Area of occupancy was estimated from the number of one km² grid squares in which the species is thought to occur at the time when its population is most constrained, which is during the breeding season for the red goshawk. Interestingly, multiplying the estimated 1000 breeding red goshawks, which would be 500 breeding pairs, by the estimated home range of 200 km² yields an area of occupancy of 100 000 km².

The area of occupancy has declined since European settlement. While this decline cannot be quantified, the lack of any breeding records in NSW over the last 50 years, and the decline in sightings of red goshawk further from the coast especially in Queensland suggest that fewer areas are now being used for breeding. Indirect evidence of reduction in the area of occupancy exists from egg collecting hotspots during the 1800s in the Cooktown, Cairns and Moreton Bay areas of Queensland and the Northern Rivers area of NSW. Breeding in these areas no longer occurs. Further, it is suggested that since European settlement, development and habitat alteration have rendered about 20% of the predicted red goshawk's range unsuitable for breeding, especially in coastal Queensland. There are no quantified predictions of future changes to area of occupancy. However, it is suspected that continuing clearing of coastal and sub-coastal forests in Eastern Australia, and on Melville Island, will likely to lead to a reduction in breeding pairs, and therefore a reduction in area of occupancy.

The distribution of the red goshawk is not severely fragmented. It is suspected that there is some fragmentation, but there is no evidence that fragmentation in the red goshawk distribution is severe. However, some fragmentation may have occurred in the more heavily settled and cleared regions of the species' range, such as in the coastal lowlands of eastern Queensland. The degree of this fragmentation in the lowlands may be masked by the persistence of birds in the adjacent foothill and hinterland country which has not suffered the same degree of

clearing.

Survey requirements and survey effort

Survey Guidelines for Australia's Threatened Birds. EPBC Act survey guidelines 6.2

EPBC Act survey requirements/techniques

Search for their characteristic nests within patches of the tallest forest (see above). In sub-coastal woodland, these areas can initially be identified from aerial photos and then searched during follow-up ground surveys. Further inland requires ground searches along river banks for nests within the tallest trees. Driving slowly through tropical woodland tracks and scanning groups of tall trees for nests can also be effective. In eastern Australia's ranges, searching for nests is more difficult but soaring birds can sometimes be located from vantage points such as mountain tops. Some success has been had surveying this species using call playbacks during the breeding season.

Survey effort guide

The use of vehicles may be warranted in some instances to cover large areas. The effort required is 50 hours over eight days.

Project survey effort

Field surveys for the red goshawk undertaken during the EIS studies include general bird surveys. During this study the red goshawk was not detected.

Occurrence within the project area

A thorough review of habitat, distribution and historical data suggests suitable nesting and feeding habitat is minimal within the project area. However, the project area is situated in close proximity to large tracts of vegetation which may provide potential habitat.

Based on the proponent's potential habitat mapping, 27 001.92ha of potential habitat is present in the project area. However, the proponent considers that habitat for this species within the project area is marginal. Suitable nesting and foraging habitat such as extensive woodlands within the range of permanent water are largely absent within the project area. Typically, watercourses within the project area do not support permanent water and adjacent vegetation or riparian zones have been extensively disturbed during historical grazing practises.

The absence of recent records and restricted amount of permanent water and extensive woodland habitat for nesting and foraging within the project area suggest this species is an unlikely resident. Potential exists for dispersive individuals to move through the project area.

Impacts of the proposed action

Within the project area, the loss of potentially suitable foraging and nesting habitat may impact this species. Potential impact on the species may also occur where avifauna species richness is reduced from habitat fragmentation.

Avoidance and mitigation measures

Mitigation and management measures proposed by the proponent relevant to the vulnerable red goshawk include

- avoid disturbance to mapped essential habitat for the species and core habitat for species
- conduct pre-construction/preclearance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for species and site-specific sensitive areas that require avoidance or buffers
- minimise vegetation disturbance. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor creek). Areas cleared for field development should be as small as practical
- design infrastructure to avoid undisturbed tracts of remnant vegetation. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection
- assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter and roll them so that the hollows are facing upwards, allowing fauna to escape
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- data collection, particularly of species identified during pre-clearing surveys, in other project related activities, should be ongoing until rehabilitation is complete
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna

species

- undertake preclearance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive habitats.

Residual impacts

The proponent has estimated that the maximum project disturbance impact on vulnerable red goshawk would be 187.14ha Core Habitat Possible.

Cumulative impacts

There is one other development project in the Northern Brigalow Belt bioregion that may impact on red goshawk habitat. The proponent has concluded that given permanent water within the project area is minimal and the species is known from the wider region, there is low potential for cumulative impacts on red goshawk and its habitat.

Offsets

To offset the significant residual impacts of the project, EHP recommends that the proponent be required to protect and enhance a parcel of land containing habitat for the red goshawk. The offset site and offset management plan proposed will need to demonstrate compliance with the EPBC Act Offsets Policy.

EHP recommends that should the project activities cause a significant residual impact to the red goshawk, any conditions of approval should require the proponent to provide a direct offset for disturbance to the red goshawk associated with Phase 1 of the project. The offset proposed for Phase 1 should be approved by the Minister for the Environment prior to the commencement of Phase 1 (see recommendations for approval conditions below).

The likely success or suitability of the proposed offset will however, be somewhat influenced by the adequacy of the management actions undertaken to improve the habitat on site. As such, a comprehensive and long-term offset management plan must be developed for review and approval by the Minister for the Environment to ensure a conservation outcome for the red goshawk is achieved.

EHP recommends that to compensate for any residual significant impact on the red goshawk, the proposed conditions of approval include the requirement for the development of an offset management plan which must contain details of the proposed offset property/s and measures proposed to ensure long term protection of the species and conservation of habitat.

Consideration of Plans/Agreements/Conservation advice

Conservation Advice: There is no approved conservation advice for the Red Goshawk.

Recovery Plan: *National recovery plan for the red goshawk* *Erythroriorchis radiatus*

Threat Abatement Plans: There are no threat abatement plans relevant to the Red Goshawk.

The National Recovery Plan for the red goshawk states that the main cause of the decline of the red goshawk in north-east New South Wales and eastern Queensland is widespread clearance of native forests and woodlands for agriculture. Other threats to the species include fragmentation and degradation of habitat, direct disturbance and/or loss of nesting sites and changes in prey availability.

The recovery plan's overall objective was stated as the maintenance of red goshawk populations across their range and implementation of measures to promote recovery of the species, such as

- monitoring of red goshawk habitat and determining territory occupancy and productivity, and the use DNA analyses of feathers to determine adult survival rates
- collating information on known nest sites from the past 25 years and producing descriptive maps of important habitat and ensure information is secure
- conducting searches to identify previously unknown pairs of red goshawks, nest sites, and habitats critical for red goshawk survival
- identifying important populations and nest sites, and using this information to inform monitoring programs and state and federal government planning frameworks
- providing specific information and advice to assist with the identification, acquisition and management of important habitat for the red goshawk
- conducting research to understand the relationship between habitat fragmentation, prey density and population persistence to better inform management
- protecting habitat through acquisition or voluntary conservation agreements
- reducing the effects of red goshawk habitat fragmentation and degradation by encouraging landholders to protect and manage threatened red goshawk territories

- training personnel from state and local government to identify and understand the threats to red goshawk habitat
- producing and distribute information on the conservation status and habitat requirements of the red goshawk;
- providing feedback to the public and agency personnel on progress of red goshawk recovery
- reviewing the effectiveness of the community awareness program.

The proposed action is not inconsistent with the objectives identified in the national recovery plan. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the avoidance of core habitat for the species, management of invasive flora and fauna species and progressive rehabilitation of disturbed areas.

Conclusions

The proponent has proposed a number of mitigation and management measures to reduce the level of impact to red goshawk and committed to disturbance limits for the project, reflected in the recommendations for approval conditions. The proponent must offset residual significant impacts to the species in accordance with the EPBC Act Offsets Policy; this is reflected in the recommendations for approval conditions.

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for pre-clearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified person (see recommendations for approval conditions).

EHP is of the view that the proposed action will not have an unacceptable impact on the red goshawk.

14. Yakka skink (*Egernia rugosa*)

EPBC Act Status: vulnerable

The yakka skink is known to occur in open dry sclerophyll forest, woodland and scrub. The core habitat of this species is within the Mulga Lands and Brigalow Belt South bioregions. Microhabitat preferences of the yakka skink include rocks, logs or tree stumps, root cavities and abandoned animal burrows.

Two records are known at 3km and 16km respectively to the west of the project area however, no records of yakka skink are known within or in close proximity to the project area and therefore no impacts on yakka skink habitat are anticipated by the proponent. The SREIS states that the northern gas field is outside the known range for the species however, marginal habitat may exist in the southern part of the project area. Yakka skink was not detected during field surveys in the project area.

The DOE's Draft Referral guidelines for the nationally listed Brigalow Belt Reptiles states that as listed Brigalow Belt reptiles are difficult to detect and population information is limited, DOE regards important habitat as a surrogate for important populations in the assessment of whether an action is likely to have a significant impact on one or more of these species. Suitable habitat for any one of the listed Brigalow Belt reptiles is considered important if it is

- habitat where the species has been identified during a survey
- near the limit of the species' known range
- large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations)
- a habitat type where the species is identified during a survey, but which was previously thought not to support the species.

Consideration of Plans/Agreements/Conservation advice

Conservation Advice: *Commonwealth Conservation Advice for Egernia rugosa (Yakka Skink)* approved on 29 April 2014.

Recovery Plan: No recovery plan has been prepared for the Yakka Skink.

Threat Abatement Plans: The following threat abatement plans are relevant to the Yakka Skink:

- *Threat Abatement Plan for Predation by the European Red Fox*
- *Threat Abatement Plan for Predation by Feral Cats*

The approved conservation advice identifies the main threats to yakka skink as the continued legacy of past broadscale land clearing and habitat degradation and other threats include inappropriate roadside management, removal of wood debris and rock microhabitat features, ripping of rabbit warrens and predation by feral animals.

The conservation advice identifies the following priority recovery and threat abatement actions would support the recovery of the yakka skink - monitoring known populations, identify populations of high conservation priority, actively discourage removal of fallen logs, leaf litter and rock from known and potential habitat sites, ensure that road widening, maintenance activities and rabbit warren ripping does not adversely impact on known populations, investigate conservation arrangements, develop and implement a management plan for foxes and feral cats, develop a suitable fire management strategy for yakka skink habitat and raise awareness for the species within the local community.

The objectives of the *Threat Abatement Plan for predation by feral cats* are to prevent feral cats occupying new areas, promote the maintenance and recovery of species affected by feral cats, improve knowledge and understanding, improve effectiveness of control operations and increase awareness.

The objectives of the *Threat Abatement Plan for predation by the European Red Fox* are to prevent red foxes occupying new areas, promote the maintenance and recovery of native species and communities that are affected, improve knowledge and understanding of red fox impacts and interactions with species and ecological processes, improve effectiveness of control options and increase awareness.

The priority management actions identified in the approved conservation advice have been considered in undertaking this assessment and in making the recommendation that the project be approved. The proposed action is not inconsistent with the objectives of relevant threat abatement plans. The proponent has committed to a range of mitigation and management measures to reduce the impact to the species, including the management of invasive flora and fauna species and progressive rehabilitation of disturbed areas.

Conclusion

Where potential habitat cannot be avoided through the planning and design phase, the proponent has committed to undertaking pre-clearance surveys for listed threatened species and communities. Following pre-clearance surveys, disturbance will be minimised in identified core habitat in accordance with the proponent's commitments. In the event that the yakka skink is identified and residual significant impacts are determined likely, the proponent will be required to undertake management actions and provide an offset in accordance with the EPBC Environmental Offsets Policy (see recommendations for approval conditions below).

In addition, to further protect the species, it is recommended that the conditions of approval include a requirement for pre-clearance surveys and vegetation clearance to be undertaken in a manner that avoids impacts to EPBC listed threatened species, including through the use of a suitably qualified person(see recommendations for approval conditions below).

Given the lack of records for the species on the project site and the avoidance and mitigation measures proposed by the proponent, a significant impact on the yakka skink as a result of the proposed action is considered unlikely.

Listed Migratory Species (sections 20 & 20A)

Australia provides critical non-breeding habitat for millions of migratory waterbirds each year. To ensure their conservation, the Australian Government has fostered international cooperation through a range of important agreements, including the Ramsar Convention and the Convention on Migratory Species, bilateral agreements with Japan, China and the Republic of Korea, and through the recently launched East Asian — Australasian Flyway Partnership. A range of important activities have also been undertaken within Australia to conserve migratory waterbird populations and their habitats.

Migratory waterbirds include species such as plovers, sandpipers, stints, curlews and snipe. These birds make round trip migrations of up to 26,000 km each year between their breeding grounds in the northern hemisphere and their non-breeding areas in the south. These trips are made in several weeks, with brief stops at staging sites along the way to rest and refuel for the next leg of their journey.

The corridor through which these waterbirds migrate is known as the East Asian - Australasian Flyway (the Flyway). It extends from within the Arctic Circle, through East and South-east Asia, to Australia and New Zealand. Stretching across 22 countries, it is one of eight major waterbird flyways recognised around the globe.

Wetland habitat loss and degradation is a significant threat to migratory waterbirds, and the conservation of important sites across the Flyway is essential to their survival. Many pressures are contributing to this degradation, of which population growth and economic development in East and South East Asia are of particular concern.

The proponent identified the following migratory species as potentially present within the project area:

- Latham's Snipe, Japanese Snipe (*Gallinago hardwickii*)
- Australian Painted Snipe (*Rostratula australis*)
- Eastern Great Egret (*Ardea modesta*)
- Cattle Egret (*Ardea ibis*)
- Rainbow Bee-eater (*Merops ornatus*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Spectacled Monarch (*Symposiachrus trivirgatus*)
- Satin Flycatcher (*Myiagra cyanoleuca*)
- Rufous Fantail (*Rhipidura rufifrons*)
- Fork-tailed Swift (*Apus pacificus*)
- White-tailed Needletail (*Hirundapus caudacutus*)
- White-bellied Sea-eagle (*Haliaeetus leucogaster*)

The following migratory bird species, were observed within the project area:

- Australian Painted Snipe (*Rostratula australis*)
- Eastern Great Egret (*Ardea modesta*)
- Cattle Egret (*Ardea ibis*); and
- Rainbow Bee-eater (*Merops ornatus*)

The SEIS determined that 5.69 ha of Core Habitat Possible for the Australian Painted Snipe, also listed as migratory, is likely to be impacted as a result of the project. Impacts to the Australian Painted Snipe are discussed above under listed threatened species.

Migratory wetland birds

The eastern great egret and cattle egret inhabit permanent and ephemeral wetlands throughout the majority of Australia. These species utilise habitat which includes freshwater wetlands with dense vegetation such as swamps, flooded grasslands or heathlands. The eastern great egret and cattle egret are known to inhabit broader habitat range which include disturbed habitat such as farm dams, agricultural lands and sewage treatment ponds.

Distribution

The eastern great egret and cattle egret inhabit permanent and ephemeral wetlands throughout the majority of Australia. Latham's snipe is mainly confined to eastern Australia.

