PEMBROKE

Olive Downs Coking Coal Project

Draft Environmental Impact Statement

Section 4

Assessment of Project Specific Matters

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

4 ASSESSMENT OF PROJECT SPECIFIC MATTERS

4.1 FLORA AND FAUNA

4.1.1 Environmental Objectives and Performance Outcomes

The environmental objectives relevant to flora and fauna, as described in the Terms of Reference for the Project, are that the:

(a) *activity is operated in a way that protects the environmental values of land including soils, subsoils, landforms and associated flora and fauna*

(b) *choice of the site, at which the activity is to be carried out, minimizes serious environmental harm on areas of high conservation value and special significance and sensitive land uses at adjacent places*

(c) *location for the activity on a site protects all environmental values relevant to adjacent sensitive use*

(d) *design of the facility permits the operation of the site, at which the activity is to be carried out, in accordance with best practice environmental management.*

The Project would achieve the following performance outcomes as identified in Part 3, Schedule 5, Tables 1 and 2 of the EP Regulation:

2 All of the following—

(a) activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land;

(b) areas disturbed will be rehabilitated or restored to achieve sites that are—

(i) safe to humans and wildlife; and

(ii) non-polluting; and

(iii) stable; and

(iv) able to sustain an appropriate land use after rehabilitation or restoration;

(c) the activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants;

(d) the application of water or waste to the land is sustainable and is managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

2 Both of the following apply—

(a) areas of high conservation value and special significance likely to be affected by the proposal are identified and evaluated and any adverse effects on the areas are minimised, including any edge effects on the areas;

(b) critical design requirements will prevent emissions having an irreversible or widespread impact on adjacent areas.

The environmental objective relevant to wetlands, as described in the Terms of Reference for the Project, is:

(b) protects the environmental values of wetlands

The Project would achieve the following performance outcome relevant to wetlands as identified in Part 3, Schedule 5, Table 1 of the EP Regulation:

2 The activity will be managed in a way that prevents or minimises adverse effects on wetlands.

The environmental objectives relevant to aquatic communities, as described in the Terms of Reference for the Project, are:

(b) environmental flows, water quality, in-stream habitat diversity, and naturally occurring inputs from riparian zones to support the long term maintenance of the ecology of aquatic biotic communities

The Project would achieve the following performance outcome relevant to aquatic communities as identified in Part 3, Schedule 5, Table 1 of the EP Regulation:

(f) any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland;

The environmental objectives relevant to groundwater dependent ecosystems (GDEs), as described in the Terms of Reference for the Project, are:

(d) volumes and quality of groundwater are maintained or alternate water supply is provided and current lawful users of water (such as entitlement holders and stock and domestic users) and other beneficial uses of water (such as surface water users, spring flows and groundwater –dependent ecosystems) are not adversely impacted by the development.

The Project would achieve the following performance outcome relevant to GDEs as identified in Part 3, Schedule 5, Table 1 of the EP Regulation:

> 2 *The activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.*

4.1.2 Description of Environmental Values

This section provides an overview of the regional and local setting (relevant to flora and fauna) and then provides a description of the terrestrial flora, terrestrial fauna, aquatic ecology and stygofauna.

This section also identifies relevant Matters of State Environmental Significance (MSES), Environmentally Sensitive Areas (ESA) and MNES relevant to the Project area.

Relevant Definitions

Project Area

The overall approximate extent of surface disturbance (clearance) associated with the Project is herein referred to as the Project area. The Project area is approximately 16,300 ha.

Study Area

The overall Study area for the ecology surveys Project covers approximately 27,000 ha of land including the full extent of the Project MDLs and MLAs. The Study area extends between 75 and 175 m either side of the proposed infrastructure corridors.

Regional and Local Setting

In a regional context, the Project is located within the Brigalow Belt North Bioregion (as defined by the Interim Bioregionalisation for Australia [IBRA] [DEE, 2018]). The Project spans across two sub-regions, with the northern extent (including the ETL, rail spur and water pipeline) falling within the Northern Bowen Basin subregion and the mine site (within MLA 700032, MLA 700033 and MLA 700034) falling within the Isaac – Comet Downs subregion.

In a local context, the Project area is located within the Bowen Basin where, in parallel with agricultural activities, open cut (and underground) coal mining is a key land use. The majority of the Project area comprises agricultural grasslands with tracts of remnant vegetation, particularly along the riparian corridor of the Isaac River (Figure 4-1) (Appendix A).

A detailed description of the regional hydrological setting is provided in Appendices D and E and is summarised in Section 4.3. Section 4.3 also describes how the Project area is located within the headwaters of the Isaac River catchment of the greater Fitzroy Basin (Appendix E).

As described in Section 4.3, the Project area is located in close proximity to the Isaac River, with ephemeral watercourses, drainage lines, and wetlands (lacustrine [dams] and palustrine [swamps]) also occurring in the landscape (Appendix B).

Terrestrial Flora Surveys

DPM Envirosciences (2018a) undertook terrestrial flora surveys within the Project MLA areas in November 2016 and again within the infrastructure corridors in September and November 2017 (spring). Follow-up flora surveys were conducted in March, May and June 2017 (autumn) within the Project MLA areas and the infrastructure corridors. The Terrestrial Flora Assessment prepared by DPM Envirosciences (2018a) is provided in Appendix A.

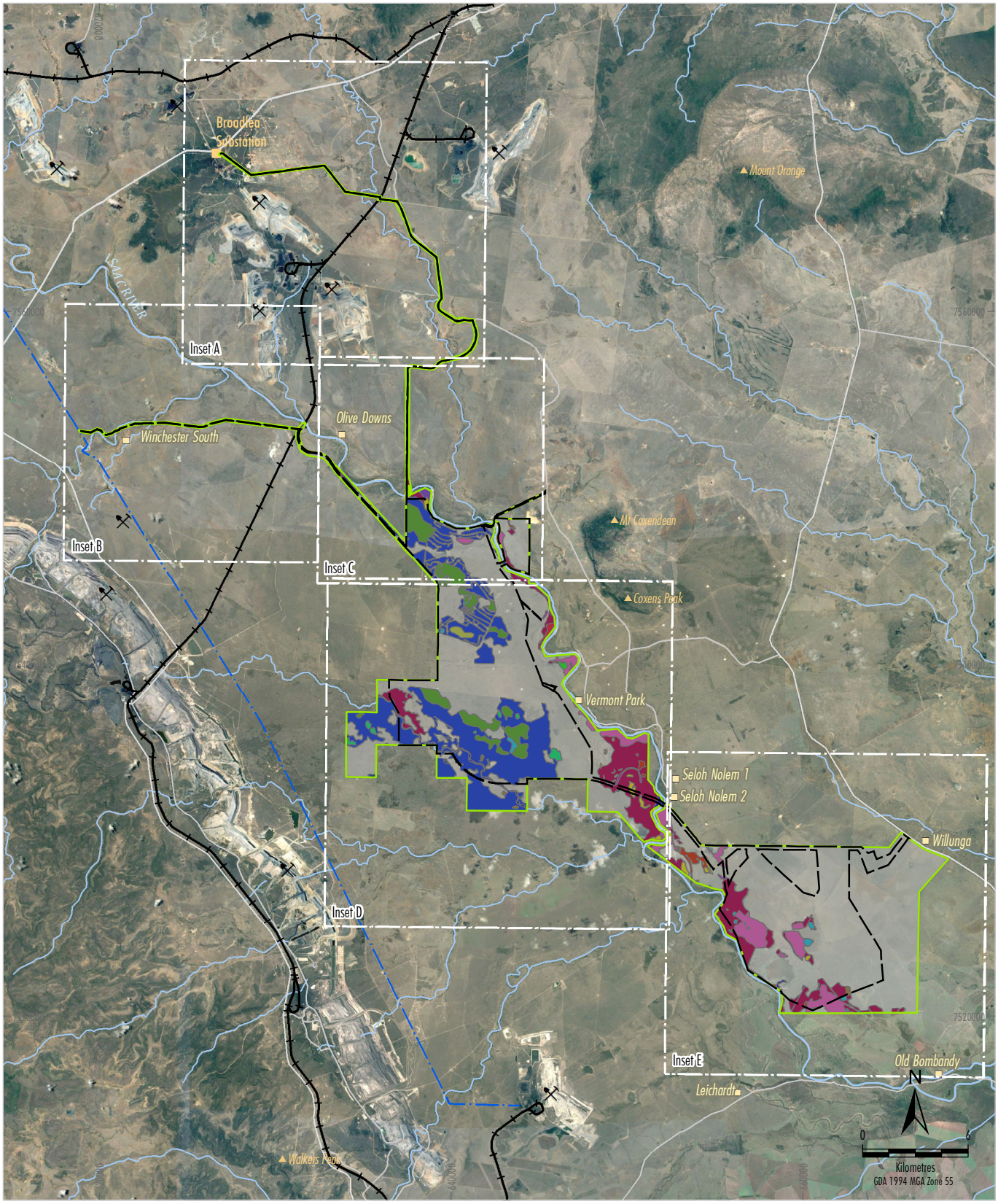
The flora surveys were undertaken in accordance with the Queensland Herbarium vegetation survey methods described in Neldner *et al*. (2017). Survey techniques included a combination of tertiary and quaternary surveys, identification of threatened ecological communities, targeted searches for conservation significant species and random meanders. A detailed description of the methodologies employed is provided in Section 3.2.6 and Appendix A.

Regional Ecosystems

Due to past and ongoing agricultural activities (e.g. clearing, grazing, thinning and cropping), the Project area is predominantly cleared land (approximately 65%) with patches of native vegetation (Figure 4-1).

A total of 21 individual native Regional Ecosystems (REs) were ground-truthed within the Project locality (Table 4-1) (Figure 4-1). These REs fall within six broad vegetation groups (Appendix A), including:

- eucalypt dry woodlands on inland depositional plains (BVG5M:5);
- eucalypt open forests to woodlands on floodplains (BVG5M:4);
- eucalypt woodlands to open forests (BVG5M:3);
- other acacia dominated open forests, woodlands and shrublands (BVG5M:10);



LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- Approved/Operating Coal Mine
- Eungella Pipeline Network
- Railway
- Peaks
- Dwelling

Ground-truthed Regional Ecosystem

- 11.3.1 - Brigalow/Belah open forest on alluvial plains
- 11.3.2 - Poplar Box woodland on alluvial plains
- 11.3.25 - Eucalypt woodland on fringing drainage lines
- 11.3.27b - Lacustrine wetland, with fringing Eucalypt woodland
- 11.3.27c - Freshwater wetlands
- 11.3.27f - Palustrine wetland, Eucalypt open woodland with fringing swamps
- 11.3.27i - Palustrine wetland, Eucalypt woodland with sedgeland
- 11.3.3 - Coolibah woodland on alluvial plains
- 11.3.4 - Eucalypt woodland on alluvial plains
- 11.3.7 - Corymbia woodland on alluvial plains
- 11.4.8 - Dawson Gum woodland to open forest
- 11.4.9 - Brigalow shrubby woodland
- 11.5.17 - Eucalypt woodland on Cainozoic sand plains
- 11.5.18 - Capricornia shrubland
- 11.5.3 - Poplar Box woodland on Cainozoic sand
- 11.5.8c - Poplar gum woodland
- 11.5.9 - Narrow-leaved Ironbark and other woodland
- 11.5.9b - Narrow leaved Ironbark, white mahogany woodland
- 11.7.2 - Acacia woodland on Cainozoic lateritic duricrust
- 11.9.2 - Silver-leaved Ironbark woodland
- non-rem

Source: DPM (2018), Pembroke (2018)
Orthophoto: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Ground-truthed Regional Ecosystems

Figure 4-1

PRN-16-02_EIS_Sect4_233A

LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- Peaks
- Dwelling

Ground-truthed Regional Ecosystem

- 11.3.1 - Brigalow/Belah open forest on alluvial plains
- 11.3.2 - Poplar Box woodland on alluvial plains
- 11.3.25 - Eucalypt woodland on fringing drainage lines
- 11.3.7 - Corymbia woodland on alluvial plains
- 11.4.9 - Brigalow shrubby woodland
- 11.5.18 - Capricornia shrubland
- 11.5.3 - Poplar Box woodland on Cainozoic sand
- 11.5.9b - Narrow leaved Ironbark, white mahogany woodland
- 11.7.2 - Acacia woodland on Cainozoic lateritic duricrust
- Non-remnant

Source: DPM (2018), Pembroke (2018), Queensland Department of Natural Resources, Mines and Energy (2017)
Orthophoto: Google Image (2016)
(Entirety of the the Approximate Extent of Proposed Surface Development is contained within Indicitive Stage 1 Disturbance Extent in this figure)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Ground-truthed Regional Ecosystems

Inset 4-1a

PRN-16-02_EIS_Sect4_2344

LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- Eungella Pipeline Network
- Peaks
- Dwelling

Ground-truthed Regional Ecosystem

- 11.3.1 - Brigalow/Belah open forest on alluvial plains
- 11.3.2 - Poplar Box woodland on alluvial plains
- 11.3.25 - Eucalypt woodland on fringing drainage lines
- 11.3.4 - Eucalypt woodland on alluvial plains
- 11.4.8 - Dawson Gum woodland to open forest
- 11.4.9 - Brigalow shrubby woodland
- 11.5.3 - Poplar Box woodland on Cainozoic sand
- 11.9.2 - Silver-leaved Ironbark woodland
- Non-remnant

Source: DPM (2018), Pembroke (2018), Queensland Department of Natural Resources, Mines and Energy (2017) Orthophoto: Google Image (2016)

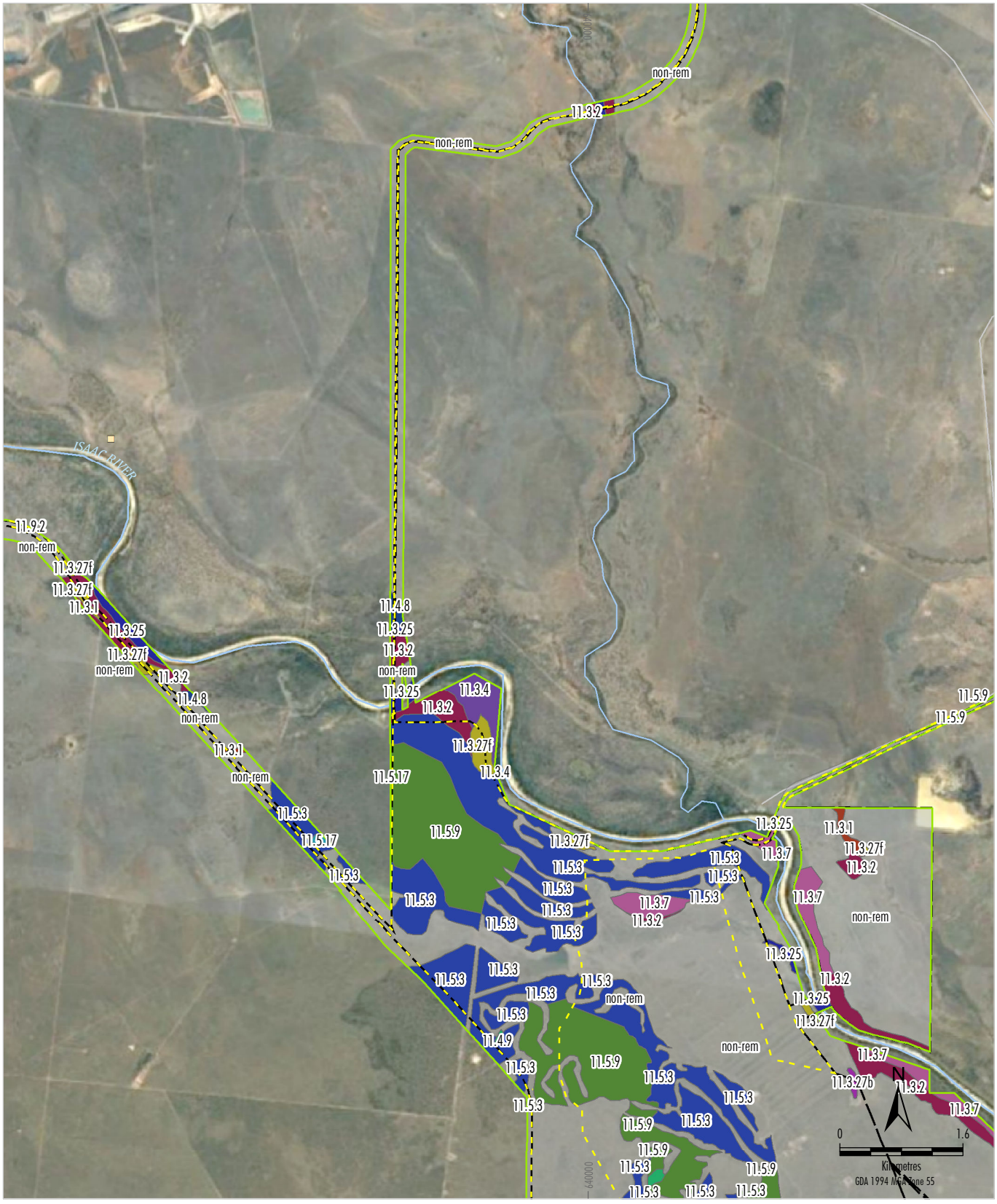
(Entirety of the the Approximate Extent of Proposed Surface Development is contained within Indicitive Stage 1 Disturbance Extent in this figure)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Ground-truthed Regional Ecosystems

Inset 4-1b



LEGEND

- Study Area
- Indicitive Stage 1 Disturbance Extent
- Approximate Extent of Proposed Surface Development
- Peaks
- Dwelling

Ground-truthed Regional Ecosystem

- 11.3.1 - Brigalow/Belah open forest on alluvial plains
- 11.3.2 - Poplar Box woodland on alluvial plains
- 11.3.25 - Eucalypt woodland on fringing drainage lines
- 11.3.27b - Lacustrine wetland, with fringing Eucalypt woodland
- 11.3.27f - Palustrine wetland, Eucalypt open woodland with fringing swamps
- 11.3.4 - Eucalypt woodland on alluvial plains
- 11.3.7 - Corymbia woodland on alluvial plains
- 11.4.8 - Dawson Gum woodland to open forest
- 11.4.9 - Brigalow shrubby woodland
- 11.5.17 - Eucalypt woodland on Cainozoic sand plains
- 11.5.3 - Poplar Box woodland on Cainozoic sand
- 11.5.9 - Narrow-leaved Ironbark and other woodland
- 11.9.2 - Silver-leaved Ironbark woodland
- Non-remnant

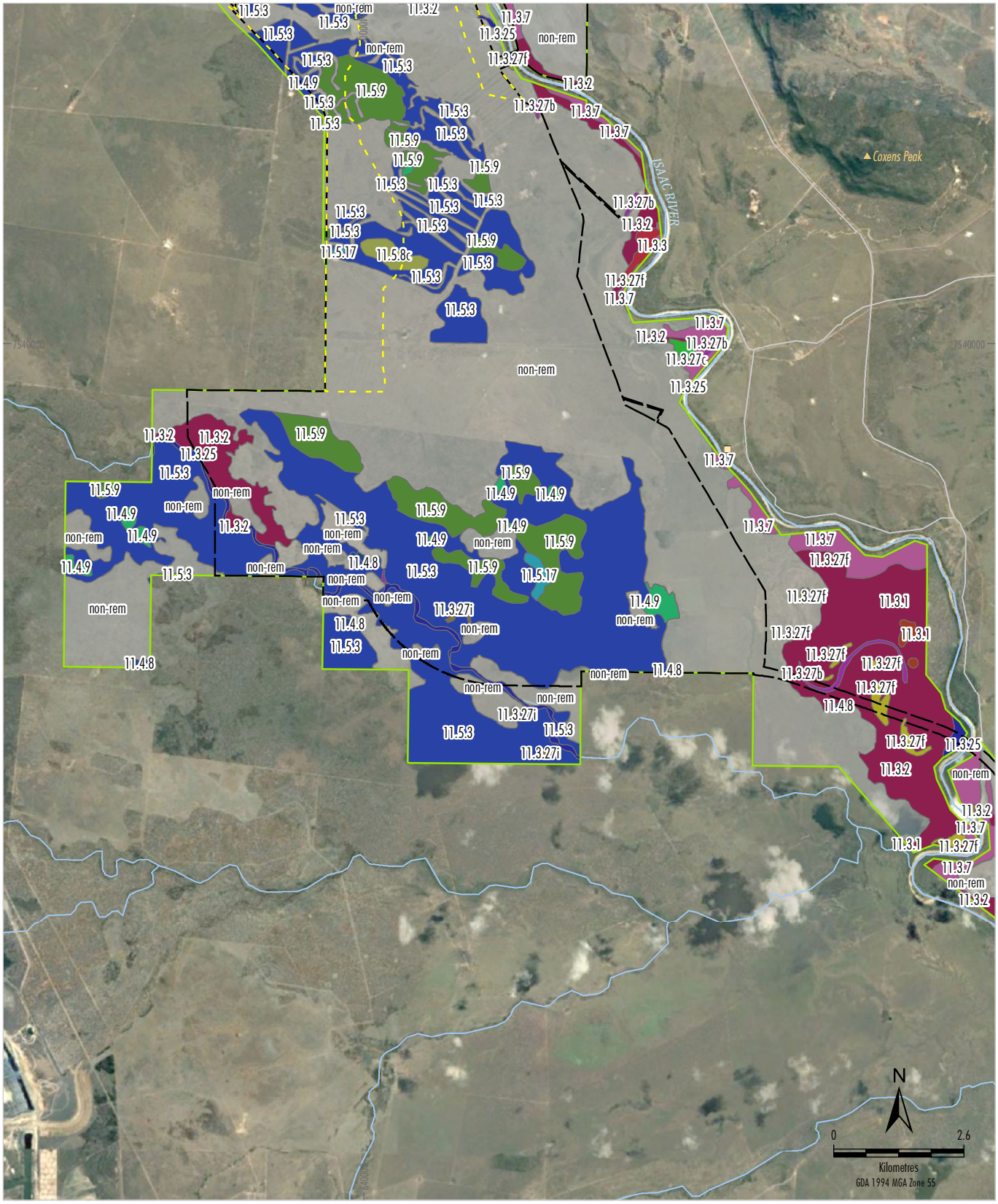
Source: DPM (2018), Pembroke (2018), Queensland Department of Natural Resouces, Mines and Energy (2017),
Orthophoto: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Ground-truthed Regional Ecosystems

Inset 4-1c



LEGEND

- Study Area
- Indicitive Stage 1 Disturbance Extent
- Approximate Extent of Proposed Surface Development
- Peaks
- Dwelling

Ground-truthed Regional Ecosystem

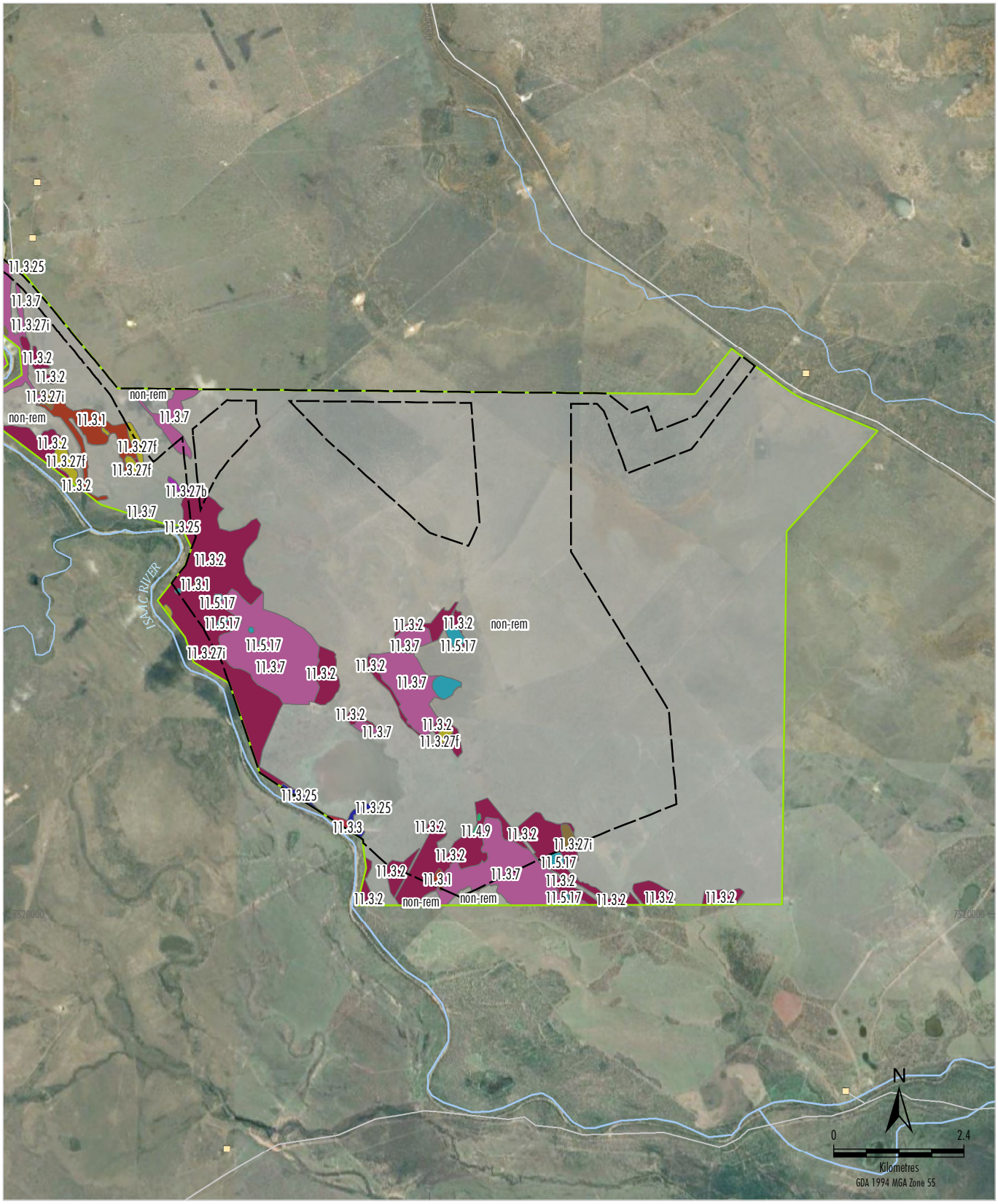
- 11.3.1 - Brigalow/Belah open forest on alluvial plains
- 11.3.2 - Poplar Box woodland on alluvial plains
- 11.3.25 - Eucalypt woodland on fringing drainage lines
- 11.3.27b - Lacustrine wetland, with fringing Eucalypt woodland
- 11.3.27c - Freshwater wetlands
- 11.3.27f - Palustrine wetland, Eucalypt open woodland with fringing swamps
- 11.3.27i - Palustrine wetland, Eucalypt woodland with sedgeland
- 11.3.3 - Coolibah woodland on alluvial plains
- 11.3.7 - Corymbia woodland on alluvial plains
- 11.4.8 - Dawson Gum woodland to open forest
- 11.4.9 - Brigalow shrubby woodland
- 11.5.17 - Eucalypt woodland on Cainozoic sand plains
- 11.5.3 - Poplar Box woodland on Cainozoic sand
- 11.5.8c - Poplar gum woodland
- 11.5.9 - Narrow-leaved Ironbark and other woodland
- Non-remnant

Source: DPM (2018), Pembroke (2018), Queensland Department of Natural Resources, Mines and Energy (2017)
Orthophoto: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT
Ground-truthed Regional Ecosystems

Inset 4-1d



PRN-14-02_EIS_Sect4_232A

LEGEND

- Approximate Extent of Proposed Surface Development
- Study Area
- Peaks
- Dwelling

Ground-truthed Regional Ecosystem

- 11.3.1 - Brigalow/Belah open forest on alluvial plains
- 11.3.2 - Poplar Box woodland on alluvial plains
- 11.3.25 - Eucalypt woodland on fringing drainage lines
- 11.3.27b - Lacustrine wetland, with fringing Eucalypt woodland
- 11.3.27f - Palustrine wetland, Eucalypt open woodland with fringing swamps
- 11.3.27i - Palustrine wetland, Eucalypt woodland with sedgeland
- 11.3.3 - Coolibah woodland on alluvial plains
- 11.3.7 - Corymbia woodland on alluvial plains
- 11.4.8 - Dawson Gum woodland to open forest
- 11.4.9 - Brigalow shrubby woodland
- 11.5.17 - Eucalypt woodland on Cainozoic sand plains
- Non-remnant

Source: DPM (2018), Pembroke (2018), Queensland Department of Natural Resources, Mines and Energy (2018)
Orthophoto: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Ground-truthed Regional Ecosystems

Inset 4-1e

Table 4-1
Ground-truthed Regional Ecosystems

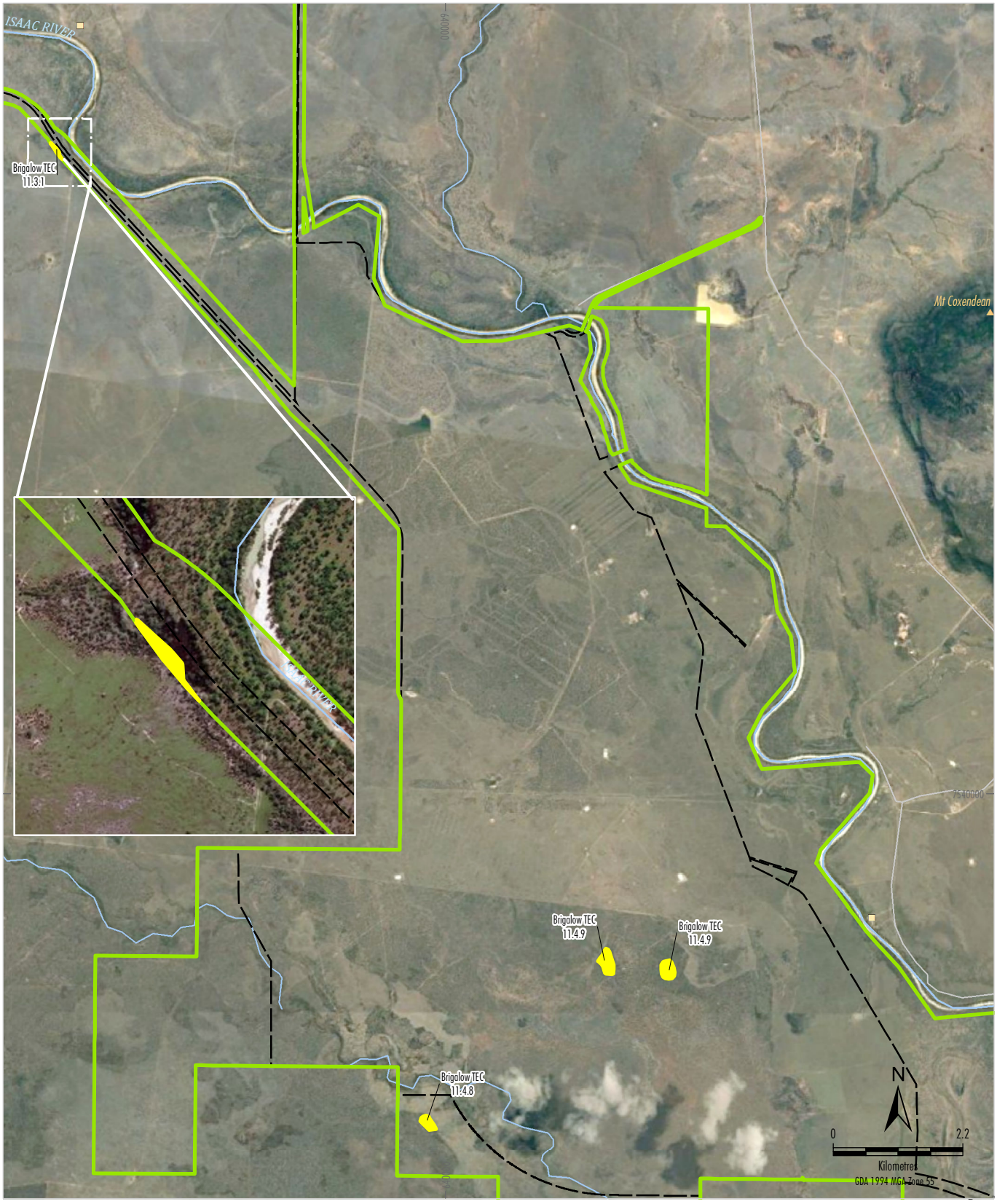
Regional Ecosystem	Conservation Status[1]		
	VM Act	Biodiversity Status	EPBC Act
RE 11.3.1 Brigalow (*Acacia harpophylla*) and / or Belah (*Casuarina cristata*) open forest on alluvial plains.	E	E	Some patches represent the Brigalow Woodland TEC[2]
RE 11.3.2 Poplar Box (*Eucalyptus populnea*) woodland on alluvial plains.	OC	OC	-
RE 11.3.25 Forest Red Gum (*Eucalyptus tereticornis*) or River Red Gum (*E. camaldulensis*) woodland fringing drainage lines.	LC	OC	-
RE 11.3.27b Lacustrine wetland, with fringing woodland, commonly River Red Gum (*Eucalyptus camaldulensis*) or Coolabah (*E. coolabah*).	LC	OC	-
RE 11.3.27c Palustrine wetland (e.g. vegetated swamp). Mixed grassland or sedgeland with areas of open water +/- aquatic species.	LC	OC	-
RE 11.3.27f Palustrine wetland, Coolabah (*Eucalyptus coolabah*) and / or Forest Red Gum (*E. tereticornis*) open woodland to woodland fringing swamps.	LC	OC	-
RE 11.3.27i Palustrine wetland (e.g. vegetated swamp). River Red Gum (*Eucalyptus camaldulensis*) or Forest Red Gum (*E. tereticornis*) woodland to open woodland with sedgeland ground layer.	LC	OC	-
RE 11.3.3 Coolabah (*Eucalyptus coolabah*) woodland on alluvial plains.	OC	OC	-
RE 11.3.3c Palustrine wetland (e.g. vegetated swamp). Coolabah (*Eucalyptus coolabah*) woodland to open woodland (to scattered trees) with a sedge or grass understorey in back swamps and old channels.	OC	OC	-
RE 11.3.4 Forest Red Gum (*Eucalyptus tereticornis*) and / or *Eucalyptus* spp. woodland on alluvial plains.	OC	OC	-
RE 11.3.7 *Corymbia* spp. woodland on alluvial plains.	LC	OC	-
RE 11.4.8 Dawson Gum (*Eucalyptus cambageana*) woodland to open forest with Brigalow (*Acacia harpophylla*) or blackwood (*A. argyrodendron*) on Cainozoic clay plains.	E	E	Some patches represent the Brigalow Woodland TEC[2]
RE 11.4.9 Brigalow (*Acacia harpophylla*) shrubby woodland with Yellowwood (*Terminalia oblongata*) on Cainozoic clay plains.	E	E	Some patches represent the Brigalow Woodland TEC[2]
RE 11.5.3 Poplar Box (*Eucalyptus populnea*) +/- Silver-leaved Iironbark (*E. melanophloia*) +/- Clarkson's Bloodwood (*Corymbia clarksoniana*) woodland on Cainozoic sand plains and / or remnant surfaces.	LC	NCP	-
RE 11.5.8c Poplar Gum (*Eucalyptus platyphylla*) woodland on white-yellow weathered sands, with grassy ground layer.	LC	NCP	-
RE 11.5.9 Narrow-leaved Ironbark (*Eucalyptus crebra*) and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and / or remnant surfaces.	LC	NCP	-
RE 11.5.9b Narrow-leaved Ironbark (*Eucalyptus crebra*), Narrow-leafed White Mahogany (*E. tenuipes*), Budgeroo (*Lysicarpus angustifolius*) +/- *Corymbia spp*. woodland.	LC	NCP	-
RE 11.5.17 Palustrine swamp with fringing Forest Red Gum (*Eucalyptus tereticornis*) woodland in depressions on Cainozoic sand plains and remnant surfaces.	E	E	-
RE 11.5.18 *Micromyrtus capricornia* shrubland on Cainozoic sand plains and/or remnant surfaces	OC	OC	-
RE 11.7.2 Monospecific stands of *Acacia* spp. forest / woodland on Cainozoic lateritic duricrusts.	LC	NCP	-
RE 11.9.2 Silver-leaf Ironbark (*Eucalyptus melanophloia*) +/- Coolabah (*E. orgadophila*) woodland on fine-grained sedimentary rocks	LC	NCP	-

Source: Appendix A.