Survey requirements and survey effort

EPBC Act survey requirements/techniques

Wetland birds vary in their conspicuousness depending on lifestyle and time of the year. Generally, species that frequent open water will be conspicuous and easily detected throughout the day. Others that inhabit dense vegetation in wetlands and on the margins of water-bodies will often be difficult to sight, and detection will usually rely on call recognition or flushing. In general, calls will be most frequent in the early morning but are also strongly dependent on time of year. Currently, three wetland species are listed as threatened under the EPBC Act.

Broadcast surveys in suitable habitat for solicited call responses and sightings. Broadcast stations may be established at wetland edges to avoid damage to wetland vegetation. Stations should usually be at least 250 m apart.

Observations of targeted foraging habitat within wetlands in the early morning or early evening are recommended. Wetland birds are detected by sightings and unsolicited calls.

Area searches in suitable habitat for sightings, nests, indicative footprints and feathers.

Project survey effort

Bird surveys were conducted using both aural and visual survey to determine the species present within individual REs. EPBC Act-listed birds were specifically investigated at habitats which might be utilised by these species (e.g. wetlands and dams).

Occurrence within project area

The rainbow bee-eater, eastern great egret and cattle egret were confirmed as present within the project area during field surveys. These species are expected to use suitable habitat throughout the project area.

In addition, while not detected during the field survey, Latham's snipe has previously been recorded in the area. It is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia. It occurs in permanent and ephemeral wetlands up to 2000 m above sea-level.

Eastern great egrets are widespread in Australia and utilise a wide range of wetland habitats. It is expected to use suitable habitat throughout the project area.

The cattle egret is widespread and common according to migration movements and breeding localities surveys. The cattle egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semiarid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It is expected to use suitable habitat throughout the project area.

Impacts of the proposed action

Potential impacts on migratory wetland birds associated with the proposed project activities include

- Habitat loss and habitat degradation. Depending on the extent and location of clearing, foraging and breeding habitat utilised by these species may be impacted. Where habitat is retained, degradation from adjacent works may result in a loss of habitat quality through secondary impacts such as sedimentation
- Edge effects such as the introduction of pest and weed species may result in the degradation of habitat. Additionally, other effects such as noise and light may result in the displacement of individuals.

Migratory wetland species are known to utilise Lake Elphinstone amongst other water-bodies in the region. Although outside the immediate project area, Lake Elphinstone could be subject to a range of indirect impacts if unmitigated, including

- altered flow regimes resulting from infrastructure development
- increased sedimentation from exposed soil surfaces following rainfall
- deleterious impacts on water quality from CSG water (e.g. increased salinity)
- increased weed incursion and outbreak from propagules transported from upstream infestations
- dam overtopping / dam breaks in the catchment of Lake Elphinstone impacting on its habitat value for migratory species.

Given the mitigation commitments detailed below for the management of potential impacts to migratory species, it is considered any residual impact on the habitat provided by Lake Elphinstone will not represent any significant impact on habitat for migratory wetland species.

In the proponent's assessment against the EPBC Act Significant Impact Criteria, they have concluded that it is unlikely that important habitat for a migratory species will be substantially modified as they will aim to avoid disturbance within, wetlands and wetland habitat which may act as habitat for these species. Preclearance surveys will also be undertaken prior to construction activities to identify additional wetland habitat in which migratory wetland bird species may inhabit.

Avoidance and mitigation measures

The following mitigation and management measures proposed by the proponent relevant to migratory wetland birds are

- avoid disturbance within waterbodies frequented by migratory wetland species
- apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas
- conduct pre-construction/precleanance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for species and site-specific sensitive areas that require avoidance or buffers
- reduce the impact of CSG water on soil structure and aquatic values, by designing and constructing wells in accordance with the *Code of Practise for Constructing and Abandoning CSG wells in Queensland*
- design creek crossings to ensure that existing flow regimes are maintained
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- prohibit harassment of wildlife and the unauthorised collection of flora or fauna, unless directed by a suitably qualified and experienced person
- design facilities to ensure natural surface water flows are not impounded, e.g., by installing culverts on roads and stormwater diversion ditches around production facilities
- data collection, particularly of species identified during pre-clearing surveys, in other project related activities, should be ongoing until rehabilitation is complete
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake precleanance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive EVNT habitats.

Migratory Woodland Birds

Five migratory bird species predominately associated with Eucalypt woodland, riparian and vine-thicket habitats which were either observed within the project area or considered a possible occurrence include are the

- Rainbow Bee-eater (*Merops ornatus*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Spectacled Monarch (*Symposiachrus trivirgatus* (syn. *Monarcha trivirgatus*))
- Satin Flycatcher (*Myiagra cyanoleuca*)
- Rufous Fantail (*Rhipidura rufifrons*).

The rainbow bee-eater was confirmed present within the project area during field assessment.

Distribution

These species tend to seasonally migrate throughout the country or region, and/or are locally nomadic. Populations of these species tend to be resident in the north whilst migrating to southern areas of their distributions during summer months.

The rainbow bee-eater is distributed across much of Australia (excluding Tasmania) and is known to exhibit a broad habitat preference which includes open Eucalypt woodland, riparian, floodplain and wetland vegetation, open farmland and roadside vegetation. The rainbow bee-eater also occurs within vine-thicket and mangrove communities. The rainbow bee-eater is often recorded in communities which are proximate to water.

The remaining migratory woodland species share similar distributions and habitat preferences. These species occur along much of eastern Australia. Unlike the rainbow bee-eater, the remaining woodland species prefer habitat types which exhibit a high structural complexity including heavily vegetated gullies, riparian vegetation, vine thickets and mangrove communities. During migration, more open communities are utilised.

Survey requirement and survey effort

EPBC Act survey requirements/techniques

Woodland migratory birds can be surveyed using standard bird survey techniques, including fix-width transect counts (e.g. 50m width) and point counts (e.g. of one hour duration).

Project survey effort

Bird surveys were conducted using both aural and visual survey to determine the species present within individual REs. EPBC Act-listed birds were specifically investigated at habitats which might be utilised by these species (e.g. wetlands and dams).

Impacts of the proposed action

Potential impacts to migratory woodland birds associated with the proposed project activities include

- habitat loss and habitat degradation. Depending on the extent and location of clearing, foraging and breeding habitat utilised by these species may be impacted
- edge effects such as the introduction of pest and weed species may result in the degradation of habitat. Additionally, other effects such as noise and light may result in the displacement of individuals.

In the proponent's assessment against EPBC Significant Impact Criteria, they have concluded that it is unlikely that important habitat for a migratory woodland bird species will be substantially modified as they will aim to avoid disturbance to known habitat for any of these species. Pre-clearance surveys will also be undertaken prior to construction activities to identify additional habitat in which migratory woodland bird species inhabit. Identified habitat will be avoided where possible.

Avoidance and mitigation measures

The following mitigation and management measures are proposed by the proponent relevant to migratory woodland birds

- avoid disturbance to potential habitat
- conduct pre-construction/precleanance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for species and site-specific sensitive areas that require avoidance or buffers
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation
- design infrastructure to avoid undisturbed tracts of remnant vegetation. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection
- construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values
- deviate access tracks and pipelines around sensitive vegetation
- design lighting in a manner that limits disruption on landscape character, views and visual amenity and direct lighting into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat
- assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter and roll them so that the hollows are facing upwards, allowing fauna to escape
- data collection, particularly of species identified during pre-clearing surveys, or other project related activities, should be ongoing until rehabilitation is complete
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake precleanance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive habitats.

Migratory Aerial Birds

Two migratory aerial bird species considered as possible occurring on the project site are the:

- Fork-tailed Swift (*Apus pacificus*); and
- White-throated Needletail (*Hirundapus caudacutus*).

Distribution

The fork-tailed swift and white-throated needletail are almost exclusively aerial, flying from less than 1 m to greater than 300 m. The white-throated needletail is widespread in eastern and south-eastern Australia whereas the fork-tailed swift occurs over much of mainland Australia. Both species are non-breeding migrants, generally arriving in October and departing by the end of April.

Both species occur over most habitat types including grasslands, however, are most often recorded flying over wooded areas, including open forest and rainforest.

Survey requirements and survey effort

There are no recommended EPBC survey guidelines for migratory aerial birds however only bird surveys conducted from October to April would detect these migratory aerial species.

Migratory woodland birds are detected by sightings and unsolicited calls.

Project survey effort

Bird surveys were conducted using both aural and visual survey to determine the species present within individual REs. EPBC listed birds were specifically investigated at habitats which might be utilised by these species.

Occurrence within the project area

Neither species was detected during field survey but are likely to feed in airspace over the Project area while on migration.

Impacts of the proposed action

Potential impacts associated with the proposed project activities include

- dust impacts - excessive dust may result in individuals above dispersing to areas away from the dust source.

Avoidance and mitigation measures

Mitigation and management measures proposed by the proponent relevant to migratory aerial birds are

- dust suppression shall be undertaken during construction and clearing activities, particularly during high wind conditions. Haul roads and other unsealed areas may be watered to suppress dust;
- minimise vegetation disturbance; and
- construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values.

White-bellied sea-eagle (*Haliaeetus leucogaster*)

Unlike the previous migratory species, this species is defined as a raptor and has been assessed individually due to the utilisation of different habitat types and requirements (particularly nesting habitat) and its associated population threats.

Distribution

The white-bellied sea-eagle is distributed along the coastline (including offshore islands) of mainland Australia and also extends inland along some of the larger waterways, especially in eastern Australia.

Terrestrial habitats in which the white-bellied sea-eagle inhabits are characterised by the presence of large areas of open water, including rivers, swamps, lakes and coastal waters. Breeding territories of the white-bellied sea-eagle are located close to water and mainly occur within tall open woodland, although nests can be located in other habitats such as rainforest, closed scrub or remnant trees within cleared land.

Survey requirement and survey effort

EPBC Act survey requirements/techniques

Wetland birds vary in their conspicuousness depending on lifestyle and time of the year. Generally, species that frequent open water will be conspicuous and easily detected throughout the day. Others that inhabit dense vegetation in wetlands and on the margins of water-bodies will often be difficult to sight, and detection will usually rely on call recognition or flushing. In general, calls will be most frequent in the early morning but are also strongly dependent on time of year. Currently, three wetland species are listed as threatened under the EPBC Act.

Broadcast surveys in suitable habitat for solicited call responses and sightings. Broadcast stations may be established at wetland edges to avoid damage to wetland vegetation. Stations should usually be at least 250 m apart.

Observation of targeted foraging habitat within wetlands in the early morning or early evening are recommended. White-bellied sea-eagles are detected by sightings and unsolicited calls.

Area searches in suitable habitat for sightings, nests, indicative footprints and feathers.

Project survey effort

Bird surveys were conducted using both aural and visual survey to determine the species present within individual REs. EPBC Act-listed birds were specifically investigated at habitats which might be utilised by these species (e.g. wetlands and dams).

Occurrence within project area

Desktop review identified the white-bellied sea-eagle (*Haliaeetus leucogaster*) as a possible occurrence within the project area. It was not detected during the field survey but is likely to utilise habitat at the larger lakes, rivers and wetlands in the project area.

Impacts of the proposed action

Potential impacts associated with the proposed project activities include

- habitat loss and habitat degradation. Depending on the extent and location of clearing, foraging and breeding habitat utilised by this species may be impacted. As detailed above, this species requires remnant vegetation within close proximity to major watercourses. Therefore, the loss of riparian communities may locally impact on the breeding success of this species
- edge effects such as disturbance of nesting pairs from human activity. It is not uncommon for adult sea-eagles to abandon a nest if disturbed (especially early on into the breeding season). The disturbance of nesting pairs may potentially lower breeding success.

Avoidance and mitigation measures

The following mitigation and management measures are proposed by the proponent relevant to the white-bellied sea-eagle

- avoid disturbance within potential habitat
- conduct pre-construction/preclearance surveys to identify any additional areas that need to be avoided, including vegetation mapping at scale suitable for site-specific planning that identified core habitats for species and site-specific sensitive areas that require avoidance or buffers
- develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals
- attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation
- design infrastructure to avoid undisturbed tracts of remnant vegetation. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection
- data collection, particularly of species identified during pre-clearing surveys, or other project related activities, should be ongoing until rehabilitation is complete
- develop a detailed pest management plan to mitigate and manage the potential spread of pest flora and fauna species
- undertake preclearance surveys to determine likelihood of weeds, weed monitoring, and targeted weed control measures within sensitive habitats.

Key threats identified to white-bellied sea-eagle include

- habitat loss and fragmentation (especially nesting habitat). Their inland distribution is limited to vegetated areas that occur in the vicinity of major waterways or waterbodies
- disturbance of nesting pairs from human activity
- water quality degradation from increased sediment runoff
- drainage of waterbodies for agriculture
- poisoning (dingo baiting).

Cumulative impact

In the Northern Brigalow Belt bioregion, there are a number of other development projects that may impact on listed migratory species or their habitat, including white-bellied sea-eagle, rainbow bee-eater, rufous fantail, satin

flycatcher, cattle egret, great eastern egret, white-throated needletail and Latham's snipe.

The proponent notes that the creation of water treatment plants and farm dams across the project area means that the potential for cumulative impacts to migratory wetland birds is minimal. In addition, wetland habitat for Latham's Snipe is restricted to larger, well vegetated water bodies and the avoidance of these areas, where practicable, will reduce the cumulative impacts to this species.

In relation to cumulative impacts to the white-bellied sea-eagle, the proponent states that habitat loss within riparian communities along major waterways may impact this species over time. However, where practicable, avoidance of remnant riparian communities and active white-bellied sea-eagles will minimise this impact.

Conclusion

The proponent has concluded that given the protection of potential habitat for listed migratory species through the project framework approach and proposed pre-clearance surveys, the project is unlikely to have a significant impact on any important populations of listed migratory species.

The migratory species that have been detected on site are all highly mobile species which may visit periodically. The project footprint does not include significant or locally uncommon habitat values and these species are therefore unlikely to utilise the site for breeding purposes. While individuals may occasionally visit the project site, it is considered unlikely that the habitat on-site would represent important habitat; or that a population would be dependent on the project area.

EHP is of the view that the proposed action is unlikely to have a significant impact on any population of listed migratory species.

Water resources - in relation to coal seam gas development and large coal mining development (section 24D & 24E)

The project has undergone a revision since publication of the EIS. Notably, the project would require the construction and development of CSG production wells, gathering lines and other infrastructure in 33 'drainage areas', up to 4000 CSG production wells, two water treatment plants – one in the Goonyella area and one in the Peak Downs area. In addition, the total amount of water estimated to be extracted over the 40 year life of the project is 264.3 GL (average 7 GL p/a) and the total amount of water to be produced is 153 GL (average 4.25 GL p/a). The project is estimated to result in the production of 4.3 tonnes of salt per megalitre of treated co-produced water, equating to 657 900 tonnes over the life of the project. The assessment documentation notes that up to 25% (1,000) CSG production wells may need to be hydraulically stimulated.

The project has the potential for a number of impacts to groundwater and surface water resources. Key water-related issues for the project are

- groundwater drawdown
- coal seam depressurisation
- interconnectivity of aquifers and ground and surface water systems
- management of saline coal seam gas (CSG) co-produced water
- surface water quality and discharges to surface water systems
- springs and groundwater dependent ecosystems
- subsidence
- induced seismicity.

Impacts to ground and surface water from project activities have been assessed by EHP in this assessment report (sections 4.9 and 4.10). Appendix 3 provides recommendations on conditions for an environmental authority.