[1] Conservation Status – E = Endangered; OC = Of Concern; NCP = No Concern at Present; LC = Least Concern.

[2] Patches of Brigalow Woodland TEC are shown on Figure 4-2.

Note: Highlighted cells are REs within the Project area.



PRN-14-02_E15_Sect4_222A

LEGEND
- Brigalow TEC
- Study Area
- Approximate Extent of Proposed Surface Development
- Approved/Operating Coal Mine
- Railway
- Peaks
- Dwelling

Source: DPM (2018), Pembroke (2018)
Orthophoto: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT
Threatened Ecological Communities

Figure 4-2

- wetland REs (swamps and lakes) (BVG5M:15); and
- other coastal communities or heaths (BVG5M:12).

Property Map of Assessable Vegetation applications under the VM Act (with the ground-truthed vegetation mapping) and RE Assessment Kits have been lodged separately with DNRM and the Queensland Museum.

A detailed description of each RE, and detailed RE mapping is provided in Appendix A.

Endangered and Of Concern Regional Ecosystems

Of the 21 REs identified within the Project locality, four have a conservation status of 'Endangered' under the VM Act (RE 11.3.1, RE 11.4.8, RE 11.4.9 and RE 11.5.17) and five have a conservation status of 'Of Concern' (RE 11.3.2, RE 11.3.3, RE 11.3.3c, RE 11.3.4 and RE 11.5.18) (Table 4-1) (Figure 4-1).

Least Concern Regional Ecosystems

Twelve REs identified within the Project locality have a conservation status of 'Least Concern' under the VM Act (RE 11.3.25, RE 11.3.27b, RE 11.3.27c, RE 11.3.27f, RE 11.3.27i, RE 11.3.7, RE 11.5.3, RE 11.5.8c, RE 11.5.9, RE 11.5.9b, RE 11.7.2 and RE 11.9.2), and are generally dominated by Poplar Box (*Eucalyptus populnea*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) (Table 4-1).

Threatened Ecological Communities Listed under the EPBC Act

One threatened ecological community listed under the EPBC Act has been recorded in the Project area and surrounds, namely, the *Brigalow (Acacia harpophylla Dominant and Co-dominant) Threatened Ecological Community* (Brigalow Woodland TEC) (Figure 4-2).

The Brigalow Woodland TEC in the locality is represented by one patch of RE 11.3.1, one patch of RE 11.4.8 and two patches of RE 11.4.9 (Table 4-1). The patches of Brigalow Woodland TEC are small, degraded by edge effects and weeds and are highly fragmented (Figure 4-2) (Appendix A).

Terrestrial Flora Species

Two sub-populations of *Bertya pedicellata*, listed as 'Near Threatened' under the NC Act, were recorded in the north-west section of the ETL corridor (Figure 4-3) (Appendix A).

No other conservation significant flora species listed under the NC Act or EPBC Act have been recorded in the Project area or surrounds, despite targeted surveys (Appendix A).

A complete list of terrestrial flora identified during the surveys of the Project locality is provided in Appendix A. A total of 346 native flora species and 73 introduced flora species were recorded across the Project area and surrounding habitats.

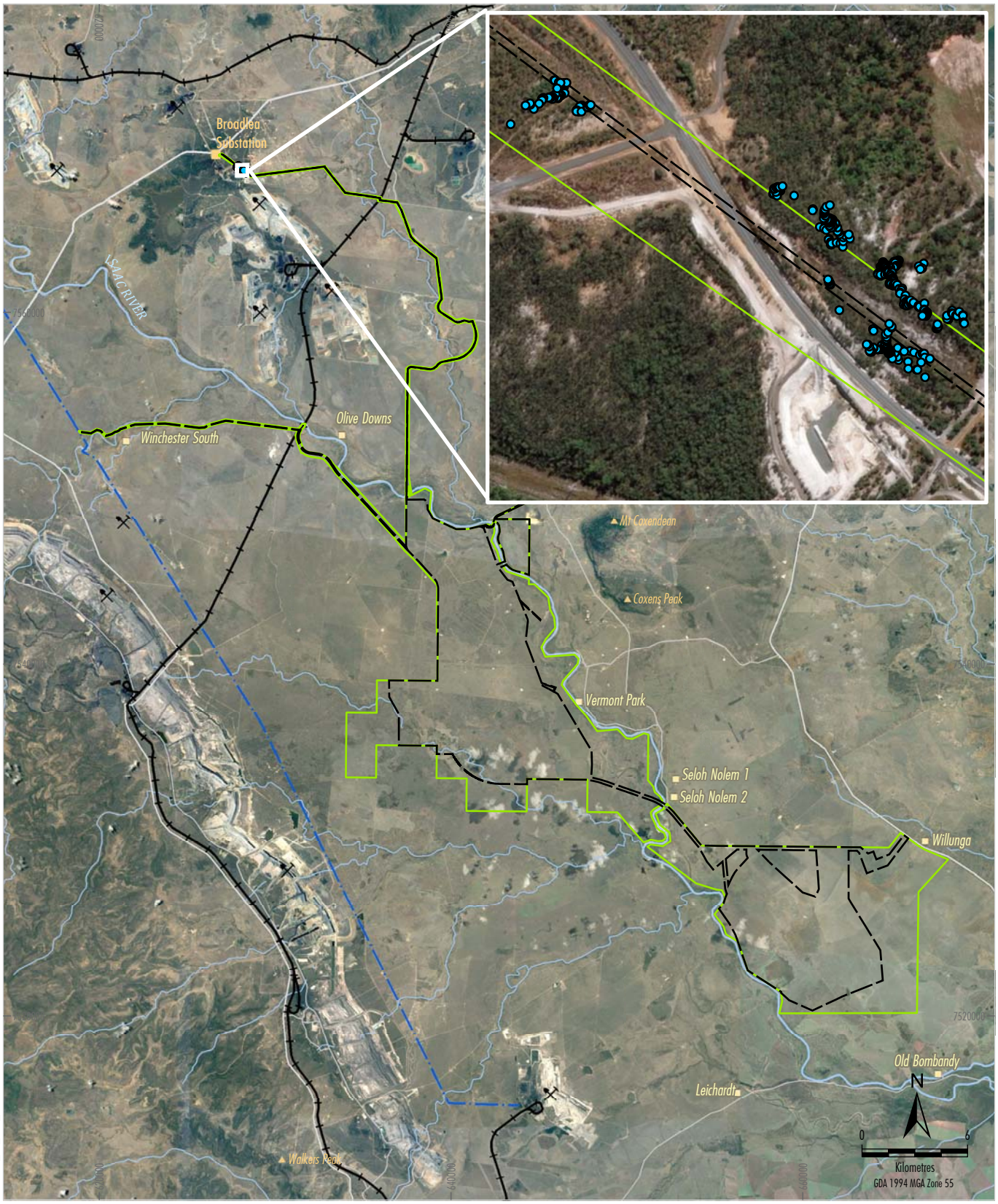
A large number of introduced flora species occur in the Project locality (Appendix A). Eleven of these are category 3 restricted matter species listed under the Queensland *Biosecurity Act 2014* (Appendix A).

Groundwater Dependent Ecosystems – Vegetation

Groundwater-Dependent Ecosystems (or GDEs) are ecosystems that rely upon groundwater for their continued existence. GDEs may be 100% dependent on groundwater, such as aquifer GDEs, or may access groundwater intermittently to supplement their water requirements, such as riparian tree species in arid and semi-arid areas (IESC, 2018).

Desktop mapping of potential GDEs throughout Queensland (DSITI 2017 and BoM 2017) indicates terrestrial and aquatic ecosystems with possible high, moderate and low potential for groundwater interaction occur within the Project locality. The desktop GDE mapping (DSITI 2017 and BoM 2017) indicates (DPM Envirosciences, 2018a):

- Terrestrial riparian vegetation associated with the Isaac River, North Creek, Cherwell Creek and Ripstone Creek is mapped as having a high potential to be dependent on subsurface expression of groundwater.



LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- Approved/Operating Coal Mine
- Eungella Pipeline Network
- Railway
- Bertya pedicellata
- Peaks
- Dwelling

Source: DPM (2018), Pembroke (2018)
Orthophoto: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Conservation Significant Flora Species

Figure 4-3

- Aquatic habitat within with the Isaac River, North Creek, Cherwell Creek and smaller associated tributaries are mapped as having a high potential to be dependent on the surface expression of groundwater.
- Terrestrial vegetation and aquatic habitat associated with a number of palustrine wetlands surrounding the Olive Downs South and Willunga domains is mapped as having a moderate potential to be associated with the surface expression of groundwater.
- Of the remaining terrestrial vegetation within the Project locality, the majority is shown as having a low to moderate potential to be dependent on subsurface expression of groundwater, with vegetation near creeks/drainage lines mapped as having moderate potential.

The accuracy of the desktop GDE mapping (DSITI 2017 and BoM 2018) of the Project locality has been reviewed by HydroSimulations (2018) and DPM Enviros ciences (2018a), with the following conclusions made based on site observations:

- The terrestrial riparian vegetation associated with the Isaac River, North Creek, Cherwell Creek and the downstream reaches of Ripstone Creek may well have a high potential to be dependent on subsurface expression of groundwater. This is because the vegetation (RE 11.3.4 and 11.3.25) comprises predominantly forest red gum (*E. tereticornis*) and river oak (*Casuarina cunninghammiana*), both species which have been shown to access groundwater in other locations (IESC, 2018) and the alluvium appears to be saturated along the Isaac River and lower reaches of the creeks at the confluence with the Isaac River (HydroSimulations, 2018).
- Aquatic habitat within Isaac River, North Creek, Cherwell Creek and smaller associated tributaries may also have a high potential to intermittently use the surface expression of groundwater during occasional periods of baseflow from the adjacent/underlying alluvium after prolonged rainfall events or following flood events (HydroSimulations, 2018). Under these conditions, recharged alluvial sediments may drain to the watercourses as the hydraulic gradient reverses, the result of which may sustain stream-flow for short periods (in the order of days to possibly weeks in the lower reaches) depending on the sequence of rainfall events (HydroSimulations, 2018).
- Terrestrial vegetation and aquatic habitat associated with the palustrine wetlands surrounding the Olive Downs South and Willunga domains are unlikely to be dependent on groundwater given that groundwater levels in these areas have been identified as being in excess of 10 mbgl (HydroSimulations 2018). These wetlands are represented by RE 11.3.27 and RE 11.5.17 (DPM Enviros ciences 2018a), which contain predominantly river red gum (*Eucalyptus camaldulensis*), and coolabah (*E. coolabah*). The watertable depth where these species use groundwater is generally less than 6 mbgl (IESC, 2018), although the species root depths may be deeper (e.g. Colloff [2014] describes that roots of mature river red gums extend to depths of at least 9–10 m, noting some recorded roots to a depth of 30 m. Despite this potential root depth, localised perched water tables within the alluvium are evident where waterbodies, such as these palustrine wetlands, continue to hold water throughout the dry period, occurring where clay layers slow the percolation of surface water (HydroSimulations, 2018). It is likely that these wetlands rely on the slow percolation of surface water after rainfall events to sustain their health rather than direct access to the groundwater system.
- All other terrestrial vegetation (REs) within the Project locality, has a low likelihood of being dependant on the presence of groundwater as the vegetation comprises eucalypt dry woodlands dominated by poplar box (*E. poulnea*) and the groundwater table is at least 10 mbgl (HydroSimulations, 2018) which would be too deep for these vegetation communities to access.

In summary, the terrestrial riparian vegetation (RE 11.3.4 and 11.3.25) and aquatic habitat associated with the Isaac River is likely to be a GDE. The terrestrial riparian vegetation (RE 11.3.25) associated with North Creek and Cherwell Creek may also be a GDE.

Environmentally Sensitive Areas

Category B ESAs recorded within the Project locality include REs with an 'Endangered' biodiversity status (Figure 4-1), namely:

- RE 11.3.1 – Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains;

- RE 11.4.8 – Dawson Gum (*Eucalyptus cambageana*) woodland to open forest with Brigalow (*Acacia harpophylla*) or Blackwood (*Acacia argyrodendron*) on Cainozoic clay plains; and
- RE 11.5.17 – Palustrine swamp with fringing Forest Red Gum (*Eucalyptus tereticornis*) woodland in depressions on Cainozoic sand plains and remnant surfaces.

Terrestrial Fauna Surveys

DPM Enviros ciences (2018b) undertook terrestrial fauna surveys within the Project MLA areas in November 2016 and in September and November 2017 (spring) within the infrastructure corridors. A follow up survey was conducted in April to May 2017 (autumn) within the Project MLA areas and the infrastructure corridors.

The Terrestrial Fauna Assessment prepared by DPM Enviros ciences (2018b) is provided in Appendix B.

The fauna surveys were conducted in consideration of the relevant State and Commonwealth survey guidelines (including but not limited to Eyre *et al.,* 2014; SEWPaC, 2011a, 2011b, 2011c; Department of the Environment, Water, Heritage and the Arts [DEWHA], 2010a, 2010b; DotE, 2014).

Survey methods included trapping (i.e. Elliott, cage, pitfall, funnel and harp traps), bat detection devices, motion detection cameras, spotlighting, diurnal bird surveys, active searches, call playback, koala spot assessments, searches for scats and other signs and habitat assessments (Appendix B). Targeted searches for threatened fauna species listed under the NC Act and EPBC Act were also conducted (Appendix B).

A detailed description of the methodology employed during the fauna surveys is provided in Section 3.2.7 and Appendix B.

Terrestrial Fauna Habitat

Cattle grazing and associated agricultural practices have impacted and caused degradation to the vegetation and fauna habitat across the Project area to varying extents.

As such, the majority of the Project area has been mapped as 'agricultural grasslands dominated by Buffel Grass (*Cenchrus ciliaris*)' and does not provide habitat features for the majority of native fauna species (with the exception of the Ornamental Snake described further below).

Despite this, there are features of the Project area which provide native fauna with opportunities for foraging and breeding (Appendix B). These are represented by (Figure 4-4):

- eucalypt dry woodlands on inland depositional plains;
- eucalypt open forests to woodlands on floodplains;
- acacia dominated open forests, woodlands and shrublands;
- palustrine wetlands (swamps);
- lacustrine wetlands (dams);
- other coastal communities and heaths; and
- waterways (watercourses and drainage features).

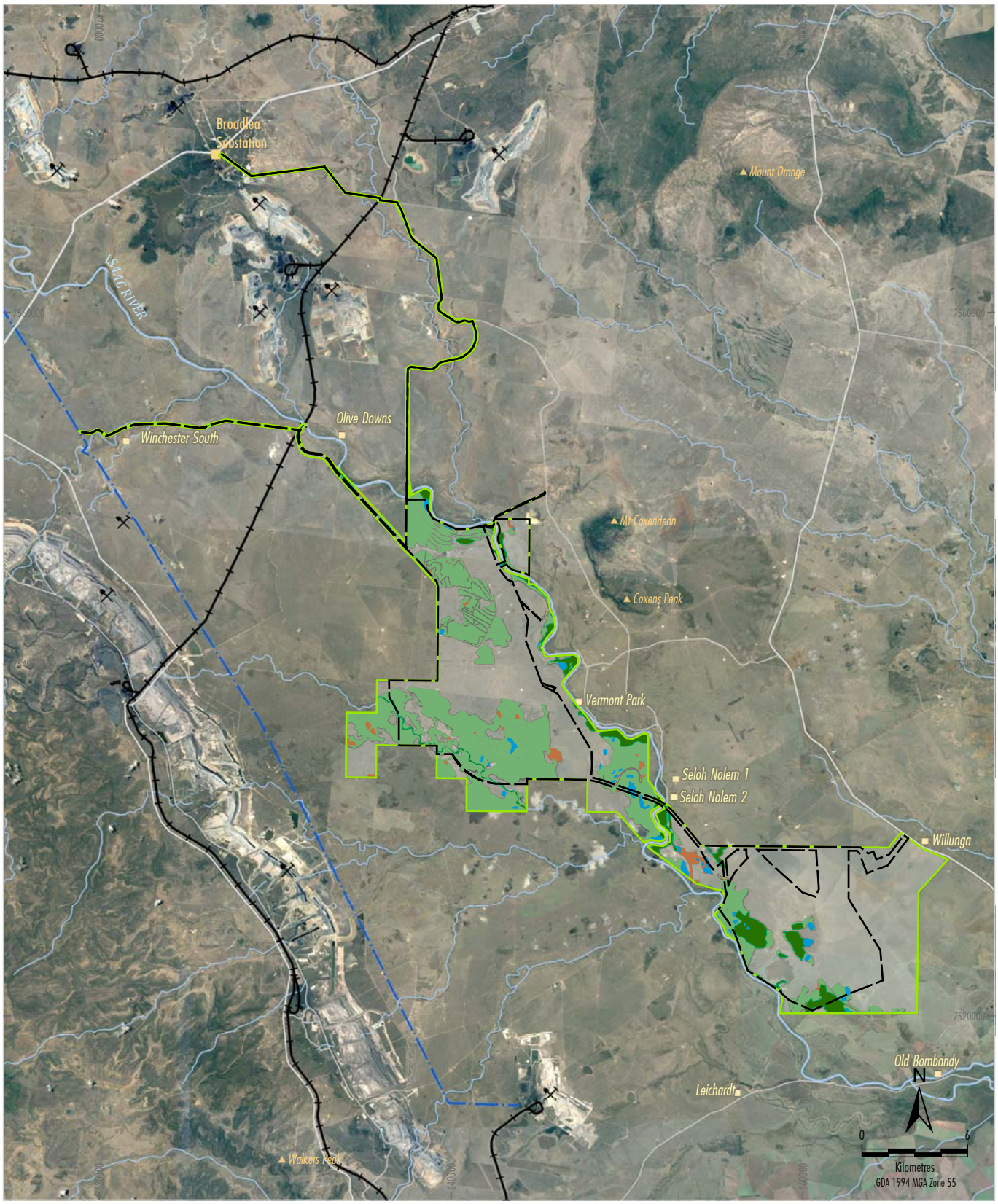
A detailed description of each fauna habitat type is provided in Appendix B.

The external connectivity of the habitats is relatively low, except for habitat along watercourses and drainage features (Figure 4-4). These areas also provide flyways for some birds and bats and movement corridors for a variety of fauna (Appendix A).

Terrestrial Fauna Species

The following conservation significant fauna species were recorded within the Project locality during the recent fauna surveys, namely (Figure 4-5) (Appendix B):

- Ornamental Snake (*Denisonia maculata*) – listed as 'Vulnerable' under the EPBC Act and NC Act;
- Australian Painted Snipe (*Rostratula australis*) – listed as 'Endangered' under the EPBC Act and Vulnerable under the NC Act;
- Squatter Pigeon (southern) (*Geophaps scripta scripta*) – listed as 'Vulnerable' under the EPBC Act and NC Act;
- Koala (*Phascolarctos cinereus*) – listed as 'Vulnerable' under the EPBC Act and NC Act;
- Greater Glider (*Petauroides volans*) – listed as 'Vulnerable' under the EPBC Act and NC Act; and;
- Short-beaked Echidna (*Tachyglossus aculeatus*) (recorded via scats) – listed as 'Special Least Concern' under the NC Act.



LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- Approved/Operating Coal Mine
- Eungella Pipeline Network
- Railway
- Peaks
- Dwelling

Ground-truthed Broad Habitat Types

- Eucalypt open forests to woodlands on floodplains
- Eucalypt dry woodlands on inland depositional plains
- Acacia dominated open forests, woodlands and shrublands
- Palustrine wetlands
- Lacustrine wetlands
- Other coastal communities and heath
- Agricultural grasslands dominated by buffel grass

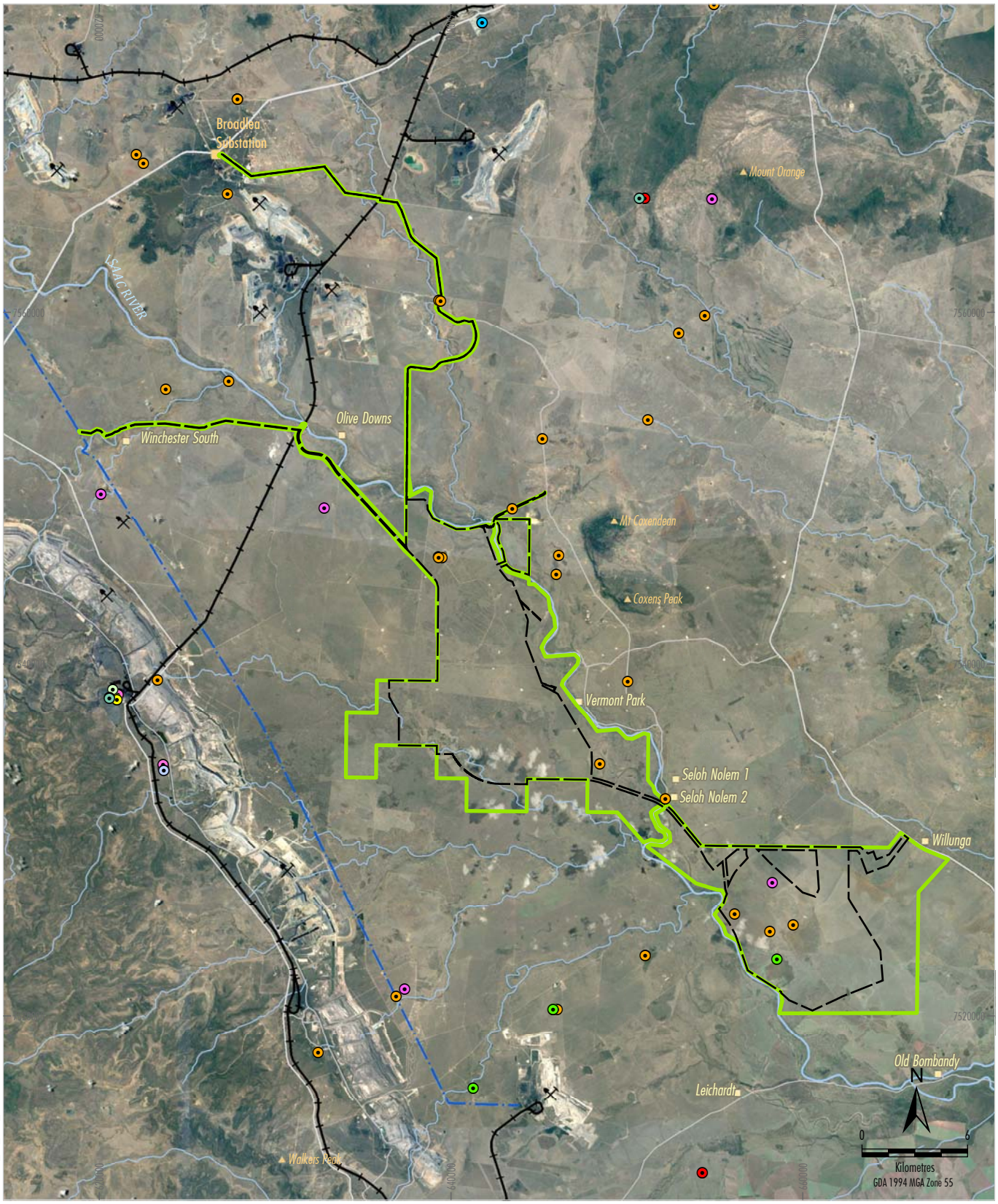
Source: Queensland Department of Natural Resources, Mines and Energy (2017), Pembroke (2018), DPM (2018)
Orthophoto: Google (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Broad Fauna Habitat Types

Figure 4-4



LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- Approved/Operating Coal Mine
- Eungella Pipeline Network
- Railway
- Peaks
- Dwelling

Threatened Species Records (Common Name)

- Black-faced Monarch
- Australian Painted Snipe
- Caspian Tern
- Glossy Ibis
- Common Greenshank
- Glossy Black-Cockatoo
- Gull-billed Tern
- Marsh Sandpiper
- Sharp-tailed Sandpiper
- Squatter Pigeon
- White-throated Needletail

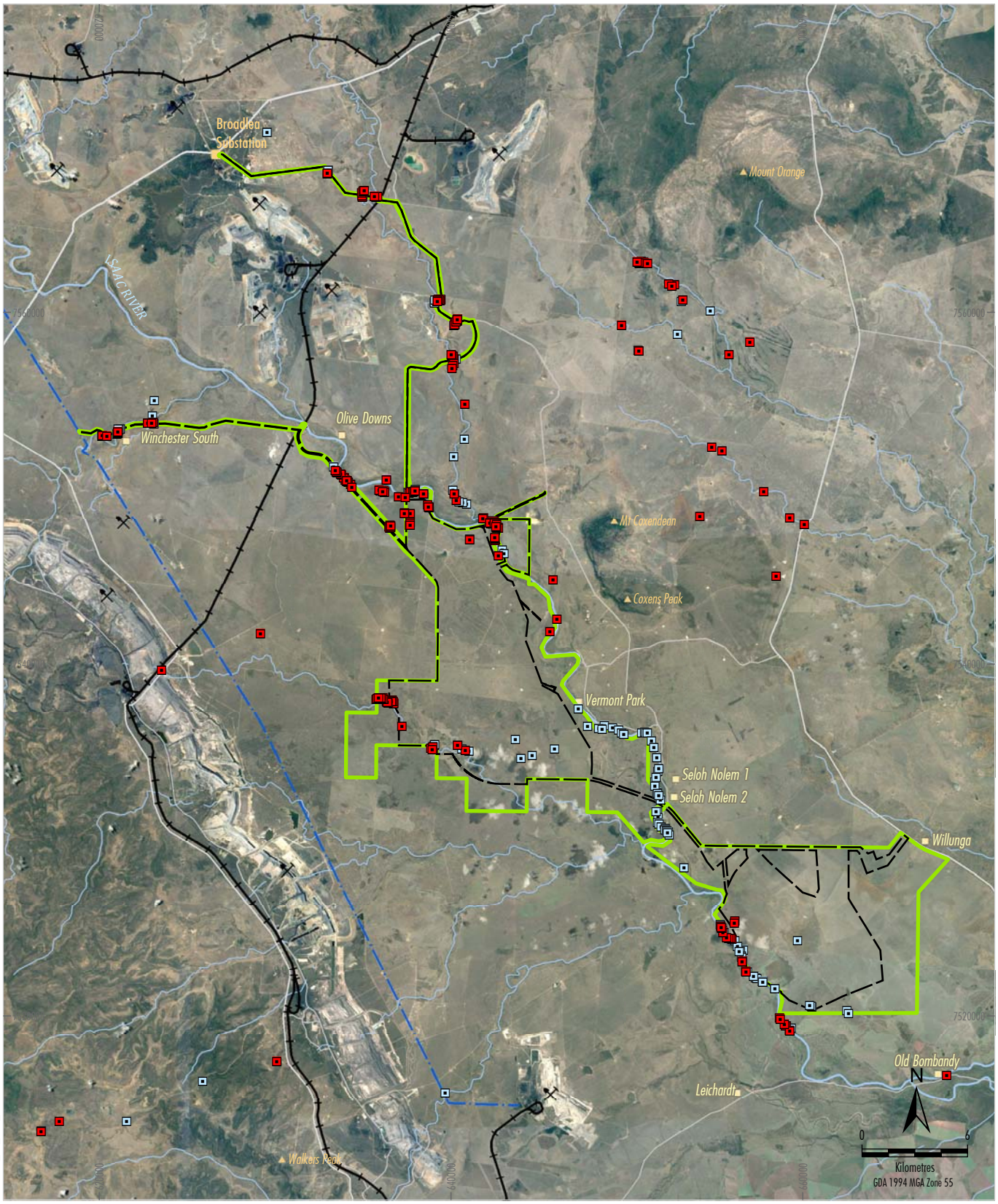
Source: DPM (2018), Pembroke (2018)
Orthophoto: Google Image (2015)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Threatened Species Records
Birds

Figure 4-5a



LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- Approved/Operating Coal Mine
- Eungella Pipeline Network
- Railway
- Peaks
- Dwelling

Threatened Species Records (Common Name)

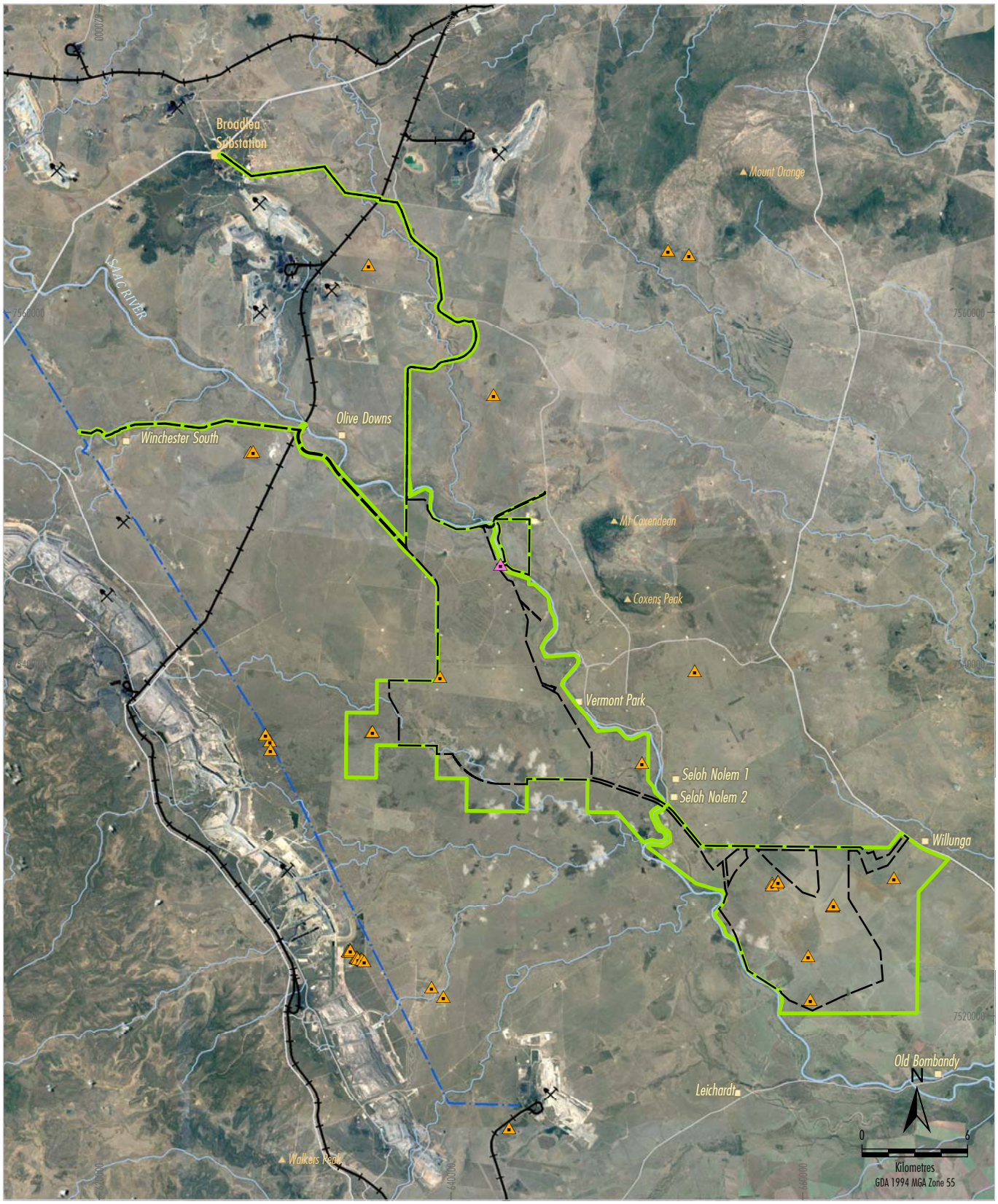
- Koala
- Greater Glider
- Short-beaked Echidna

Source: DPM (2018), Pembroke (2018)
Orthophoto: Google Image (2015)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT
Threatened Species Records
Mammals

Figure 4-5b



LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- Approved/Operating Coal Mine
- Eungella Pipeline Network
- Railway
- Peaks
- Dwelling

Threatened Species Records (Common Name)

- Ornamental Snake
- Common Death Adder

Source: DPM (2018), Pembroke (2018)
Orthophoto: Google Image (2015)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT
Threatened Species Records
Reptiles

Figure 4-5c

As demonstrated by the locations of the conservation significant fauna species records shown on Figure 4-5, the majority of these records occur along the Isaac River and associated watercourses and drainage lines.