EHP sought advice from the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining (IESC) on the project EIS (advice received May 2013) and DOE sought advice from the IESC on the project SREIS (advice received July 2014). A discussion on the IESC advice provided to EHP is provided in section 4.9 and 4.10 of this assessment report.

The SREIS notes that the Queensland Government has established a comprehensive framework for regulating water resources including those potentially impacted by the project, including

- *Petroleum & Gas Act and the Petroleum Act*—Production rights to extract gas and co-produced (associated) water are provided under the P&G Act and the Petroleum Act. These Acts give tenure holders the right to take or interfere with groundwater to the extent necessary to extract the desired petroleum/gas.
- *Water Act 2000*—The Water Act establishes the responsibility for tenure holders to monitor and manage any impacts caused by the exercise of these groundwater rights and to 'make-good' any impairment of private bore water supplies. The Water Act also requires the preparation of Underground Water Impact Reports (UWIR) on the cumulative impacts of all groundwater users and establishes underground water management objectives.
- *Environment Protection Act 1994* —The EP Act regulates the management of the associated (co-produced) water once produced. The State's policy position on this is stated in EHP's *Coal Seam Gas Water Management Policy 2012*. It also encourages CSG operators to consider the feasibility of using CSG water to meet make-good obligations as part of developing their CSG water management strategies and plans.
- *Water Resources (Great Artesian Basin) Plan 2006* - primary legislation for groundwater management of the Great Artesian Basin (GAB) in Queensland. The southerly tenement of the proposed project (ATP 1025) includes a portion of the GAB recharge area. Due to the limited overlap with the Mimosa Management Area, the above mentioned GAB plans are of limited relevance to the current project.
- *Fitzroy Basin Water Resource Plan 2011* - The WRP provides for the allocation and management of water in the Fitzroy Basin. The proposed project northern tenements are located within the declared Isaac Connors GMA, as defined under Chapter 2, Section 7, Schedule 3, Schedule 4, and Schedule 7 of the Fitzroy Basin WRP. Water take or interference with groundwater sources would require a licence.

Groundwater

The EIS Section 14 Groundwater describes the existing groundwater values within and surrounding the project development area and provides an assessment of the potential for these values to be affected by direct and indirect impacts associated with the construction, operation and decommissioning phases of the project. Detailed information on the groundwater assessment was included in EIS Appendix L Groundwater and Geological

Technical Report. EIS Appendix M Groundwater Model Technical Report provided groundwater drawdown predictions associated with the proposed CSG production.

The SREIS Section 7 Groundwater provided updated information on groundwater resulting from changes to the project description (SREIS Section 3 Project Description) and submissions on the EIS, to assess impacts on groundwater. Detailed information on the supplementary assessment was contained in SREIS Appendix E Supplementary Groundwater Assessment.

The geology of the Bowen Basin project area is characterised by folded and faulted sedimentary units overlain by more recent sediments and intrusive basalt. Groundwater resources in the region include shallow (Quaternary Alluvium and Tertiary Basalt), intermediate (Triassic) and deep aquifers (Permian). Coal seams located in the Permian Blackwater Group are the CSG production targets and generally contain brackish-sodic or saline-sodic groundwater. The EIS states that the groundwater of individual coal seams is locally confined by interbedded shale, mudstone and siltstone aquitards that show little or no pressure response to seasonal rainfall. The Rewan Formation is a regional confining aquitard that underlies and traverses the central axis and large sections of the Bowen Basin, except in areas along the eastern and western margins, where the Permian Blackwater Group sub-crops and/or outcrops.

The SREIS section 7 states that the faults in the project area have limited permeability and are more likely to behave as barriers to groundwater flow as opposed to conduits. According to the assessment documentation, groundwater resources in the project area are limited and the majority of groundwater use is from shallow aquifers in a limited number of locations. The EIS states that the catchment of the project area has 39 groundwater licences for extractions with a combined allocation of approximately 17,000 ML/yr. These groundwater allocations are for irrigation, intensive stock watering and industrial and domestic supply.

The EIS for the project states that given the large scale of the project, there is the potential for groundwater dependent ecosystems (GDEs) to exist in the project area. The main identified environmental values identified in the project region include terrestrial vegetation, riverine and palustrine wetlands and river baseflow systems. No springs were identified in the project area, based on records kept by the Queensland Herbarium. Seventeen springs occur outside the project area, some 10 to 40 km south and southeast of Blackwater, on a sandstone plateau known as the Blackdown National Park.

Potential impacts to groundwater

Drawdown

The proponent developed a numerical groundwater model to predict impacts that would be due to the proposed CSG production. SREIS Appendix E Supplementary Groundwater Assessment Table 8.4 showed the modelled drawdowns in selected target aquifers for the cumulative scenario and Bowen gas project only scenario at the end of CSG production (40 year operation) and 50 years after operations cease. The predicted drawdown levels in primary aquifers ranged from >2 to >5m for the Bowen gas only scenario and a range of >50 to >100m for the cumulative scenario which included all of the existing coal projects, irrigation and other allocations assumed to be fully used. The model results indicate that the potential impact area (5m drawdown contour) within the coal seam aquifers could extend up to approximately 10 km from the CSG well fields. The model also indicates that drawdown in the shallow aquifers may only occur as isolated areas where coal seams outcrop.

Post-production groundwater level recovery was predicted to be slow, with coal seam baseline pressures unlikely to be re-established after 1000 years. The rate of groundwater recovery may be further slowed by the adjacent existing and future mining operations. The assessment documents stated that the model showed that faults in the Bowen Basin behave as barriers to groundwater flow along and across fault planes near CSG wells.

The EIS modelling indicates that only a very small extent of drawdown will occur in the shallow groundwater system, based on the extent of 2 m drawdown impacts presented. In the context of existing and likely coal projects and other CSG projects in the Bowen Basin,

Depressurisation

SREIS Appendix E states that impacts caused by coal seam gas depressurisation may include groundwater quality effects caused by aquifer flux inter-connectivity, reduced groundwater supply to existing or future groundwater users, reduced groundwater availability for GDEs, impacts to cultural and spiritual values, and subsidence.

Groundwater in the target coal seams of the Blackwater Group will typically be depressurised by CSG production to about 40 to 50m (of hydraulic head) above the top of the target coal seams. Each CSG well is predicted to produce a drawdown cone within the target coal seams and these drawdown cones will amalgamate to create a regionally

extensive depressurisation impact within the target coal seams. The conceptual hydrogeological model (EIS Section 14 Figure 14.6) indicates that the Rewan Formation and the low permeability Blackwater Group interburden aquitards will mostly contain the impacts of CSG depressurisation. Subsequently, the induced groundwater flow and depressurisation is mostly lateral, through the coal seams, rather than vertical, between coal seams and interbedded formations.

The EIS also states that drawdown impacts on plateau groundwater and the Blackdown Tableland spring complex would be unlikely because the system is perched above the Bowen Basin plains and the Rewan Formation aquitard confines the groundwater from below.

Subsidence

The EIS states that the potential mechanism for subsidence occurring from the production of CSG is volumetric changes in the coal formation and adjacent overburden. Subsidence is likely to occur after extraction of water from aquifers caused by shrinkage of the coal seam due to gas extraction, and compression of the coal seam and overlying formations due to reduced groundwater pressures.

The proponent considers the project to be analogous to the Arrow Moranbah Gas Project and has predicted that any subsidence associated with the project is likely to be similar to the Moranbah Gas Project's measured and calculated range of 15mm to 75mm. The subsidence potential and observed effects from CSG development in the Moranbah Gas Project area was stated as substantially less than that from longwall coal mining in the area (typically in the range of 1-3m).

Any subsidence from CSG development would be broadly distributed and that differential subsidence would not occur. The SREIS Appendix E provided detailed subsidence predictions.

Induced seismicity

SREIS Section 7 states that induced seismicity could result from project activities such as drilling, seismic surveys and hydraulic stimulation and injection. The EIS states that the Bowen Basin is relatively aseismic with only a few small seismic events recorded, with the generation of few structural landscape features in the Bowen Basin resulting during recent geological times reflecting limited tectonic activity. The IES includes evidence indicating that seismic events can only be detected by sensitive equipment and are not perceptible at the surface.

SREIS Appendix E stated that induced seismic events are non-cumulative in magnitude terms and the risk associated with induced seismicity in the Bowen Basin due to hydraulic stimulation is very low and most likely less than the historically recorded magnitudes or those generated by mining activities.

Impacts to groundwater dependent ecosystems (GDEs)

A review of GDEs was carried out as part of the SREIS. No known springs are located in the project area although several spring complexes and vents were identified in a 50 km buffer to the project area. The proponent has concluded that the recharge springs in the Blackwater area, which rely on interaction of the water table or perched aquifers with the surface, will not be affected by the groundwater drawdown in source aquifers, as they are beyond the predicted extent of the groundwater drawdown impact area.

The SREIS states that Lake Elphinstone, a Nationally Important Wetland, was identified as a potentially groundwater dependent ecosystem. The lake is fed by local run-off and stream flow from the catchment but could also receive flows from shallow groundwater systems. The Bowen River and Birralee-Pelican Creek have the potential to receive groundwater baseflow from the volcanic bedrock into which it has incised but it is beyond the predicted extent of groundwater drawdown from the project.

The SREIS states that key findings in relation to impacts to GDEs are

- GDEs associated with coal measure outcrops and watercourses are unlikely to be affected because the water table is typically greater than 10 m below ground level, beyond the root zone for vegetation;
- a single spring vent may potentially be affected as it overlies areas subject to drawdown in excess of the 0.2 m trigger threshold for any underlying aquifer. There is no predicted drawdown of the source aquifer and is therefore unlikely to be affected; and
- Lake Elphinstone and Birralee-Pelican Creek will not be impacted as they are outside the predicted drawdown area.

The SREIS identified additional groundwater management measures, including the commitment to establish a UWIR for all tenements in the project area, not just the tenements in the Surat CMA. The commitment to develop a Springs Impact Management Strategy (SIMS) was made for any springs found likely to be impacted on or off the project area.

The EIS Appendix EE Stygofauna Assessment provides a desktop assessment of the potential for stygofauna to

occur in the zone of influence of the project. The EIS notes that the occurrence of stygofauna in the Bowen Basin is poorly documented and researched, with studies limited to the regulatory requirements for coal mining projects in the region. Of the 13 studies completed, 127 groundwater sites have been sampled, with 15 bores found to contain stygofauna. The EIS notes that the majority of stygofauna in Australia has been found in unconsolidated sediments such as alluvium, fractured rock aquifers and the remainder in sedimentary rocks. There has been no stygofauna recorded in coal seams.

The desktop review presented in the EIS identified aquifer type and associated hydrologic conductivity and porosity as the key determinants for stygofauna presence. The EIS concluded that the likelihood of finding stygofauna in coal seams would be low due to low permeability, less connectivity to recharge and water quality properties. A range of management strategies for activities that could potentially impact on stygofauna were presented in EIS Appendix EE including further monitoring if required. Well drilling and construction procedures would minimise the potential impact to any aquifers that may be intersected.

Hydraulic fracturing

The assessment of the main considerations associated with hydraulic fracturing is contained in the project EIS Appendix L Groundwater and Geology Technical Report. The proponent considers the main risks associated with hydraulic fracturing on groundwater are the potential impacts on the physical nature of the target coals and interbedded units, potentially resulting in increased interconnection of geological units and the possible cross contamination of groundwater quantities. The EIS states that the confining nature of the units between coal seams within the Blackwater Group indicates limited groundwater resources. Therefore, the proponent concludes that any increased hydraulic stimulation would have a limited area of influence and effect on aquitards and coal seams.

Cumulative impacts

The cumulative effects of CSG development on groundwater formations was reviewed as part of the SREIS. The SREIS states that there are 13 operational coal mines in the project area, a further 28 coal mines operate near the project area and 13 more are planned. The quantitative assessment presented in the assessment documentation includes two modelled scenarios: groundwater extraction from the Bowen Gas Project and extraction from the Bowen Gas Project, Moranbah Gas Project and registered groundwater users as recorded in the DNRM Water Management System. The qualitative assessment presented comprised a review of publicly available information for existing coal mine developments in the Bowen Basin. Information was presented in SREIS Appendix E Figure 8.3, Table 8.5, Table 8.6, Table 8.7, and Table 8.8. The review concluded that groundwater drawdown was generally localised to the mine and surrounding area (potentially extends 5 to 30 km from the operating coal mines near Moranbah) and limited to the period of operations.

The assessment documentation states that the revised water production (life of project reduction from 274GL to 153 GL) and the actual non-coal seam gas usage estimations (<20% of the Water Management System Database entitlements) are factors that have resulted in a likely overestimation of drawdown from the EIS cumulative impact modelling.

OGIA and NRM advised that any cumulative impact issues resulting from the interaction of CSG impacts with mining impacts are not a basis to establish a cumulative management area under the Water Act. They noted that the potential for cumulative impact issues and appropriate management responses would be a matter for ongoing review through underground water impact reporting under the Water Act.

Avoidance, mitigation and management measures

The EIS states that the implementation of groundwater monitoring and management procedures considered necessary to ensure impacts of the project on groundwater resources are minimised. Measures proposed include continued baseline monitoring, establishment of a groundwater monitoring network, validation and re-calibration of the existing groundwater model, placement of CSG wells away from major fault zones, and the correct design and construction of wells, water storage and waste storage facilities.

The proponent has committed to a range of measures to avoid, mitigate and manage impacts to groundwater. SREIS Appendix O describes the proponent's mitigation commitments in relation to impacts to groundwater

- implement nominated corrective actions of any contamination of groundwater;
- implement groundwater monitoring reporting;
- implement a regional groundwater monitoring network;
- review and update the existing groundwater model;
- implement Underground Water Impact Report (UWIR) requirements for each petroleum tenure;
- establish groundwater quality and levels;
- establish datum levels for each aquifer system;
- undertake GDE and supporting aquifer identification and assessment;

- CSG production wells constructed and decommissioned in accordance with relevant codes;
- avoid the use of oil-based drilling fluids;
- avoid unnecessary vegetation clearing;
- CSG dams designed, constructed and managed in accordance with EHP guidelines and EA conditions;
- account for groundwater conditions when locating CSG infrastructure;
- install and regularly monitor groundwater monitoring bores for leak detection;
- include existing landholder bores in development and implementation of Baseline Assessment Plans; and
- undertake periodic well integrity checks.

IESC advice

Section 4.9 of this assessment report provides a discussion on the IESC advice of May 2013 provided to EHP on the project EIS. The key issues raised in the IESC advice to EHP in relation to groundwater are

- the numerical groundwater model is based largely on literature values and engineering data. More detailed field validation is needed, including a sensitivity analysis of the role of faults based on field data
- further conceptualisation of the groundwater processes is required to account for hydrogeological variation across the northern Bowen Basin
- the potential for hydraulic stimulation to result in aquifer interconnection (and the potential for coal seam gas contamination) along faults cannot be adequately assessed when the proximity to potentially stimulated wells near faults is unknown
- detailed consideration should be given to the risks for aquifer connectivity in the areas where the Rewan Formation is not present, particularly where the Blackwater Group subcrops and outcrops; the cumulative groundwater impacts of coal and gas projects operating within the northern Bowen Basin are not sufficiently addressed within the EIS. The cumulative impact assessment needs to be based on an adequate information set
- a cumulative impact assessment of well integrity is needed to enable adequate assessment of the potential impacts on a regional scale and to determine appropriate mitigation measures.

In the IESC advice to DOE of July 2014, the IESC noted that additional investigations undertaken by Arrow following their May 2013 advice has improved the understanding of faulting, hydraulic stimulation, fracture propagation and subsidence in the region. In addition, the numerical groundwater model has been peer reviewed.

The IESC advised that further consideration of options are needed for the disposal of salt generated from the project. The project is estimated to result in the production of 4.3 tonnes of salt per megalitre of treated co-produced water, equating to 657 900 tonnes over the life of the project. While the disposal of salt to landfill is the currently deemed by the proponent as the most viable option, given the timeframes for the project, alternate options should be considered by the proponent. A discussion on the options for the management of brine and disposal of recovered salt is provided in the project EIS CSG Water and Salt Management Strategy.

The IESC noted that the numerical groundwater model is an important management tool to predict the location and magnitude of impacts arising from project operations. The IESC advised that validation, refinement and regulator revision of the conceptual model for groundwater and surface water dynamics is required and in particular, the representation and extent of the Rewan Formation should be updated and further detail on maximum predicted drawdown in model layers is required. In addition, the groundwater model needs to be updated to take into consideration the existence of the many coal mines and other groundwater users within the region. Even if groundwater drawdown for the project is not predicted to intersect with other users, the total water balance should be identified.

The IESC raised concerns in relation to the potential for groundwater drawdown and changes to groundwater flow associated with faults and interaquifer connectivity. The IESC advised that validation of theoretical fault analysis with field data and testing of the Bowen Basin, particularly given the prevalence of faulting within the basin, is required. In addition, the risk of aquifer interconnectivity around fault zones needs to be monitored and managed.

The IESC reiterated their previous advice to EHP in relation to the need for a groundwater monitoring program to determine a baseline for ongoing impact assessment and management. The IESC advised that the proponent should undertake a monitoring regime for GDE's to enable an adequate assessment of existing conditions prior to groundwater extraction, noting that the survey should be carried out with particular focus on vegetation including *E. Raveretiana* and *A. Harpophylla*.

The IESC commented that specific detail on hydraulic stimulation and chemical risk assessment was not available for review by the Committee. The IESC raised concerns in relation to the potential for hydraulic stimulation to result in aquifer interconnection along faults and the ability to adequately assess impacts when the proximity of potentially stimulated wells near faults is unknown. In their advice, the IESC recommended that the proponent undertake a

monitoring and risk assessment of hydraulic stimulation events, including risks associated with the use of particular chemicals. In addition to the existing state reporting requirements, the hydraulic and chemical risk assessment should also include how hydraulic stimulation and fracture propagation will be monitored and controlled and an assessment of risks for each chemical to be used.

The IESC commented that the cumulative groundwater impacts of coal and gas projects operating in the northern Bowen Basin are not sufficiently addressed in the project EIS. The Committee has concerns regarding the limited inclusion of cumulative data within the numerical groundwater model and the resultant uncertainty of the model in predicting the drawdown from the development. In addition, the IESC advised that project data and relevant information should be made accessible to assist the knowledge base for future research and future regional scale assessments.

Management of residual impacts - in their advice to DOE of July 2014, the IESC concluded that uncertainties remain in relation to groundwater drawdown; potential changes to groundwater flow associated with faults and interaquifer connectivity, management of co-produced water, potential impacts associated with hydraulic stimulation and chemical use and cumulative impacts.

Further discussion of the proponent's response to the IESC's advice of July 2014 is also included in section 4.10 of this assessment report.

Groundwater monitoring network

The proponent notes that the requirement for the establishment of a groundwater monitoring program and many of the monitoring requirements detailed in the IESC's advice to DOE are requirements of the *Water Act 2000* and will be addressed when preparing the Water Management Strategy (WMS) to be prepared for the Underground Water Impact Report (UWIR) for the Bowen Gas project tenures. Notably, the requirement for baseline assessments, early warning triggers for groundwater drawdown, data relating to the movement of groundwater between affected aquifers and information on the thickness or presence of the Rewan Formation, must be completed as part of the UWIR process.

Noting the IESC's concerns in relation to the limited data provided in the SREIS to substantiate the understanding of groundwater within the project region, and the framework approach to the project, EHP recommends that the conditions of approval require the proponent to implement a groundwater monitoring program. The monitoring program should include the installation of dedicated monitoring bores at appropriate depths and locations, with sampling at appropriate frequency to establish baseline data, seasonal groundwater trends and aberrations in groundwater quality and levels. The proponent should also undertake groundwater monitoring to check model predictions that aquifer interconnectivity risks are low and undertake further work during operations to confirm that faults present in the Bowen Basin (including subvertical faults and folds) do not provide preferential pathways for groundwater flow.

Numerical groundwater model

In their response to the IESC's advice to DOE, the proponent states that review and update of the groundwater model is facilitated through the UWIR process. This includes an annual review of new data, including whether there has been any material changes to the predictions presented in the UWIR.

Noting the IESC's advice in relation to the current limitations of the existing groundwater model and considering the conceptual nature and scale of the project, EHP recommends that the conditions of approval include a requirement for the proponent to review and regularly update the numerical groundwater model, including updating uncertainty and sensitivity analyses, predicted drawdowns for each groundwater model layer and the incorporation of water balance inputs.

Hydraulic stimulation

In response to the IESC's comments concerning the lack of specific information provided in the SREIS regarding hydraulic stimulation and chemical use, the proponent has stated that if there is a need to hydraulically stimulate any wells, a project specific execution plan will be developed for each hydraulic stimulation campaign. The proponent also noted that as per the requirements of the EP Act, strategies must include details of process control monitoring to be undertaken during stimulation activities to detect water quality impacts and interconnectivity. The assessment under the EP Act also includes the identification and assessment of chemicals to be used in the process, including hazard assessments and characterisation of potential environmental and human health risk and impacts.

Consistent with the IESC's advice and considering the limited information provided in the assessment documentation, including the specific location of wells potentially to be stimulated, EHP recommends that the conditions of approval include a requirement for the proponent to undertake a hydraulic stimulation and chemical risk assessment, including how hydraulic stimulation and fracture propagation in all well types will be monitored.

Cumulative impacts

The project EIS acknowledges the potential for interactions between the project and other existing and future projects in the area to result in cumulative impacts on groundwater users. The proponent has committed to providing the results of the cumulative impact scenario outputs from the Arrow Bowen Basin EIS groundwater model to facilitate the development of a regional cumulative groundwater model should a cumulative management area be declared over the project area.

In accordance with the IESC advice, EHP recommends that the conditions of approval require the proponent update the numerical groundwater model to take into account, where the information is available, the cumulative impacts on groundwater of regional project drawdown. In addition, noting the advice from OGIA and NRM, EHP recommends that the proposed conditions of approval require the proponent to contribute data to any quantitative assessment of cumulative impacts which may be implemented in the future. The proponent should also be required to make data and relevant information from the project accessible to assist the knowledge base for future research and regional scale assessments.

Surface water

The project tenements occupy approximately 8,000km² of gently sloping plains in the Bowen Basin with two major river basins – the Burdekin River Basin which drains the project area to the west to southwest and north, and the Fitzroy River Basin, which drains the project to the south and southeast. These large rivers contain a number of sub-catchments, namely the Suttor River, Bowen River, Isaac-Connors Rivers and Mackenzie River sub-catchments.

The waterways across the study area are slightly to moderately disturbed due to current mining and grazing activities. The Suttor River and its tributaries are ephemeral with waterholes supplied by groundwater. The impact of the Burton Gorge Dam on low flow hydrology in the Isaac River influences the disturbed status of aquatic habitat values in the Isaac River. The waterways located within the Fitzroy Basin are ephemeral in nature and provide seasonal habitat for aquatic fauna and flora.

The SREIS identified 109 riverine and 423 non-riverine wetlands in the project area incorporating a range of wetland types (described in SREIS Appendix H section 4.3.1) varying in ecological value and incorporating riverine systems including the Isaac River and non-riverine lacustrine and palustrine wetlands such as modified dams and vegetated swamps. Of the listed wetlands, 66 riverine and 191 non-riverine wetlands were identified as occurring within the gas drainage areas and of these, 14 riverine and 29 non-riverine wetlands were identified as high or very high ecological value under the AquaBAMM classification. Section 4.11 Aquatic Ecology of this assessment report describes these values.

Lake Elphinstone in the upper catchment of the Isaac River was identified as an Environmentally Significant Area (ESA) and is listed as Important Wetlands in Australia. The lake is the largest natural fresh water body in Central Queensland and is an important bird breeding ground and refuge.

Surface water values and potential impacts on surface water values were described in EIS Section 15 Surface water. Technical information, including overland flow assessments and flood modelling, was addressed in EIS Appendix N Surface Water Technical Report. SREIS Section 8 Surface Water included additional information on geomorphology, hydrology and surface water quality assessment at, or adjacent to, areas proposed for central gas processing facilities, CSG water treatment facilities and proposed CSG water discharge areas. SREIS section 8 also summarised water quality results measured in the relevant catchments namely the Upper Isaac River, Connors River, Mackenzie River, Suttor River and Bowen River. All five catchments were described as containing extensive ephemeral stream networks with wet season flow periods, except for the Mackenzie River at Riley's Crossing which has perennial flows.

Detailed information was included in the SREIS Appendix F Surface Water Technical Report on the baseline water quality of the Isaac River which has been identified by the proponent as a potential receiving waterway for CSG water discharges. Site specific field assessments of the water quality of the Isaac River in the identified potential receiving environments for CSG water releases have not been undertaken due to a lack of waterway flows.

SREIS Section 9 Hydrology and Geomorphology addresses flow regimes, hydraulic parameters and geomorphology of the Isaac River reaches presented as possible receiving environments. SREIS Appendix F Surface Water Technical Report provides a surface water quality assessment incorporating the EHP and DNRM surface water quality database, and water quality sampling for the SREIS at the proposed CSG water discharge reaches. The assessment was undertaken to determine the capacity of potentially affected watercourses to accept the proposed discharges and to determine the water quality objectives for those watercourses. The Isaac River was shown to carry excess sediment inputs from changes to land use (agriculture and mining).

Overland flow was identified as a significant hydrological process and was described for the project area. SREIS

Appendix G Hydrology and Geomorphology Technical Report provides an assessment of the potential for flood inundation from 1% AEP events and overland flows of sub-catchments that have been identified as areas for the WTF1, WTF2 and the holding dams.

Impacts to surface water

The proponent has stated that they do not intend to take or divert surface waters for the project other than small volumes for construction purposes where alternative sources are not available. The SREIS states that project activities that have the potential to impact on surface water resources are

- exploration and drilling activities
- construction, operation and decommissioning of project infrastructure
- discharge and storage of hydrotesting water
- discharge and storage of treated and untreated CSG water and brine concentrate;
- discharge of treated sewage
- the construction and rehabilitation of watercourse crossings for infrastructure
- disturbance by vehicle movements, particularly where crossings are not reinforced or elevated.

The proponent has identified the key potential impacts to surface waters as

- interference with naturally occurring overland flow and flooding
- degradation of surface waters resulting from the discharge of treated or untreated CSG water
- increased erosion and sedimentation associated with overland flow restrictions; controlled CSG water releases, and construction, operation and decommissioning activities
- uncontrolled releases of stormwater and contaminants.

EIS Section 15 provides a detailed discussion of the impacts associated with each project phase and these are also discussed in Section 4.10 of this assessment report.

Erosion and sedimentation

Project activities, including mobilisation of sediment during construction, alterations of surface water flows and flow paths, and discharges to waterways have the potential to impact on habitat for listed threatened species such as the Fitzroy River Turtle and Black Ironbox. The EIS (Appendix O Aquatic Ecology Technical Report) provides an assessment of the potential impacts of project activities on aquatic ecology including the Fitzroy River Turtle. The report notes that the impact of the mobilisation of sediment into waterways as a result of riparian vegetation clearance will be minimal. In addition, most of the waterways in the project area are ephemeral and impacts to the aquatic environment posed by creek crossings and other construction activities can be minimised by timing construction with periods of dryness and ensuring that rehabilitation is complete before wet season flows commence.

The SREIS Appendix N Surface Water Technical Report includes a discussion of the potential impacts to surface water associated with the project. The SREIS notes that sediment mobilised during construction activities may enter surface water runoff during rainfall events and discharge to watercourses, leading to adverse effects on water quality. Watercourse crossings have the potential to alter flow paths with detrimental impacts on stream geomorphology and water quality. Increased bed scour can lead to adverse water quality through increased turbidity. The SREIS Appendix O Commitments Update states that buffer zones will be adopted for project activities (with the exception of required creek crossings) in different areas of constraint, as defined by the project's constraints mapping.

Discharges of CSG water to waterways

Coal seam gas co-produced water will be discharged where beneficial uses are not feasible. Two potential locations have been identified for the WTFs enabling two reaches of the Isaac River to be identified as potential locations for discharges. The SREIS notes that the release of CSG water has the potential to impact on the flow regime, aquatic habitat and water quality within receiving waterways. The persistent controlled release of treated CSG water has the potential to alter the natural flow regime by introducing additional flows with potential impacts to geomorphology through altered sediment and erosion patterns within the stream channel. In addition, the release of CSG water has the potential to impact water quality with potential impacts to aquatic ecosystems and downstream users.

The hydrology of the Isaac River and likely impacts of water discharges on flow in the Isaac River are presented in SREIS Section 9.3.1. The reaches of the Isaac River proposed for each WTF were shown to have highly ephemeral flow regimes limited to short duration flows between December and April, with the remainder of the year

dry or with limited isolated pools. The EIS states that any proposed discharge in either reach of the Isaac River would take account of when high flow conditions persist. This may occur three to four times per wet season lasting an average of 8 to 16 days. In the vicinity of drainage area 2, bankfull flows occur on average once every two years for up to four days. Flows in the WTF2 reach would be similar. Further monitoring would be required to confirm flows at the specific reach and site proposed for discharge.

The EIS documents did not describe in detail the beneficial water uses to be implemented or the details of likely proposed discharges of untreated CSG water to surface waters. The SREIS stated that the WTF's would have capacity to treat up to 20 ML/d each. Both WTF1 and WTF2 would discharge CSG water to the Isaac River during operations and also in emergency situations depending on wet season magnitudes and demands for distribution via the Isaac River channel to water users for beneficial use. The EIS did not specify the location of any CSG water discharge points and focused on identifying and assessing specific impacts of CSG water discharges on the water quality of the Isaac River in the WTF1 and WTF2 reaches where discharge points were proposed. The proponent has committed to undertaking site specific impact assessment for any EA application.

The SREIS Section 15 provided an updated project description with two reaches of the Isaac River main channel nominated for the potential discharge of treated and possibly untreated CSG water. Changes to the project description such as the reduction of wells and changes in the infrastructure configuration also changed the potential impacts to the surface water. The SREIS provided studies on flow regimes, hydraulic parameters and geomorphology of the Isaac River reaches nominated to receive discharges.

Disposal to watercourses is the least preferred option under the CSG waste hierarchy in EHP's *CSG Water Management Policy 2012*, which promotes avoidance, reduction, reuse, recycling, recovering, treatment and disposal. Section 4.21 Waste of this assessment report contains further information on proposed CSG water management, including disposal. The SREIS stated that treated CSG water may be blended with untreated CSG water to meet the water quality guideline values for the protection of beneficial users, including irrigation, stock watering, drinking water and aquatic ecosystem function.