Of the above species, the Ornamental Snake, Australian Painted Snipe, Squatter Pigeon, Koala and Greater Glider, are all assessed in detailed in Section 3.

Echidna scats were recorded within brigalow (*Acacia harpophylla*) woodland and within poplar box (*Eucalyptus populnea*) woodland (Appendix B) in November 2016. Echidnas are expected to inhabit many patches of remnant vegetation within the Study area. The short-beaked echidna would potentially occur in all habitats across the Project area including cleared areas.

In addition, the common death adder (*Acanthophis antarcticus*) has previously been recorded from the Study area, but was not detected during the fauna surveys by DPM Envirosciences (2018b). The next closest database record of this species is located approximately 90 km north-east of the Project area (ALA 2018).

The existing record was reported to be a large specimen found dead (presumably by cane toad poisoning) on the Iffley property during fauna surveys by 3d Environmental / Ecosmart for the Arrow Bowen Gas Project in 2011, in a patch of brigalow (*Acacia harpophylla*) with gilgai (pers. comm. Mark Sanders 16 February 2018). This isolated patch of vegetation falls within the Study area approximately 100 m west of the Isaac River (Appendix B).

The species has a very broad habitat range and may be associated with any of the habitat types containing remnant vegetation located in the Project area. However, if it were to occur, it would only be expected to occur in very low numbers given it was not recorded despite targeted surveys.

A total of 239 native fauna species were recorded within the Project area and surrounds, comprising 12 amphibian species, 34 reptile species, 159 bird species and 34 mammal species (Appendix B).

Feral animals recorded by DPM Envirosciences (2018b) (Appendix B) included the Cane Toad, European Rabbit, European Hare, Feral Cat, Domestic Dog, House Mouse and Feral Pig.

Aquatic Ecology Surveys

Aquatic ecology surveys were conducted by DPM Envirosciences (2018c) for the Project (Appendix C). Aquatic ecology surveys were conducted in the 'early wet' season in December 2016, October and November 2017. Follow-up surveys were also conducted in the 'late wet' season in June and July 2017 (Appendix C).

Aquatic ecology surveys were completed at sites on watercourses, drainage lines and wetlands upstream, within and downstream of the Project area (Appendix C).

Aquatic ecology surveys comprised an assessment of aquatic habitat condition (in accordance with the Australian River Assessment System [AUSRIVAS] protocol described in the Queensland *AUSRIVAS Sampling and Processing Manual* [DNRM, 2001]), and water quality sampling, as well as sampling and habitat assessment for aquatic flora, fish, mammals, crustaceans, macroinvertebrates and turtles (Appendix C).

Targeted searches for threatened fauna species listed under the Queensland *Fisheries Act 1994* and EPBC Act were also conducted (Appendix C).

Aquatic Habitat/Ecosystems

Watercourses

All the watercourses/drainage lines within the Project area are ephemeral and expected to experience flow only after sustained or intense rainfall and runoff in the catchment (Appendix C). Stream flows are highly variable, with most channels drying during winter to early spring when rainfall and runoff are typically low (Sections 4.2 and 4.3) (Appendix C).

The Project area contains two mapped watercourses, namely the Isaac River and Ripstone Creek (Sections 4.2 and 4.3). On 5 February 2018, DNRME determined that all other unnamed features within the Project MLA areas were drainage lines, as per the definition under the *Water Act 2000*.

The Isaac River is an ephemeral watercourse. Surface flows in the Isaac River typically persist for about half of the year, enough for some macroscopic plants and animals to complete the aquatic stages of their life cycles, as well as allowing for the passage of aquatic fauna upstream and downstream of the Project area (Sections 4.2 and 4.3) (Appendix C).

Surface flow within Ripstone Creek is ephemeral (Sections 4.2 and 4.3). Intermittent pools are expected to persist on Ripstone Creek and its tributaries at locations with less permeable clay substrates, where the composition of aquatic macrophytes suggests that standing water may persist for months, sufficient for some macroscopic plants and animals to complete the aquatic stages of their life cycles (Appendix C).

The watercourses are described further in Sections 4.2.2 and 4.3.2.

Wetlands

There are no wetlands of National or International Importance identified within the Project area and surrounds (Appendix C).

DES (2018) regional mapping indicates that 11 wetlands of high ecological significance (HES) occur in the Project locality (Figure 4-6). Flora surveys by DPM Envirosciences (2018a) confirmed these wetlands are present (Appendix C).

In addition, a number of other general ecological significance wetlands (e.g. pools of standing water within the Isaac River and associated tributaries), lacustrine wetlands (e.g. dams), palustrine wetlands (e.g. swamps) and RE wetland types have been mapped in the Project locality (Appendix C).

Most wetlands within the Project locality have been impacted by stock, which use the systems for water and camps. These systems fill during floods and retain water for relatively short periods (Appendix B).

The lacustrine wetlands of the Study area include dams of approximately 2 ha, 3 ha and 5 ha on Willunga, a 5 ha dam on Vermont Park, 1 ha, 2 ha and 12 ha dams on Iffley, part of a 30 ha dam on Deverill, as well as a number of smaller dams (<1 ha) that are too small to appear in the Queensland Wetlands Mapping (Appendix C).

These lacustrine wetlands provide a water source for an array of aquatic and terrestrial fauna, domestic livestock, as well as foraging and breeding habitat for waterbirds, wader birds, frogs, reptiles, water rats and other mammals. Thirty-six species of birds (primarily waterfowl and wader birds) were detected utilising one of the larger dams within the Study area (Appendix C) during the terrestrial fauna surveys in November 2016 (DPM Envirosciences 2018b).

Aquatic Flora Species

No aquatic flora species listed under the NC Act or EPBC Act were recorded during the surveys (Appendix C).

A total of 48 species of aquatic flora were identified during the aquatic ecology surveys (Appendix C). Two of these species are listed as Prohibited and Restricted Biosecurity Matter under the Queensland *Biosecurity Act 2014*.

The majority of aquatic flora species encountered are common emergent species such as aquatic (or semi-aquatic) grasses, sedges and rushes. The greatest diversity of aquatic flora was recorded from the palustrine wetlands that had retained water between the early and late wet sampling periods.

The lack of both diversity and abundance of aquatic plants at some sites is likely indicative of harsh physical conditions, cattle grazing and trampling, or a combination of these factors (Appendix C).

Aquatic Fauna Species

No aquatic fauna species listed under the NC Act, FM Act or EPBC Act were recorded during the surveys (Appendix C).

Fish

A total of 17 species of fish were recorded within the Project locality during the aquatic ecology surveys (Appendix C). Two pest fish species were encountered during the early wet surveys, namely Tilapia (Oreochromus mossambicus) and Mosquito Fish (Gambusia holbrooki) (Appendix C).

Turtles

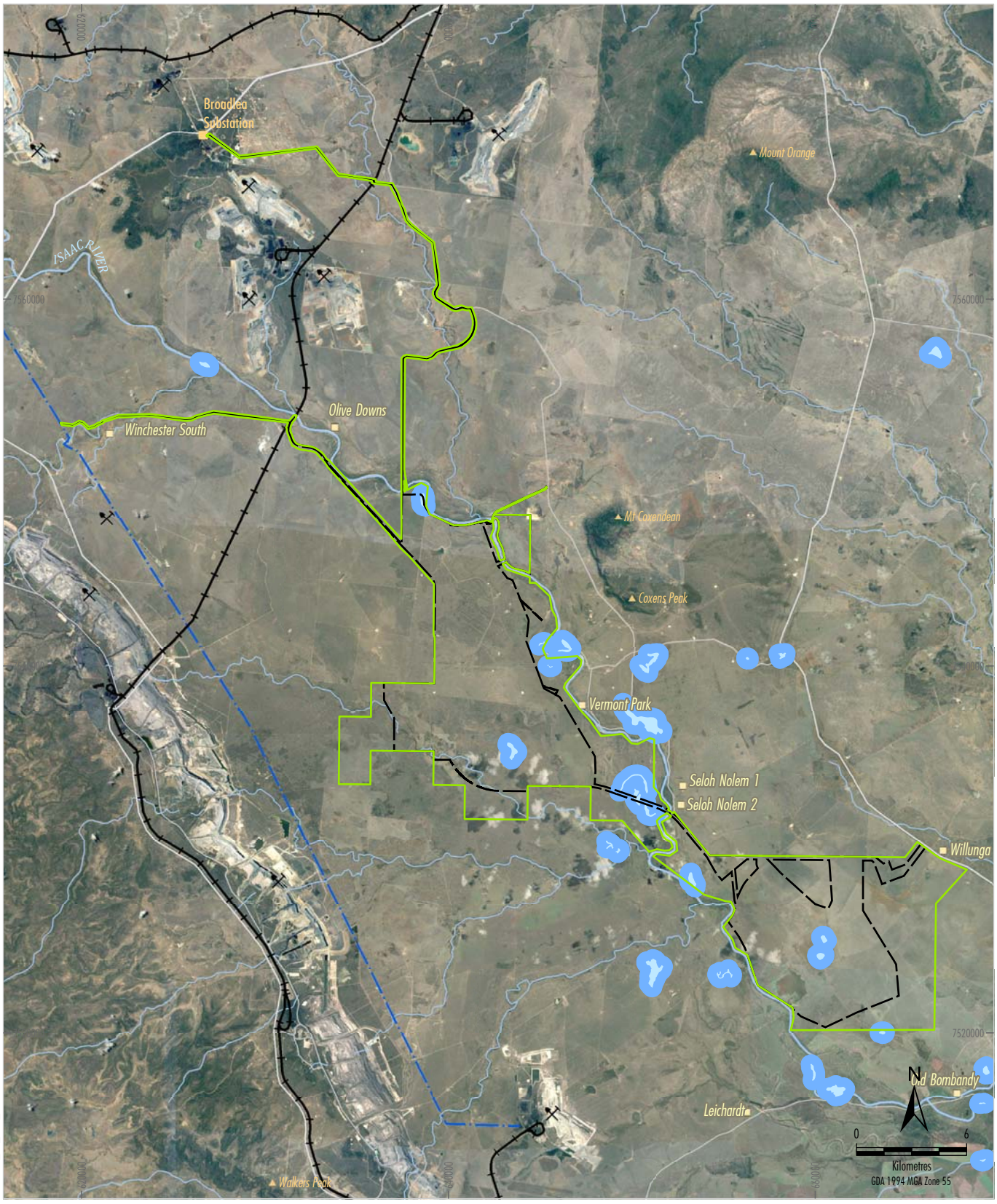
Three Least Concern turtle species were recorded from the Study area (Appendix C):

- Eastern Snake-necked Turtle (*Chelodina longicollis*);
- Broad-shelled Turtle (*Chelodina expansa*; and
- Krefft's River Turtle (*Emydura macquarii krefftii*).

No suitable habitat for conservation significant turtles was identified during the surveys (Appendix C).

Platypus

No platypus, or any evidence of their breeding (i.e. burrows) were encountered during the surveys, despite targeted searches of accessible sites (Appendix C).



PRN-16-02_EIS_Sect4_221A

LEGEND

- Study Area
- Approximate Extent of Proposed Surface Development
- High Ecological Significance Wetlands
- Wetland Protection Area (500 m Buffer)
- Approved/Operating Coal Mine
- Peaks
- Dwelling
- Railway
- Eungella Pipeline Network

Source: Queensland Department of Natural Resources, Mines and Energy (2018), Pembroke (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Referable Wetlands

Figure 4-6

The Wetland*Info* database for the Fitzroy Basin (DEHP 2018b) identifies the platypus as having previously been recorded from the Fitzroy Basin. Although some riverine waterbodies provided habitat suitable for platypus breeding (including relative permanence of water, and bank substrates dominated by silt / clay, as opposed to apedal sediments such as sand), the seasonal nature of most riverine and palustrine waterbodies of the Study area are not conducive to sustaining a population of platypus.

The potential for platypus occurring in lacustrine wetlands (lakes and farm dams) of the Study area was assessed as part of the 2017 late wet aquatic surveys, and it was determined that the habitat was unsuitable (Appendix C).

Macroinvertebrates

A total of 75 aquatic macroinvertebrate taxa representing 22 orders were retained within samples collected from riverine (bed and edge habitat) and wetland ecosystems within the Study area (including the MLA and proposed infrastructure corridors).

Aquatic macroinvertebrate communities showed variability amongst seasons, reflecting the ephemeral and seasonal nature of the waterways and wetlands sampled. Biotic indices, including taxonomic composition, PET taxa, pollution-tolerant taxa, SIGNAL2 and AusRivAS OE50 scores, were generally within or favourably above the 20-80th percentile of the relevant guidelines.

Macroinvertebrate species recorded consisted predominantly of Coleoptera (beetles), Hemiptera (true bugs) and Diptera (true flies) (Appendix C). Five macrocrustacean taxa were recorded (Appendix C).

Stygofauna

The stygofauna assessment (Appendix C) comprised a desktop review of potential habitat and sampling (conducted in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITIA, 2014).

A pilot survey was carried out to sample the local presence of subterranean aquatic fauna in consideration of the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITIA 2015).

HydroSimulations (2018) installed 17 groundwater monitoring bores in nine locations across the Study area from November 2016 to March 2017, comprising eight paired bores (one shallow and one deep) and a single shallow bore.

HydroSimulations (2018) recorded the characteristics of the groundwater (SWL, ph and EC) for each of the bores installed. Of the nine shallow bores, only two were suitable for stygofauna sampling (GW01-S and GW18-S) (Appendix C), as four bores were dry and two hypersaline (>20,000 µS/cm). 4T (2012) report that stygofauna have not been recorded in Queensland within groundwater with EC greater than 20,000 µS/cm.

The two bores (GW01-S and GW18-S) were sampled. HydroSimulations (2018) incorporated slot widths of 1.5 mm into the screened interval of these bores so that they are also suitable for stygofauna sampling (Appendix C).

A total of 132 additional bores were identified within 10 km of the Project MLAs by the Project bore census conducted by ENRS (2018) and subsequently assessed for their potential to be suitable stygofauna sampling bores. Of the 132 additional bores (Appendix C):

- 111 bores potentially suitable but not accessible due to landholder access constraints.
- 18 bores not able to be sampled due to lack of access to the water in the bore (capped bores).
- 3 bores located around the Willunga Domain (capped with taps) but no data on water quality or slot width in the screened interval.

Matters of State Environmental Significance

MSES prescribed under the *Environmental Offsets Regulation 2014* are listed in Table 4-2, along with an assessment of the relevance to the Project area.

Table 4-2
Impacts to MSES and MNES

MSES		Relevance to the Project Area
Regulated Vegetation	'Endangered' or 'Of Concern' regional ecosystems; or	The Project area contains the following REs that are listed MSES: • RE 11.3.1 – 'Endangered'. • RE 11.4.8 – 'Endangered'. • RE 11.4.9 – 'Endangered'. • RE 11.5.17 – 'Endangered'. • RE 11.3.2 – 'Of Concern'. • RE 11.3.3 – 'Of Concern'. • RE 11.3.4 – 'Of Concern'.
	Regional ecosystems within mapped vegetation management wetlands	The Project area contains vegetation management wetlands with associated remnant vegetation.
	Regional ecosystems within the defined distance of a vegetation management watercourse	The Project area contains vegetation management watercourses with remnant riparian vegetation.
Connectivity Areas		Remnant vegetation in the Project area connects to remnant vegetation outside of the Project area.
Wetlands and Watercourses		The Project area contains wetlands of high ecological significance.
Designated Precinct in a Strategic Environmental Area		The Project area is not in a designated precinct in a strategic environmental area.
Protected Wildlife Habitat	Ornamental Snake[#]	Ornamental Snakes were recorded at three locations within the Olive Downs South domain and a further five locations within the Willunga domain.
	Common Death Adder	A dead Common Death Adder was recorded within the Project locality in 2011 but has not been recorded since despite targeted surveys.
	Australian Painted Snipe[#]	A single Australian Painted Snipe was observed during the field surveys in a small wetted gilgai within the Agricultural grasslands habitat type in the Willunga domain.
	Squatter Pigeon (southern)[#]	The Squatter Pigeon (southern) was recorded on a number of occasions within the Project locality.
	Koala[#]	The Koala was recorded on a number of occasions within the Project locality, with records heavily concentrated along the Isaac River and associated tributaries.
	Greater Glider[#]	The Greater Glider was recorded on a number of occasions within the Project locality, with records heavily concentrated along the Isaac River and associated tributaries.
	Short-beaked Echidna	Echidna scats were recorded at two locations within the Project locality.
Protected Areas		The Project area does not contain protected areas.
Highly Protected Zones of State Marine Parks		The Project area is not within a State Marine Park.
Fish Habitat Areas		The Project area does not contain any declared Fish Habitat Areas.
Waterways Providing for Fish Passage		Waterways within the Project area provide for fish passage.
Marine Plants		The Project area is not within a marine environment.
Legally Secured Offset Areas		The Project area does not contain any legally secured offset areas.

Source: Appendices A, B and C.

[#] These species are also listed under the EPBC Act.

Matters of National Environmental Significance

Five threatened species and one community listed under the EPBC Act have been recorded in the Project locality (Appendices A and B) (Figures 4-2 and 4-5):

- Ornamental Snake;
- Australian Painted Snipe;
- Squatter Pigeon;
- Koala;
- Greater Glider; and
- Brigalow Woodland TEC.

Each of the above MNES is also listed as MSES as identified above.

Section 3 compiles the assessment of impacts on the controlling provisions and addresses the relevant Terms of Reference including the provision of impact avoidance, mitigation and offset measures.

4.1.3 Potential Impacts

The following sub-sections evaluate the likely impacts of the Project on flora and fauna. Proposed measures to avoid and mitigate potential impacts on flora and fauna are provided in Section 4.1.4.

Land Clearance – Vegetation

As described in Section 4.1.2, the land within the Project area is largely cleared of native woodland/forest vegetation due to past and ongoing agricultural land use (approximately 10,655 ha [65%] has been previously cleared) (Figure 4-1).

The Project would require the clearance of various patches of woodland/forest (totalling approximately 5,661.5 ha) over the life of the Project. The native vegetation types that would be cleared by the Project include:

- approximately 4,805 ha of eucalypt dry woodlands on inland depositional plains;
- approximately 658.5 ha of eucalypt open forests to woodlands on floodplains;
- approximately 78 ha of acacia dominated open forests, woodlands and shrublands; and
- approximately 120 ha of wetland REs (swamps and lakes).

All of the native vegetation communities/REs to be cleared occur extensively in the surrounding landscapes and subregions (Appendix A).

Measures that would be implemented by Pembroke to mitigate the impact of the Project on native vegetation (including vegetation clearance procedures) are described in Section 4.1.4.

Land Clearance – Terrestrial Fauna Habitat

The native vegetation communities/REs proposed to be cleared for the Project provide habitat resources for fauna species (Figure 4-4). The fauna habitat types in the Project area include (in order of dominance) (Figure 4-4):

- approximately 4,805 ha of eucalypt dry woodlands on inland depositional plains;
- approximately 658.5 ha of eucalypt open forests to woodlands on floodplains;
- approximately 78 ha of acacia dominated open forests, woodlands and shrublands;
- approximately 110.5 ha of palustrine wetlands (swamps); and
- approximately 9.5 ha of lacustrine wetlands (dams).

All of the fauna habitat types mapped within the Project area occur extensively within the surrounding landscape (Appendix B).

The Project would disturb animal breeding places and, therefore, Pembroke would comply with the NC Act requirements by preparing a Species Management Program (under section 332 of the *Nature Conservation [Wildlife Management] Regulation, 2006*). The Species Management Program would be prepared prior to the commencement of construction.

Land Clearance – Aquatic Habitat

The Project would remove aquatic habitat in the Project area, comprising ephemeral watercourses and drainage lines, as well as ephemeral and semi-permanent wetlands (including artificial dams).

These habitats are not expected to support aquatic species of conservation significance listed under the NC Act or EPBC Act given the lack of suitable habitat features (Appendix C).

The only 'watercourses' (as defined by the *Water Act 2000*) that would be directly impacted by the Project are the Isaac River, Ripstone Creek and Cherwell Creek and this direct impact is due to crossings associated with roads and the proposed rail line, along with a permanent watercourse diversion of Ripstone Creek.

The other drainage features within the Project area were determined by DNRM to not meet the criteria to be mapped as a 'watercourse', and as such, have been determined to be 'drainage features' as per the definition in the *Water Act 2000*.

The following is a list of direct impacts related to each of the activities within the Project area (Appendix C):

- Project mining area – the mining activities will result in the removal of aquatic ecosystems located within the Project area. This would include removal of ephemeral drainage lines, clearance of a section of Ripstone Creek and development of a diversion for this section of the watercourse, as well as removal of riverine, palustrine and lacustrine wetlands (including modification and/or removal of seven HES wetlands). The Project mining area would also involve the construction of an overland conveyor and haul road between the Olive Downs South and Willunga Domains. The conveyor and haul road would be restricted to a construction corridor of 180 m width, however this would be reduced when crossing the Isaac River where, within 200 m of the defining bank, the construction corridor width would be limited to 45 m to reduce impacts on aquatic habitat. Within the disturbance corridor, aquatic habitat would be removed.
- Access road – the Olive Downs South Domain access road would require one crossing of the Isaac River and a crossing of an ephemeral drainage line, limited to a 40 m wide disturbance corridor. The crossing of the Isaac River would result in the removal of aquatic habitat and the riparian vegetation along the banks of the Isaac River. The crossing would be constructed using selected materials for the pavement with low flow culverts laid under the pavement at the lowest point in the river bed to convey low river flows beneath the access road.
- Haul road – the Olive Downs South Domain haul road (to the eastern waste emplacement) would require one crossing of the Isaac River, limited to a 60 m wide disturbance corridor. Construction of the haul road would result in the removal of temporary aquatic habitat from within the watercourse and include low flow culverts to minimise potential impacts on fish passage.
- Project rail spur and loop – the Project rail spur and loop would require require two crossings of ephemeral drainage lines and palustrine wetlands associated with the Isaac River. Disturbance associated with the Project rail spur and loop would be limited to a 70 m wide corridor which would be co-located with the proposed water pipeline. New culvert crossings would be installed along the rail spur, with the final locations to be determined during the detailed design.
- Water pipeline – the water pipeline would require two crossings of ephemeral drainage lines associated with the Isaac River and a third crossing of Cherwell Creek, at the location of an existing road crossing. Disturbance associated with the water pipeline would be limited to a 20 m wide corridor.
- ETL – the detailed design of the ETL would implement aerial crossings over waterways (including the Isaac River) and thereby avoid clearing of riparian vegetation or instream aquatic habitat.

The Project would result in the loss of 120 ha of palustrine and lacustrine wetlands (comprising 61 ha of HES wetlands).

Staged Clearing

Land clearing is proposed to occur in the following four stages:

- Stage 1- 2019-2024;
- Stage 2 – 2025-2030;
- Stage 3 – 2031-2050; and
- Stage 4 –2051- end of mine.

Stage 1 of the Project would include the following works (Section 4.1.5):

- construction of each of the infrastructure corridors:
  - rail corridor;
  - ETL;
  - water pipeline;
  - Olive Downs South access road;

- construction of the mine infrastructure area (including offices, workshops, CHPP, ROM pad, ILF cells);
- development of the north-western waste emplacement;
- construction of temporary flood levees located within the Stage 1 boundary; and
- commencement of open cut mining in Pit 1.

The subsequent stages include:

- Stage 2 – all works proposed during the Willunga domain construction period.
- Stage 3 – all works proposed up until year 2050.
- Stage 4 – all works required until completion of the Project.

Changes to Hydrology

Surface Water Flows

During active mining operations, the mine water management system would capture runoff from areas that would have previously flowed to the receiving waters. The maximum mine-affected catchment areas represent (Hatch, 2018a):

- approximately 13% of the Ripstone Creek catchment to its confluence with the Isaac River; and
- less than 1% of the Isaac River at a location downstream of the Project (i.e. the ISDS stream gauge), which is not significant.

The changed topography as a result of the Project final landform would have the following impacts on catchment areas (Hatch, 2018a):

- The catchment draining to Ripstone Creek would reduce by around 19 km^2 (compared to pre-mining conditions), a decrease of less than 7%.
- The catchment draining to the Isaac River would reduce by around 49 km^2 (compared to pre-mining conditions), a decrease of less than 1%.

Based on the analysis undertaken by Hatch (2018a), no adverse water flow related impacts are likely to occur on habitats surrounding the Project, because no measurable impacts on surface water flows are likely to occur (Appendix A).

Erosion and Sedimentation

An Erosion and Sediment Control Plan would be developed and implemented throughout construction and operations. A 'best practice' approach would be adopted which is consistent with the International Erosion Control Association (IECA) recommendations. The following broad principles would apply:

- minimise the area of disturbance;
- where possible, apply local temporary erosion control measures;
- intercept runoff from undisturbed areas and divert around disturbed areas; and
- where temporary measures are likely to be ineffective, divert runoff from disturbed areas to sedimentation basins prior to release from the site.

If implemented effectively, environmental risks to water quality from disturbed area runoff are expected to be low (Hatch, 2018a).

Further to this, elevated landforms (i.e. waste rock emplacements) would be progressively rehabilitated (e.g. by establishment of a protective vegetation cover [i.e. cover crop], construction of graded banks, rock-lined waterways, and/or diversion banks) which would minimise potential for sediment transport downstream of the Project.

Surface runoff from the waste rock emplacements would be directed to dedicated sediment dams. Sediment dams would be retained until the revegetated surface of the waste rock emplacements are stable and runoff water quality reflects runoff water quality from similar un-mined areas, at which time these controls would be removed and the areas would be free-draining.

Given the above, the final landform is unlikely to lead to an increase in sediment transport downstream of the Project that would result in adverse impacts on terrestrial flora or fauna.

Mine Water Discharge

The surface water assessment (supported by site water balance modelling) by Hatch (2018a) concludes that:

- No uncontrolled spills of mine-affected water from the worked water dams are predicted under normal operating conditions.

- Some overflow of water from sediment dams (designed in accordance with the Best Practice Erosion and Sediment Control guideline [International Erosion Control Association Australasia 2008]) may occur during wet periods; however, it is unlikely that this would have a measurable impact on receiving water quality.
- There is a predicted negligible impact on the downstream water quality through releases from the Project.

Based on the implementation of management strategies (e.g. Erosion and Sediment Control Plan), the risks of elevated dissolved solids and other contaminants impacting downstream waters is considered to be low (Hatch 2018a).

Based on the analysis undertaken by Hatch (2018a), no measurable impacts on surface water quality are likely to occur from discharge of mine-affected waters. If no measurable impacts on surface water quality are likely to occur, no adverse impacts are likely to occur on surrounding habitats.

Leaks and Spills

Leaks or spills of hydrocarbon-based fluids from construction equipment and spread of coal dust represents a potential risk to aquatic habitat downstream of the Project.

The Preliminary Risk Assessment conducted by Operational Risk Monitoring (2018) concluded that there is a 'Low' risk of this event (or one similar) occurring given the implementation of suitable management measures, including implementation of a spill response and appropriate water management system.

As such, the Project is unlikely to result in leaks/spills that would eventuate in serious environmental harm to native species or their habitat.

Groundwater Dependent Ecosystems – Vegetation

Terrestrial Riparian Vegetation

The terrestrial riparian vegetation (RE 11.3.4 and 11.3.25) associated with the Isaac River is likely to be a GDE (DPM Envirosciences, 2018a).

Groundwater drawdown predictions have been produced by HydroSimulations (2018), indicating that drawdown in the alluvium is only predicted to reach / extend past the Isaac River in an approximately 4 km stretch of the Isaac River at the very northern extent of the Project area and an approximately 2.5 km stretch of the Isaac River adjacent to the Willunga Domain. The drawdown in these areas is not expected to exceed 2 m, while the potential drawdown at the downstream reaches of Ripstone Creek may reach up to 5 m (HydroSimulations 2018).

Although the potential drawdown of approximately 2 to 5 m is predicted to occur in areas where vegetation may be dependent on subsurface expression of groundwater, it is unlikely that this potential impact would result in a significant impact to terrestrial riparian vegetation surrounding the Project (DPM Envirosciences, 2018a). This is due to the fact that the vegetation in these locations is subject to continuous (natural) wetting and drying cycles which in turn results in continual fluctuations in the groundwater levels in these locations (DPM Envirosciences, 2018a).

The Project would not result in a drawdown in the alluvial aquifers that would dewater the aquifer to the extent that it would not recover following rainfall (HydroSimulations, 2018).

The terrestrial riparian vegetation associated with North Creek and Cherwell Creek may also be a GDE. The terrestrial riparian vegetation and aquatic habitats along North Creek and Cherwell Creek are located outside the area of potential drawdown associated with the Project (HydroSimulations 2018). As such, these features are unlikely to be impacted by the Project (DPM Envirosciences, 2018a).

Aquatic Habitats

The aquatic habitat associated with the Isaac River, North Creek, Cherwell Creek and smaller associated tributaries may be a GDE at times for a short period after a rainfall events. However, the aquatic habitat is ephemeral and the aquatic species that occur in this habitat are prone to wetting and drying cycles (DPM Envirosciences, 2018c).

The Project would not result in any negligible changes to baseflow contributions to North Creek or Cherwell Creek given the distance of these waterways from the proposed mining area (HydroSimulations, 2018).

HydroSimulations (2018) predicts that the Project would result in a potential 0.5% reduction in flow within the Isaac River during mining operations. It should be noted that this potential reduction is applying to the entire reach of the Isaac River adjacent the Project area.

Given the ephemeral nature of the Isaac River and the small contribution of baseflow, which only occurs after periods of prolonged rainfall, this predicted reduction in baseflow would only have a minimal impact on the presence of aquatic habitat within the Isaac River and associated tributaries. The aquatic species which would occur in this habitat are prone to wetting and drying cycles and would continue to persist in the environment despite the potential reduction in baseflow (DPM Envirosciences, 2018c).

HydroSimulations (2018) also considered potential baseflow impacts to Ripstone Creek and concluded that there would be no perceptible change in baseflow.

Waste Rock Emplacement Areas

As the mine progresses, waste rock material will be placed within out-of-pit and in-pit waste rock emplacement areas. Waste rock emplacement areas may produce seepage as a result of rainfall inundation. The waste rock material exhibits similar to improved water quality compared to water within regolith material (HydroSimulations 2018). However, the waste rock material generally exhibits poorer water quality compared to the alluvium (HydroSimulations 2018).

Seepage from in-pit emplacements is not expected to migrate to the surrounding alluvium, as the groundwater level that would ultimately equilibrate within the waste rock would be below the base of the alluvium (HydroSimulations 2018). Given this, the Project is not expected to have a significant impact on groundwater quality that would lead to any adverse impact on potential GDEs (DPM Envirosciences, 2018a).

Final Voids

Water within final voids would evaporate from the lake surface and draw in groundwater from the surrounding geological units. Evaporation from the lake surface would concentrate salts in the lake slowly over time (HydroSimulations 2018). This gradually increasing salinity is not expected to pose a risk to the surrounding groundwater regime as the final voids are predicted to remain permanent sinks (HydroSimulations 2018). Given the final voids would be sinks, the final voids would not result in any adverse groundwater quality related impacts on GDEs (DPM Envirosciences, 2018a).

Stygofauna

Consistent with the findings by 4T (2012), the generally poor groundwater quality (indicated by EC levels up to 26,800 µs/cm) within the regolith material suggests the groundwater environment is unsuitable for stygofauna (DPM Envirosciences, 2018c). Direct or indirect impacts on groundwater within the unconfined aquifer is unlikely to impact stygofauna (as stygofauna are unlikely to be present) (DPM Envirosciences, 2018c).