The CSG water discharge frequencies, timing and volumes were not defined in the EIS documents. The SREIS used the estimates of bankfull elevation along with the discharge rating curves, to estimate bankfull discharge. SREIS section 9 Table 9.2 provided these estimations for the Isaac River reaches proposed for the WTFs. The SREIS scoped the Isaac River assimilative capacity for potential discharges without significantly impacting the flow and geomorphic characteristics of the Isaac River indicating that such increases in flow, if managed properly, would not result in significant adverse impacts on watercourse geomorphology, water quality and aquatic ecology. The SREIS proposed further assessments to determine appropriate frequency, timing and volume of proposed discharges.

Brine and salt management

The SREIS Appendix D Coal Seam Gas Water and Salt Management Strategy sets out management options for the beneficial use and disposal of excess CSG water and brine, in accordance with the *Queensland Coal Seam Gas Water Management Guidelines*. CSG water would be made available for beneficial use by the agricultural industry, other industries, domestic uses and finally discharge to the Isaac River under EA conditions should there be excess water remaining after beneficial use. Brine produced from the treatment of CSG co-produced water using reverse osmosis would be stored in dams and reduced to a waste salt concentrate via evaporation. The waste salt concentrate would then be disposed of to a regulated waste facility. The EIS stated that this is the only viable option for salt disposal. Other brine management options, including selective salt recovery, injection and discharge to the ocean were studied but rejected.

The proponent stated (SREIS Section 8) that dams for CSG co-produced water and brine would be designed and constructed in accordance with EHP's *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures*. Any EA application would contain the details on specific sites for infrastructure such as WTF locations, discharge points, and associated dam capacities. The EIS documents identified potential impacts to downstream aquatic ecosystems and receptors, the risk of seepage and failure or overtopping from dams. The proponent stated that information on stream flows, watercourse water quality, CSG co-produced water quality and the extent of mixing zones, as well as aquatic ecology would be provided in any EA application. The proponent operates reverse osmosis plants at two locations in central Queensland and states that the proposed Bowen Gas plant would operate on a similar basis.

Flooding

The EIS Appendix N included information on flood levels and flooding history and overland flow modelling. Maps of overland flow, flooding and stream characterisation summaries were included in EIS appendix N. The EIS states that a flood frequency analysis had been undertaken for the project river systems.

Cumulative impacts

SREIS section 8 Surface water summarised the surface water resources in the project area and impacts by historic and current land uses such as agriculture, mining and urban development. The SREIS states that competing land uses should all be subject to appropriate water quality management and, at times large volumes of coal mine affected water discharged to the Isaac River such that any project CSG water that may be discharged should not have significant additional impacts on water quality and flow.

EIS Section 15 Surface Water and SREIS Section 8 Surface Water provide a high level qualitative assessment of cumulative impacts to surface water resources. The qualitative assessment is based on the project not discharging under 'normal' operating conditions, with discharges limited to controlled emergency releases during high rainfall events. The assessment highlighted changes to watercourse hydrology as a potential cumulative impact and concluded that the project would not significantly contribute to cumulative impacts. It was recognised that numerous coal and other CSG developments in the region had indicated that water could be released to watercourses during operations. No cumulative impact assessment of current and approved discharges to the Isaac River from coal projects was presented.

The assessment documentation also considered potential discharges to surface waters from relevant coal mines. The SREIS states that the development of the project discharge strategy would consider potential impacts from the proponent discharges and other relevant discharges, to watercourses potentially affected by the proposed discharges at the WTF1 and WTF2 proposed locations north and south of Moranbah on the Isaac River.

Avoidance, mitigation and management measures

The SREIS states that providing all management commitments are fully implemented including discharge strategies, significant cumulative impacts on the Isaac River's flow regime, geomorphic character and water quality would not occur. SREIS Section 9 Table 8.7 summarises the potential small size and low significance of residual impacts to surface water. The proponent's commitments (SREIS Appendix O) on water management include the following management actions.

Overland flows

Mitigation measures are proposed to avoid and mitigate potential changes to overland flow, flood flows with the potential for erosion, water-logging, interference with irrigation systems and infrastructure, loss of access to water, impacts to general farming operations, and potential conflict between neighbouring landholders including:

- avoid disrupting overland natural flow paths and, where avoidance is not practicable, maintain connectivity of flow in watercourses;
- communicate and negotiate with landholders;
- reach agreement with landholders on access tracks and other infrastructure location to minimise overland flow impacts;
- seek landholders' knowledge of overland flow regimes on their properties;
- design access tracks, gathering lines and well pads so they do not impede overland flow;
- construct all weather access tracks to maintain the existing hydrologic and hydraulic regimes including overland flows;
- reinstate natural drainage lines and follow fence lines, roads or tracks to minimise disturbance;
- decommission infrastructure in such a manner that it will not adversely affect overland flow;
- develop and implement erosion and sediment control plans based on Best Practice Erosion and Sediment Control Manual (IECA, 2008) supported by topographic LIDAR data and landholder advice;
- avoid stockpiling of soil in irrigated floodplain areas to avoid impacts to overland flow; and
- design and implement fences for security and low impacts on surrounding land use and overland flow.

Flooding

The proponent's commitments on managing the risk of floods on project infrastructure and environmental harm include watercourse crossings to be designed to minimise impacts on geomorphology and river flows, where practical major facilities would be constructed above the 1:100 year flood level, schedule construction works during the dry season to minimise the risk of flooding wherever possible, and checking for flood warnings or subscribing to flood warning services where relevant during construction of watercourse crossings.

Coal seam gas water discharge

The SREIS section 8 and Appendix D addressed the potential impacts associated with the proposed discharge of treated and untreated CSG water during operations and in emergency situations. The water quality assessment provided limited water sampling information which was not adequate to define local water quality objectives. The potential impact on water quality as a result of discharges of unspecified waters was not adequately assessed.

The SREIS Appendix D states that selecting and designing the discharge points on the Isaac River and developing

the discharge strategy would involve a number of considerations including river flows, water quality (discharge and receiving) and dam capacity. Commitments for managing proposed discharge of CSG water are provided in the SREIS Appendix F and Appendix O, including timing and volume of discharge, waterway flows and mixing zone capacity.

The SREIS did not clarify when discharge of untreated water is proposed and the proposed discharge water quality for operational discharge was not defined. SREIS appendix D included recommendations for additional studies of the natural flow regime, stream geomorphology, water quality and ecological response to changed habitat as a result of discharges, to inform development of a discharge strategy.

The IESC advised that where discharge to the environment is proposed, a discharge strategy should be developed that considers the flow requirements of water related assets and the influence of other discharges occurring in the region, including demonstration that there is sufficient assimilative capacity in the Isaac River main channel at the proposed discharge locations.

Hydrostatic test water

The source, chemical treatment, and disposal of pipeline hydrostatic test water were not detailed in the EIS documents. The proponent has committed to developing and implementing a hydrostatic testing procedure prior to commencement of hydrotest activities, including consultation with landholders and regulatory authorities prior to sourcing and disposing of hydrotest water. The EIS states that specific details on hydrostatic test water would be provided in support of applications for an EA. A hydrostatic testing strategy would be developed to manage hydrotest activities to prevent contaminants from entering waterways. Information on the proposed hydrostatic testing was provided in EIS Section 4 and SREIS Section 3 Project Description.

Beneficial use

The SREIS states that beneficial use options for managing CSG water would be the first priority before consideration of discharge to the Isaac River. Beneficial use options listed in the EIS as follows

- supply of treated CSG water to augment the domestic water supply within the project area;
- supply of treated CSG water to water service providers (such as Sunwater);
- supply of treated (and in certain instances untreated) CSG water to coal mines within the Bowen Basin;
- supply of treated CSG water to third party agricultural users; and
- own use (within Project operations) of treated (and in certain instances untreated) CSG water.

Details on each option were provided in the SREIS Appendix F Surface Water Technical Report. The proponent notes that beneficial use is the preferred option for the management of coal seam gas water and beneficial use would be further investigated when applications for an EA are made. If beneficial use is found not to be feasible then controlled discharge to watercourses would be the management solution intended. The proponent currently holds an EA allowing discharge by the proponent's Moranbah Gas Project where a reverse osmosis plant is in operation. This allows discharges to the Isaac River during and immediately after flow events.

IESC advice on surface water impacts

Section 4.10 of this assessment report provides a discussion on the IESC advice of May 2013 provided to EHP on the project EIS.

In their advice to DOE the IESC acknowledge that the project's assessment documentation is at a conceptual stage however, there is insufficient information to provide confidence in the assessment of the potential risks associated with the project. The IESC concluded that uncertainties remain in association with the storage, management and disposal of co-produced CSG water and the potential for cumulative impacts on surface water resources as a result of this disposal. The key issues raised in the IESC advice in relation to surface water are

- the assessment of impacts to waterways is not sufficient to enable a thorough consideration of changes to water resources
- both a site-specific and a regional water balance model are needed to enable an assessment of changes to water resources
- the management of co-produced water is not sufficiently addressed within the project's assessment documentation, largely as the management plan is based on a conceptual layout and hypothetical treatment strategies
- as per the advice to EHP, further detail is required to ensure that the risks associated with the management and disposal of brine/salt produced are managed and that risks are appropriately characterised and mitigated
- where discharge to the environment is proposed, a discharge strategy should be developed that considers the flow requirements of water related assets and the influence of other discharges occurring in the region, including demonstration that there is sufficient assimilative capacity in the Isaac River main channel at the proposed discharge locations.

In response to the IESC's advice that further consideration of options for the disposal of salt generated from the project is required, the proponent noted that a thorough analysis of the available options for salt management has been carried out and it was determined that disposal to landfill is the most viable option. The proponent also stated that, as committed to in the project SREIS, Arrow will consider possible optimisations such as enhanced evaporation options and encouraging landfill sites to be developed locally to further mitigate any potential impact on the environment.

Management of residual impacts

In their advice to DOE of July 2014, the IESC concluded that uncertainties remain in relation to the storage, management and disposal of co-produced CSG water. Further discussion of the proponent's response to the IESC's advice of July 2014 is also included in section 4.10 of this assessment report.

In response to the IESC's advice that environmentally sustainable outcomes for the beneficial use of co-produced water should be ensured, the proponent has confirmed that they intend to maximise beneficial use of co-produced water, in line with the state's CSG Water Management Policy.

The project SREIS has confirmed that discharge of co-produced water is likely to be required for the project. The IESC noted that where discharge to the environment is proposed, a discharge strategy should be developed that considers the flow requirements of water related assets and the influence of other discharges occurring in the region. In particular, discrepancies in modelled bankfull flow discharge rates may mean there is potential for discharge of CSG water to adversely affect geomorphology and aquatic ecosystems. In their response to the IESC advice, the proponent provided further discussion on the findings of the Environmental Flow Assessment and confirmed that a discharge strategy will be developed as part of the state EA application process.

Consistent with the IESC's advice in relation to the management of co-produced water, EHP recommends that the proponent investigate measures for beneficial use, including the optimum re-use of co-produced water. EHP also recommends that the proponent develop a discharge strategy, to be informed by further field studies, to determine suitable trigger values and existing environmental values in the proposed water discharge areas of the Isaac River. The proponent should address any requirements under relevant legislation and water management plans in developing the strategy (e. g. Burdekin and Fitzroy River Water).

Conclusion on impacts to surface and groundwater resources

The matters raised by the IESC in their advice to EHP and DOE in relation to impacts to surface water resources have been considered in the recommendations for approval conditions provided below. EHP advises that the recommended conditions for an environmental authority at Appendix 3 should be considered in developing the EPBC approval conditions to be applied to the project.

While the project has the potential for a number of impacts to water resources, EHP is of the view that these impacts can be managed through appropriate mitigation and management measures including the proponent's commitments, recommendations by EHP for any environmental authority and the recommendations for conditions for the EPBC approval.

Following EHP's assessment of water impacts, they are of the view that the project will not have an unacceptable impact on a water resource in relation to coal seam gas development and large coal mining development.

Conclusion

The proposed action, to construct, operate and decommission a coal seam gas field and associated infrastructure in the Bowen Basin, Queensland is considered likely to impact on EPBC listed threatened species and communities and water resources, if acceptable mitigation and offset measures are not implemented.

The proponent has proposed a package of mitigation measures which includes the management of threatened species *in situ*, progressive revegetation and rehabilitation of impact areas and measures to monitor and manage water resources. Additionally, the proponent has committed to offsetting areas of land for the long term protection and conservation of habitat for listed threatened species and for ecological communities.

EHP considers that the likely impacts of the proposed action on listed threatened species and communities and water resources will be acceptable, provided the action is undertaken in accordance with the recommendations for approval conditions and consistent with the mitigation, management and offset measures proposed by the proponent.

EHP has considered all matters required to be considered under the bilateral agreement with the Commonwealth. The EHP recommends the proposed action be approved with conditions.

Recommendations for EPBC approval conditions

EHP recommends that the conditions for an environmental authority at Appendix 3 should be considered in developing the EPBC approval conditions to be applied to the project. EHP makes the following recommendations for conditions of the EPBC Act approval:

Listed threatened species and communities (ss 18 & 18A)

Recommendation – disturbance limits

The proponent must not exceed the agreed whole of project disturbance limits (ha) for EPBC listed threatened species and communities.

Recommendation – pre-clearance surveys

The proponent should undertake preclearance surveys of disturbance areas prior to clearing each construction site. Preclearance surveys must be undertaken by a suitably qualified person and in accordance with agreed survey guidelines. The proponent should regularly report the outcomes of the surveys in order to reconcile actual impacts against agreed whole of project disturbance limits for EPBC listed threatened species and communities.

Recommendation – unanticipated occurrence of listed species found in preclearance surveys

Should the occurrence of any EPBC listed species that is not already considered as known or have the potential to occur in the project area be found in the preclearance survey, the proponent must propose measures for avoiding or mitigating any disturbance to the species and their habitat. In addition, where significant residual impact is considered likely to occur, the proponent must provide an offset for the unanticipated impact in accordance with DOE's *EPBC Act Offsets Policy*.

Recommendation – management of impacts to MNES during vegetation clearance, construction, operation and decommissioning of the project

The proponent must implement measures that will avoid, mitigate and manage impacts to EPBC listed species and its habitat and EPBC listed ecological communities during clearance of vegetation, construction, operation and decommissioning of the Project. The proponent should undertake vegetation clearance for each construction stage in a manner that avoids impacts to EPBC listed fauna species, including through the use of a suitably qualified person. The proponent must ensure that management actions are carried out in a manner that is not inconsistent with relevant recovery plans, conservation advice and threat abatement plans.

Recommendation – listed threatened species and communities management

The proponent should communicate the likely occurrence of EPBC listed threatened species and communities to landholders, and propose measures to involve landholders in the implementation of management actions, including pest and weed control and fire management.

Recommendation - EPBC Offsets requirements

The proponent should ensure that any required offsets comply with the *EPBC Act Environmental Offsets Policy (2012)*. The proponent may carry out the project in stages and deliver an environmental offset for each stage of the action's impact on EPBC listed threatened species and communities. The proponent should submit an Offset Management Plan for Phase 1 of the Project, consistent with the EPBC Act Offsets Policy which provides details of the offset proposed for significant residual impacts associated with project Phase 1. The Offset Management Plan should be submitted to DOE for approval by the Minister for the Environment prior to the proponent commencing project Phase 1.

Water Resources - in relation to coal seam gas development and large coal mining development (ss 24D & 24E)

Recommendation – groundwater monitoring program

The proponent should establish a groundwater monitoring network and develop a groundwater sampling regime to establish baseline data for groundwater resources that may be impacted by the project, including groundwater quality, levels and pressures, monitoring of aquifers to determine hydraulic connectivity and for determining connectivity between surface and groundwater; and measures to monitor impacts to groundwater dependent ecosystems.

Recommendation – numerical groundwater model

The proponent should be required to update the existing numerical groundwater model. The model should be regularly revised to predict impacts and inform appropriate management responses, including updated uncertainty and sensitivity analyses, any changes to inflows and outflows of the model and additional regional hydrogeological

data, inform cumulative impacts and to include representation and extent of the Rewan Formation.

Recommendation – hydraulic stimulation

Prior to commencement of hydraulic stimulation, the proponent should undertake a hydraulic stimulation and chemical risk assessment, including how hydraulic stimulation and fracture propagation in all well types will be monitored and controlled; a risk assessment on individual chemicals and total fracturing fluid.

Recommendation – cumulative impacts

The proponent should contribute data to any quantitative assessment of cumulative impacts to which may be implemented in the future by regulatory agencies. The proponent should make data and relevant information from the project publicly accessible to assist the knowledge base for future research and any future regional scale assessments.

Recommendation – release of CSG water

The proponent should develop a strategy for discharge of co-produced water, with discharge only in accordance with any environmental authority issued under the Environmental Protection Act 1994 (Qld). The strategy should be informed by further field studies to determine suitable trigger values and existing environmental values, including the potential for impacts to EPBC listed threatened species in the proposed water discharge areas of the Isaac River.

Recommendation – beneficial use

The proponent should investigate measures for beneficial use, including the re-use of co-produced water on site. The proponent should address information requirements for any application for beneficial reuse of treated CSG co-produced water, including a beneficial use approval under the *Waste Reduction and Recycling Act 2011* and *Environmental Protection Act 1994*.

Appendix 5 Excerpts from EIS documents - Tables

FROM SREIS section 3 Project Description:

Table 3.1 Project Changes Since Release of the EIS

• EIS Section	• EIS Project Description	• Description of Change (in Supplement)
4.3 – Major Infrastructure Components	Integrated processing facility (IPF) – to treat (dehydrate) and compress the gas to export pressure, and treat water for beneficial use.	The term IPF is no longer being used and is now incorporated into central gas processing facilities (CGPF). Water treatment facilities (WTFs) will be co-located at CGPFs. Simply a change to naming convention.
4.3.1 – Production Facilities Figure 4-4 Indicative Facilities Layout	For the purpose of the EIS, production facility locations were assumed to be located somewhere near the centre of each development area (17 in total) of 12 km radius . The indicative layout of production facilities across the Project area were presented in Figure 4–4 of the EIS.	Due to expected low gas pressures, as a result of the preliminary engineering undertaken in the concept select phase, the number of development (or drainage) areas has increased to 33 in total, however; each of these drainage areas now represent an approximate 6 km radius catchment area for gathering well production (gas and water), and distributing to surface production facilities located at or near the centre of drainage area. These 33 drainage areas will be developed over the Project life, however; Arrow does not expect all facilities to be operating together at one single time. See Figure 3–1. The number and location of development areas has been revised – this influences the indicative location of facilities. This change is now presented in Figure 3–1.
4.3.1.1 – Facility Gas Compression Table 4-2 Production Facility Compression Types	Detailed information in Table 3-2 outlines a comparison between compression types presented in the EIS and the new case for the SREIS.	See Table 3–2 for a comparison between compression types presented in the EIS and the new case for the SREIS.
4.3.1.1 – Range of Facility Sizes Table 4-3 Production Facility Area Requirements	Production facility area requirements: FCF = 200 x 250 m; CGPF = 600 x 250 m; and IPF = 800 x 250 m + up to 1 km ² for dams.	Production facility area requirements: FCF = 200 x 380 m (maximum size); and CGPF = 500 x 250 m + up to 0.6 km ² for dams (dimensions are provisional, may vary following design review).
4.3.1.2 –Field Compression Facilities	Field compression facilities (FCF) were to be installed to boost the gas pressure to enable transportation of the gas over long distances.	FCFs will be installed to boost the gas pressure and enable transportation of the gas over long distances. FCFs will also now include a water transfer station (WTS) to facilitate transfer of water from FCF to FCF en route to a CGPF.

• EIS Section	• EIS Project Description	• Description of Change (in Supplement)
4.3.1.2 – Field Compression Facilities	Previously electrical power was to be reticulated to an FCF from the nearest CGPF or IPF.	It is presently anticipated that electrical power will be reticulated to FCFs from a central location, which will be the CGPFs for Phase 1 of the development, and strategic FCFs for subsequent phases. An FCF will receive high voltage power via Arrow owned 66 kV distribution network from where the voltage is stepped-down to 11 kV for distribution to users within the facility and to wellhead facilities. See Section 3.6.
4.3.1.2 – Field Compression Facilities	At an FCF, water was to be received from the local production area gathering systems, collected in a storage tank, and pumped to the closest IPF.	At an FCF, water will be received from the local production area gathering systems, collected in storage tanks, and pumped to another FCF or to a CGPF, whichever is the closest.
4.3.1.3 – Central Gas Processing Facilities	Gas was to be compressed to reach a high pressure (10,200 to 15,000 kPag).	The gas will be compressed to reach high pressure (10,200 to 13,500 kPag) - see Table 3–2.
4.3.1.3 – Central Gas Processing Facilities	A combination of screw and reciprocating compression was assumed as the reference case for the EIS.	Centrifugal compressors are proposed to be used as part of the SREIS case - see Table 3–2.
4.3.1.3 – Central Gas Processing Facilities	Gas flows at the Project’s CGPFs were likely to range between 60 and 210 TJ/d .	Peak installed capacity at the CGPFs is likely to be between 360 TJ/d to 450 TJ/d - see Table 3–2.
4.3.1.3 – Central Gas Processing Facilities	The gas was to be received at the facility at a controlled pressure of approximately 40 kPag at the inlet manifold and 30 kPag at the suction to compression .	The gas will be received at the CGPF from the FCFs at a controlled pressure of approximately 3,100 kPag at the inlet manifold and 3,000 kPag at the suction to compression .
4.3.1.3 – Central Gas Processing Facilities	A slug catcher will separate any bulk water in the gas before it is directed to the first stage of compression.	Any bulk water in the gas is separated in a slug catcher before the gas is directed to the first stage of compression. Water collected at the slug catcher will be collected in the utility dam to avoid contaminating the WTF with the corrosion inhibitor. See Section 3.4.
4.3.1.3 – Central Gas Processing Facilities	At a CGPF, water was to be received from the local production area gathering systems, or from gathering systems of adjacent production areas via low pressure trunklines. The water was to be collected either in a utility dam or tank and pumped, via a WTS to an IPF.	At the co-located WTF, produced water will be collected, treated and then stored onsite for distribution to the end user, which may include irrigation, mine wash water, water utility company or town water supply. Further details are provided in Section 3.4
4.3.1.4 – Integrated Processing Facilities	Integrated processing facilities (IPF).	The term ‘IPF’ is no longer being used for the SREIS case . WTFs will now be co-located with the CGPFs not at the previously named IPFs. See Section 3.4.

• EIS Section	• EIS Project Description	• Description of Change (in Supplement)
4.3.2 – Production Well Development	Up to 6,625 production wells were expected to be drilled throughout the Project area over the approximate 40 year Project life to maintain gas supply to the LNG plant.	Approximately 4,000 production wells will be drilled throughout the Project area over life of the Project (up to 40 years) to maintain gas feed to the LNG plant.
4.3.2 – Production Well Development Figure 4-6 Indicative SIS Well Schematic	Surface-in-seam (SIS) chevron wells in a dual lateral configuration were proposed to be used on a nominal 800 m grid pattern. Multi-seam hydraulically fractured: vertical, cased and cemented wells, which are perforated and fracture-stimulated to provide formation access. It was proposed that up to 25% of wells developed could potentially be hydraulically fractured. The indicative layout of the SIS chevron well was presented in Figure 4-6.	Currently, development plans involve drilling and completion of two base case well types: Multi Branch Laterals (MBLs): multi branched horizontal wells drilled in-seam to intersect a vertical producer; and Multi-seam hydraulically fractured: vertical, cased and cemented wells, which are perforated and fracture-stimulated to provide formation access. As with the EIS, it is proposed that up to 25% of wells developed could potentially be hydraulically fractured. See Section 3.3, Figures 3-2 to 3-4 show the layout of the MBL wells.
4.3.2 – Production Well Development	No reference in the EIS Project Description chapter (Section 4) to groundwater monitoring bores.	Groundwater monitoring bores in accordance with Arrow's statutory obligations (see Section 3.3.3)
4.3.3.1 – Surface-in-seam Chevron Wells	A horizontal, SIS, dual-lateral in a chevron configuration. This design included two production laterals per well (and therefore requires that three holes are drilled, from three separate surface locations, to provide one "dual lateral producer").	A horizontal MBL well. A multi-well pad will be comprised of either 4 wells (2 vertical production conduits plus 2 lateral wells), 8 wells (4 vertical production plus 4 lateral) or 12 (6 vertical production plus 6 lateral) wells. See Section 3.3.1 for further details on layout and configuration of wells.
4.3.3.1 – Surface-in-seam Chevron Wells	On a nominal 800 m grid pattern, an indicative density of one producer well per 160 to 320 acres (65 to 130 ha) was typically expected.	Wells will be clustered together onto common well pads, wherever possible. See Section 3.3.1.
4.3.3.1 – Surface-in-seam Chevron Wells	During the drilling phase, each well pad was to occupy an area of 8,100 m ² (90 m x 90 m) such that for each SIS dual-lateral producer, the required collective well pad area (for the three separate pads) was to be 24,300 m ² .	During the drilling phase, the estimated multi-well pad area will be 130 m x 175 m (4 wells pad), 130 m x 235 m (8 wells pad) and 130 m x 295 m (12 wells pad). See Section 3.3.1.
4.3.3.1 – Surface-in-seam Chevron Wells	Once the well is installed, the footprint was to be reduced to approximately 10 m x 10 m such that for each SIS dual-lateral producer, the required collective well pad operational area (for the three separate pads) would be approximately 17 m x 17 m.	The area required for drilling is only temporary; post drilling, the site can be rehabilitated down to the area required for the operational footprint. The estimated operational footprint is 100 m x 155 m (4 well pad), 100 m x 215 m (8 well pad) and 100 m x 275 m (12 well pad). See Section 3.3.1.

• EIS Section	• EIS Project Description	• Description of Change (in Supplement)
4.3.3.2 – Multi-seam Hydraulically Stimulated Vertical Well	During the drilling phase each well pad would occupy an area of approximately 8,100 m ² (90 m x 90 m).	During the drilling phase each single-well pad may occupy an area of 16,900 m ² (130 m x 130 m). See Section 3.3.1.
4.3.5 – Power Generation and Distribution	Integrated power generation was presented as the preferred option to supply power to the production facilities in the EIS.	Power supply from the grid is the base case for the SREIS. Integrated power generation is considered a temporary alternative if grid connection is not completed on time. Under this option, it is proposed to develop temporary power generation utilising CSG as a fuel source at selected CGPFs and FCFs as required for approximately two years of the initial development. See Section 3.6 of this report for the revised description of electricity supply for the Project.
4.3.7 – Water Treatment and Storage Facilities	Total associated water volume to be extracted over the life of the Project is estimated at approximately 264.3 GL (over 40 years) Average production = 7 GL/a Peak production = 10 GL/a	Estimated total water produced is 153 GL Average production = 4.25 GL/a (average is over 36 years) Peak production = 10.4 GL/a
4.3.7 – Water Treatment and Storage Facilities	The term 'IPF' was used in the EIS to describe the facility that would contain both gas compression and processing equipment and also a WTF. The EIS presented the following dam sizes (per WTF): Aggregation dam – 600 ML Treated water dam – 600 ML Brine dam (x2) – 960 ML	For the SREIS, the term 'IPF' is no longer considered and the WTFs will be co-located with the two CGPFs with the potential of a third WTF to be constructed near Blackwater. As part of the SREIS reference case and for planning purposes, the following preliminary dam sizing (per WTF) has been adopted (based on a nominal facility throughput of 20 ML/d): Associated water storage (feed) dam – 400 ML (providing a minimum of 20 days storage) Clear (treated) water dam – 600 ML Brine storage dam(s) – 1,800 ML See Section 3.4 of this report for further detailed information on changes to the WTFs.
4.3.10 – SCADA and Telecommunications	The High Speed Backbone Network (HSBN) was to interconnect the FCFs, CGPFs and the IPFs as well as extending where required into the well fields.	The HSBN will interconnect the FCFs and CGPFs as well as extending into the well fields.

• EIS Section	• EIS Project Description	• Description of Change (in Supplement)
4.3.10 – SCADA and Telecommunications	<p>The HSBN was to be implemented by either buried fibre optic cable or microwave links.</p> <p>Fibre optic cables were also to be assessed for use within upstream facilities to reduce site cabling installations.</p>	<p>The HSBN will include buried Fibre Optic Cable and Microwave Radio links.</p> <p>Where practical, the fibre optic cables will be placed in the same easement as the low pressure gas gathering pipelines and medium pressure infield pipelines.</p> <p>Arrow communications tower specifications are for long term free standing towers. Arrow towers meet CAA guidelines. Depending on the geography they range in height from 65 m to 100 m conceptually.</p> <p>It is estimated there would be 4 towers.</p> <p>See Section 3.8.5.</p>
4.3.11.1 - Depots	Depots were proposed to be located at four IPF facilities – see Figure 4-9 of the EIS.	Depots (including storage yards) will be located adjacent to the two CGPFs.
4.3.11.2 – Accommodation Facilities	<p>Accommodation for the construction and operation workforce of the Project was expected to include a combination of temporary workforce accommodation facilities (TWAfs) and permanent housing.</p> <p>These accommodation facilities were expected to be located in the vicinity of an IPF.</p>	<p>It is currently envisaged that purpose-built accommodation will be constructed as follows:</p> <p>Two main villages located near the CGPFs.</p> <p>To reduce driving distances and its associated risks, several smaller temporary villages (currently estimated to be four) are expected to be required when the facilities associated with the drainage area furthest away from the CGPFs are under construction.</p> <p>As the majority of the operations and maintenance personnel are expected to be sourced from outside the Project area, accommodation villages co-located with the Central Operating Bases (COB) will be built to house the Project personnel.</p> <p>See Section 3.9 of this report for details on the revised workforce and accommodation strategy.</p>
4.3.11.3 – Borrow Pits	The Project construction and operations activities will require foundation aggregate for construction of camps, roads and production facilities.	The Project construction activities will require crushed rock, gravel, sand and soil for construction of roads and tracks, production facilities and accommodation camps. The materials will be purchased from commercial quarries and / or borrow pits on Arrow land will be developed.
4.3.11.3 – Borrow Pits (Concrete)	No mention in EIS Project Description of concrete.	Concrete required for the construction of the facilities will be sourced from local suppliers. Temporary batching plants will be established as necessary for areas that are remote from fixed plants.