The stygofauna desktop review and water quality analysis indicate that stygofauna could potentially occur in the unconsolidated sediments (alluvium) associated with the Isaac River. All available bores (two) were sampled in order to confirm whether stygofauna are present. No stygofauna were found which may suggest that either stygofauna are not present, in low abundance or the sample size was too low (DPM Envirosciences, 2018c).

An assessment is provided in DPM Envirosciences (2018c) assuming that stygofauna are present within the unconsolidated sediments (alluvium).

The Project would directly intercept groundwater from the unconsolidated sediments (alluvium) and sub-artesian aquifers which could provide potential habitat for stygofauna as identified by 4T (2012) (DPM Envirosciences, 2018c).

Given this, the Project would result in a drawdown in the unconsolidated sediments associated with the Isaac River of more than 5 m, predominantly adjacent the Olive Downs South Domain (HydroSimulations, 2018).

Drawdown in the unconsolidated sediments adjacent the Willunga Domain would be less than 5 m and would only occur in a small portion of the alluvium associated with the Isaac River (HydroSimulations, 2018).

As indicated by HydroSimulations (2018), the alluvium is not limited to the Project area and appears to be saturated along the Isaac River and lower reaches of the creeks at the confluence with the Isaac River (HydroSimulations, 2018).

This indicates that the potential habitat for stygofauna (if they were to occur) is much more extensive than the alluvium within the area of influence associated with the Project. Given the extent of the alluvium along the Isaac River, it is unlikely that the Project would result in a significant impact to any stygofauna community (if they were to occur) (DPM Envirosciences, 2018c).

In summary, although the Project may have local impacts on the stygofauna community (if they were to occur), these are likely to be insignificant when placed in the regional context of the whole groundwater system (DPM Envirosciences, 2018c).

Introduced Species

Activities that could spread weeds during construction and operation include soil disturbance, vehicle movements and movement of soil. Disturbed areas (including those undergoing rehabilitation) provide a substrate in which weed species may grow.

Activities associated with the Project may provide increased refuge and scavenging resources (e.g. discarded food scraps) for these species, unless appropriately managed to discourage them (Appendix B).

Measures that would be implemented by Pembroke to mitigate the potential increase in abundance of introduce species are described in Section 4.1.4.

Noise, Dust and Artificial Lighting

The Project would result in an increase in noise, dust and artificial lighting (Appendices G and K, and Section 4.13).

Dust from the Project is unlikely to adversely impact surrounding native vegetation given vegetation in the locality is already subjected to dust from agricultural activities and exposed soils (Appendix A).

There is limited habitat surrounding the Project that would be subjected to noise and any potential impact to native fauna is likely to be temporary as mining progresses. Any adverse impact from noise on fauna or their habitat is likely to be localised and comparatively minor compared to the impact of habitat loss (Appendix B).

Whilst ensuring that operational safety is not compromised, Pembroke would seek to minimise light emissions from the Project by select placement, configuration and direction of lighting to reduce potential impacts to the surrounding environment where practicable.

A detailed description of mitigation and management measures to be implemented by Pembroke to minimise the potential dust, noise and lighting impacts is detailed in Sections 4.5.3, 4.9.3 and 4.13.3, respectively.

Vehicular Strike

Increased vehicular traffic movements would occur as a result of the Project. Additional vehicular traffic movements associated with construction and operation of the Project have the potential to result in the injury or mortality of some fauna species. In general, the risk of injury or fatality from vehicle strike is greatest where roads cross vegetated corridors or other specific fauna movement corridors (Appendix B).

There are three locations where access and haul roads would cross the Isaac River and associated riparian woodlands, that serves as a movement corridor and refuge habitat for native fauna (Appendix B).

The Project rail corridor has been located through areas of relatively low habitat value (i.e. primarily agricultural grasslands and regrowth vegetation). Similarly, the access roads for the Project are located through areas of relatively low habitat value and, for the vast majority, make use of existing roads and previously cleared lands.

In consideration of the above, the additional use of the local road network, and construction of the Project rail corridor, the Project poses a low additional risk to fauna from vehicle strike (Appendix B).

Changes to Natural Fire Regimes

A change in natural fire frequency can impact natural ecosystems. Accidental bushfires could potentially start in a variety of ways at the Project if not appropriately managed (e.g. from machinery or vehicles traversing dry grass) (Appendix B).

Measures that would be implemented by Pembroke to mitigate the potential changes in natural fire regimes are described in Section 4.1.4.

Matters of National Environmental Significance

The EPBC Act Controlling Provisions Assessment for the Project (Section 3) compiles assessments of impacts and mitigation for the controlling provisions and addresses the DEE's requirements outlined in the Final ToR.

Significant Impact Assessments have been conducted for all MNES which are known or have the potential to occur within the Project area in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DotE 2013b) (DPM Envirosciences, 2018a and b).

As a result of the Significant Impact Assessment, it was determined that a biodiversity offset would be provided for the following MNES:

- Brigalow EEC;
- Ornamental Snake;
- Australian Painted Snipe;
- Squatter Pigeon;
- Koala; and
- Greater Glider.

The Significant Impact Assessment indicated that there are no flora species listed under the EPBC Act at risk of a significant impact (DPM Envirosciences, 2018a) (Section 3).

Matters of State Environmental Significance

Significant Impact Assessments have been conducted for all MSES which are known or have the potential to occur within the Project area in accordance with the *Queensland Environmental Offsets Policy - Significant Residual Impact Guideline* (DEHP, 2014a).

A detailed assessment for all MSES that are also identified as MNES is provided in Section 3. This includes:

- Ornamental Snake;
- Australian Painted Snipe;
- Squatter Pigeon;
- Koala; and
- Greater Glider.

A summary of potential impacts to the MSES identified in the Project locality (as described in Section 4.1.2) is provided in Table 4-7.

MSES which are not 'substantially the same' as matters already described in Section 3 (i.e. MNES), are assessed further below. These include (Table 4-7):

- Regulated Vegetation;
- Connectivity;
- Protected Wildlife Habitat (Common Death Adder and Short-beaked Echidna);
- Wetlands and Watercourses;
- Waterways Providing for Fish Passage.

Regulated Vegetation

The clearance of Regulated Vegetation associated with the Project is outlined in Table 4-3.

In accordance with the *Queensland Environmental Offsets Policy - Significant Residual Impact Guideline* (DEHP, 2014a), each of these impacts, with the exception of the clearance of RE 11.3.4, would be considered significant and would therefore be offset by Pembroke.

Connectivity

Connectivity in the landscape is measured by the Landscape Fragmentation and Connectivity (LFC v1.5) tool designed by DES (2018). In deciding if an offset is required for connectivity areas, the significance of the ecosystem tract in the context of the local and the regional landscape is considered.

A development impact on connectivity areas is determined to be significant if either of the following tests are true:

- The change in the core remnant ecosystem extent at the local scale (post impact) is greater than a threshold determined by the level of fragmentation at the regional scale; or
- Any core area that is greater than or equal to 1 ha is lost or reduced to patch fragments (core to non-core).

The outcomes of the Landscape Fragmentation and Connectivity (LFC v1.5) tool for the Project concluded that the Project would have a significant impact on connectivity (Table 4-3).

Protected Wildlife Habitat

Assessment of Significance for the Project impacts on the Common Death Adder and the Short-beaked Echidna against the criteria outlined in the *Queensland Environmental Offsets Policy - Significant Residual Impact Guideline* (DEHP, 2014a) are provided in Tables 4-3 and 4-4 respectively.

In summary, it is concluded that the Project would not result in a significant impact to either of these two species (Table 4-7) (Appendix B).

Wetlands and Watercourses

As described in Section 4.1.3, the Project would remove 61 ha of HES Wetlands. An assessment of the potential impacts on this MSES, in accordance with the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (DEHP 2014a) is provided in Table 4-5.

In summary, it is concluded that the Project would result in a significant impact to wetlands (Table 4-7) (Appendix C).

Table 4-3
Likelihood of Significant Adverse Impact on the Common Death Adder

Assessment Criteria[1] Is the Action likely to:	Assessment
lead to a long-term decrease in the size of a local population	As the species has only been detected in study area once in the past 5 years, and the next closest database record is located approximately 90 km from the Project area, it is unlikely that the Project area supports a local population of this species. If the species were to occur, it is expected only to be in very low numbers. The Project is unlikely to lead to a long-term decrease in the size of any local population, if it were present.
reduce the extent of occurrence of the species	Given the reasons outlined above, the Project is not likely to reduce the extent of occurrence of this species.
fragment an existing population	The Project is not likely to fragment an existing population into two or more populations given the lack of records of this species within the Project area.
result in genetically distinct populations forming as a result of habitat isolation	As outlined above, the Project is not likely to fragment an existing population, and as such would not result in genetically distinct populations forming, given the lack of records of this species within the Project area.
result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	Cane toads are implicated as a threat to the species (DEHP 2018). There are a number of existing threats to the common death adder, including the presence of introduced fauna species (including cane toads), as evidenced by the only record of this species within the study area being a snake that was found dead from likely cane toad poisoning. Through effective pest management, Pembroke's Weed and Pest Management Plan would seek to identify, treat, and propose removal strategies to manage these risks to avoid a significant impact to this species.
introduce disease that may cause the population to decline	The Project does not include activities that would result in a disease that may cause the species to decline.
interfere with the recovery of the species	The Project would not interfere substantially with the recovery of the species because habitat resources for the common death adder would remain outside of the Project area, such that the species is likely to persist in the landscape, if it were to occur.
cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	The Project would affect generic foraging and potentially breeding habitat for the common death adder. Given the extent of similar and higher quality habitat located on adjacent and nearby lands, the habitat on site is unlikely to be of any specific significance to the local population, if it were to occur.

Source: DPM Enviros ciences (2018b)

[1] As defined by the *Queensland Environmental Offsets Policy – Significant Residual Impact Guideline* (DEHP 2014)

Table 4-4
Likelihood of Significant Adverse Impact on the Short-beaked Echidna

Assessment Criteria[1] Is the Action likely to:	Assessment
a long-term decrease in the size of a local population	It is highly likely that a local population of the Echidna would extend well beyond the study area given the number of previous records in the locality (ALA 2018) and that large areas of suitable habitat occurs on adjacent and nearby lands. The Project would impact the Echidna through the removal of habitat which includes open woodland and regrowth. This would affect foraging habitat and connectivity would also be reduced. However, given that the local population would extend well beyond the site, and that large areas of suitable habitat would remain outside the Project area, the Project is only likely to affect a few individuals of the overall population and would be unlikely to lead to a decline.
a reduced extent of occurrence of the species	Given the abundance of this species and the availability of surrounding potential habitat it is unlikely that the Project would significantly reduce the area of occupancy of the species relative to its range.
fragmentation of an existing population	The echidna is relatively mobile and would be able to cross disturbed areas and open ground. Sufficient connectivity for this species is likely to remain after clearance and no populations are likely to become fragmented as a result of the Project.
result in genetically distinct populations forming as a result of habitat isolation	As discussed above, no fragmentation or isolation of the local population is likely to result from the Project.
disruption to ecologically significant locations (breeding, feeding or nesting sites) of a species	The Project would affect generic foraging and potentially breeding habitat for the local echidna population. Given the extent of similar and higher quality habitat located on adjacent and nearby lands, the habitat on site is unlikely to be of any specific significance to the local population.

Source: DPM Enviros ciences (2018b)

[1] As defined by the *Queensland Environmental Offsets Policy – Significant Residual Impact Guideline* (DEHP 2014)

Table 4-5
Likelihood of Significant Adverse Impact on Wetlands and Watercourses

Assessment Criteria[1] *Is it likely that the action will result in environmental values being affected in any of the following ways:*	Assessment
areas of the wetland or watercourse being destroyed or artificially modified;	The Project would remove or modify seven wetlands mapped as HES Wetlands (totally approximately 61 ha).
a measurable change in water quality of the wetland or watercourse—for example a change in the level of the physical and/or chemical characteristics of the water, including salinity, pollutants, or nutrients in the wetland or watercourse, to a level that exceeds the water quality guidelines for the waters; or	No measurable impacts on surface water quality of the remaining wetlands are likely to occur from changes in surface water as (Hatch 2018a): • no uncontrolled spills of mine affected water from the mine water dam are predicted; • release of treated water from sediment dams (designed in accordance with the Best Practice Erosion and Sediment Control [International Erosion Control Association Australasia 2008]) to the downstream environment would only occur in accordance with the EA conditions (once developed) which is unlikely to have a measurable impact on receiving water quality; and • there is a predicted negligible impact on the downstream water quality through controlled releases from the Project in accordance with the EA (once granted).
the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected; or	The Project would remove or modify seven wetlands mapped as HES Wetlands (totally approximately 61 ha). The Project would not result in the habitat or lifecycle of native species dependent upon the HES Wetlands that would remain within the Study area being seriously affected, given there would not be any measurable impact to the surface water quality as a result of the Project (Hatch, 2018a).
a substantial and measurable change in the hydrological regime or recharge zones of the wetland, e.g. a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or	The Project would remove or modify seven wetlands mapped as HES Wetlands (totally approximately 61 ha). The potential flow regime changes to the wetlands adjacent the Project has been assessed by Hatch (2018a). In conclusion, it was determined that, despite some catchment excision, potential hydrological changes to these wetlands would be negligible as the wetlands would continue to be inundated during and following rainfall / flood events adjacent the Isaac River.
an invasive species that is harmful to the environmental values of the wetland being established (or an existing invasive species being spread) in the wetland.	The introduction and spread of invasive weeds may occur as a result of the Project; however, threat levels are unlikely to change significantly due to the Project given the current agricultural use of the surrounding area and implementation of mitigation and management measures proposed to be implemented by Pembroke. Given this it is unlikely that the Project would result in an invasive species that is harmful to the HES Wetlands that would remain within the Study area.

Source: DPM Enviros ciences (2018c)

[1] As defined by the *Queensland Environmental Offsets Policy – Significant Residual Impact Guideline* (DEHP 2014)

Waterways Providing for Fish Passage

As described in Section 4.1.3, waterway crossings would be constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF, 2017b) using box culverts to permit crossing during low flow events, enabling fish passage to be maintained within / through the Project area.

Each crossing would be designed to be inundated during moderate to high flow events (which may negate the need for baffling) allowing fish passage above and around the structure.

An assessment of the potential impacts on this MSES, in accordance with the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (DEHP 2014a) is provided in Table 4-6.

In summary, it is concluded that the Project would not have a significant impact on Waterways Providing for Fish Passage given waterway crossings would be constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF, 2017b) so as not to create a barrier to fish movement.

Cumulative Impacts – Terrestrial Ecology

The Project area is made up of some patches of remnant vegetation and grazing land. It is immediately south of the approved (yet not constructed) Olive Downs North Mine and within approximately 8 km of existing mines to the west (Peak Downs and Saraji Mine).

Table 4-6
Likelihood of Significant Adverse Impact on Waterways Providing for Fish Passage

Assessment Criteria[1] Is the Action likely to:	**Assessment**
Result in the mortality or injury of fish	The Project would not result in barriers that cause the mortality or injury of native fish because: ▪ waterway crossings would be constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF, 2017b) so as not to create a barrier to fish movement; and ▪ the diversion of Ripstone Creek would be sensitively designed to replicate natural features where possible and provide similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge for fish inhabiting or passing through the diversion of Ripstone Creek;.
Result in conditions that substantially increase risks to the health, wellbeing and productivity of fish seeking passage such as through the depletion of fishes energy reserves, stranding, increased predation risks, entrapment or confined schooling behaviour in fish.	The Project is unlikely to result in conditions that would substantially increase risks to the health, wellbeing and productivity of fish seeking passage because: ▪ waterway crossings would be constructed so as not to create a barrier to fish movement; and ▪ the diversion of Ripstone Creek would be designed to replicate similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge for fish inhabiting or passing through the diversion of Ripstone Creek.
Reduce the extent, frequency or duration of fish passage previously found at a site.	The Project would not reduce the extent, frequency or duration of fish passage previously found at the Project area because: ▪ waterway crossings would be constructed with consideration to the Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works (DAF, 2017b) so as not to create a barrier to fish movement; and ▪ the diversion of Ripstone Creek would be sensitively designed to replicate natural features where possible and provide similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge for fish inhabiting or passing through the diversion of Ripstone Creek. Further, the Surface Water Assessment (Hatch 2018a) concludes that the Project is unlikely to result in a significant reduction to the extent, frequency and duration of flows encountered in waterways around the Project area.

Table 4-6 (Continued)
Likelihood of Significant Adverse Impact on Waterways Providing for Fish Passage

Assessment Criteria[1] Is the Action likely to:	Assessment
Substantially modify, destroy or fragment areas of fish habitat (including, but not limited to in-stream vegetation, snags and woody debris, substrate, bank or riffle formations) necessary for the breeding and/or survival of fish.	Waterways mapped as Moderate and Low risk of impact on fish movement would be removed or otherwise impacted by mining activities. However, these waterways are generally of low stream order (1 or 2), are highly ephemeral, and are not considered to constitute, nor provide a conduit to, fish habitat areas essential for the breeding and / or survival of native fish. Ripstone Creek (mapped as High risk of impact on fish movement) would be diverted to the south of its existing alignment to allow for mining operations in this area. This diversion would not result in a significant impact to fish passage given the proposed diversion would be sensitively designed to replicate natural features where possible and to simulate aquatic habitat attributes of the affected reach of Ripstone Creek and allow the free passage of fish both upstream and downstream in a safe manner.
Result in a substantial and measurable change in the hydrological regime of the waterway, for example, a substantial change to the volume, depth, timing, duration and frequency of flows.	Surface water hydrology would be altered by the Project as a result of capturing water in dams, water loss due to use for Project operation or pond evaporation and releasing water during flow events. The volume, depth, timing, duration and frequency of flows would continue to reflect the ephemeral and variable flow nature of the waterways around the Project area. The Project is considered unlikely to result in a substantial and measurable change in the hydrological regime of these waterways (Hatch 2018a). The seasonality of fish movements would not be affected.
Lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues to movement in local fish species.	The Project would not lead to an abrupt or otherwise significant change in water quality parameters (Hatch 2018a) that would be expected to cue local fish movement. Any water releases required by the Project would be managed in accordance with the EA Conditions (once developed). The risk of deteriorating water quality would be mitigated by monitoring stream and release water quality and quantity in accordance with the EA (once granted).

Source: DPM Enviroscience (2018c)

[1] As defined by the *Queensland Environmental Offsets Policy – Significant Residual Impact Guideline* (DEHP 2014)

Table 4-7
Summary of Residual Significant Impacts on MSES

MSES			Total Area of Impact (ha)	DEHP (2014d) Residual Significant Impact Test	Significant Impact?
Regulated Vegetation	'Endangered' or 'of concern' regional ecosystems*; or	RE 11.3.1 – 'Endangered'.	14	> 0.5 ha (where in a dense to mid-dense [structural category] regional ecosystem)	Yes
		RE 11.4.8 – 'Endangered'.	4.5		Yes
		RE 11.4.9 – 'Endangered'[A].	59		Yes
		RE 11.5.17 – 'Endangered'.	62	> 2 ha (where in a sparse [structural category] regional ecosystem)	Yes
		RE 11.3.2 – 'Of Concern'.	859.5		Yes
		RE 11.3.3 – 'Of Concern'.	5		Yes
		RE 11.3.4 – 'Of Concern'.	1		No
	Regional ecosystems within mapped vegetation management wetlands		49	Within 50 m of defining bank	Yes
	Regional ecosystems within the defined distance of a vegetation management watercourse		126	Within 5 m of defining bank	Yes
Connectivity Areas			5,665	Refer to footnote B	Yes
Wetlands and Watercourses			61	Areas of the wetland or watercourse being destroyed or artificially modified	Yes
Protected Wildlife*	Ornamental Snake#		7,666	Project likely to result in any of the significant impact criteria outlined in DEHP (2014b)	Yes
	Australian Painted Snipe#		120		Yes
	Squatter Pigeon (southern)#		5,463.5		Yes
	Koala#		5,583.5		Yes
	Greater Glider#		5,583.5		Yes
Waterways Providing for Fish Passage			0	Project likely to result in any of the significant impact criteria outlined in DEHP (2014b)	No

Source: Appendices A, B and C.

A 13 ha of this community is mapped as the Brigalow TEC under the EPBC Act

B Application of the DEHP (2016) *Landscape Fragmentation and Connectivity Tool* showed that impacts of the Project on landscape connectivity would be significant.

This species is also listed under the EPBC Act.

* The REs and species habitats overlap (i.e. the REs and habitats are not mutually exclusive).

The native RE and fauna habitat types to be cleared during the life of the Project occur more widely in surrounding landscapes and subregions (Appendices A and B). The clearing for the Project would remove a further 5,661.5 ha of remnant vegetation, representing 0.42% of the remaining remnant vegetation in the Northern Bowen Basin and Isaac-Comet Downs biodiversity sub-regions (Accad, *et al*., 2017).

Offset areas to be established for the Project would also significantly increase the area of protected habitat that will be managed for conservation.

Cumulative Impacts – Aquatic Ecology

The Isaac River is the main watercourse which bisects the Project area and flows in a north-west to south-east direction, passing the township of Moranbah and the Millennium, Poitrel and Daunia coal mines upstream of the Project. The Isaac River flows to the north-east of the Olive Downs South domain and then further downstream to the south of the Willunga domain before continuing in a south-easterly direction (Hatch, 2018a).

The site water management system has been designed such that the risk of off-site uncontrolled release of mine affected water during operations is very low and sediment inputs can be controlled through drainage, and erosion and sediment control measures. On this basis, the Project is not expected to make any significant contribution to cumulative sediment loads in the Fitzroy River Basin (Hatch, 2018a).

The outcomes from the water balance modelling indicate that the proposed controlled release strategy would achieve the regional WQOs for the Isaac River and therefore not impact on its environmental values (Hatch, 2018a).

Given that the Project mine affected water releases would be managed within an overarching strategic framework for management of cumulative impacts of mining activities, the proposed management approach for mine water from the Project is expected to have negligible cumulative impact on surface water quality and associated aquatic habitat values (Hatch, 2018a).

The Project would not result in a significant cumulative impact to the aquatic flora and fauna of the Isaac River system, given the limited potential impacts associated with the Project and the implementation of mitigation and management measures (Appendix C).

4.1.4 Mitigation Measures, Management and Monitoring

Consistent with DES' management hierarchy, the mitigation strategy for the Project has focused on a hierarchy of:

1. avoidance;
2. minimisation;
3. mitigation; then
4. offset residual impacts.

Refinement of the Mine Design to Avoid Land Clearance

The following measures would be implemented to avoid and / or minimise impacts on terrestrial ecology:

- Mine – Where possible, riparian vegetation along the Isaac River has been avoided in the mine design and a minimum buffer zone of 200 m between the mine pits and Isaac River has been implemented.
- Overland conveyor – The overland conveyor would run North-west from the Willunga Domain and cross the Isaac River approximately 4.5 km from its origin point. The conveyor would be restricted to a construction corridor of 180 m however this would be reduced when crossing the Isaac River; where, within 200 m of the defining bank, the construction corridor width would be limited to 45 m to reduce impact on the riparian habitat.
- Access road – the proposed 3.5 km access road would be co-located with existing public and private roads as far as possible to reduce impacts to native vegetation. The access road would be restricted to 40 m at the crossing point to reduce the impact on the riparian habitat.
- Haul road crossing – The haul road crossing of the Isaac River would provide access to the waste emplacement on Deverill from the Olive Downs South Domain. The crossing would be located approximately 2 km south-south east of the access road where it crosses the Isaac River entering an area ground-truthed as being RE 11.3.25 of Least Concern. The haul road would be restricted to a construction corridor of 60 m.
- Water pipeline – the proposed water pipeline would connect to the existing Eungella Pipeline west of the Project. The water pipeline would be approximately 23 km long and has been co-located with the rail corridor as far as possible (for a distance of 15 km from the mine site to the existing Norwich Park Branch to reduce native vegetation clearance. All patches of TEC have been avoided and impacts to Endangered and Of Concern REs minimised by minimising the corridor for the water pipeline to 20 m.
- ETL – the proposed ETL utilises an existing easement between the sub-station on Peak Downs Highway and the rail (Norwich Park Branch), then follows Daunia Road and Annandale Road before heading south for 13 km across predominately cleared land to the MLA. The ETL would be restricted to a construction corridor of 10 m.
- Rail spur – The final location of the rail spur would maintain a buffer zone of approximately 85 m to the bank of the Isaac River at its closest point (affecting 1.5 km of the rail alignment). It has avoided all areas of TEC and most Endangered RE (with the exception of waterway crossings).

Further to this, all waterway crossings would be designed and constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF, 2017b) to avoid potential impacts to aquatic ecology.

Vegetation Clearance Procedures

Vegetation clearance procedures would be developed as part of a Vegetation Management Plan which would prepared for the Project and would include:

- Boundaries of areas to be cleared, and those not to be cleared, would be defined during construction and operation.
- An internal Ground Disturbance Permit would be required prior to any clearing so that clearing activities are authorised prior to disturbance.
- Clearing of native vegetation would be undertaken progressively over the life of the mine and only in areas required for mining activities within the following year. This would have the effect of minimising the area of exposed land.
- Pre-clearance flora and fauna surveys would be undertaken by suitably experienced and qualified persons.
- Collection of native seed from the Project area for use in rehabilitation program.
- A suitably trained and qualified person would be present during the clearing of habitat.
- Management of fauna identified during clearing may include relocating individuals to adjacent habitat or treating injuries.
- Pre-clearance surveys to *Bertya pedicellata* within habitat proposed to be cleared along the ETL alignment. Impacts to *Bertya pedicellata* would be avoided where possible.
- Where applicable, and in consultation with DES, limit time of construction to avoid breeding seasons for threatened species.
- Salvage and reuse of selected trees (e.g. tree hollows) for use as fauna habitat in rehabilitation areas (e.g. habitat logs).

Management of Conservation Significant Species

As described in Section 4.1.3, Pembroke would prepare a Species Management Program (in accordance with section 332 of the *Nature Conservation [Wildlife Management] Regulation 2006*).

A Protected Plant Clearing Permit would be obtained if impacts to the *Bertya pedicellata* are required as part of the ETL construction. If required (to be determined following detailed design of the ETL), Energy Queensland would apply for this permit.

Rehabilitation

The Project area (e.g. waste emplacements and infrastructure areas) would be progressively rehabilitated and revegetated, so the post-mining landforms are safe and stable. Rehabilitation would commence as soon as reasonably practicable after areas become available for rehabilitation.

Pembroke would develop a Rehabilitation and Mine Closure Plan.

Rehabilitation procedures to be adopted for the Project and proposed final land uses are discussed in detail in Section 5.

Waterway Crossings

All waterway crossings proposed as part of the Project would be constructed with consideration to the *Accepted development requirement for operational works that is constructing or raising waterway barrier works* (DAF, 2017) so as not to create a barrier to fish movement and minimise impacts on aquatic ecology.

Feral Animal Control Strategies

Feral animals would be discouraged at the Project by maintaining a clean, rubbish-free environment. Any waste storage facilities associated with the Project would be designed and located to restrict fauna access.

Appropriately qualified persons would be engaged to undertake bi-annual pest animal monitoring in the Project area. Feral animal control strategies (e.g. baiting and trapping) would be implemented in the Project area in accordance with relevant standards, to maintain low abundance of declared animals.

Section 4.13 provides further information regarding declared feral animal management strategies.

Pembroke would also develop and implement a Weed and Pest Management Plan for the Project (Section 4.13.4).

Weed Management

Pembroke would implement a Weed and Pest Management Plan for the Project which would detail the weed prevention techniques proposed to be implemented in the Project area, including:

- clearing of vegetation to be restricted to the minimum required to enable the safe construction, operation and maintenance of the Project, including infrastructure corridors;
- implementation of a Weed and Pest Management Plan for the Project;
- identification of weed infestations and prioritisation of areas requiring weed treatment;
- strategies for preventing weed spread (i.e. machinery wash-down, boot scrubbing facilities, disposal of weed material); and
- conducting rehabilitation activities for disused areas of the mine, as soon as possible.

Section 4.13.4 provides further information regarding weed management strategies.

Fauna Management

Pembroke would implement a Fauna Species Management Plan for the Project, which would include the following measures:

- Where applicable, clearing activities would avoid breeding seasons for threatened species.
- Fauna exclusion fencing would be installed around construction sites or operational mine areas.
- Implementation of vehicle speed limits on-site.
- Pets would not be allowed on-site.
- Where applicable, fencing and fauna crossings would be maintained to allow safe fauna movement.
- Artificial lighting would be minimised and the use of lighting on-site would be in accordance with the relevant Australian Standards.
- Use of licenced fauna spotter-catchers for relocation of native animals, including native fish and turtles impacted by dewatering habitat.

Bushfire Prevention and Management

Bushfire prevention and management measures would include:

- Implementation of a Safety Management System and associated frameworks to record and monitor fire including:
  - incident management framework;
  - hazard / near miss reporting process;
  - incident notification; and
  - crisis management and evacuation framework.
- Allowance for appropriate buffer distances between the Project and surrounding bushland.
- Minimise any chemicals used in the Project area and ensure they are handled and disposed of in accordance with the relevant Safety Data Sheet.
- Ensure access tracks are able to be used for fire-fighting and other emergency purposes by Queensland Fire and Rescue Service.

Receiving Environment Management Program

Pembroke would prepare a Receiving Environment Monitoring Program (REMP) for the Project in accordance with the *Receiving Environment Monitoring Program Guideline* (DEHP, 2014b). The REMP would identify:

- the Environmental Values (EVs) that need to be enhanced or protected for receiving waters potentially affected by a release;
- measurable indicators associated with these EVs (physical, chemical or biological);
- Water Quality Objectives (WQOs) for these indicators;
- suitable test sites within the receiving waters that are potentially impacted by the release;
- suitable control sites where a background or reference condition can be established;
- methodologies for assessing the condition of, and impacts to, EVs at test sites using both WQOs and control site data based on appropriate and valid assessment protocols from relevant guideline documents; and
- quality control and assurance procedures adopted to produce monitoring results that are reliable and useful.

The REMP would be prepared prior to commencement of operations.

4.1.5 Biodiversity Offset Strategy

Offset Requirements

Measures that are proposed to avoid and mitigate impacts from the Project on terrestrial and aquatic flora and fauna (including MSES and MNES) are described in Sections 3 and 4.1.4. This section describes an offset strategy aimed at addressing the residual impacts on MSES and MNES.

The Terms of Reference for the Project states the following in relation to biodiversity offsets:

11.27 The EIS must describe the residual impacts of each proposed action for each relevant matter protected by the EPBC Act, after all proposed avoidance and mitigation measures are taken into account.

11.28 The EIS must identify whether the residual impacts are significant with reference to the Matters of National Environmental Significance, Significant impact guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999.

11.29 If those residual impacts are significant the EIS must propose offsets for relevant matters protected by the EPBC Act consistent with the Environment Protection and Biodiversity Conservation Act 1999, Environmental Offsets Policy.

11.53 The EIS should identify whether the project will result in a significant residual impact on matters of State environmental significance (MSES) with reference to the Queensland Environmental Offsets Policy, Significant Residual Impact Guideline 2014.

11.54 For staged offsets, the full extent of potential impacts on prescribed environmental matters from the entire proposal needs to be taken into account as part of the significant residual impact test.

11.55 The proposed offsets should be in line with the requirements set out in the Queensland Environmental Offsets Policy (Version 1.2) 2016. [1]

The EO Act and EPBC Act and the following related policies are relevant to the environmental offset proposal for the Project:

- *Queensland Environmental Offsets Policy (Version 1.6)* (DES, 2018); and
- *EPBC Act Environmental Offsets Policy* (DSEWPC 2012a) (and supporting EPBC Act Offsets Assessment Guide [DSEWPC, 2012b]).

Significant Residual Impact on State and National Matters

Land clearing for the Project is proposed to occur in multiple stages. Stage 1 would include the following works:

- construction of each of the infrastructure corridors:
  - rail corridor;
  - ETL;
  - water pipeline;
  - Olive Downs South access road;
- construction of the mine infrastructure area (including offices, workshops, CHPP, ROM pad, ILF cells);
- development of the north-western waste emplacement;
- construction of temporary flood levees located within the Stage 1 boundary; and
- commencement of open cut mining in Pit 1.

The Stage 1 disturbance boundary is shown on Figure 4-1. The Stage 1 disturbance boundary includes the full extent of the following Actions:

- Olive Downs Project Water Pipeline (EPBC 2017/7868);
- Olive Downs Project Electricity Transmission Line (EPBC 2017/7869); and
- Olive Downs Project Rail Spur (EPBC 2017/7870).

The Stage 1 disturbance boundary would facilitate approximately the first five years of mining of the Olive Downs Project Mine Site and Access Road (EPBC 2017/7867).

Table 4-8 quantifies the significant residual impacts on MSES and MNES for each stage of clearance. The Offset Strategy proposed to compensate for these significant residual impacts is described below.

[1] The *Queensland Environmental Offsets Policy (Version 1.2) 2016* has been replaced by the *Queensland Environmental Offsets Policy (Version 1.6)* (DES 2018).

Table 4-8
Residual Significant Impact on National and State Matters

Relevant Matter			Residual Impacts					Significant Residual Impacts Likely?
			Stage 1 (ha)	Stage 2 (ha)	Stage 3 (ha)	Stage 4 (ha)	Total (ha)	
Matters of National Environmental Significance								
Brigalow TEC			0	0	13	0	13	Yes
Ornamental Snake			506	1,596	3,916	1,648	7,666	Yes
Australian Painted Snipe			21	24	50	25	120	Yes
Squatter Pigeon (southern)			805.5	1,738	2,211	709	5,463.5	Yes
Koala			826.5	1,762	2,261	734	5,583.5	Yes
Greater Glider			826.5	1,762	2,261	734	5,583.5	Yes
Matters of State Environmental Significance								
Regulated Vegetation	'Endangered' or 'of concern' regional ecosystems*; or	RE 11.3.1	2	6.5	5.5	0	14	Yes
		RE 11.4.8	1	3.5	0	0	4.5	Yes
		RE 11.4.9[A]	2.5	0	21.5	35	59	Yes
		RE 11.5.17	5	1	32.5	23.5	62	Yes
		RE 11.3.2	21.5	401.5	416	20.5	859.5	Yes
		RE 11.3.3	0	0	4.5	0	5	Yes
		RE 11.3.4	1	0	0	0	1	No
	Regional ecosystems within mapped vegetation management wetlands		7	23	19	0	49	Yes
	Regional ecosystems within the defined distance of a vegetation management watercourse		6	94.5	13	12.5	126	Yes
Connectivity Areas			830.5	1773	2289	769	5661.5	Yes
Wetlands and Watercourses			9.5	6	23.5	22	61	Yes
Designated Precinct in a Strategic Environmental Area			0	0	0	0	0	No
Protected Wildlife Habitat*	Ornamental Snake		As indicated above, these species are also listed under the EPBC Act and as such there is no requirement to offset under the *Queensland Environmental Offsets Policy (Version 1.6)* (DES 2018).					
	Australian Painted Snipe							
	Squatter Pigeon (southern)							
	Koala							
	Greater Glider							
Protected Areas			0	0	0	0	0	No
Highly Protected Zones of State Marine Parks			0	0	0	0	0	No
Fish Habitat Areas			0	0	0	0	0	No
Waterways Providing for Fish Passage			0	0	0	0	0	No
Marine Plants			0	0	0	0	0	No
Legally Secured Offset Areas			0	0	0	0	0	No

[A] 13 ha of this community is mapped as the Brigalow TEC under the EPBC Act

* The REs and species habitats overlap (i.e. the REs and habitats are not mutually exclusive).

Biodiversity Offset Strategy

Pembroke propose to offset the significant residual impacts on Matters of National Environmental Significance in accordance with the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012) and offset the significant residual impacts on Matters of State Environmental Significance in accordance with the *Queensland Environmental Offsets Policy (Version 1.6)* (DES 2018).

Pembroke propose a staged environmental offset in consideration of the staged land clearing described above. The offset for each stage of clearance would be provided before clearing the relevant stage. A land-based proponent-driven offset is proposed to address the relevant impacts from Stage 1.

The Stage One Offset Area would compensate for the impacts associated with each of the following Actions in full:

- Olive Downs Project Water Pipeline (EPBC 2017/7868);
- Olive Downs Project Electricity Transmission Line (EPBC 2017/7869); and
- Olive Downs Project Rail Spur (EPBC 2017/7870).

In addition, the Stage One Offset Area would compensate for the impacts associated with approximately the first five years of mining of the Olive Downs Project Mine Site and Access Road (EPBC 2017/7867).

For subsequent stages (Stages 2 to 4), the offset would be provided before the commencement of each stage. It is likely that the residual significant adverse impacts can be offset given the following (Appendix A):

- The native vegetation communities / fauna habitats to be cleared during the life of the Project (including those listed as 'Endangered' and 'Of Concern') all occur extensively in the surrounding landscape and subregions.
- The surrounding landscape contains large areas of non-remnant vegetation (required to offset the significant residual impact on 'Connectivity').

Stage One Offset Area

The Stage One Offset Area is comprised of three distinct areas located on the eastern side of the Isaac River, adjacent the Project area (Figure 4-7).

The Stage One Offset Area occurs within the same subregion and catchment as the Project, on the eastern side of the Isaac River.

The Stage One Offset Area covers an overall area of approximately 6,065 ha. Within the Stage One Offset Area, there is approximately 1,200 ha which is not required to be included in an offset area for Stage 1 and may be used to offset impacts from subsequent stages. These areas are mapped on Figure 4-7 as 'Areas Retained for Future Offset'. Despite, retaining these areas to account for future stages, these areas would be conserved and managed as part of the greater Stage One Offset Area.

Pembroke owns the land on which the Stage One Offset Area is proposed and there are no other relevant parties with registered interests under the Qld *Land Act 1994* or the Qld *Land Title Act 1994* (Table 4-9).

Table 4-9
Relevant Offset Area Details

Reference	Landholder Details
Registered Owner on Title	Pembroke Olive Downs Pty Ltd
Real Property Descriptions	Twenty Mile – Lot 5, SP 113322 Deverill – Lot 18, SP 113322

Ecology Surveys

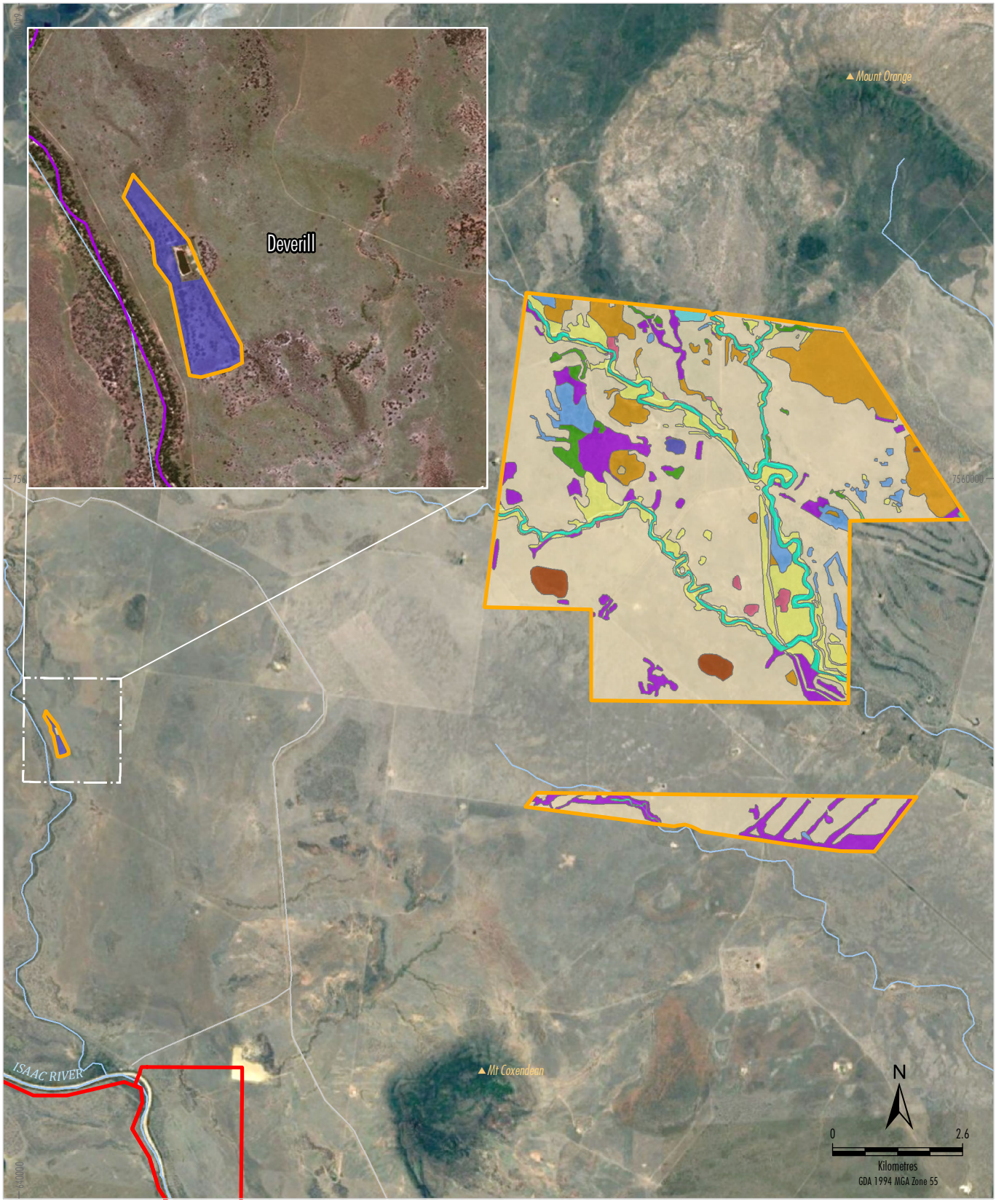
Flora and Vegetation Surveys

DPM Envirosciences (2018a) (Appendix A) undertook flora surveys in the Stage One Offset Area in accordance with contemporary survey guidelines. The flora and vegetation surveys were undertaken in March to May 2018. The detailed methods and findings from these surveys are provided in Appendix H of DPM Envirosciences (2018a) (Appendix A).

Flora survey techniques included quaternary surveys, ground-truthing regional ecosystems, identification of threatened ecological communities, targeted searches for conservation significant species and random meanders (DPM Envirosciences, 2018a).

Threatened Fauna Surveys

DPM Envirosciences (2018a) (Appendix A) undertook fauna surveys across the Stage One Offset Area targeting conservation significant fauna species, including the Koala, Greater Glider, Ornamental Snake, Australian Painted Snipe and Squatter Pigeon.



LEGEND

Mining Lease Application Boundary
Stage 1 Offset Boundary
Peaks
Dwelling

Regional Ecosystem

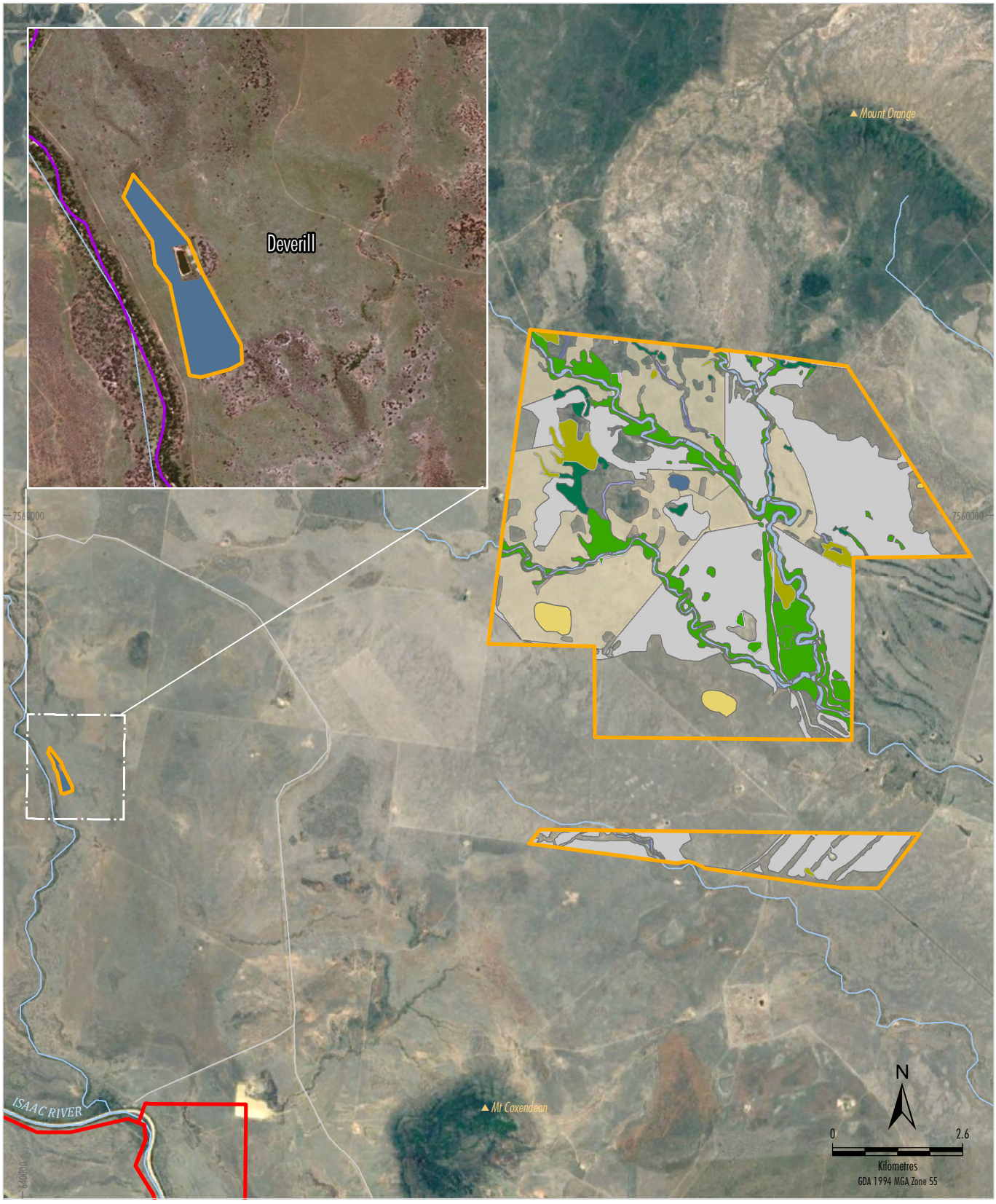
RE 11.11.1
RE 11.12.7
RE 11.3.1
RE 11.3.2
RE 11.3.2/11.3.25/11.3.1
RE 11.3.25
RE 11.3.27f
RE 11.4.8
RE 11.4.9
RE 11.4.9/11.5.3
RE 11.5.17
RE 11.5.3
RE 11.5.9
Non-remnant

Source: DPM (2018), Pembroke (2018), Queensland Department of Natural Resources, Mines and Energy (2017)
Orthophoto: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT
Regional Ecosystem Mapping
Stage 1 Offset Area

Figure 4-7a



LEGEND

Mining Lease Application Boundary

Stage 1 Offset Boundary

Peaks

Dwelling

Matters of State Environmental Significance

Regulated Vegetation

- RE 11.3.1
- RE 11.3.2
- RE 11.4.8
- RE 11.4.9
- RE 11.5.17

REs Associated with Watercourses

- RE 11.3.25
- RE 11.5.3
- RE 11.5.9

REs Associated with Wetlands

- RE 11.3.27f
- RE 11.5.17

Wetlands

- RE 11.5.17
- RE 11.3.27f

Connectivitiy

- Regrowth

Other

- Areas Retained for Future Offset

Source: DPM (2018), Pembroke (2018), Queensland Department of Natural Resources, Mines and Energy (2017)
Orthophoto: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Matters of State Environmental Significance
Stage 1 Offset Area

Figure 4-7b

Habitat for each of the target conservation significant species was mapped in the Stage One Offset Area during the surveys.

Habitat Quality Assessments

Terrestrial habitat quality assessments were conducted by DPM Enviroscience (2018a) (Appendix A) within the Stage 1 disturbance boundary and in the Stage One Offset Area in accordance with the *Guide to Determining Terrestrial Habitat Quality Version 1.2* (DEHP 2017b).

Presence of Relevant Matters

The regional ecosystems ground-truthed within the Stage One Offset Area are listed in Table 4-10a and shown on Figure 4-7. Each RE is described in detail in Appendix A.

Table 4-10b provides a reconciliation of the Stage 1 Project offset requirements against the ecological values of the Stage One Offset Area.

As demonstrated in Table 4-10b, the Stage One Offset Area contains all matters that require offsetting as part of Stage 1 of the Project and is suitably sized to satisfy the requirements of the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012) and *Queensland Environmental Offsets Policy (Version 1.6)* (DES 2018).

Threatened Fauna Species

Each of the threatened fauna species relevant to the Project offset strategy are both MNES and MSES. Given this, the *EPBC Act Offsets Assessment Guide* (DSEWPC, 2012b) was applied to determine the offset requirements for each species (Appendix B).

The following threatened fauna species were all recorded in the Stage One Offset Area:

- Koala;
- Greater Glider;
- Ornamental Snake; and
- Squatter Pigeon (southern).

Suitable habitat for each of these species, in addition to the Australian Painted Snipe, occurs in the Stage One Offset Area (Table 4-10b).

A combination of remnant vegetation and regrowth eucalypt woodland within the Stage One Offset Area has been mapped as potential habitat for each of these species (Figure 3-33) (Appendix B).
The remnant vegetation within the Stage One Offset Area is described further below. The regrowth eucalypt woodland is generally less than 15 m in height and estimated to be less than 20 years old. It was noted that all areas of regrowth had high levels of weeds, and would benefit from management.

Regulated Vegetation

The Project would result in the removal of 'Endangered' and 'Of Concern' REs which are MSES, as described in Section 4.1.3. Endangered and Of Concern REs that are proposed to be cleared in Stage 1 of the Project (Table 4-8) are all located within the Stage One Offset Area, as follows:

- Approximately 30 ha of RE 11.3.1 (listed as Endangered under the VM Act);
- Approximately 74 ha of RE 11.4.8 (listed as Endangered under the VM Act);
- Approximately 153 ha of RE 11.4.9 (listed as Endangered under the VM Act);
- Approximately 64 ha of RE 11.5.17 (listed as Endangered under the VM Act); and
- Approximately 501 ha of RE 11.3.2 (listed as Of Concern under the VM Act).

As shown in Table 4-8, the Project would also result in the removal of REs that intersect a wetland on the vegetation management wetlands map. Within the Stage One Offset Area, DPM Enviroscience (2018) has mapped approximately 23.5 ha of RE 11.3.27 and a further 4 ha of RE 11.5.17 that intersect a wetland (Table 4-10b).

Further to this, the Project would also remove REs within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map (Table 4-8). DPM Enviroscieces has mapped approximately 53 ha of REs associated with a watercourse within the Stage One Offset Area, providing an offset for this MSES.

The *Queensland Environmental Offsets Policy (Version 1.6)* requires an offset ratio of 1:4 which has been met, and in most cases exceeded, for each of the relevant MSES identified above.

Table 4-10a
Ground-truthed Regional Ecosystems within the Stage One Offset Area

Regional Ecosystem	Conservation Status[1]		Area (ha)
	VM Act	EPBC Act	
RE 11.3.1 Brigalow (*Acacia harpophylla*) and / or Belah (*Casuarina cristata*) open forest on alluvial plains.	E	Some patches represent the Brigalow Woodland TEC[2]	30
RE 11.3.2 Poplar Box (*Eucalyptus populnea*) woodland on alluvial plains.	OC	-	505
RE 11.3.25 Forest Red Gum (*Eucalyptus tereticornis*) or River Red Gum (*E. camaldulensis*) woodland fringing drainage lines.	LC	-	219
RE 11.3.27f Palustrine wetland, Coolabah (*Eucalyptus coolabah*) and / or Forest Red Gum (*E. tereticornis*) open woodland to woodland fringing swamps.	LC	-	23
RE 11.4.8 Dawson Gum (*Eucalyptus cambageana*) woodland to open forest with Brigalow (*Acacia harpophylla*) or blackwood (*A. argyrodendron*) on Cainozoic clay plains.	E	Some patches represent the Brigalow Woodland TEC[2]	73
RE 11.4.9 Brigalow (*Acacia harpophylla*) shrubby woodland with Yellowwood (*Terminalia oblongata*) on Cainozoic clay plains.	E	Some patches represent the Brigalow Woodland TEC[2]	154.5
RE 11.5.3 *Eucalyptus populnea +/- E. melanophloia +/- Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	LC	-	418.5
RE 11.5.9 *Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces			451
RE 11.5.17 Palustrine swamp with fringing Forest Red Gum (*Eucalyptus tereticornis*) woodland in depressions on Cainozoic sand plains and remnant surfaces.	E	-	63.5
RE 11.1.1 *Sporobolus virginicus* grassland on marine clay plains			12.5
		Non-Remnant Vegetation	**4,115**
		Total	**6,065**

Source: Appendix A.

[1] Conservation Status – E = Endangered; OC = Of Concern; NCP = No Concern at Present; LC = Least Concern.

[2] Patches of Brigalow Woodland TEC are shown on Figure 3-33.

Table 4-10b
Stage One Offset Area Reconciliation

Relevant Matter			Stage 1 Impact (ha)	Area within the Stage One Offset Area	Offset Requirement Satisfied
Matters of National Environmental Significance					
Ornamental Snake			506	854	Yes[1]
Australian Painted Snipe			21	86	Yes[1]
Squatter Pigeon (southern)			805.5	2,736	Yes[1]
Koala			826.5	2,736	Yes[1]
Greater Glider			826.5	2,736	Yes[1]
Matters of State Environmental Significance					
Regulated Vegetation	'Endangered' or 'of concern' regional ecosystems*; or	RE 11.3.1	2	30	Yes[2]
		RE 11.4.8	1	74	Yes[2]
		RE 11.4.9[A]	2.5	153	Yes[2]
		RE 11.5.17	5	64	Yes[2]
		RE 11.3.2	21.5	501	Yes[2]
	Regional ecosystems within mapped vegetation management wetlands		7	27.5	Yes[2]
	Regional ecosystems within the defined distance of a vegetation management watercourse		6	53	Yes[2]
Connectivity Areas			830.5	1,135	Yes[2]
Wetlands and Watercourses			9.5	38	Yes[2]

[A] 13 ha of this community is mapped as the Brigalow TEC under the EPBC Act

* The REs and species habitats overlap (i.e. the REs and habitats are not mutually exclusive).

[1] In accordance with the *EPBC Act Offsets Assessment Guide* (DSEWPaC, 2012b).

[2] In accordance with the *Queensland Environmental Offsets Policy* (Version 1.6) (DES 2018).

Connectivity

Stage 1 of the Project would remove approximately 830.5 ha of remnant vegetation which has been determined, as outlined in Section 3.1.3, to result in a significant impact to 'connectivity'. Pembroke would compensate for this impact through the regeneration of regrowth vegetation within the Stage One Offset Area.

Approximately 1,135 ha of regrowth eucalypt woodland is located within the Stage One Offset Area (Figure 4-7a).

The regrowth vegetation would be managed by Pembroke in order to return these areas to remnant woodland within 20 years. Should monitoring indicate that the natural regeneration is not progressing towards remnant status, Pembroke would undertake revegetation activities to assist in this process.

Wetlands

The Project would result in the removal or modification of HES wetlands (Table 4-8) which have been mapped as the palustrine wetland (vegetated swamp) wetland type.

The impact on these wetlands is proposed to be offset by four wetlands (totalling approximately 38 ha) within the Stage One Offset Area. These wetlands have been mapped as the palustrine wetland (vegetated swamp) habitat type (comprising 38 ha) (Table 4-10b).

Management Measures

Prior to the commencement of construction, Pembroke would develop an Offset Management Plan for the Project which would detail the following measures proposed to be undertaken within the Stage One Offset Area:

- feral animal control to reduce habitat degradation (particularly by feral pigs);
- reducing weed cover (reducing indirect threats that affect habitat quality);
- addition of species specific greater glider nest boxes (to improve sheltering habitat);
- conservation of gilgai areas with offset agreement and covenant on title to ensure long-term protection;
- removal of barbed wire fencing;
- implementation of controlled livestock grazing regimes to encourage natural regeneration of foraging trees and prevent further degradation of habitat; and

- fuel management to avoid high intensity bushfires.

Long-term conservation

Pembroke would seek to secure the Stage One Offset Area as a Nature Refuge, as requested by DNRME and DES during consultation regarding the Project.

Pembroke will submit a Notice of Election for the proposed Stage 1 Offset Area to DES at least three months prior to the commencement of that stage. Additional Notices of Election would then be submitted for subsequent stages.

The Notices of Election will be accompanied by reports from an appropriately qualified specialist that describes the estimated significant residual impact to each prescribed environmental matter for the upcoming stage, and the actual significant residual impact from the preceding stage, if applicable.

Reconciliation of the Stage One Offset Area against EPBC Act Environmental Offsets Policy

A reconciliation of the Stage One Offset Area against the EPBC Act Environmental Offsets Policy (SEWPaC, 2012) is provided in Table 4-11.

Table 4-11
Reconciliation of the Proposed Offset Strategy against EPBC Act Environmental Offsets Policy

Offset Principles*	Elements of the Project Offset that address these Requirements
Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environmental law and affected by the action.	The Stage One Offset Area has been specifically tailored to the protected matters relevant to Stage One of the Project (i.e. Ornamental Snake, Australian Painted Snipe, Squatter Pigeon [southern], Koala and Greater Glider) and would deliver an overall conservation outcome that improves or maintains the viability of each protected matter.
Be built around direct offsets but may include other compensatory measures.	The Commonwealth offset requirements for Stage One of the Project would be satisfied by the Stage One Offset Area.
Be in proportion to the level of statutory protection that applies to protected matter.	The Stage One Offset Area would provide for greater than 100% of the offset liability for each protected matter relevant to Stage One of the Project. This has been determined by applying the *EPBC Act Offsets Assessment Guide* (DSEWPC 2012b).
Be of a size and scale proportionate to the impacts on the protected matter.	The Stage One Offset Area would provide for greater than 100% of the offset liability for each protected matter relevant to Stage One of the Project. This has been determined by applying the *EPBC Act Offsets Assessment Guide* (DSEWPC 2012b). Given this, it is determined that the Stage One Offset Area would be of a suitable size and scale proportionate to the impacts of each protected matter.
Effectively account for and manage the risks of the offset not succeeding.	The *EPBC Act Offsets Assessment Guide* (DSEWPC 2012b), which has been applied to Stage One of the Project accounts for the risk of the offset not succeeding. In addition, measures to manage the Stage One Offset Area would provide for ongoing adaptive management in the unlikely event that the offset is not succeeding. The implementation of the offset strategy is likely to be a condition of Environmental Approval.
Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs.	The implementation of the offset strategy is beyond existing requirements, in that it is not part of any private conservation reserve system. The enduring protection that would be applied to the Stage One Offset Area would be new and additional under duty of care or any environmental planning laws.
Be efficient, effective, transparent, proportionate, scientifically robust and reasonable.	The Stage One Offset Area would efficiently and effectively compensate for the impacts on the protected matters and help maintain the viability of the protected matters. Flora and fauna surveys of the Stage One Offset Area have been undertaken to determine: • the area of the offset in comparison to the area of impact; • the nationally threatened fauna species present (or predicted to occur) and their conservation status; and • the connectivity and condition of the native vegetation / fauna habitat; and • management actions.
Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	Pembroke would seek to secure the offset area as a Nature Refuge, as requested by DNRME and DES during consultation regarding the Project. Further, the management of the Stage One Offset Area would be detailed within an Offset Management Plan.

Source: DPM Enviroscienes (2018a)

* *EPBC Act Environmental Offsets Policy* (SEWPaC, 2012a).

4.2 WATER QUALITY

Potential impacts of the Project on water quality have been considered in the following assessments:

- Groundwater Assessment, prepared by HydroSimulations (Appendix D);
- Surface Water Assessment, prepared by Hatch (Appendix E);
- Geomorphology Assessment, prepared by Fluvial Systems (Attachment A in Appendix E);
- Geochemistry Assessment, prepared by Terrenus Earth Sciences (Appendix L); and
- Aquatic Ecology Assessment, prepared by DPM Enviros ciences (Appendix C).

The Groundwater Assessment, Surface Water Assessment and Geochemistry Assessment have been peer reviewed by suitably qualified and experienced experts in their respective fields, including:

- Dr Frans Kalf (groundwater);
- Mr Tony Marszalek (surface water); and
- Dr Alan Robertson (geochemistry).

The peer review letters are provided in Attachment 4.

The Groundwater Assessment (Appendix D) has considered the cumulative drawdown impacts of the Project and surrounding mines (existing and approved), as well as the approved Bowen Gas Project.

The Surface Water Assessment (Appendix E) has included a cumulative assessment of catchment excision and controlled releases from both the Project and surrounding mines (existing and approved), as well as the approved Bowen Gas Project.

Section 4.2.1 provides a description of the environmental objectives and performance outcomes.

A description of existing local and regional water quality, including baseline data and the existing monitoring regime is provided in Section 4.2.2. Section 4.2.3 describes the potential impacts of the Project on groundwater and surface water quality including cumulative impacts and Section 4.2.4 outlines the proposed mitigation measures, management and monitoring.

4.2.1 Environmental Objectives and Performance Outcomes

The relevant environmental objectives as stated in the Terms of Reference for water quality are that the Project be operated in a way that:

(a) protects the environmental values of waters

(b) protects the environmental values of wetlands

(c) protects the environmental values of groundwater and any associated surface ecological systems

The corresponding Item 2 performance outcomes as stated in Schedule 5, Part 3, Table 1 of the *Environmental Protection Regulation 2008* to be achieved are provided in Table 4-12.

4.2.2 Description of Environmental Values

A range of environmental values have been nominated broadly for the three mapped areas across the Project area (Figure 4-8):

- Isaac northern tributaries;
- Isaac western upland tributaries; and
- Isaac and lower Connors River main channel.

All three mapped areas nominate the following environmental values:

- aquatic ecosystems;
- irrigation;
- farm supply/use;
- stock water;
- human consumption;
- primary recreation;
- secondary recreation;
- visual recreation;
- drinking water;
- industrial use; and
- cultural and spiritual values.

Only the Isaac western upland tributaries mapped areas have ‘aquaculture’ nominated as an environmental value.

The following sub-sections present a summary description of the baseline water quality data and the water quality of the local and regional surface water and groundwater resources to assist in describing the relevant environmental values and corresponding water quality objectives (WQOs) for the Project.