• EIS Section	• EIS Project Description	• Description of Change (in Supplement)
4.3.12 - Workforce	Peak total Project workforce was expected to occur in September 2016 with 1,760 personnel. Two smaller peaks were expected to occur in December 2019 with 1,342 personnel and in May / June 2046 with 1,300 personnel.	<p>The daily construction workforce is expected to peak at around 2,450 personnel in 2018. From 2017 to 2019 the average daily workforce is expected to be over 1,000 personnel which coincides with the construction of the two CGPFs and the Phase 1 FCFs.</p> <p>The average daily construction workforce will reduce to around 500 to 900 personnel from 2020, after which it will further reduce to 400 or less personnel from 2028 onwards. See Section 3.9 for further details.</p>
4.3.13 – Workforce Accommodation	Workforce accommodation was assumed to be co-located with the IPFs.	<p>It is currently envisaged that purpose-built accommodation will be constructed as follows:</p> <p>Two main villages located near the CGPFs; and</p> <p>Several smaller temporary villages (currently estimated to be four) are expected to be required when the facilities associated with the drainage area furthest away from the CGPFs are under construction.</p> <p>See Section 3.9 of this report for details on the revised accommodation strategy.</p>
4.4 – Development Planning	<p>For the purpose of the EIS, production facility locations were assumed to be located somewhere near the centre of each development area (17 in total) of 12 km radius.</p> <p>The indicative layout of production facilities across the Project area were presented in Figure 4-4 of the EIS.</p>	<p>Due to expected low gas pressures, as a result of the preliminary engineering undertaken in the concept select phase, the number of development (or drainage) areas has increased to 33 in total, however; each of these drainage areas now represent an approximate 6 km radius catchment area for gathering well production (gas and water), and distributing to surface production facilities located at or near the centre of drainage area. These 33 drainage areas will be developed over the Project life, however; Arrow does not expect all facilities to be operating together at one single time. See Figure 3–1.</p> <p>The number and location of development areas has been revised – this influences the indicative location of facilities. This change is now presented in Figure 3–1.</p> <p>See Section 3.2 of this report for details on the revised development planning and sequencing for the Project.</p>
4.5 – Development Sequence	14 development regions were presented in the EIS.	<p>The overall Project development area has been sub-divided into 9 development regions (see Figure 3–1).</p> <p>See Section 3.2 of this report for details on the revised development planning and sequencing for the Project.</p>

• EIS Section	• EIS Project Description	• Description of Change (in Supplement)
4.6 - Construction	No outline of pipeline crossing construction techniques	The SREIS case presents three options for pipeline crossings depending on the nature of each specific crossing: Open cut; Horizontal directional drilling; and Bored. See Section 3.7.6 for detailed on the types of construction for pipeline crossings.
4.6.1 – Construction Schedule	Project was to commence production from the first phase of facilities in January 2017, with facilities construction required in the 2015 to 2016 period, and initial well drilling commencing in 2016 .	The Project will commence production from the first phase of facilities in January 2018, with facilities construction required in the 2016 to 2017 period , and initial well drilling planned to commence in 2015 .
4.6.2 – Production Wells	Production wells were to be installed progressively throughout the Project life, starting in 2016 .	Production wells will be drilled progressively throughout the Project life, starting in 2015 and ending in 2041.
4.6.2 – Production Wells	Production wells (construction).	See Section 3.3 and 3.7.2 for details on construction for revised well types.
4.6.2 – Production Wells	Well site completions	Additional information incorporated. See Section 3.7.2 for additional information on well site completions.
4.6.3 – Gathering Systems	Trenching	Additional information incorporated. Plough-in is also being considered as a construction method for gathering systems as part of the SREIS reference case (this was not considered in the EIS). See Sections 3.7.3.1 and 3.7.3.2 for further details on trenching and plough-in.
4.6.4 – Production Facilities	No mention of off-site pre-fabrication and assembly.	In order to minimise the site construction activities, off-site pre-fabrication and assembly will be used to the maximum practicable extent.

• EIS Section	• EIS Project Description	• Description of Change (in Supplement)
4.6.6 – Power Generation Facilities	Power generation facilities were to be located within the production well sites and production facility sites and the subsequent construction methods are similar to those described for construction of production facilities.	<p>This SREIS reference case is based on electrical power being predominantly used to drive the upstream equipment located at each of the facilities. This is the preferred approach, however; Arrow has included an option for temporary gas powered generation for approximately two years of the initial Project development in the case that connection to the national grid is delayed.</p> <p>In specific cases, power for remote wellheads may be generated on-site by gas fired engines during the Project life. It is proposed that up to 10% (400) of all wells may potentially be gas powered due to being unfeasible to connect to powerlines</p> <p>See Section 3.6 for details on construction of transmission lines and the distribution network.</p>
4.6.7 – Construction Workforce	A peak construction workforce of approximately 1,540 personnel was expected to occur in 2016, when three IPFs in Area 4, Area 5 and Area 7 and one CGPF in Area 6 were to be constructed.	<p>The daily construction manpower is expected to peak at around 2,450 personnel in 2018.</p> <p>See Section 3.9 for further details.</p>
4.7.3 – Production Facilities	The operational life of a production facility was expected to be approximately 30 years .	<p>The CGPFs are expected to be suitably maintained and overhauled and will therefore operate for the full Project life. The FCFs will typically have an operational life of between 15 and 25 years each.</p>

FROM SREIS section 3 Project Description:

Table 1 Indicative Timing of each Drainage Area Coming Online

1. Year	Development Area ¹																																	
	1	2	3	4	6	8	9	11	12	13	14	15	16	18	19	20	21	22	23	25	27	28	29	30	31	32	33	34	35	36	38	39	40	
2018	█	█		█		█															█											█	█	█
2019									█							█	█		█				█	█		█						█		
2022																									█									
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2026					█										█					█														
2027																																	█	
2028																																█		
2029																		█																
2030																											█							
2031														█																				

2. ¹ Note: Development area numbering is not sequential (i.e. no missing numbers – total of 33 development areas)

FROM SREIS section 16 Waste Management:

Table 16.4

• Waste type	• Class	• Estimated Quantity	• Management Measure
Construction of wells			
Cleared vegetation	Recyclable waste	10 m ³ per well	Land holders to be consulted and best practices implemented such as: use in progressive rehabilitation; respreading over disturbed land to minimise erosion; or, left onsite for habitat use. Where practicable remove material from site and reuse in other areas [B406].
Soil	General waste	2 m ³ per well	Construction of production wells: Soil to be stockpiled and used for rehabilitation onsite. Stockpiles will be located away from water sources and in clear areas, and stabilised for the duration of the activity [B407].
Reverse osmosis (RO) water filters and filter media containing solids not removed in upstream filtration processes.	Regulated waste	30 m ³ per year	Construction of production wells: RO water filters and filter media disposed to appropriate licensed landfill [B408].
Drill cuttings; Drill fluid additives: clay stabilisers, cement additives, disinfectant, viscosifier, foaming agent and fluid loss prevention; and. Residual muds.	Recyclable and/or Regulated waste	10 m ³ to 75 m ³ per well	Drilling fluids will typically be removed by tanker or vacuum truck either for direct re-use, or recycling. Where reuse or recycling of drilling fluids is not practical, fluids may be managed onsite, or taken to a licensed disposal facility. Drill cuttings will be reused or recycled wherever possible, with direct disposal to licenced landfill only undertaken where no other practical alternative exists. Any onsite management of residual drilling material will utilise methods that are in accordance with environmental authority conditions.
Soil contaminated with oil or chemicals	Regulated waste	30 m ³ per year	Construction of wells: Soil contaminated with oil or chemicals will be taken to a licensed waste processing facility for recycling or disposal [B412].
Used lubricating oil and filters; and Unused or spent chemicals.	Regulated waste	25 drums per year	Recycled where possible and transported by a licensed contractor to an appropriately licensed waste facility for disposal [B413].
Empty drums and containers	Regulated waste	25 drums per year	Recycled where possible, or taken to an appropriately licensed waste facility [B414].
Hard waste, including excess concrete, wood pallets, scrap metal, other packaging materials.	General waste	0.5 m ³ per well	Taken to an appropriately licensed waste processing facility for recycling or disposal [B415].
Spent and unused solvents, paints and paint wastes.	Regulated waste	Residual	Transported to an appropriately licensed waste facility [B416].
Acids and caustics	Regulated waste	Residual	Collected and disposed of at licenced / authorised waste facilities [B417].

• Waste type	• Class	• Estimated Quantity	• Management Measure
Paper and cardboard	Recyclable waste	More than 1 t annually	Reused or recycled, where practical [B418].
General waste from workers' accommodation areas.	General waste	More than 1 t annually	Recycled or reused where practical and transported to a licensed waste facility [B419].
Air emissions, including nitrogen oxide, sulphur dioxide, carbon monoxide, particulate matter.	Air emissions	See the Air Quality chapter (Section 5) of the SREIS	Select equipment with consideration for low emissions to air (NO _x , SO _x), high energy efficiency and fuel efficiency [B004].
Construction and operation of facilities, gas and water gathering system			
Cleared vegetation for low pressure gathering line; and Cleared vegetation for medium-pressure pipeline.	Recyclable waste	150 m ³ per well	Land holders to be consulted and best practices implemented such as: use in progressive rehabilitation; respreading over disturbed land to minimise erosion; or, left onsite for habitat use. Where practicable remove material from site and reuse in other areas [B406].
Grey water (contaminated stormwater runoff)	Recyclable or Regulated waste	30 million litres per day (max)	Construction and operation of facilities, gas and water gathering system: Grey water shall be either collected and treated onsite or transported offsite to a municipal treatment facility [B420].
Hydrostatic test water	Recyclable or Regulated waste	100 ML per gas field	Construction and operation of facilities, gas and water gathering system: Hydrostatic test water shall be reused, or, at the end of its useful life, collected in segregated storage for removal to a licenced facility for processing [B423].
Used chemicals and oils	Regulated waste	450 kg per day	Used lubricating oil and filters and unused or spent chemicals to be recycled where possible and transported by a licensed contractor to an appropriately licensed waste facility for disposal [B413].
Scrap swarf (high-definition polyethylene fillings).	Recyclable waste	2.8 t per gathering network per year	Scrap swarf (high-definition polyethylene fillings) to be reused or recycled where possible, or taken to an offsite licensed waste facility [B425].
Debris from blow out (cleaning) of pipes.	Regulated waste	3 t per year	Debris from blow out (cleaning) of pipes to be stored in a sealed container in a bunded area or will remain in drilling pit before being transported to a licensed waste facility [B426].
Unused composite pipe; and Unused high density polyethylene (HDPE).	Recyclable waste	80 m of various diameter (110-455 mm) per well	Unused composite pipe and unused high definition polyethylene to be recycled where possible or disposed to an offsite licensed waste facility [B427].

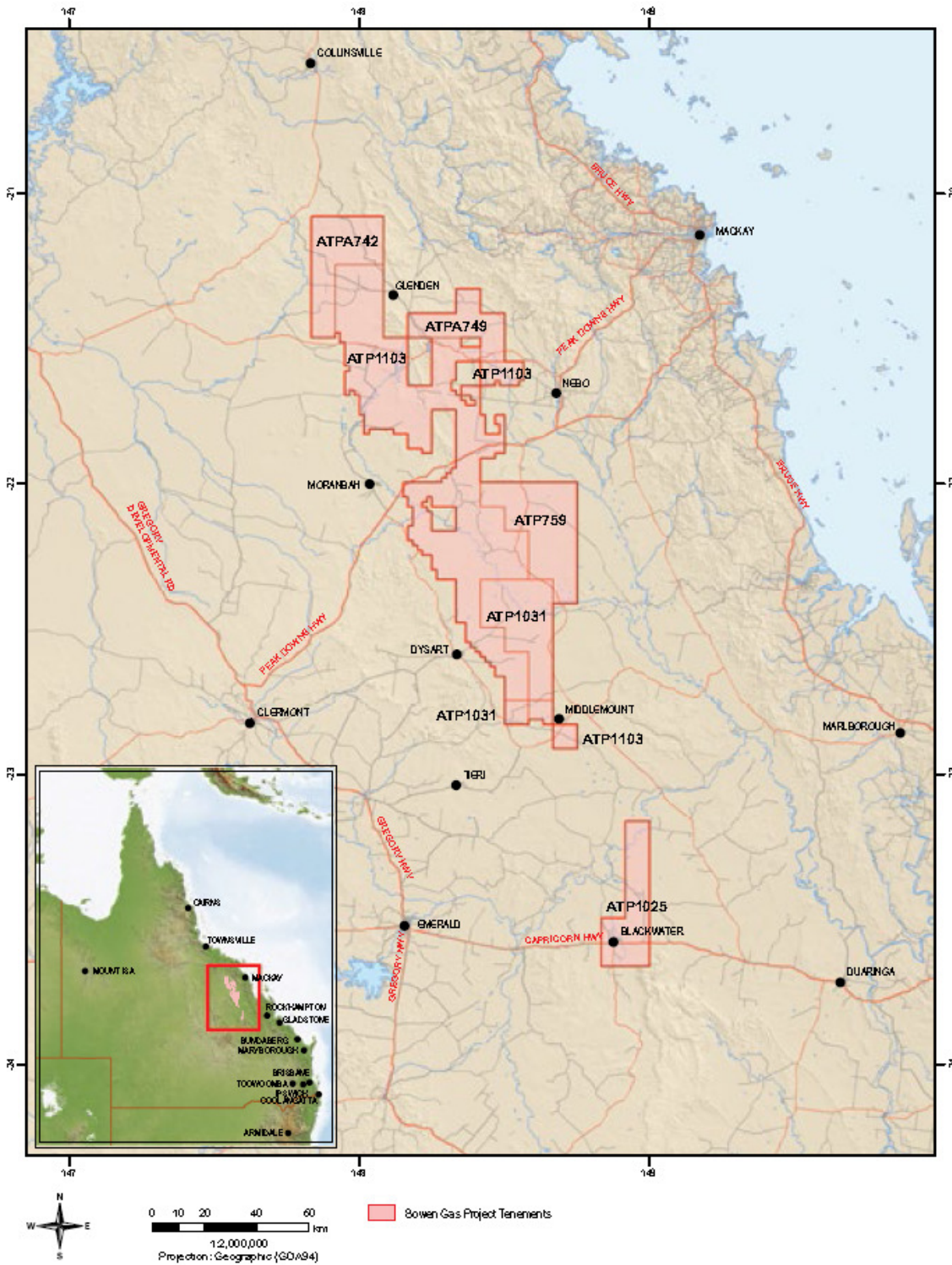
• Waste type	• Class	• Estimated Quantity	• Management Measure
Air emissions (e.g. exhaust fumes and dust) from engines, vehicles and construction activities.	Air emissions	See the Air Quality chapter (Section 5) of the SREIS	Select equipment with consideration for low emissions to air (NO _x , SO _x), high energy efficiency and fuel efficiency [B004]. Implement dust suppression measures for roads and construction sites to ensure that dust does not cause a nuisance [B014].
Membrane modules	Regulated waste	2 every 3 years	Membrane modules to be collected and disposed of in an offsite regulated waste facility [B428].
Lead acid batteries	Regulated waste	4 per FCF 18 per CGPF	Lead acid batteries to be recycled or transported to an offsite regulated facility [B429].
Concrete waste	Inert waste	100 t per FCF 700 t per CGPF	Concrete waste to be reused or recycled where possible [B430].
Cut and fill materials from dams	Inert waste	Nil (all to be used)	If the cut and fill materials from dams is contaminated, soils will be managed in accordance with the Draft Contaminated Land Guideline 1998 or updated versions thereof as described in Section Z.4.2 of the Draft EM Plan [B364].
Domestic wastes such as general wastes (office consumables, paper, plastic, glass, etc.), kitchen refuse, garden waste, packing waste (cardboard, plastic, wood pallets, etc.).	General waste	Unknown (dependent on domestic activity)	Domestic wastes such as general wastes (office consumables, paper, plastic, glass, etc.), kitchen refuse, garden waste, packing waste (cardboard, plastic, wood pallets, etc.) to be reused or recycled where possible. Otherwise transported offsite to a licensed waste disposal facility [B431].
Empty drums and containers	Regulated waste	115 drums per year per facility	Empty drums and containers to be recycled where possible, or taken to an appropriately licensed waste facility [B414].
Wooden pallets, formwork	Recyclable waste	26 m ³ per FCF 190 m ³ per CGPF	Wooden pallets, formwork to be reused or recycled where possible, otherwise transported offsite to a regulated waste disposal facility [B432].
Glass, reinforced plastic pipe offcuts	Recyclable waste	6 t per FCF 10 t per CGPF	Glass, reinforced plastic pipe offcuts to be reused or recycled where possible, otherwise transported offsite to a regulated waste disposal facility [B433].
Oily rags and sorbents	Regulated waste	Approximately 0.5 t per year	Oily rags and sorbents to be transported offsite to a regulated waste disposal facility [B434].
Packaging materials (cardboard, styrofoam, plastic wrappers, bunting, lining, end caps, containers).	Recyclable waste	150 m ³ per FCF 1,275 m ³ per CGPF	Packaging materials (cardboard, styrofoam, plastic wrappers, bunting, lining, end caps, containers) to be reused or recycled where possible, otherwise transported offsite to a regulated waste disposal facility [B435].
Plastic pipe offcuts / scrap, electric cable waste.	General or recyclable waste	9 t per FCF 35 t per CGPF	Plastic pipe offcuts / scrap, electric cable waste to be reused or recycled where possible, otherwise transported offsite to a regulated waste disposal facility [B436].
Spent filter media bulk bags	General waste	Less than 1 t annually	Spent filter media bulk bags to be transported offsite to a regulated waste disposal facility [B437].