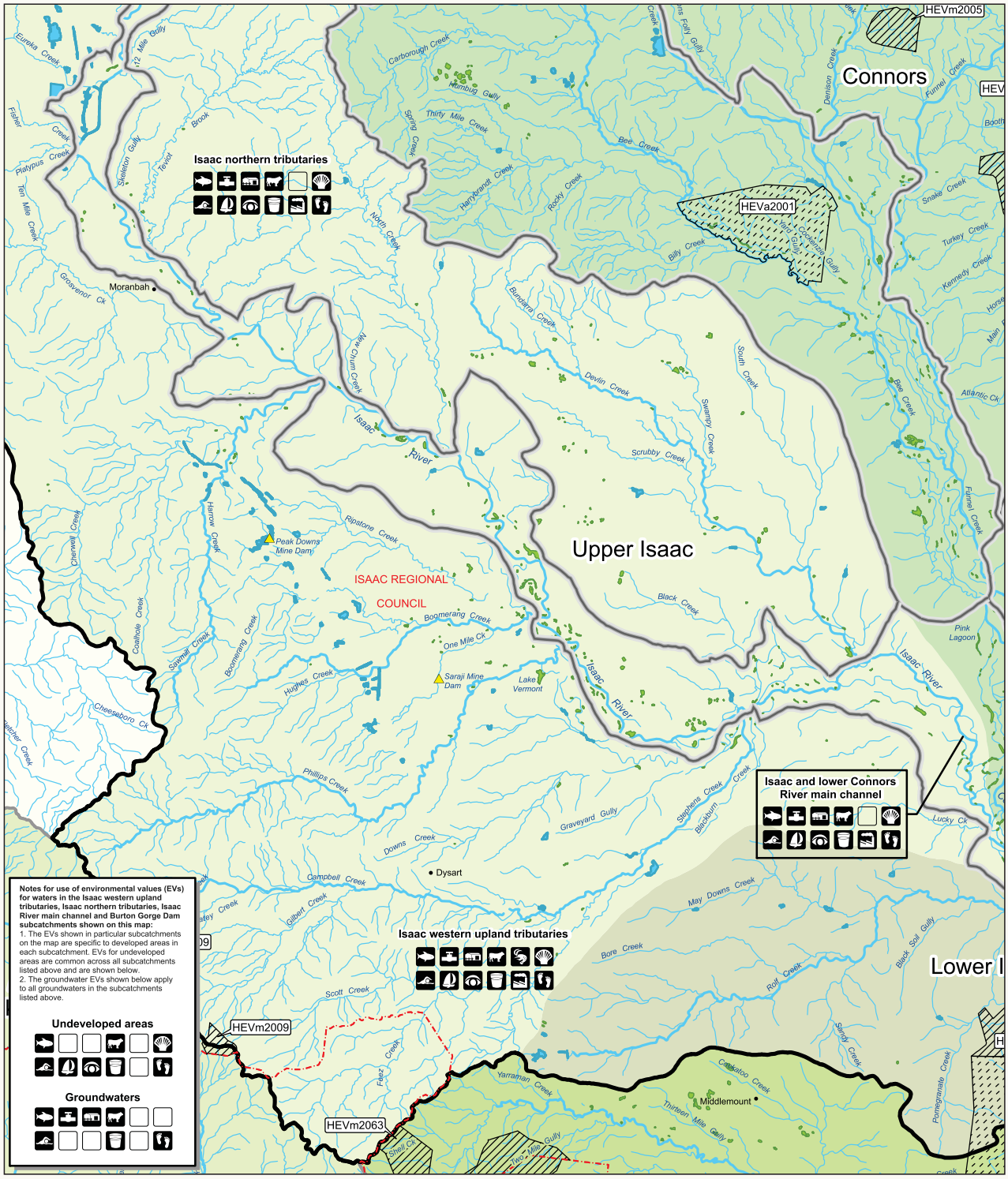
Table 4-12
Item 2 Performance Outcomes for Water, Wetlands and Groundwater

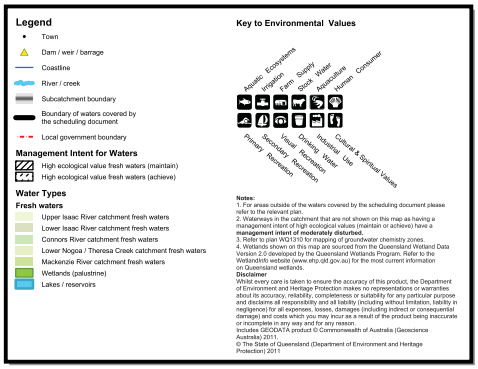
Schedule 5, Part 3, Table 1 of the Environmental Protection Regulation 2008	Project Achieved
Water – Performance Outcomes	
2 All of the following— *(a) the storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks;*	Yes (Section 4.2.4)
(b) contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water;	Yes (Section 4.2.3)
(c) the activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment;	Yes (Section 4.2.3)
(d) the disturbance of any acid sulfate soil, or potential acid sulfate soil, will be managed to prevent or minimise adverse effects on environmental values;	Yes (Section 4.10)
(e) acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered;	Yes (Sections 4.2.3, 4.2.4 and 4.10)
(f) any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland;	Yes (Sections 4.2.3 and 4.2.4)
(g) for a petroleum activity, the activity will be managed in a way that is consistent with the coal seam gas water management policy, including the prioritisation hierarchy for managing and using coal seam gas water and the prioritisation hierarchy for managing saline waste;	N/A
(h) the activity will be managed so that adverse effects on environmental values are prevented or minimised.	Yes (Section 4.2.4)
Wetlands – Performance Outcomes	
2 The activity will be managed in a way that prevents or minimises adverse effects on wetlands.	Yes (Section 4.2.3)
Groundwater – Performance Outcomes	
2 The activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems. ***Note** – Some activities involving direct releases to groundwater are prohibited under section 63 of this regulation.*	Yes (Section 4.2.4)

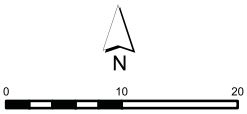
Baseline Water Quality Datasets

Water quality data has been collected and analysed from a number of different sources during the assessment of the Project including (Figure 4-9):

- a range of recorded physio-chemical parameters, including continuous monitoring for select analytes, at the Deverill gauging station on the Isaac River (DNRME) (since 1964);
- upstream surface water quality results for the Isaac River presented as part of the Red Hill Mining Lease EIS (2010-11);
- upstream surface water quality results for North Creek presented as part of the Moorvale Coal Project EIS (2000);
- surface water quality results presented in receiving environment monitoring reports for the Saraji Mine (e.g. Isaac River, Phillips Creek and Hughes Creek [draining to Boomerang Creek]) (Gauge, 2017a; 2017b), Peak Downs Mine (e.g. Isaac River, Boomerang Creek, Ripstone Creek and Cherwell Creek) (Gauge, 2014; 2017c) and Lake Vermont Mine (e.g. Isaac River and Phillips Creek) (AARC, 2012; 2017; and GHD, 2016);
- downstream surface water results for the Isaac River and Phillips Creek presented as part of the Lake Vermont Northern Extension EIS (2013);
- continuous (sub-daily) logger records for pH, EC and temperature at the downstream ISDS gauging station on the Isaac River (since late 2016);







Projection: Mercator

Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

Source: Queensland Government (2013)

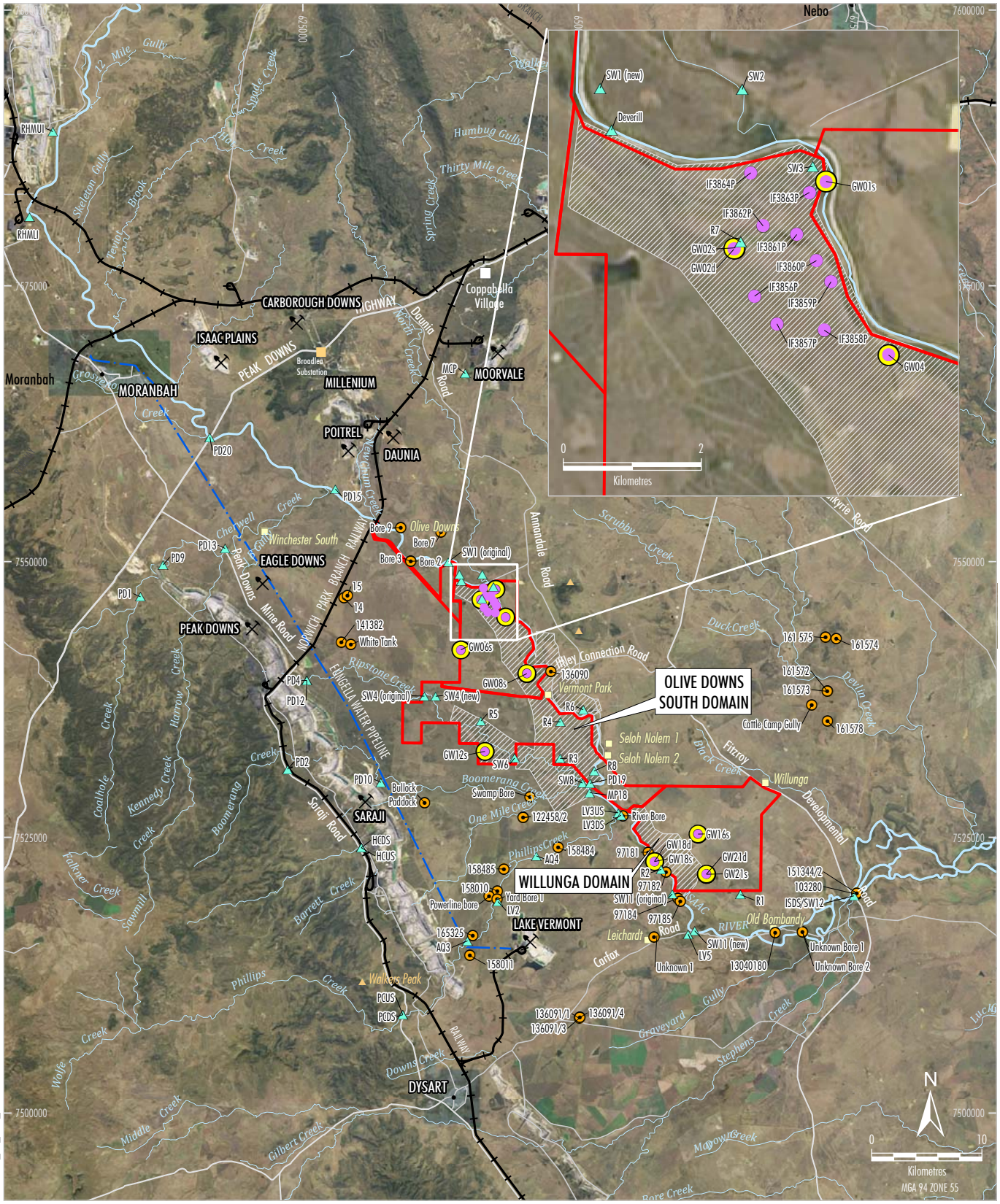
PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Environmental Values – Water Quality (Isaac River Sub-basin)

Figure 4-8

PRN-16-02_EIS_Sect 3_0144



PRN-16-02_EIS_Sect4_213B

LEGEND

- Mining Lease Application Boundary
- Approved/Operating Coal Mine
- Eungella Pipeline Network
- Railway
- Dwelling
- TEM Survey Approximate Extent
- Groundwater Quality Monitoring Site
- Sampled Groundwater Bore
- Stygofauna Sampling Site
- Surface Water Quality Monitoring Site

Source: Geoscience Australia - Topographical Data 250K (2006)
Department of Natural Resources and Mines (2016)
Orthophotography: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Water Quality Monitoring - Baseline Data

Figure 4-9

- surface water quality results during the opportunistic baseline sampling campaign for the Project (during 2017 and 2018) including sites on the:
  - Isaac River (SW1; SW2; SW3; SW8; SW11; SW12); and
  - Ripstone Creek (SW4; SW6).
- surface water quality results during the aquatic ecology surveys conducted in December 2016 and July 2017 by DPM Enviros ciences including sampling sites on the:
  - Isaac River (R2; R6; R8);
  - Ripstone Creek (R5); and
  - unnamed tributaries and riverine wetlands of the Isaac River and Ripstone Creek (R1; R3; R4; R7).
- groundwater quality results during the stygofauna sampling conducted by DPM Enviros ciences (Appendix C);
- groundwater quality sampling undertaken at 43 bores as part of the Bore Census for the Project in 2017 by ENRS (Appendix D);
- groundwater quality sampling undertaken as part of the groundwater investigation program (commencing in early 2017), including sampling of:
  - 15 tertiary/alluvial standpipe installations (GW01s; GW02s; GW04; GW06s; GW08s; GW12s; IF3856P-IF3864P) at the Olive Downs South domain;
  - three tertiary/alluvial standpipe installations (GW16s; GW18s; GW21s) at the Willunga domain;
  - two coal measure standpipe installations (GW18d; GW21d) at the Willunga domain; and
  - one coal measure standpipe installation (G02d) at the Olive Downs South domain;
- groundwater (resistivity) data from the transient electromagnetic (TEM) survey conducted by Groundwater Imaging (Appendix D); and
- groundwater sampling and quality analysis undertaken by DPM Enviros ciences as part of the stygofauna assessment included, as part of the Aquatic Ecology Assessment (Appendix C).

Regional Surface Water Quality

The Isaac River is the surface water resource of regional relevance to the Project. Further downstream, the Isaac River converges with the Connors River and then the Mackenzie River which joins the Fitzroy River and ultimately flows to the eastern coast of Australia (i.e. Keppel Bay near Rockhampton).

Water quality data is available for the Isaac River at locations upstream, adjacent and downstream of potential influences of the Project.

Collation and comparison of available regional water quality data for the Isaac River at the Deverill and Yatton gauging stations, and further upstream at the Red Hill Mining Lease, are included in the Surface Water Assessment (Appendix E). Available datasets presented in receiving environment monitoring reports for the Saraji Mine, Peak Downs Mine and Lake Vermont Mine have also been considered.

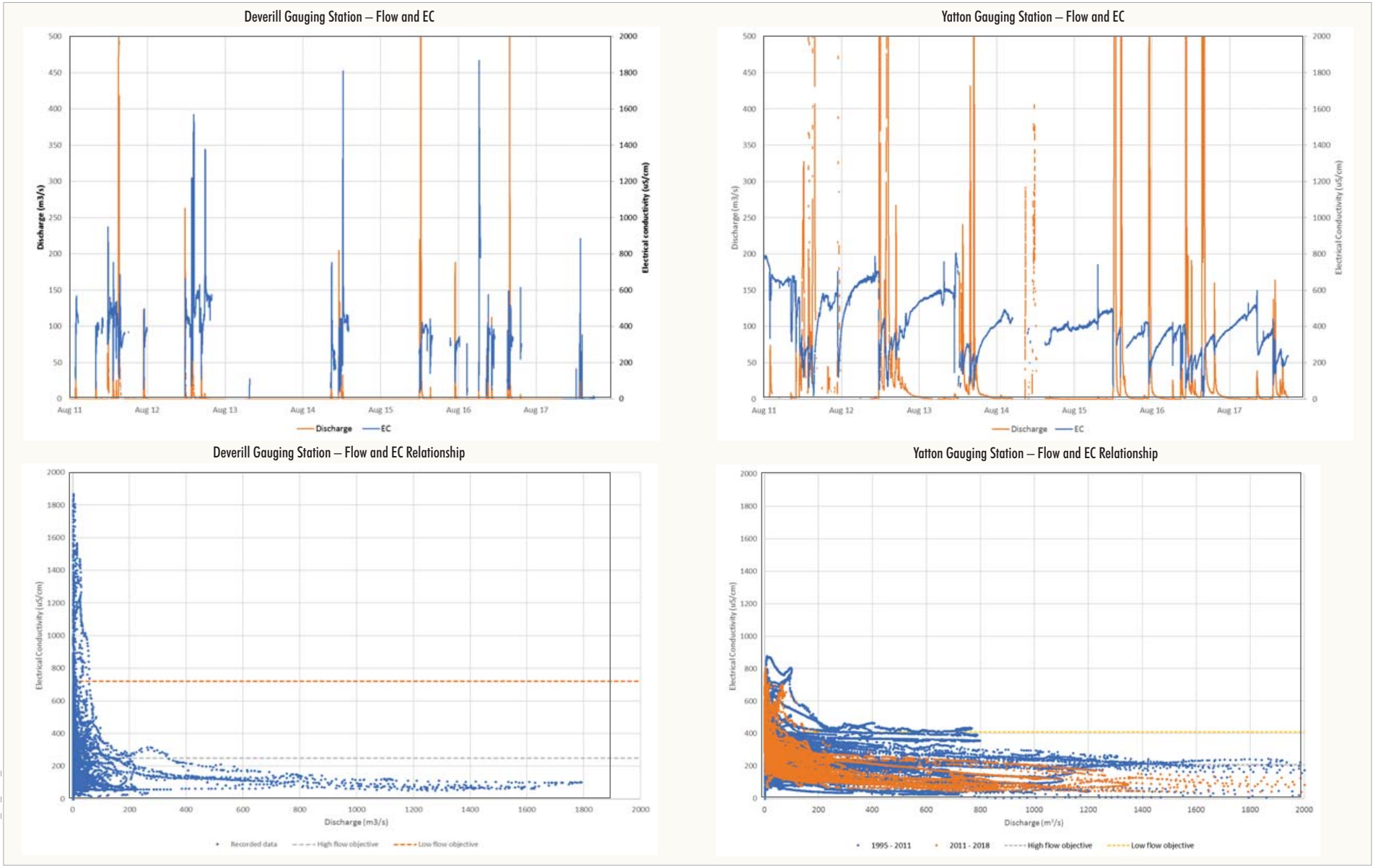
Electrical Conductivity – Isaac River

The Deverill gauging station is located near the upstream boundary of the Project and would be representative of water quality that drains past the site. The Yatton gauging station is located downstream of the Connors River confluence but includes mining releases from all mines within the Isaac River catchment.

A time history of recorded instantaneous EC and stream flow for the Isaac River at the Deverill gauging station from 2011 is presented on Figure 4-10. The relationship between instantaneous flow and EC is also shown on Figure 4-10.

The data collected by DNRME at the Deverill gauging station spans the period from 2011 to 2018 and indicates (Appendix E):

- The EC for high flows greater than 200 m^3/s are generally below the high flow WQO EC of 250 µS/cm.
- The EC of instantaneous flows below 100 m^3/s vary significantly from 50 µS/cm to 1,870 µS/cm with many flow events exceeding the low flow WQO EC of 720 µS/cm.
- The mean daily EC has exceeded the low flow WQO on a total of 23 days over this period and all of these days experienced some flow (not stagnant flow).



PRN-16-02_EIS_Sect 3_015A

Source: Hatch (2018)

A time history of recorded instantaneous EC and stream flow for the Isaac River at Yatton gauging station from 2011 is presented on Figure 4-10. The relationship between instantaneous flow and EC recorded from 1995 to 2011 as well as from 2011 to 2018 is shown on Figure 4-10. The results indicate (Appendix E):

- The EC for high flows greater than 200 m^3/s vary much more than at Deverill but are generally below 400 µs/cm.
- The high flow EC since 2011 has generally been below the high flow WQO.
- The low flow EC has frequently been above the low flow WQO of 410 µS/cm. EC rises during extended baseflow periods, which would be associated with either the Connors River or an increase in baseflow in the reach between Deverill and Yatton gauges.
- The recorded low flow EC is generally less than at Deverill.

Sub-daily monitoring data recorded at the ISDS gauging station on the Isaac River downstream of the Project since late 2016 is also presented in the Surface Water Assessment (Appendix E). The recorded EC was within the Isaac River WQOs (i.e. less than 720 µs/cm) for most of the event, however there was a period of elevated EC including a spike of around 3,100 µs/cm on 6 April 2017. This spike occurred for about 12 hours and was not recorded at the Deverill gauging station. The cause of this spike in EC is not known, but is likely due to the release of water from an operating mine between the Deverill and ISDS gauges (Appendix E).

According to the DES website, ten coal mines upstream of the ISDS gauge released to the Isaac River catchment during this period.

There was a second short period of elevated EC in May 2017 that exceeded the Isaac River WQOs. However, there were no recorded releases upstream of the gauge during this period.

The baseline datasets show that the water quality in the Isaac River during and after significant flow events has exceeded the Isaac River WQOs in the past for short periods of time due to releases from operating coal mines. However, for the most part, the water quality in the Isaac River is within the WQOs.

Local Surface Water Quality

Local surface water quality sampling has been undertaken as a component of the baseline surface water and aquatic assessments for the Project.

Analyses for a range of physio-chemical parameters were completed at a number of sites along the Isaac River and its local tributaries including (Figure 4-9):

- Isaac River [upstream] (SW1-Original; SW1-New; and SW3);
- North Creek (SW2);
- Ripstone Creek (SW4-Original; SW4-New; and SW6);
- Boomerang Creek (SW8); and
- Isaac River [downstream] (SW11-Original; SW11-New; and SW12).

It is however noted that the majority of the samples taken during the baseline campaign were from pooled water as no flow was present at the time of the sampling rounds.

The above sampling sites were supplemented by surface water quality sampling events conducted as part of the aquatic surveys in December 2016 and July 2017 at a number of local riverine sites including (Figure 4-9):

- Isaac River [adjacent] (R2; R6; and R8);
- Ripstone Creek (R3; and R5); and
- other unnamed tributaries draining to the Isaac River (R1; R4; and R7).

The datasets collected as part of the baseline surface water and aquatic assessments for the Project were augmented with the surface water quality data presented as part of the Moorvale Coal Project EIS (2000) for North Creek, as well as that presented as part of the Lake Vermont Northern Extension EIS (2013) including Phillips Creek sites (AQ3; AQ4; and MP3) (Figure 4-9).

A comprehensive suite of the local surface water quality results is presented in Appendix E, including comparisons to relevant WQOs (discussed further below).

Groundwater Quality

An analysis of water quality attributes of groundwater within the Project area and surrounds is provided in Appendix D.

Available water quality data has been compared to the:

- Fitzroy Basin Zone 34 groundwater quality objectives for deep and shallow water;
- Australian Drinking Water Guidelines (ADWG) (NHMRC 2011); and
- ANZECC (2000) guidelines for aquatic ecosystems, irrigation (long term and short term) and stock water supply.

The main geological units include alluvium, regolith and interburden (sandstone/ siltstone) and coal of the Permian aged coal measures and are discussed below.

Alluvium

While water within the Isaac River is largely fresh, water within the alluvium has recorded ranges from fresh to moderately saline with an average TDS of 1,458 mg/L, ranging between 201 mg/L and 3,430 mg/L. Alluvium groundwaters can be classified as Na-Ca or Na-Mg type water, and are higher in bicarbonate than the other groundwater units (Appendix D).

Spatial distribution of TDS depicts all fresh water quality localised along the Isaac River, with brackish to moderately saline water along the river and tributaries. However, salinity within the alluvium can be highly variable spatially. Results for government alluvial bore RN13040180 indicates EC can range between 199 µS/cm and 7,400 µS/cm (fresh to moderately saline). By comparison, EC as recorded at the Deverill gauging station since 2011, ranges between 49 µS/cm and 1,173 µS/cm (fresh to brackish).

The water quality data for the alluvium occasionally shows an inverse correlation in EC to rainfall residual mass curve, with rising EC recorded during periods of declining/below average rainfall and vice versa (Appendix D).

Comparing the available data to relevant guideline levels, the summary results indicate that water within the Quaternary alluvium is generally suitable for stock water supply and irrigation. However, the alluvial groundwater generally exceeds guideline levels for drinking water (i.e. TDS, chloride and sodium) and freshwater aquatic systems. The alluvial groundwater also records concentrations of total and dissolved copper above the WQOs for Zone 34 (shallow) (Appendix D).

Regolith

Water within the regolith material is generally highly saline, but can be brackish to moderately saline with an average TDS of 9,757 mg/L, ranging between 1,460 mg/L and 18,600 mg/L. The proportion of chloride is higher within the regolith material, which can be classified as Na-Cl-SO_4 or Na-Cl-HCO_3 type water (Appendix D).

Water within the regolith material exhibits poorer quality compared to the alluvium and is not considered a suitable groundwater resource for livestock, irrigation, drinking water or aquatic ecosystems. The water within regolith material also exceeds the WQOs (Zone 34 –shallow) for EC, chloride, calcium, sodium, hardness, magnesium, sulfate, copper and manganese (Appendix D).

Coal Measures (Interburden and Coal)

Water within the Permian coal measures can range between fresh and highly saline, but is generally saline within the coal seams, and brackish to moderately saline within the interburden units. Coal seam units of the Permian coal measures recorded an average TDS of 7,402 mg/L, ranging between 2,544 mg/L and 14,700 mg/L. The interburden units of the Permian coal measures recorded an average TDS of 4,746 mg/L, ranging between 421 mg/L and 18,400 mg/L. The Permian coal measures generally contain Na-Cl type water, with some also recording a high proportion of Mg but with very little sulphate compared to the other groundwater units (Appendix D).

As expected, the salinity within the coal measures appears to increase with depth. Bores within the coal measures near the sub-crop areas in the west of the Project area generally record moderately saline water quality, which increases to saline quality where the coal measures are deepest near the Isaac River. This corresponds with the coal measures being largely recharged by rainfall where they occur at sub-crop (Appendix D).

Water within the siltstones and sandstones of the Permian coal measures is generally suitable for stock water supply, with the exception of some TDS concentrations exceeding guideline levels for pigs and poultry. In contrast, groundwater within the coal seams generally exhibits a higher TDS, which, on average, is higher than the guideline level for beef cattle but below the guideline level for sheep.

Comparison of results to the guideline levels indicates the coal measures are not considered a suitable groundwater resource for irrigation, drinking water or aquatic ecosystems. Groundwater within the coal measures (coal and interburden) record concentrations of manganese and iron above the WQOs (Zone 34 –shallow) (Appendix D).

Project Water Quality Objectives (Draft)

Draft WQOs have been developed for the Project for each physical and chemical parameter, based on a review and consideration of:

- the lowest WQO for each relevant environmental value; and
- the available baseline water quality datasets.

Where the available baseline water quality datasets demonstrate clearly that the lowest WQO could not be achieved, an alternative WQO has been derived.

Where there remains substantial ambiguity, the lowest WQO has been adopted as the default, until such time as ongoing baseline datasets are available to derive an alternative WQO.

The draft water quality objectives for the Project are presented in Table 4-13.

4.2.3 Potential Impacts

The assessment of impacts on water quality in the Surface Water Assessment (Appendix E) and Groundwater Assessment (Appendix D) has been conducted in accordance with the DEHP Guideline ESR/2015/1837: *Application Requirements for Activities with Impacts to Water*. The *Technical Guideline – Wastewater Release to Queensland Waters*.

Surface Water Quality

Potential impacts of the Project on surface water quality include the reduction in surface water quality due to uncontrolled runoff from disturbed areas and/or release of contaminants, drainage/seepage from waste rock and/or coal reject emplacements, alteration of groundwater quality (including the potential to affect surface water resources), and/or controlled releases. Each of these potential impacts is discussed below.

Runoff and Contaminants

Land disturbance associated with mining activities has the potential to adversely affect the quality of surface runoff by increasing sediment loads from waste rock and coal reject emplacement areas and releasing mine affected water with high salt loads.

Water management, erosion and sediment controls (e.g. sediment dams) and other land contamination controls that would be applied to the Project are described in Sections 2.7 and 4.10. Acid rock drainage potential is described in the following sub-section.

The Project water balance model was used to assess the risk of uncontrolled releases from the mine affected water management system. No uncontrolled releases to the Isaac River were modelled (Appendix E).

To achieve the ‘no mine affected water storage uncontrolled release’ objective, the Project would be operated such that water could be temporarily stored in the active open cut pit if required (e.g. as a result of exceedance of the design capacity of the water management system). Alternatively, Pembroke would construct additional pit water dams ahead of mining in the Olive Downs South domain to temporarily store any excess mine affected water until there is sufficient out-of-pit storage available.

An overflow could therefore only occur during an extreme rainfall event which would also generate significant volumes of runoff from the surrounding undisturbed catchment, as well as in the receiving waterways. Hence it is unlikely that mine affected dam overflows would have a measurable impact on receiving water quality and therefore the environmental values (Appendix E).

The proposed water management system would have a negligible impact on Wetland Protection Areas located adjacent to the Project area.

In the operational phase, progressive rehabilitation of the waste rock emplacements would minimise the potential generation of sediment.

Table 4-13
Draft Water Quality Objectives for the Project

Physio-chemical Parameter	Draft WQO	Relevant Environmental Value
pH	6.5-8.5	Aquatic Ecosystem
Conductivity (EC) – Baseflow	< 720 µS/cm	Aquatic Ecosystem
Conductivity (EC) – High flow	< 250 µS/cm	Aquatic Ecosystem
Total Dissolved Solids	< 2,000 mg/L	Stock Watering
Total Hardness (as $CaCO_3$)	< 150 mg/L	Drinking Water
Suspended Solids	< 55 mg/L	Aquatic Ecosystem
Sodium	< 30 mg/L	Drinking Water
Sulphate	< 25 mg/L	Aquatic Ecosystem
Turbidity	< 50 NTU	Aquatic Ecosystem
Colour	50 Hazen Units	Drinking Water
Dissolved Oxygen	85-110% Saturation	Aquatic Ecosystem
	> 4 mg/L (at surface)	Drinking Water
Iron	< 10 mg/L	Irrigation
Manganese	< 10 mg/L	Irrigation
	< 1.9 mg/L	Aquatic Ecosystem
Aluminium	< 5 mg/L	Stock Watering
	<0.055 mg/L	Aquatic Ecosystem
Boron	< 5 mg/L	Stock Watering
	< 0.37 mg/L	Aquatic Ecosystem
Zinc	< 5 mg/L	Irrigation
	< 0.008 mg/L	Aquatic Ecosystem
Lithium	< 2.5 mg/L	Irrigation
Fluoride	< 2 mg/L	Irrigation
Arsenic	< 2 mg/L	Irrigation
	< 0.5-5 mg/L	Stock Watering
	< 0.024 mg/L	Aquatic Ecosystem
Chromium	< 1 mg/L	Stock Watering
	< 0.001 mg/L	Aquatic Ecosystem
Copper	< 1 mg/L	Stock Watering (Cattle)
	< 0.0014 mg/L	Aquatic Ecosystem
Nickel	< 1 mg/L	Stock Watering
	< 0.011 mg/L	Aquatic Ecosystem
Beryllium	< 0.5 mg/L	Irrigation
Vanadium	< 0.5 mg/L	Irrigation
Cobalt	< 0.1 mg/L	Irrigation
Lead	< 0.1 mg/L	Stock Watering
	< 0.0034 mg/L	Aquatic Ecosystem
Uranium	< 0.1 mg/L	Irrigation
Molybdenum	< 0.05 mg/L	Irrigation
Selenium	< 0.02 mg/L	Stock Watering
	< 0.005 mg/L	Aquatic Ecosystem
Cadmium	< 0.01 mg/L	Stock Watering
	<0.0002 mg/L	Aquatic Ecosystem
Mercury	< 0.002 mg/L	Irrigation
	< 0.00006 mg/L	Aquatic Ecosystem
Total Nitrogen	< 500 µg/L	Aquatic Ecosystem

Table 4-13 (Continued)
Draft Water Quality Objectives for the Project

Physio-chemical Parameter	Draft WQO	Relevant Environmental Value
Organic Nitrogen	< 420 µg/L	Aquatic Ecosystem
Oxidised Nitrogen	< 60 µg/L	Aquatic Ecosystem
Total Phosphorus	< 50 µg/L	Aquatic Ecosystem
Filterable Reactive Phosphorus	< 20 µg/L	Aquatic Ecosystem
Ammonia Nitrogen	< 20 µg/L	Aquatic Ecosystem
Chlorophyll a	< 5 µg/L	Aquatic Ecosystem

Source: after Hatch (2018a).

An Erosion and Sediment Control Plan would be developed and implemented throughout construction and operations.

If implemented effectively, environmental risks from disturbed area runoff are expected to be low (Appendix E).

In rainfall events below the design standard, runoff from disturbed areas would be intercepted and treated by sediment dams. In larger events that exceed the design standards, these dams would overflow following a period of settlement treatment.

Available geochemical information indicates that the runoff draining to the sediment dams should have low salinity. Overflows would only occur during significant rainfall events which would also generate runoff from surrounding undisturbed catchments. Hence it is unlikely that sediment dam overflows would have a measurable impact on receiving water quality or environmental values (Appendix E).

Geochemistry (Drainage and Seepage)

A Geochemistry Assessment was conducted by Terrenus Earth Sciences (2018) and is presented in Appendix L. The assessment was undertaken to evaluate the geochemical nature of potential spoil and coal reject materials likely to be produced from the Project (particularly during the first 10 years of mining operation) and to identify any environmental issues that may be associated with mining, handling and storing these materials. Based on the geochemical testwork, waste rock is expected to:

- be overwhelmingly non-acid forming (NAF) with excess acid neutralising capacity (ANC) and have a negligible risk of developing acid conditions; and
- generate relatively low-salinity surface runoff and seepage with low soluble metals concentrations.

Overall, the geochemical assessment found that approximately 70% of potential coal reject material has essentially no risk associated with acid generation, with the remaining 30% of coal reject material having a relatively low degree of risk associated with potential acid generation. The material has a low sulphur (and sulphide) concentration and low metals/metalloids concentrations (Appendix L). By comparison to the life of mine waste rock material (in the order of 9,000 Mbcm), the total proportion of coal rejects would be less than 2%.

The magnitude of any localised acid, saline or metalliferous drainage would be buffered by the presence of the alkaline NAF spoil. As a bulk material (of relatively small total quantity), coal reject is regarded as posing a generally low risk of environmental harm and health-risk (Appendix D).

It is important to note that the results from the geochemical assessment represent an ‘assumed worst case’ scenario as the samples are pulverised prior to testing, and therefore have a very high surface area compared to materials in the field and do not account for mixing during emplacement.

Notwithstanding, appropriate management practices have been recommended and would be adopted for the handling and placement of coal rejects as summarised in Section 4.2.4.

Controlled Releases

Controlled releases would be conducted in accordance with the proposed controlled release strategy described in Section 2.7.6.

The outcomes from the water balance modelling indicate that the proposed controlled release strategy would achieve the regional WQOs for the Isaac River and therefore not impact on its environmental values (Appendix E). As shown on Figure 4-11, the modelled downstream EC in the Isaac River (for median climatic conditions) is below the receiving water contaminant trigger level of 700 µS/cm on all controlled release days (Appendix E).

Controlled releases would not occur within Wetland Protection Areas located adjacent to the Project area.

Rehabilitated Mine Landforms

As described in Section 5, sediment dams would be retained until the revegetated surface of the waste rock emplacements are stable and runoff water quality reflects runoff water quality from similar undisturbed areas, at which time these controls would be removed and the areas would be free-draining.

Alteration of Groundwater Quality

Workshops and Storages

There is considered to be limited potential for groundwater contamination to occur with relation to workshops and fuel/chemical storage areas as each would be developed in accordance with current Australian Standards (including adequate bunding and equipped for immediate spill clean-up).

Out-of-Pit Waste Rock Emplacement Areas

As the mine progresses, waste rock material would be placed within selected out-of-pit emplacement areas. The out-of-pit waste rock emplacement areas may produce seepage as a result of rainfall inundation.

Runoff from disturbed areas outside the open cut pits and infrastructure areas, such as waste rock emplacement areas (both active and under rehabilitation) would be captured in the sediment dams and managed under the mine water management system. The system would be designed to capture and reuse water on-site, with the only offsite discharge being via approved controlled release points.

The waste rock material exhibits similar to improved water quality compared to water within regolith material (Appendix D). While the waste rock material generally exhibits poorer water quality compared to the alluvium, the Cainozoic sediments generally comprise surficial soil and clays, up to 10 m in thickness.

Where the low permeability surficial clays are present, they would inhibit potential seepage from the waste rock emplacement to the underlying regolith and alluvium (Appendix D).

In-Pit Waste Rock Emplacement Areas

The in-pit waste rock emplacement areas would be rehabilitated progressively as the mine develops. The mine plan includes fully backfilling Pits ODS1 ODS2, ODS4, ODS5, ODS6 and ODS9, as well as partial backfilling areas of Pits ODS3 and ODS7/ODS8. Similarly, the mine plan for the Willunga domain includes fully backfilling Pits WIL1, WIL2, WIL3 and WIL4 and partially backfilling Pit WIL5.

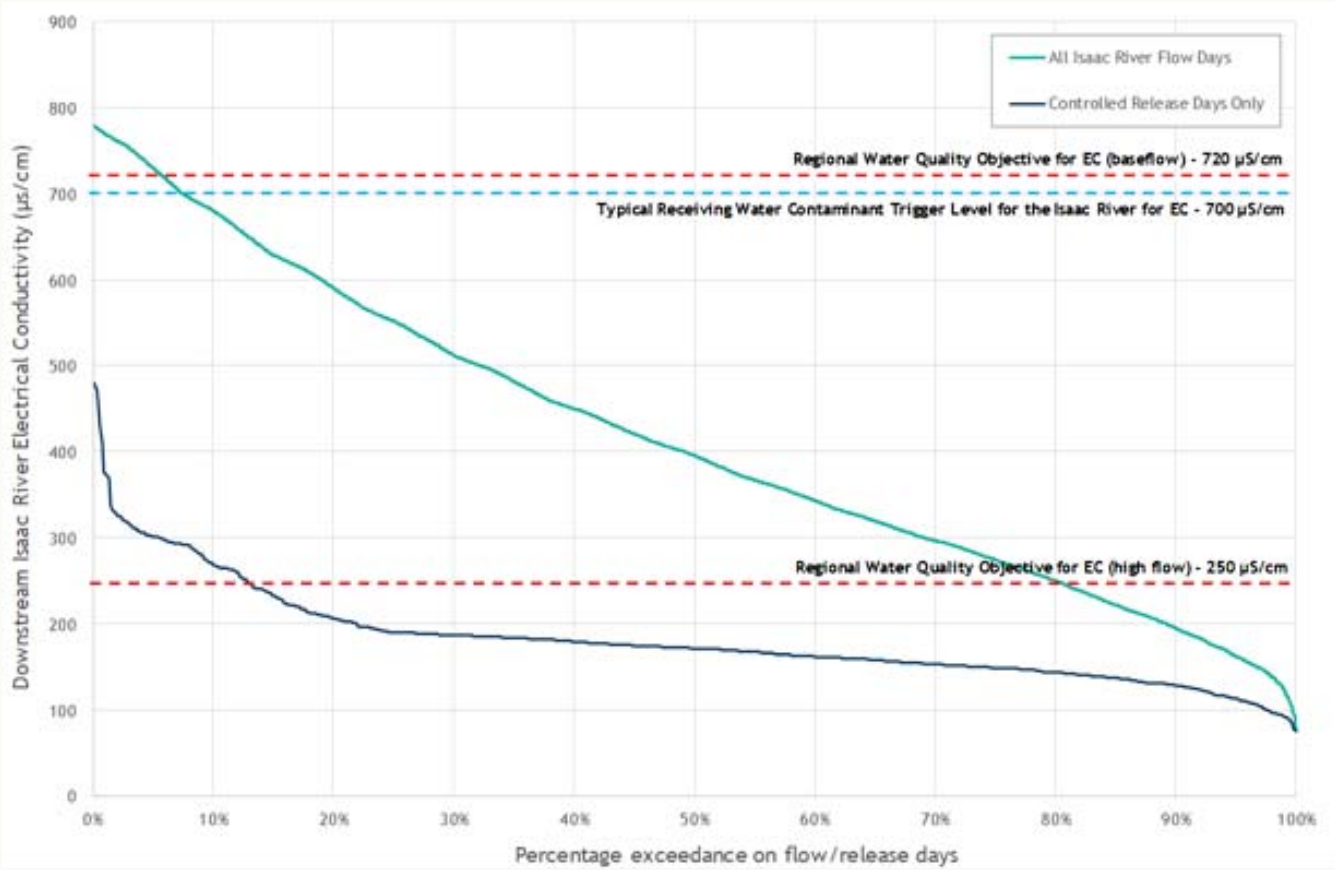
Groundwater within the backfilled pit at the northern end of the Olive Downs South domain (Pit ODS1) and the backfilled pit at Willunga (Pit WIL1) are predicted to recover back towards pre-mining levels (Appendix D).

The waste rock material exhibits similar to improved water quality compared to groundwater within the Permian coal measures and regolith material. While the waste rock material generally exhibits poorer water quality compared to the alluvium, the groundwater levels would either remain below the base of the alluvium or, in cases where above the base of the alluvium, the hydraulic gradient would not exist to enable interaction between water in the in-pit waste rock material and surrounding alluvium (Appendix D).

Final Voids

Within the Olive Downs South domain, two final voids are proposed, one at Pit ODS3 and one within Pits ODS7/ODS8. The two voids are separated by waste rock material, which enables flow-through from Pit ODS3 towards Pits ODS7/ODS8.

Modelling determined that the void water levels could recover back to approximately 80 mAHD in Pit ODS3, and to 25 mAHD in Pits ODS7/ODS8. The recovered levels in Pits ODS3 and ODS7/ODS8 are around 65 m and 140 m below the pre-mining groundwater level, which means these final voids would act as a sink to groundwater flow (Appendix D).



PRN-16-02_EIS_Sect 3_016A

Source: Hatch (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Modelled Downstream Water Quality – Isaac River Median Climatic Conditions

Figure 4-11

Within the Willunga domain, one final void is proposed within the WIL5 pit area, with modelling predicting a final void pit lake level of around 63 mAHD. Based on this, groundwater levels would remain over 77 m below the pre-mining groundwater level, which means the final void would act as a sink to groundwater flow (Appendix D).

Water within these final voids would evaporate from the lake surface and draw in groundwater from the surrounding geological units. Evaporation from the lake surface would concentrate salts in the lake slowly over time. This gradually increasing salinity would not pose a risk to the surrounding groundwater regime as the final voids remain permanent sinks (Appendix D).

Cumulative Impacts – Releases

As described above, the site water management system has been designed such that the risk of off-site uncontrolled release of mine affected water during operations is very low and sediment inputs can be controlled through drainage, and erosion and sediment control measures. On this basis, the Project is not expected to make any significant contribution to cumulative sediment loads in the Fitzroy River Basin (Appendix E).

It is also noted that any coal seam gas water that may be released into the Isaac River by the Bowen Gas Project would have an insignificant effect on the receiving environment (Appendix E).

Water balance simulation of the final voids post-mining shows that the water surface is expected to reach an equilibrium water level well below the void overflow level and regional water table and would remain a groundwater sink (Appendix E).

The development of the proposed controlled release strategy to the Isaac River has been based on the existing release conditions for nearby operating coal mines.

The release conditions have been developed by the regulators within an overarching strategic framework for the management of the cumulative impacts of water releases from mining activities and are therefore expected to have negligible cumulative impact on surface water quality and associated environmental values (Appendix E).

4.2.4 Mitigation Measures, Management and Monitoring

Water Management System

As described in Section 2.7.1, key water quality related objectives of the Project water management system are to maintain separation between runoff from areas undisturbed by mining and water generated within active mining areas where practicable, and to design and operate the mine such that there is no uncontrolled mine affected water overflow to the receiving environment.

Sizing of sediments dams would be designed in accordance with the Best Practice Erosion and Sediment Control guideline (IECA, 2008) and an Erosion and Sediment Control Plan would be developed and implemented throughout construction and operations.

Surface Water Monitoring Program

Monitoring of surface water quality both within and external to the mine site would form a key component of the surface water management system. Monitoring of upstream, onsite and downstream water quality would assist in demonstrating that the site water management system is effective in meeting its objective to protect the integrity of local and regional water resources and allow for early detection of any impacts and appropriate corrective action.

The surface water monitoring protocols would:

- be implemented to comply with the Project Environmental Authority;
- provide valuable information on the performance of the water management system; and
- facilitate adaptive management of water resources on the site.

Surface runoff and seepage from ROM and product coal stockpiles would be monitored for ‘standard’ water quality parameters including, but not limited to, pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids.

Sediment Dam Monitoring

Surface runoff and seepage from waste rock emplacements, including any rehabilitated areas, would also be monitored for 'standard' water quality parameters including, but not limited to, pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/ metalloids.

The sediment dam monitoring would be used to validate the anticipated quality of water runoff reporting to sediment dams and haul road runoff dams. Initially, the sediment dam monitoring would occur on a regular (e.g. monthly) basis to demonstrate the water quality of stored waters is consistent with the relevant operating parameters to allow releases from sediment dams to occur when required. Subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the sediment dam monitoring would be reviewed and updated accordingly (e.g. to occur only when releases occur).

Controlled Releases

Controlled releases would be conducted in accordance with the proposed controlled release strategy described in Section 2.7.6.

Management and Monitoring of Waste Rock and Coal Rejects (Drainage and Seepage)

Waste Rock Emplacements

Waste rock is expected to be overwhelmingly NAF with excess ANC, and to have a negligible risk of developing acid conditions. Furthermore, waste rock is predicted to generate low to moderate-salinity surface runoff and seepage with low soluble metal/metalloid concentrations (Appendix L). Notwithstanding, Pembroke would undertake validation testwork of potential waste rock materials from the Willunga domain as the Project develops to enable appropriate spoil management measures to be planned and implemented as required.

Further, surface runoff and seepage from waste rock piles, including any rehabilitated areas, would be monitored for 'standard' water quality parameters including, but not limited to, pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/ metalloids.

It is however noted that some waste rock materials may be sodic (to varying degrees) with potential for dispersion and erosion (to varying degrees) (Appendix L). Where highly sodic and/or dispersive spoil is identified, this material would not be placed in areas which report to final landform surfaces and would not be used in construction activities.

It is expected that highly sodic and dispersive waste rock may not, in some cases, be able to be selectively handled and preferentially disposed of – although Pembroke would take reasonable measures to identify and selectively place highly sodic and dispersive waste rock. In such cases, waste rock landforms would need to be constructed with short and low (shallow) slopes (indicatively slopes less than 15% and less than 200 m long) and progressively rehabilitated to minimise erosion (Appendix L).

Where waste rock is used for construction activities, this would be limited (as much as practical) to unweathered Permian sandstone materials, as these materials have been found to be more suitable for construction and for use as embankment covering on final landform surfaces.

Regardless of the waste rock type, especially where engineering or geotechnical stability is required, testing would be undertaken during construction to determine the propensity of such materials to erode.

Coal Rejects

The management of coal rejects generated by the Project is described in Section 2.5.7. As concluded in the Geochemistry Assessment (Appendix L), when disposed amongst alkaline NAF waste rock within in-pit emplacements (or the out-of-pit emplacement during the early years of mining), the overall risk of environmental harm and health-risk that emplaced coal rejects pose is very low.

Notwithstanding, a Mineral Waste Management Plan would be developed prior to the commencement of mining for the handling and disposal of fine reject and coarse reject material for the Project.

Pembroke would undertake validation testwork of actual coal reject materials from the CHPP during development of the Project – particularly during the first two years of CHPP operation following commissioning and following commencement of mining and coal processing at the Willunga domain.

Testwork would comprise a broad suite of environmental geochemical parameters, such as pH, EC (salinity), acid-base account parameters, total metals and soluble metals.

Groundwater Quality Monitoring

Groundwater quality sampling of existing monitoring bores would continue in order to provide longer term baseline groundwater quality around the Project site, and to detect any changes in groundwater quality during and post-mining. Several bores within the mine footprint would continue to be monitored until they are destroyed as the mine progresses.

The existing groundwater monitoring network would be consolidated to remove bores in close proximity to each other (e.g. S6 and S10) and augmented with additional proposed monitoring locations around the pit footprint and proposed coal reject emplacements/ILF cells.

Groundwater quality monitoring would continue to be undertaken on a quarterly basis. As part of the full water quality monitoring, in addition to collecting field parameters (EC and pH), water samples would be submitted to a NATA accredited laboratory for analysis of:

- physio-chemical indicators (TDS and total suspended solids [TSS]);
- major ions (calcium, fluoride, magnesium, potassium, sodium, chloride, sulphate), hardness and ionic balance (total anions/cations);
- total alkalinity as $CaCO_3$, HCO_3, CO_3; and
- total and dissolved metals: (Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, U, V and Zn).

Subject to accessibility, quarterly groundwater quality monitoring would also be conducted on privately-owned landholder bores predicted to be impacted by drawdown associated with the Project (Section 4.3).

Groundwater Quality Triggers and Data Review

Groundwater quality triggers would be established to monitor predicted impacts on both environmental values and predicted changes in groundwater quality, and would be developed in line with the Department of Science, Information Technology and Innovation (DSITI) guideline on *Using monitoring data to assess groundwater quality and potential environmental impacts* (DSITI, 2017). Impact assessment criteria for the site would be documented within a Water Management Plan.

Groundwater quality triggers would be established for each groundwater unit potentially impacted by the Project, including alluvium, regolith and the Permian coal measures.

Each year, an annual review of groundwater quality trends would be conducted by a suitably qualified person. The review would assess the change in groundwater quality over the year, compared to historical trends and impact assessment predictions.

Groundwater Model Validation

Every five years, the validity of the groundwater model predictions would be assessed and, if the data indicates significant divergence from the model predictions, the groundwater model would be updated for simulation of mining.

Groundwater Licensing

Underground water rights would be exercised for the life of the Project as described in Section 4.3.4.

Water Management Plan

A Water Management Plan would be prepared prior to commencement of construction cognisant of the DES guideline for the *Preparation of water management plans for mining activities* (DERM, 2010) and would include:

- details of the potential sources of contaminants that could impact on water quality;
- a description of the water management system for the Project;
- measures to manage and prevent saline drainage and sodicity;
- measures to manage and prevent acid rock drainage;
- corrective actions and contingency procedures for emergencies; and
- a program for monitoring and review of the effectiveness of the Water Management Plan.

Erosion and Sediment Control Plan

An Erosion and Sediment Control Plan would be developed and implemented throughout the construction and operations stages for the Project.

A ‘best practice’ approach would be adopted which is consistent with the International Erosion Control Association (IECA) recommendations. The following broad principles would apply:

- minimise the area of disturbance;
- where possible, apply local temporary erosion control measures;
- intercept runoff from undisturbed areas and divert around disturbed areas; and

- where temporary measures are likely to be ineffective, divert runoff from disturbed areas to sedimentation basins prior to release from the site.

The Erosion and Sediment Control Plan would be reviewed and revised by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and management of stormwater.

Receiving Environment Monitoring Plan

REMP would be developed prior to the commencement of operations for the Project in accordance with the DEHP *Guideline Model Mining Conditions*. The REMP would be implemented to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity.

4.3 WATER RESOURCE

Potential impacts of the Project on water resources have been considered in the following assessments:

- Groundwater Assessment, undertaken by HydroSimulations (Appendix D);
- Surface Water Assessment, undertaken by Hatch (Appendix E);
- Flooding Assessment, undertaken by Hatch (Appendix F);
- Geomorphology Assessment, prepared by Fluvial Systems (Attachment A in Appendix E); and
- Aquatic Ecology Assessment, undertaken by DPM Enviros ciences Pty Ltd (Appendix C).

The water resource assessments have been peer reviewed by suitably qualified and experienced experts in their respective fields, including:

- Dr Frans Kalf (groundwater); and
- Mr Tony Marszalek (surface water and flooding).

The peer review letters are provided in Attachment 4.

A summary of MNES including water resources is also provided in Section 3. The water resources assessments (and others including the Geochemistry Assessment [Appendix L]) have been prepared cognisant of the IESC's *Information Guidelines for Proponents Preparing Coal Seam Gas and Large Coal Mining Development Proposals* (IESC, 2018).

The proposed Project water management systems are described in Section 2.7 and the performance modelled (i.e. site water balance) in Appendix E.

The Groundwater Assessment has considered the cumulative impacts of the approved and foreseeable open cut and underground coal mines surrounding the Project (Appendix D). The surrounding mines within the model include Poitrel, Daunia, Peak Downs, Lake Vermont, Eagle Downs and Saraji.

The Surface Water Assessment (Appendix E) has included consideration of a number of other coal mines and projects that are currently operating within the Isaac River catchment upstream of the ISDS streamflow gauge.

A cumulative assessment of controlled releases from the Project and the surrounding mines, and the approved Bowen Gas Project treated water releases, was also undertaken (Appendix E).

Section 4.3.1 provides a description of the relevant environmental objectives. A description of existing local and regional water resources, including baseline data and the existing monitoring regime is provided in Section 4.3.2. Section 4.3.3 describes the potential impacts of the Project on groundwater and surface water resources including cumulative impacts and Section 4.3.4 outlines the proposed mitigation measures, management and monitoring.

Water quality and flooding related considerations have been assessed and described separately in Sections 4.2 and 4.4 respectively.

4.3.1 Environmental Objectives

The relevant environmental objectives as stated in the Terms of Reference for water resources are that the construction, operation and decommissioning of the Project should aim to meet the following objectives:

- *equitable, sustainable and efficient use of water resources;*
- *environmental flows, water quality, in-stream habitat diversity, and naturally occurring inputs from riparian zones to support the long term maintenance of the ecology of aquatic biotic communities;*
- *the condition and natural functions of water bodies, lakes, springs and watercourses are maintained—including the stability of beds and banks of watercourses; and*

- *volumes and quality of groundwater are maintained or alternate water supply is provided and current lawful users of water (such as entitlement holders and stock and domestic users) and other beneficial uses of water (such as surface water users, spring flows and groundwater-dependent ecosystems) are not adversely impacted by the development.*

4.3.2 Description of Environmental Values

Data from a number of different sources has been analysed in the assessment of the Project on water resources to assist in describing the environmental values. In addition to the baseline water quality data listed in Section 4.2.2, available surface water flow and groundwater data has been utilised, including:

- rainfall and evaporation records from BoM and DNRME weather stations with a significant period of record near the Project (Figure 2-21);
- data from DNRME streamflow gauges in the Isaac River catchment area (Figure 4-12 and Appendix E);
- data from the ISDS monitoring station installed by Pembroke on the Isaac River, downstream of the Project (Figure 4-12 and Appendix E);
- REMP and Annual Return documents provided by the DES for nearby operating coal mines (Appendix E);
- baseline aquatic ecology surveys undertaken by DPM in December 2016 and July 2017 for the Project (Appendix C);
- data from the existing Pembroke groundwater monitoring and investigation program in the vicinity of the Project (Figure 4-13 and Appendix D);
- publicly available data from neighbouring Lake Vermont groundwater monitoring sites (Figure 4-13); and
- geomorphology survey in the vicinity of the Project (Figure 4-14 and Attachment A in Appendix E).

The baseline groundwater monitoring and investigation program for the Project has included the following (Figure 4-13):

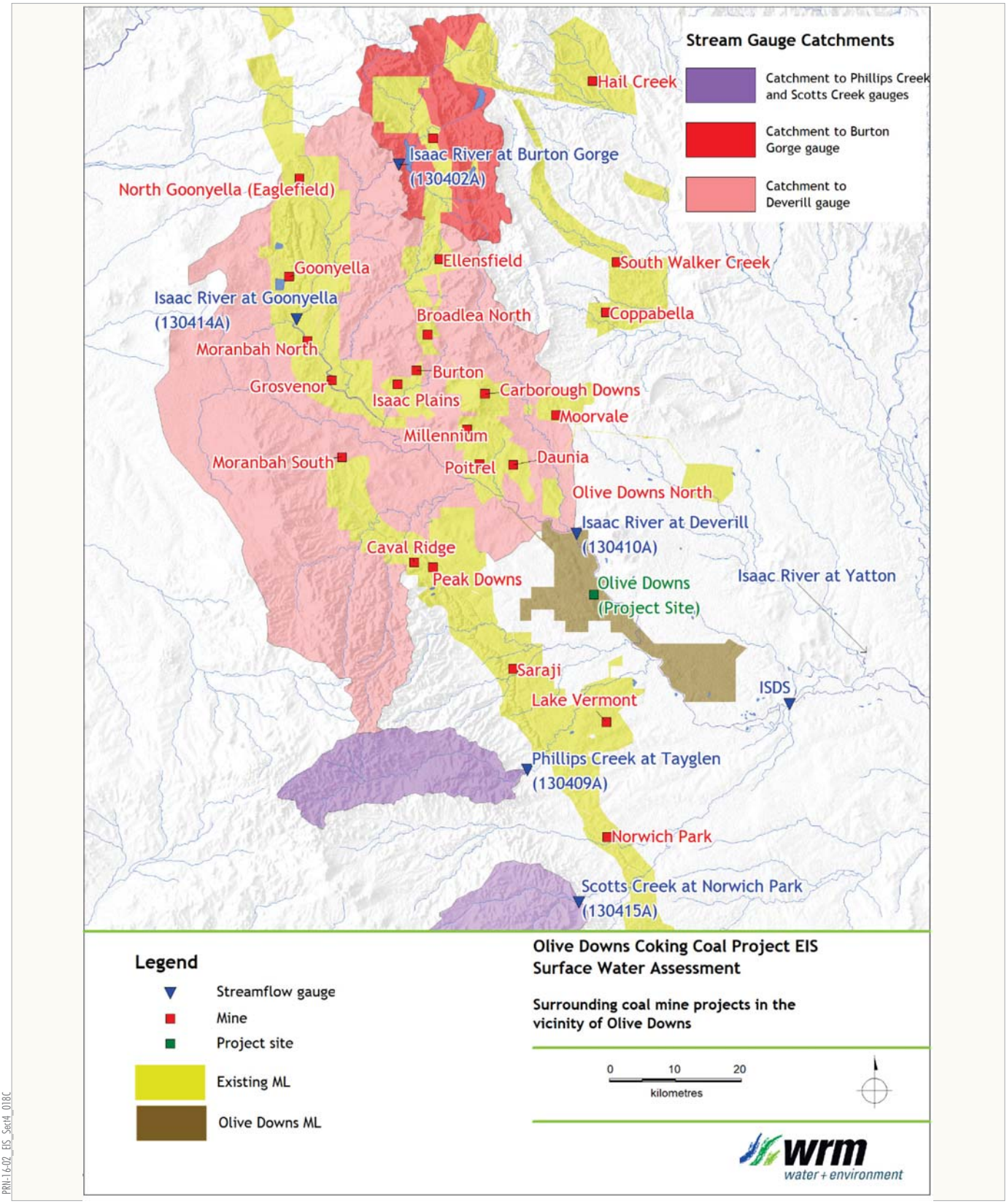
- 18 Tertiary/Alluvial Standpipe Installations:
  - GW01s, GW02s, GW04, GW06s, GW08s & GW12s [Olive Downs South domain].
  - Nine Additional Shallow Drill holes (IF3856P – IF3864P) [Olive Downs South domain – Initial Years].
  - GW16s, GW18s & GW21s [Willunga domain].
- Three (3) Coal Measure Standpipe Installations:
  - GW02d [Olive Downs South domain].
  - GW18d & GW21d [Willunga domain].
- Five (5) Vibrating Wire Piezometer (VWP) Installations:
  - GW01d, GW06d, GW08d & GW12d [Olive Downs South domain].
  - GW16d [Willunga domain].
- Six (6) Aquifer Test Sites (Rising/Falling Head Test Methods):
  - Alluvium/Tertiary – GW01s, GW12s & GW18s.
  - Coal Measure – GW02d, GW18d & GW21d.
- Air-lift and Packer Testing at Borehole 1CR04 (from 52 m to 164 m);
- Core Permeability Testwork (in Laboratory) from exploration holes 1CR04, 1CR05 and 1CR17:
  - Horizontal Conductivity (16 samples).
  - Vertical Conductivity (15 samples).
- Bore Census (desktop [DNRME GWDB] and ground-truthing) (Attachment A5 in Appendix A of Appendix D); and
- TEM Survey (Attachment A4 in Appendix A of Appendix D).

The first groundwater monitoring installations were established in November 2016, and additional alluvial monitoring bores were constructed in November 2017. The bores target a range of hydrostratigraphic units, including:

- Quaternary alluvium;
- regolith (Cainozoic sediments);
- Rewan Group;
- coal seams of the Rangal Coal Measures; and
- interburden and overburden material of the Rangal Coal Measures.

Extensive hydraulic testing was conducted on all major geological units. This included testing of core samples for vertical and horizontal hydraulic conductivity (anisotropy), slug testing (rising/falling head tests) and packer testing for horizontal hydraulic conductivity, as well as documented airlift yields (Appendix D).

To assist with further definition of alluvium in the vicinity of the Project, Groundwater Imaging Pty Ltd (2017) completed a TEM survey. The TEM survey results are presented in Appendix D.



PRN-16-02_EIS_Sect4_018C

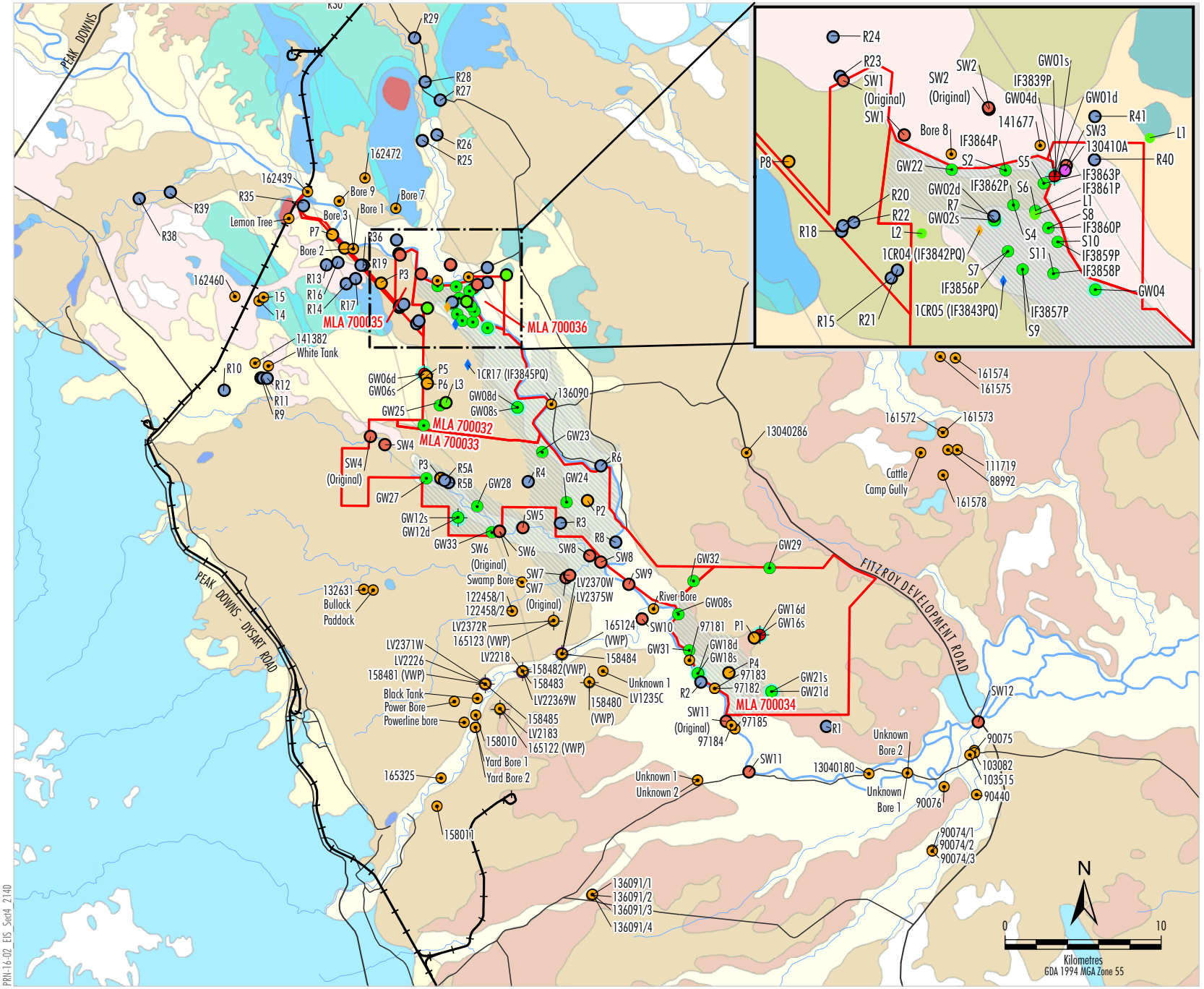
Source: WRM (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Surface Water Flow Monitoring Locations

Figure 4-12



LEGEND

- Mining Lease Application Boundary
- TEM Survey Approximate Extent

Groundwater Monitoring Sites

- VWP
- Standpipe
- Stygofauna Sampling Site

Testwork Site

- Air-lift and Packer Testing
- Core Permeability Testwork
- Groundwater Bore Identified in Bore Census

Lake Vermont Groundwater Monitoring Sites

- VWP
- Standpipe

Surface Water Monitoring Sites

- Pembroke Monitoring Site
- Riverine Monitoring Site
- Lacustrine Wetland
- Palustrine Wetland

Surface Geology

- Granitoid Intrusion
- Back Creek Group
- Moranbah Coal Measures
- Rangal Coal Measures
- Fort Cooper Coal Measures
- Quaternary Alluvium
- Quaternary Regolith (Qr)
- Quaternary Regolith (Qr\b)
- Clematis Group
- Rewan Group
- Tertiary to Quaternary Alluvium
- Duaringa Formation

Source: Queensland Department of Natural Resources and Mines (2016), Department of Natural Resources and Mines (2017), DPM (2018), JBT Consulting (2016), Pembroke (2018)

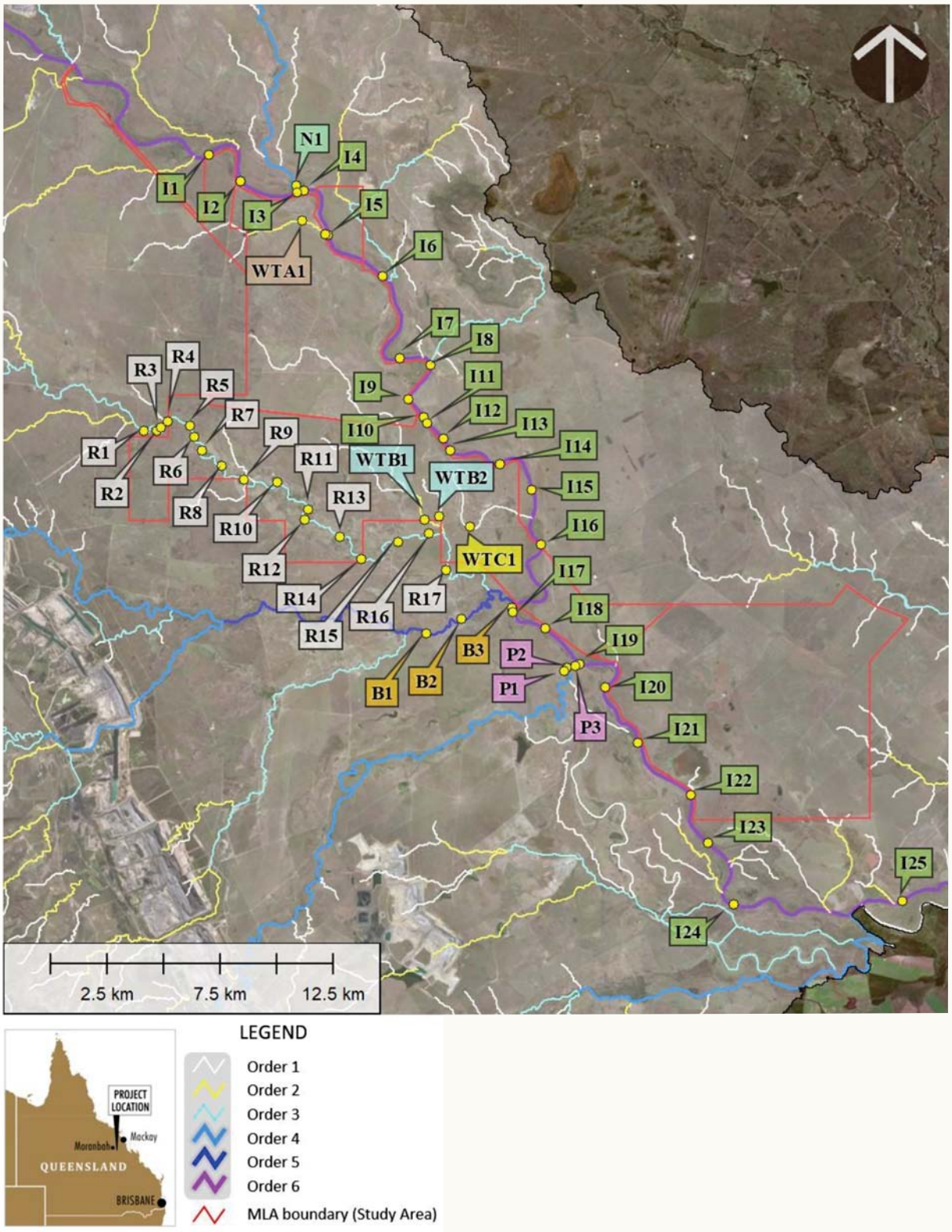
PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Groundwater Monitoring and Investigation Sites

Figure 4-13

PRM-16-02_EIS_Sect4_2140



PRN-16-02_EIS_Sect4_020C

Source: Fluvial Systems (2018)

Regional Hydrology

The Project is located within the headwaters of the Isaac sub-catchment of the greater Fitzroy Basin. The major rivers and tributaries of the Fitzroy catchment include the Fitzroy, Dawson, Nogoa, Comet, Isaac and Mackenzie Rivers.

The Isaac River is the main watercourse which bisects the Project area and flows in a north-west to south-east direction, passing the township of Moranbah and the Millennium, Poitrel and Daunia coal mines upstream of the Project.

The Isaac River flows to the north-east of the Olive Downs South domain and then further downstream to the south of the Willunga domain before continuing in a south-easterly direction (Appendix E).

The Project is in the Isaac-Connors sub-catchment area, which has a catchment area of approximately 22,364 km^2 (Figure 2-12).

The DNRME Isaac River at Deverill stream gauge (#130410A) is located on the Isaac River adjacent to and in the north-west of the Project (Figure 4-12). Historical streamflow data for the Isaac River at Deverill is available from May 1968 and is presented in Appendix E.

Local Hydrology

Tributaries of the Isaac River in the vicinity of the Project include (from upstream to downstream):

- North Creek;
- Ripstone Creek;
- Boomerang Creek; and
- Phillips Creek.

North Creek enters the Isaac River immediately upstream of the Deverill gauging station, north of the Project area (Figure 4-12). The North Creek catchment area upstream of its confluence with the Isaac River is approximately 342 km^2 with predominant land use within the catchment being stock grazing and the Moorvale Coal Mine. The Moorvale Coal Mine has approval to discharge water to North Creek. Similarly, the approved Olive Downs North Mine may be constructed and operated within the North Creek catchment and include water discharges to North Creek.