• Waste type	• Class	• Estimated Quantity	• Management Measure
Steel offcuts and scrap metal	Recyclable waste	16 t per FCF 230 t per CGPF	Steel offcuts and scrap metal to be reused or recycled, where practical [B438].
Waste salt concentrate (solid product resulting from solar evaporation of RO brine).	Regulated waste	18,000 t per year average 45,000 t peak year	Waste salt concentrate (solid product resulting from solar evaporation of RO brine) shall be transported offsite to a regulated waste disposal facility [B439].
Salt precipitation waste product	Regulated waste	2,220 t per year average	Waste salt concentrate (solid product resulting from solar evaporation of RO brine) shall be transported offsite to a regulated waste disposal facility [B439].
Rubber and tyres	Recyclable waste	6 pick-ups yearly for a 35 TJ/d facility	Rubber and tyres to be reused where possible. Collected for removal by licensed transporter for processing at a licensed facility for recycling or disposal [B440].
Anti-seize compounds	Regulated waste	6 empty tins per FCF 35 per CGPF	Anti-seize compounds to be collected and disposed of in regulated waste facilities [B441].
Domestic cleaning products	Regulated waste	12 small empty containers per FCF 70 per CGPF	Domestic cleaning products to be collected and disposed of in regulated waste facilities [B442].
Fuels	Regulated waste	Residual	Fuels to be reused, recycled or collected and disposed of in regulated waste facilities [B443].
Greases and oils	Regulated waste	50 L per FCF 370 L per CGPF	Greases and oils to be reused, recycled or collected and disposed of in regulated waste facilities [B444].
Triethylene glycol	Regulated waste	10 m ³ per IPF	Triethylene glycol to be reused or collected and disposed of in a regulated waste facility [B445].
Contaminated stormwater runoff	Potentially containing high TSS or hydrocarbons	Unknown (dependent on final design and rainfall)	Contaminated stormwater runoff to be collected and treated within the wastewater treatment system [B446].

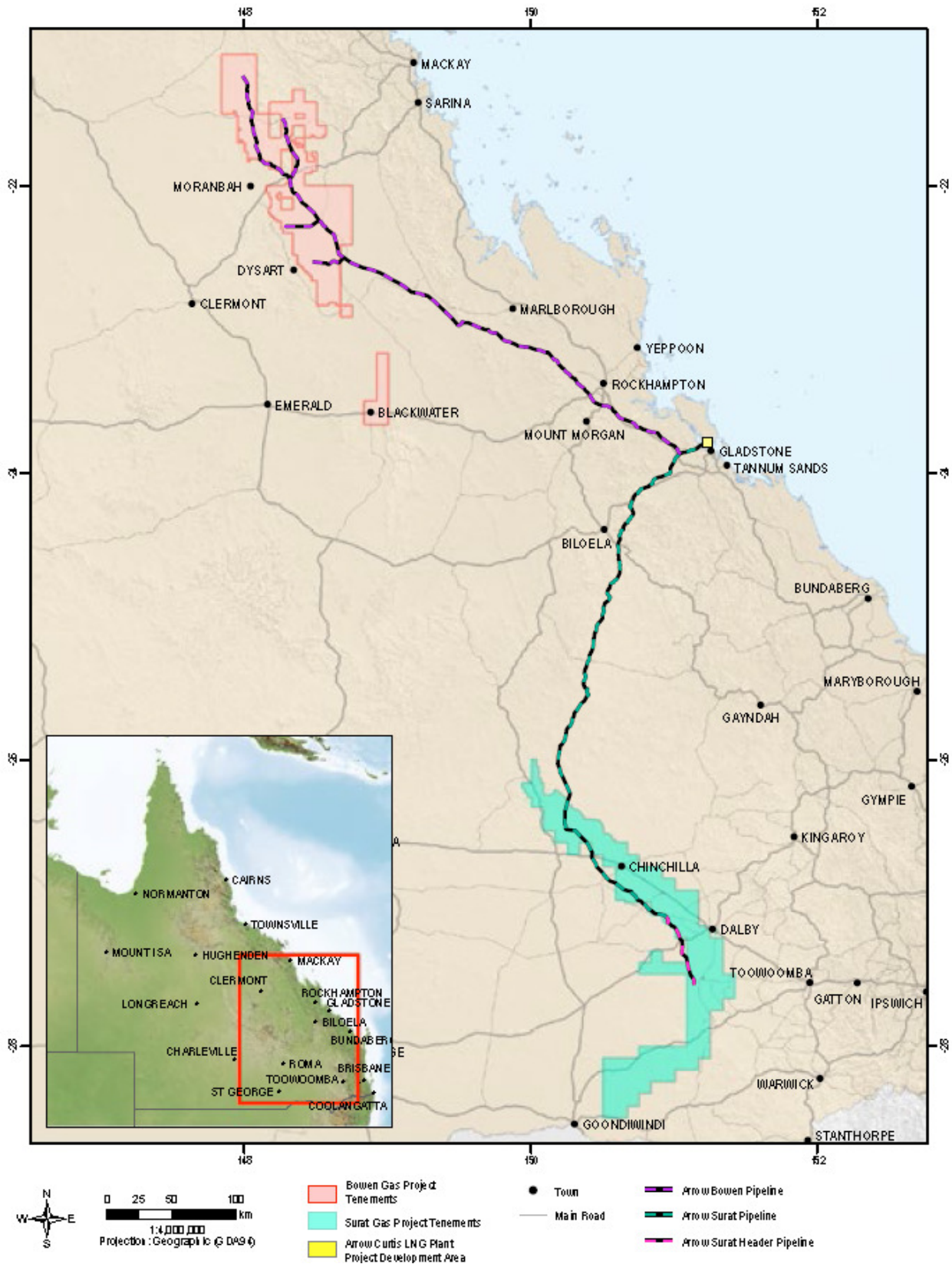
• Waste type	• Class	• Estimated Quantity	• Management Measure
Lube oil	Regulated waste	Engines: 750 L every 3,000 hours each Lubrication oil from compressors 20 L/d	Lube oil to be collected and disposed of in an offsite regulated waste facility [B447].
Oil entrained in the compression process	Regulated waste	30 t maximum per year	Oil entrained in the compression process to be reused, recycled or collected and disposed of in regulated waste facilities [B448].
Paint waste	Regulated waste	12 tins per FCF 70 per CGPF	Paint waste to be collected and stored onsite for reuse, where possible, or transported offsite to a licensed regulated waste facility [B449].
Reverse osmosis treatment chemicals	Regulated waste	Less than 1,000 L per CGPF	Reverse osmosis treatment chemicals to be collected, piped and stored in a suitable dam [B450].
Waste or wash out liquids	Regulated waste	2 m ³ per FCF 5 m ³ per CGPF	Waste or wash out liquids to be reused or removed by licensed tanker or carrier to a licensed commercial waste facility [B451].
Wastewater (sewage)	Regulated waste	5 ML per 8 month period for each FCF 24 ML per year for each CGPF	Wastewater (sewage) to be collected and transported offsite to a municipal treatment facility or treated onsite [B452].
Decommissioning and rehabilitation			
Construction debris, contaminated soil, sludge	Regulated waste	100 m ³	Construction debris, chemical / oil contaminated soil and sludge to be recycled or reused where possible or taken to an offsite licensed waste facility [B454].
Electrical cables	Regulated or recyclable waste	Unknown (final design not available)	Electrical cables to be abandoned or stored for recycling or reused where possible, or taken to an offsite licensed waste facility [B455].
Fencing	General or recyclable waste	Unknown (final design not available)	Fencing to be left in consultation with landowners or stored for reuse (some excess pipe is maintained for future maintenance and repair requirements) or collected for disposal to licensed landfill [B456].
Gas compressors	Recyclable waste	Up to 130 varying sized units	Gas compressors, low pressure high-density polyethylene gas pipelines, medium pressure gas pipelines, production well heads, power generators, pumps, sewage

• Waste type	• Class	• Estimated Quantity	• Management Measure
Low pressure HDPE gas pipelines	Recyclable waste	Unknown (final design not available)	treatment plant and tanks and storage tanks to be abandoned or stored for reuse (some excess pipe is maintained for future maintenance and repair requirements), or collected for disposal to licensed landfill [B457].
Medium pressure gas pipelines	Recyclable waste	Unknown (final numbers not available)	
Well heads	Recyclable waste	Up to 4,000	
Power generators	Recyclable or regulated waste	Up to 110 varying sized units but potentially less	
Pumps	Recyclable	Several hundred	
Sewage treatment plant and tanks	Recyclable	Unknown (final design not available)	
Storage tanks	Recyclable	Several hundred	

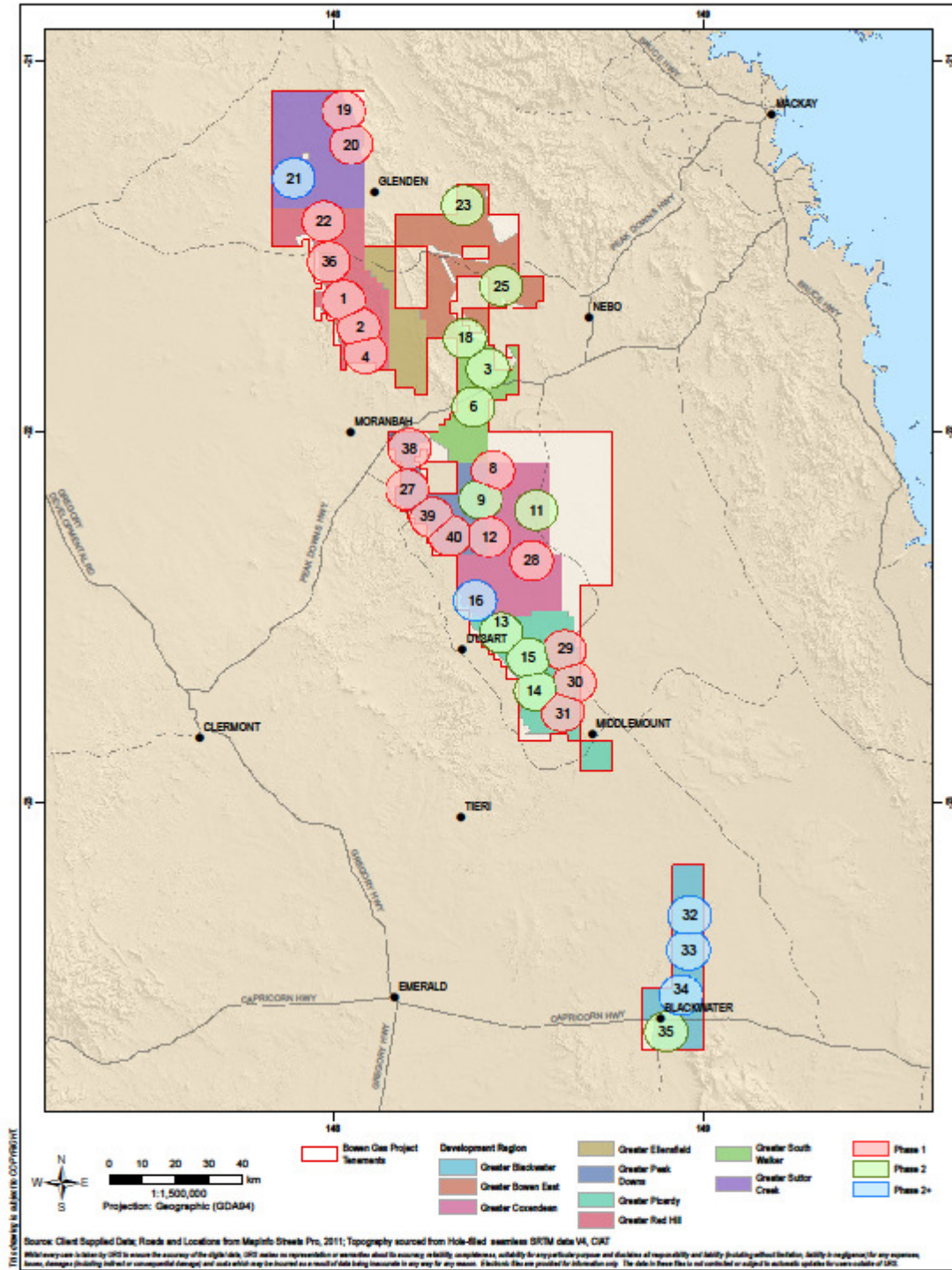
Appendix 6 Excerpts from EIS - Figures



Bowen Gas Project tenements
 (Source: EIS Executive Summary Figure 2)



Related projects and the Bowen Gas Project
 (Source: EIS, Executive Summary, Figure 1)



BOWEN GAS PROJECT SREIS

INDICATIVE PROJECT LOCATION AND DEVELOPMENT AREAS

URS | PROJECT DESCRIPTION | Figure: 3-1

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Indicative project drainage areas
 (Source: SREIS Project Description, Figure 3.1)

Appendix 7 References and guidelines

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