Ripstone Creek (Figure 2-1) runs west to east, south of the Olive Downs South domain, while intersecting Pit ODS9. The Ripstone Creek catchment area is approximately 286 km^2 with predominant land use within the catchment being stock grazing and the Peak Downs Coal Mine (which has approval to discharge water to Ripstone Creek).

Boomerang Creek (Figure 2-1) runs west to east, south of the Olive Downs South domain and joins the Isaac River between the Olive Downs South domain and Willunga domain. The Boomerang Creek catchment area is approximately 156 km^2 with predominant land use within the catchment being stock grazing and the Saraji Coal Mine. The Saraji Coal Mine has an existing diversion of Boomerang Creek and has approval to discharge water to Boomerang Creek.

Phillips Creek (Figure 2-2) has a catchment area of approximately 487 km^2 to the confluence with the Isaac River. Land uses within the Phillips Creek catchment include low intensity cattle grazing and open cut mining. The Saraji Coal Mine and Lake Vermont Coal Mine both have existing diversions/ levees on Phillips Creek and approval to discharge water to Phillips Creek.

Surface Water Users

Detailed information regarding individual licences for Isaac River surface water users was obtained through analysis of water licences data provided by DNRME. Some limitations in the dataset include the absence of names of water users, and in some cases, allocated volumes for water licenses due to privacy restrictions (Appendix E).

Details regarding the volume, source and purpose of the licences are presented in Appendix E.

Groundwater Regime

A conceptual hydrogeological model of the groundwater regime (Figure 4-15) was developed by HydroSimulations (2018) based on the available groundwater data, and the results of the groundwater investigation program and TEM survey (Groundwater Imaging Pty Ltd, 2017).

The hydrogeological regime relevant to the Project comprises the following hydrogeological units (Appendix D):

- Cainozoic sediments:
  - Quaternary alluvium – unconfined aquifer localised along Isaac River; and
  - Regolith – unconfined and largely unsaturated unit bordering alluvium.

- Triassic Rewan Group – aquitard; and
- Permian coal measures with:
  - Hydrogeologically 'tight' interburden units; and
  - Coal sequences that exhibit secondary porosity through cracks and fissures.

Alluvium

Alluvium is present in the Project area and surrounds on the northern and eastern edge of the Olive Downs South domain and on the western edge of the Willunga domain. The extent and thickness of the unconsolidated sediments was assessed using a TEM survey, verified with site geological logs, conducted by Groundwater Imaging Pty Ltd in July 2017 (Appendix D).

The TEM survey identified that alluvial sediments occur further west than is mapped by the Queensland Government at the Olive Downs South domain. These sediments are generally less than 12 m thick, but the alluvium can be up to 30 m thick within a narrow corridor along the Isaac River, thinning out with distance from the river (Appendix D).

The findings from the TEM survey, along with the CSIRO *Soil and Landscape Grid of Australia* (CSIRO, 2015) data and site geological logs have been used to refine the assessments.

Of all the monitoring bores intersecting the alluvium, four (GW04, GW08s, S2 and S11) have remained dry between June 2017 and February 2018. The remaining bores recorded a saturated thickness of between 2 m to 12 m within the alluvium (Appendix D).

The surficial alluvium along the upper reaches of tributaries to the Isaac River is largely dry, however the alluvium of the Isaac River itself does appear saturated (Appendix D).

Alluvial groundwater levels at the Olive Downs South and Willunga domains are presented in the Groundwater Assessment (Appendix D) including spatial contour distribution of the groundwater levels using a combination of water levels obtained in alluvial monitoring bores installed as part of the Project, and from water level observations collected during the landholder bore census survey. Groundwater within the alluvium is unconfined, with water levels generally between 10 m to 20 m below ground surface (the top of the unit) (Appendix D).

The higher groundwater elevations (167 mAHD) were recorded for bores positioned closest to the Isaac River in the north-west (S8 and GW01s). Lower groundwater elevations (140 mAHD) at the Willunga domain in the south-east are approximately 13 m below surface (Appendix D).

The water levels in the alluvium clearly follow the downstream flow gradient of the Isaac River, with south-easterly flow gradients (Appendix D).

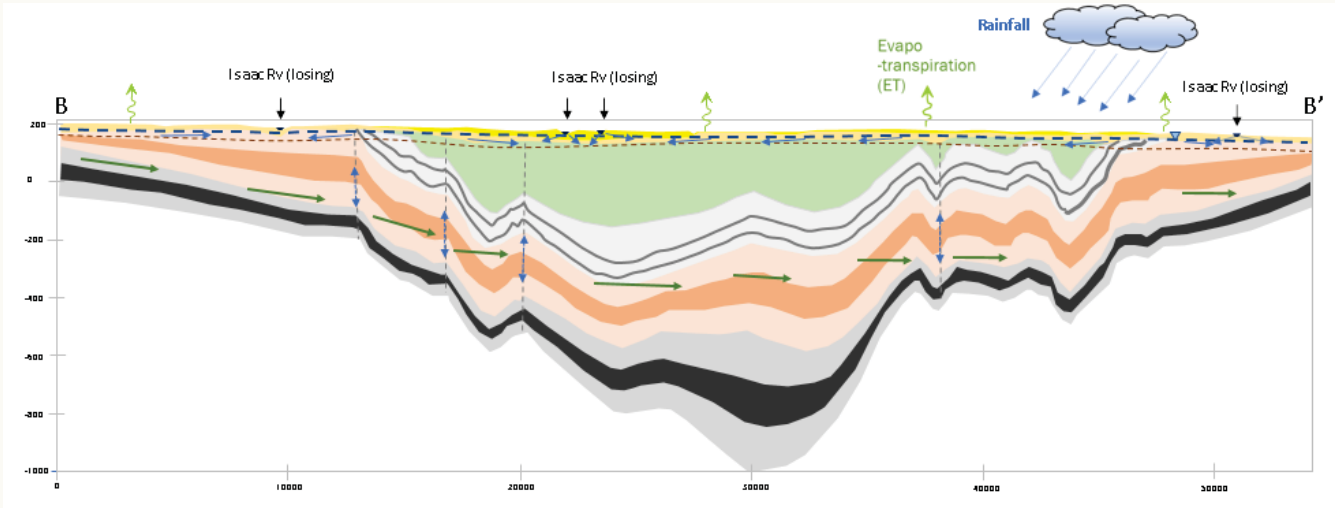
Recharge to the alluvium is considered to be mostly from stream flow or flooding, with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow sub-surface. Groundwater within the alluvium is likely discharged as evapotranspiration from riparian vegetation growing along the Isaac River, as well as potential baseflow contributions after significant rainfall and flood events (Appendix D).

The groundwater hydrographs presented in Appendix D demonstrate that the elevation of water (ponded or flowing) between June 2017 and February 2018 at the Deverill stream gauge (located approximately 200 m from bore GW01s which recorded levels more than 3 m below the river elevation), indicate losing conditions, that is no baseflow component in the Isaac River at the Olive Downs South domain (Appendix D).

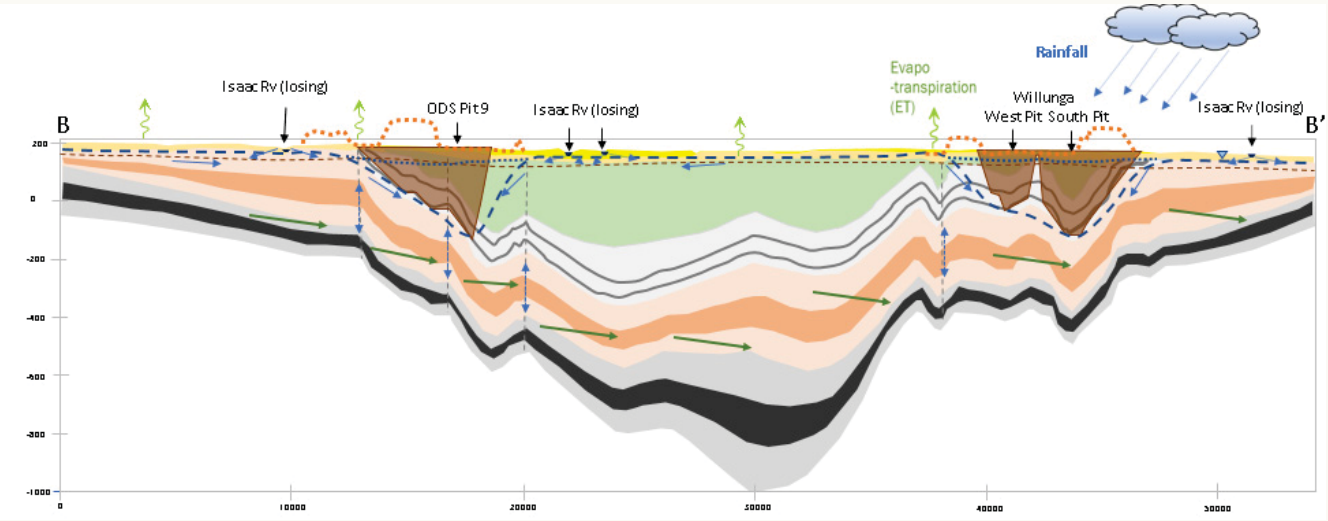
Notwithstanding, occasional periods of baseflow to the Isaac River from the underlying alluvium may occur after prolonged rainfall events or following flood events. Under these conditions, recharged alluvial sediments would drain to the river as the hydraulic gradient reverses and sustains stream-flow for a short period after the rainfall event (Appendix D).

Geological logs indicate the alluvium is underlain by low permeability stratigraphy (i.e. claystone, siltstone and sandstone) at the site, which likely restricts the rate of downward leakage to underlying formations.

Localised perched water tables within the alluvium are evident where waterbodies continue to hold water throughout the dry period (e.g. pools in the Isaac River and floodplain wetlands), occurring where clay layers slow the percolation of surface water (Appendix D).



Pre-Mining



Post-Mining

PRN-16-02_EIS_Sect 3_021A

Source: HydroSimulations (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Conceptual Model of the Groundwater Regime (Pre-Mining and Post-Mining)

Figure 4-15

Regolith

The surficial regolith material covering much of the Project area comprises Cainozoic (Quaternary to Tertiary) aged sediments, including alluvium and colluvium. Based on site geological logs, the regolith comprises a heterogeneous distribution of fine to coarse grained sand, clay, sandstone and claystone. The regolith material is generally 15 m to 45 m thick. The units are all recorded as being highly weathered, with the depth of weathering extending to around 50 m below surface, into the underlying coal measures (IMC, 2014).

Groundwater monitoring conducted at the Project includes two monitoring bores intersecting the regolith at the Olive Downs South domain (GW06s and GW12s) and two within the Willunga domain (GW16s and GW21s). Of these bores, two (GW06s and GW16s) have remained dry (unsaturated) between June 2017 and February 2018. Similar unsaturated conditions have been recorded for exploration holes intersecting the regolith across the Project site (Appendix D).

Overall, the regolith is considered to be largely unsaturated, with the presence of water restricted to lower elevation areas along the Isaac River and the lower reaches of its tributaries (i.e. Ripstone Creek). Flow within the regolith where it is saturated is likely a reflection of topography, flowing towards nearby drainage lines (Appendix D).

The regolith material comprises low permeability strata (i.e. clay and claystone), which likely restricts rainfall recharge. Groundwater discharge is likely to occur primarily via evapotranspiration, with some baseflow to streams from the regolith under wet climatic conditions. Vertical seepage through the regolith is likely to be limited by the underlying low-permeability Rewan Group and other aquitards (Appendix D).

Triassic (Rewan Group)

The Triassic sediments include an isolated pocket of Clematis Group sediments to the east of the Isaac River near the Olive Downs South domain, and the more regionally extensive Rewan Group. The outcrop of Clematis Group is approximately 100 m thick and forms a localised topographic high at an elevation of around 330 mAHD (Appendix D).

The Rewan Group is present throughout the Vermont Park and southern Iffley areas of the Olive Downs South domain but is limited to a small area in the north-western corner of Willunga. Where it occurs, the Rewan Group is present beneath the alluvium and regolith. The unit thickens towards the Isaac River, and can be up to 300 m thick at the Project site (Appendix D).

Groundwater monitoring conducted at the Project includes three VWPs with operational sensors targeting the Rewan Group (GW01d, GW08d and GW16d). Confined groundwater conditions occur within the Rewan Group sediments. Groundwater elevations range from 163 mAHD at the northern end of Olive Downs South domain (GW01d), down to 136 mAHD at the Willunga domain (GW16d), indicating a general south-easterly hydraulic gradient. It should be noted, however, that the very low permeability strata that comprise the Rewan Group mean that groundwater transmission and flow within this unit is likely very limited (Appendix D).

Groundwater elevations for VWPs GW01d, GW08d and GW16d are presented in Appendix D. At all sites, groundwater elevations within the Rewan Group are above those recorded within the deeper Permian coal measures, indicating a downward hydraulic gradient (Appendix D).

Permian Coal Measures

The Permian coal measures underlie the Rewan Group and surficial cover, and outcrop along the ridgelines to the east and west of the Project area.

In increasing depth (age) order, the major coal measures of the Blackwater Group in the area include the:

- Rangal Coal Measures;
- Fort Cooper Coal Measures; and
- Moranbah Coal Measures.

The shallowest coal measures, the Rangal Coal Measures, are around 90 m – 195 m thick at the Project site and contain the target seams (e.g. Leichhardt and Vermont) for the Project. The non-coal portions (interburden) of the sequence are predominantly sandstones, siltstones, mudstone and shales. The Leichhardt Seam occurs at depths of between 25 m and 317 m below surface at the Olive Downs South domain. At the Willunga domain, the Leichhardt Seam occurs 30 m to 270 m below surface.

The Fort Cooper Coal Measures conformably underlie the Rangal Coal Measures and also occur at outcrop to the east and west of the Isaac River.

The Moranbah Coal Measures conformably underlie the Fort Cooper Coal Measures. The coal measures occur at subcrop to the west of the Project area, where they are targeted as part of the Peak Downs and Saraji coal mines.

Groundwater occurrence within the Permian coal measures is largely restricted to the more permeable coal seams that exhibit secondary porosity through fractures and cleats (Appendix D).

Groundwater monitoring conducted at the Project includes two monitoring bores (GW02d, GW18d) targeting the coal seams, one bore (GW21d) targeting the interburden and five VWP locations (GW01d, GW06d, GW08d, GW12d and GW16d) targeting multiple units within the Permian coal measures sequence.

The water levels in the Permian coal measures generally follow the downstream flow gradient of the Isaac River, with south-east hydraulic gradients. Permian groundwater elevations range from around 170 mAHD north of the Olive Downs South domain, down to 130 mAHD at the Willunga domain to the south-east (Appendix D).

Groundwater Users

A field bore census of groundwater bores and wells within 20 km of the Project was conducted by external field contractors (ENRS) from September to November 2017. Of the bores inspected across the 12 properties, the following was summarised (Appendix D):

- 22 bores were equipped with a submersible pump with variable power sources (i.e. mains power, diesel motor and windmill).
- 25 bores were positioned near water storage tanks, ranging in size from 20 kL to 100 kL, with two bores equipped with a float actuated pressure switch to maintain tank water levels. There were limited details on abstraction volumes and yields, but some report maximum yields of around 1 L/s to 2 L/s.
- Four of the existing bores are within 5 km of the proposed pit footprints within the Olive Downs South domain. Three of the bores (Bore 8, RN141677 and RN136090) apparently intersect the Isaac River alluvium. One bore (Swamp Bore) on the Meadowbrook property intersects Permian coal measures to a depth of around 85 m. Two of the four bores (Bore 8 and RN136090) are equipped with submersible pumps and are used for stock and domestic use, respectively. Bore RN141677 is not currently used and the measured total depth does not match with the drill details, indicating the bore may have collapsed. Swamp Bore is also not currently in use or equipped, but the landholder indicates it has previously been used for stock water supply with a yield of around 1,600 gallons per hour (gph).
- Seven of the bores are within 5 km of the proposed pit footprints within the Willunga domain. The seven bores (RN97180, RN97181, RN97182, RN97183, RN97184, RN97185 and River Bore) are relatively shallow (< 40 m deep), intersect the Isaac River alluvium and are used for stock water supply. Three of the bores (RN97181, RN97182 and River Bore) are equipped with electric submersible pumps, with a maximum yield of around 1.3 L/s. One of the bores (RN97180) is assumed to be present, but could not be accessed during the bore census. The landholder indicated the bore has had a yield of 800 gph.

Groundwater Dependent Ecosystems

Groundwater dependent ecosystems are described separately in Section 4.1 and Appendix D.

Calibrated Numerical Groundwater Flow Model

A 3D numerical groundwater flow model was developed for the Project using MODFLOW-USG (Appendix D).

The model is centred over the Project and is elongated in the north-west to south-east direction to follow geological strike. The model is approximately 55 km x 70 km at its widest extents (Figure 4-16). The model domain was selected based on the following considerations:

- The south-west and north-east boundaries are represented by the outcrop of the Back Creek Group, which is considered to be the regional low permeability basement for the purpose of the groundwater flow modelling.

- The north-west and south-east boundaries are approximately 15 km from the edge of the proposed open cut pits and include the surrounding mines for cumulative impact assessment.

Geological fault features are represented by mesh refinement in the model to allow for sensitivity analysis. Over the 14 model layers, the total cell count for the model is 966,821 (Appendix D).

The model was calibrated and verified to existing groundwater levels, using reliable measurements from representative bores within the model domain. Both steady-state and transient calibration models have been developed:

- Steady-state model of average pre-2006 conditions.
- Transient model calibration based on temporal pre-mining data at quarterly time intervals from January 2006 to December 2017.

The objective of the calibration was to replicate the observed groundwater levels in accordance with the modelling guidelines developed by Barnett et al., (2012) and utilise available data and information obtained from the baseline datasets as part of the groundwater monitoring and investigation program including the bore census in 2017.

Utilising the available datasets, the steady state and transient calibrations achieved 8.7% and 7.9% scaled root mean square (SRMS) errors, respectively. This indicates a good calibration and is within the Australian guidelines indicator of <10% SRMS (MDBC, 2001; Barnett *et al*., 2012) (Appendix D).

Sensitivity analysis was conducted to understand how changes to a range of the groundwater flow model assumptions and variables might influence the model predictions. This included assessment of the influence of selected physical properties (specific yield and spoil properties), fault structures and the approved Bowen Gas Project.

A more complex Monte Carlo style uncertainty analysis was also undertaken where numerous model inputs were changed at the same time, and presents the resulting probabilities for predicted spatial drawdown extents (i.e. bores affected by more than 1 m drawdown or more), transient stream (enhanced) leakage and alluvium water take (direct and indirect).

The results of the sensitivity analysis and uncertainty analysis are detailed in the Groundwater Assessment (Appendix D).

4.3.3 Potential Impacts

The potential impacts of the Project on water resources include:

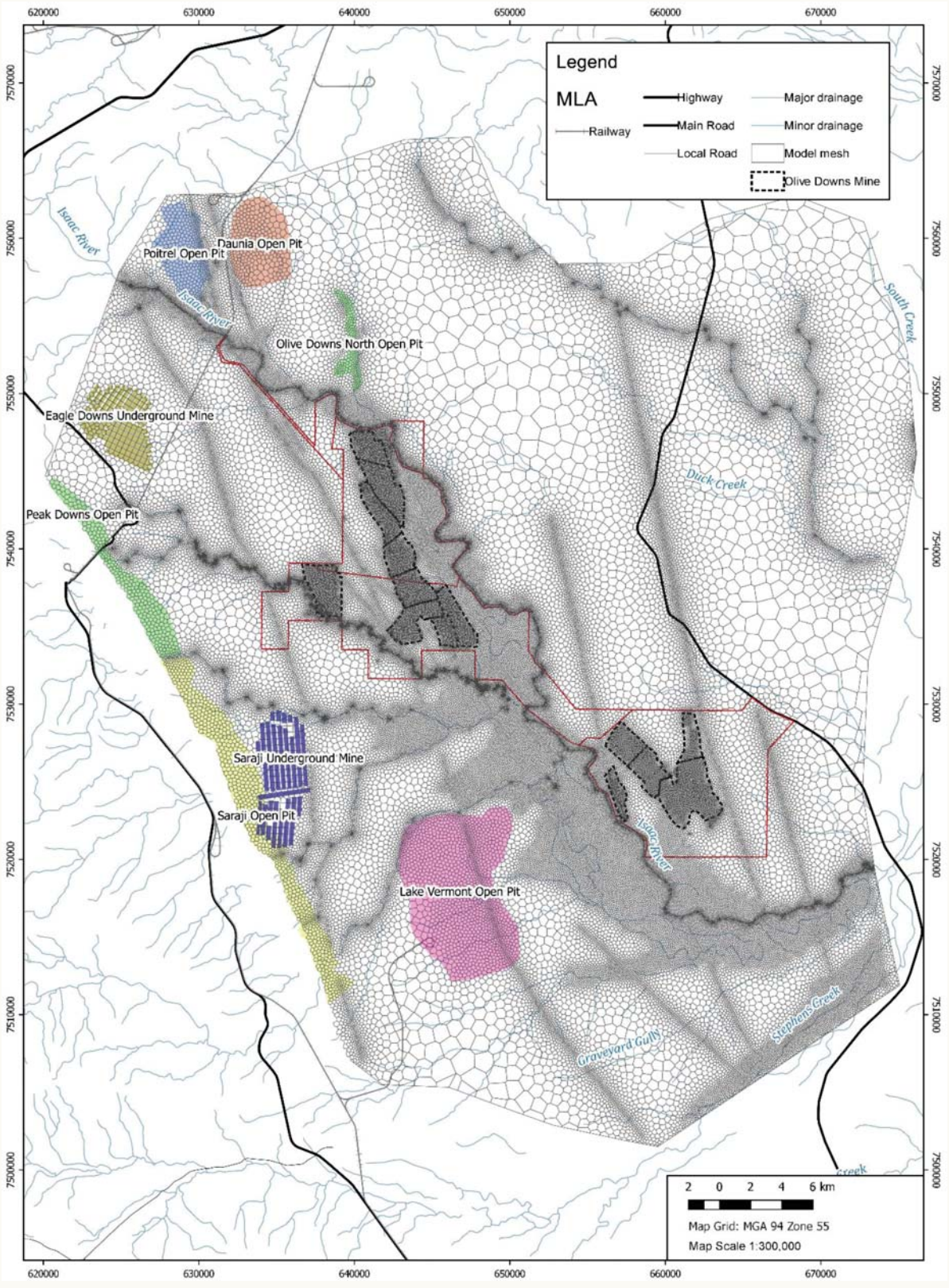
- impacts on flows and the flooding regime in Ripstone Creek (including diversion of a section) and the Isaac River and its tributaries;
- loss of catchment area draining to local drainage paths due to capture of runoff within on-site storages and the open cut pits;
- impacts on regional water availability due to the potential need to obtain water from external sources to meet construction and operational water requirements for the Project;
- adverse impacts on the quality of surface runoff draining from the disturbance areas to the various receiving waters surrounding the Project, during both construction and operation of the Project (refer Section 4.2.2);
- adverse impacts on environmental values in the Isaac River associated with controlled releases from the mine water management system;
- cumulative surface water impacts of all projects in the region on the environmental values of the receiving waters;
- direct interception of groundwater, requiring licensing of the associated water take from Groundwater Unit 1 (Quaternary alluvium) and Groundwater Unit 2 (sub-artesian aquifers) under the *Water Plan (Fitzroy Basin) 2011*;
- groundwater drawdown in up to 5 privately-owned bores constructed in alluvium (2) and Permian coal measures (3); and
- cumulative groundwater depressurisation and drawdown with surrounding mines and the Bowen Gas Project.

An assessment of the potential impacts was undertaken as part of the Groundwater Assessment (Appendix D), Surface Water Assessment (Appendix E) and Flooding Assessment (Appendix F). The results are described below.

Surface Water Flow and Flooding Regimes

Flooding

The results of the Flooding Assessment undertaken by Hatch (2018b) for the 50%, 2%, 1% and 0.1% AEP flood events show that the majority of peak flows would be unchanged by the Project, with only a few insignificant changes occurring (Appendix F).



PRN-16-02_EIS_SectE_024C

Source: HydroSimulations (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Numerical Groundwater Flow Model Extents

Figure 4-16

Potential impacts related to flooding and diversion of Ripstone Creek are described separately in Section 4.4.3.

Catchment Excision (Operations and Post-Mining)

During active mining operations, the mine water management system would capture runoff from areas that would have previously flowed to receiving waters. The estimated maximum captured catchment areas during the seven stages of the Project are provided in Table 4-14 and excludes areas managed under the Erosion and Sediment Control Plan strategy and areas that are fully rehabilitated.

Table 4-14
Maximum Captured Catchment Area

Project Stage	Maximum Captured Catchment Area (km^2)	
	Ripstone Creek (to confluence with Isaac River)	Isaac River (to the ISDS stream gauge)
Stage 1	6	10
Stage 2	21	48
Stage 3	26	50
Stage 4	31	48
Stage 5	36	49
Stage 6	35	51
Stage 7	35	38
Total Catchment Area	286	7,782

Source: Appendix E.

The maximum mine-affected catchment areas represent:

- approximately 13% of the Ripstone Creek catchment to its confluence with the Isaac River; and
- less than 1% of the Isaac River at a location downstream of the Project (i.e. the ISDS stream gauge), which is not significant.

Given that the runoff volumes from the Erosion and Sediment Control Plan areas would be higher than under natural conditions, the loss of stream flows would likely be less than the loss of catchment area. Further, the loss of catchment to Ripstone Creek only affects the furthest downstream reach (approximately 8 km) of the creek adjacent the Project and within the tenement areas (Appendix E).

A comparison of the captured catchment areas of the existing mining projects considered in the cumulative impact assessment with the Isaac River catchment to the ISDS gauge was undertaken in Appendix E.

When taking into account potential controlled release volumes from the operating mines in accordance with their current release rules (as well as the approved Bowen Gas Project), the overall loss of catchment area and associated stream flow reductions estimated would be further reduced by the controlled releases by the Project.

An area of approximately 49 km^2 would report to the final voids at the completion of mining. The changed topography as a result of the Project final landform would have the following impacts on catchment areas:

- The catchment draining to Ripstone Creek would reduce by around 19 km^2 (compared to pre-mining conditions), a decrease of less than 7% of the total 286 km^2 catchment area.
- The catchment draining to the Isaac River would reduce by around 49 km^2 (compared to pre-mining conditions), a decrease of less than 1% of the total 7,782 km^2 catchment area.

Influence on Baseflow (Groundwater)

The Isaac River is ephemeral in nature, with flows following rainfall events that generate runoff. The baseflow predicted by the groundwater model therefore represents water moving through the shallow sediments in the base of the river under the surface.

While recognising that the Isaac River is largely a losing system, with seepage of surface water into the underlying alluvium, changes to water levels induced by mining would increase the hydraulic gradient between the alluvium and Isaac River. The Groundwater Assessment (Appendix D) therefore conservatively predicts that the rate of seepage from the Isaac River to the alluvium could increase by an average of 2.6 ML/day (total) over the life of the Project. This represents a potential 0.5% reduction in average flow (Appendix D).

Post-mining, the final landform would retain the final voids. The zone of influence would retract around the final voids as groundwater levels recover. This would then result in a reduction in the long-term average from the Isaac River to the alluvium to 1.9 ML/day (total) at post closure equilibrium (Appendix D).

The Groundwater Assessment (Appendix D) also considered potential baseflow impacts to Ripstone Creek and concluded that there would be no perceptible change in baseflow (Appendix D).

The potential post-mining surface water impacts, primarily relating to the design of the final landform and performance of the up-catchment diversions and rehabilitated mine landforms in the long-term, are discussed in the sub-sections below.

Regional Water Availability

A significant proportion of mine site water requirements would be sourced from water collected on-site, including rainfall runoff and groundwater inflows to the open cut pits which would be stored in the mine affected water dams for recycling and reuse (Appendix E).

The results of the water balance modelling (Appendix E) show that there is less than a 10% probability that the proposed water licence allocation of 2,250 ML would require supplementing in any year.

If, during operations, there was a risk that the licence allocation could be exceeded, the site water demands could be adjusted accordingly (e.g. reduce dust suppression demand) or alternative water harvesting measures on-site could be implemented, to avoid and/or minimise any impacts on regional water availability.

Controlled Releases and Cumulative Impacts

Mine affected water from the Project would be managed through a mine water management system which is designed to operate in accordance with typical EA conditions and the model water conditions. That is, it would have controlled release conditions and in-stream trigger levels aligned with the WQOs in the EPP (Water).

The outcomes from the water balance modelling indicate that the proposed controlled release strategy would achieve the regional WQOs for the Isaac River and therefore not impact on its environmental values (Appendix E).

Given that the Project mine affected water releases would be managed within an overarching strategic framework for management of cumulative impacts of mining activities, the proposed management approach for mine water from the Project is expected to have negligible cumulative impact on surface water quality and associated environmental values.

Direct Groundwater Inflows/Interception (Water Licensing)

The total annual volumes of groundwater predicted to be intercepted as part of the Project are presented in Table 4-15 and Appendix D.

The total peak inflow due to the Project is expected to be about 4.5 ML/day (1,636 ML/year), while the average is expected to be about 1.7 ML/day (638 ML/year) over the duration of mining (Appendix D).

The Project would directly intercept groundwater from the Quaternary alluvium and sub-artesian aquifers under the *Water Plan (Fitzroy Basin) 2011*. Over the life of the Project, groundwater licensing would vary and involve allocation of up to (Appendix D):

- 623 ML/year for the alluvium; and
- 1,199 ML/year for sub-artesian aquifers.

Post-mining, there would be evaporation from the lakes that would form within the final voids. The results indicate that at equilibrium post closure, groundwater licensing requirements would reduce and involve allocation of approximately:

- 146 ML/year for the alluvium; and
- 183 ML/year for sub-artesian aquifers.

Table 4-15
Predicted Average Groundwater Inflows by Stage

Project Stage	Project Years*	Domain (ML/day)		Average (ML/day)
		ODS	Willunga	
Stage 1	2020-2030	0 – 1.1	0 – 0.2	0.8
Stage 2	2031-2040	1.5 – 2.3	0.3 – 2.3	3.3
Stage 3	2041-2050	0.5 – 2.1	0.1 – 2.5	2.3
Stage 4	2051-2060	0.6 - 2.0	<0.1 – 0.1	1.5
Stage 5	2061-2072	0.3 - 0.4	<0.1 – 0.1	0.4
Stage 6	2073-2085	0.2 - 0.3	<0.1 – 0.3	0.4
Stage 7	2086-2098	0.3 - 0.4	<0.1 – 0.1	0.4

Source: Appendix D.

Groundwater Drawdown (Impacts on Groundwater Users)

Table 4-16 presents a summary of privately-owned bores in the vicinity of the Project (Figures 4-17a and 4-17b), that are predicted by the Groundwater Assessment (Appendix D) to experience more than 1 m drawdown due to the Project.

Table 4-16
Predicted Maximum Drawdown at Privately-owned Property Bores

Bore ID	Property	Geology	Predicted Maximum Project Drawdown (m)
Bore 8	Olive Downs	Alluvium	3.6
RN97181 (Pisscutter)	Willunga	Alluvium	1.6
Swamp Bore	Meadowbrook	Permian	14.4
RN122458 (Rolfies #2)	Meadowbrook	Permian	11.5
RN122458 (Rolfies #1)	Meadowbrook	Permian	11.5

Source: after Appendix D.

The predicted decline in groundwater level of 3.6 m at Bore 8 has the potential to impact on groundwater supply from the bore. However, drawdown within the bore is associated with mining in Pit ODS1, which concludes mining in model year 2044. Based on the mine schedule, alluvial groundwater at Bore 8 is expected to recover to approximately 50% pre-mining levels during the life of the Project (Appendix D).

Groundwater levels at RN97181 are predicted to decline by up to 1.6 m. Maintenance works (e.g. lowering of the pump) may be necessary to ensure the groundwater supply is maintained during the life of the Project; however, the Project would not impact on the landholder's ability to use the bore. Drawdown within RN97181 is associated with mining at Pit WIL1 that intersects alluvium, which concludes mining in model year 2044. Based on the mine schedule, alluvial groundwater at RN97181 is expected to recover to near pre-mining levels during the life of the Project (Appendix D).

Groundwater levels at Swamp Bore, RN122458 (Rolfies #1) and RN122458 (Rolfies #2) are predicted to decline by 14.4 m, 11.5 m and 11.5 m, respectively. If the bores were to be used, this may influence the installation of pump equipment, but would not impact on the landholders' ability to use the bores.

Drawdown within the three bores is largely associated with mining at Pits ODS6, ODS7 and ODS8, which commences from model year 2030. Groundwater levels are predicted to recover slightly by the end of mining, to around 11 mbgl at Swamp Bore and 18 mbgl, at RN122458 (Rolfies #1) and RN122458 (Rolfies #2) (Appendix D).

Cumulative Groundwater Depressurisation and Drawdown

Cumulative impacts associated with approved and foreseable open cut and underground coal mines surrounding the Project was modelled (Appendix D).

The results show that the zone of depressurisation from surrounding open cut and underground mines reaches the predicted zone of depressurisation from mining at the Project.

The magnitude of the drawdowns is greatest in or closely around the mining area, and gradually reduces with distance from the mine. The zone of depressurisation from mining in the Willunga domain is not affected by mining at surrounding mines (i.e. no cumulative impacts).

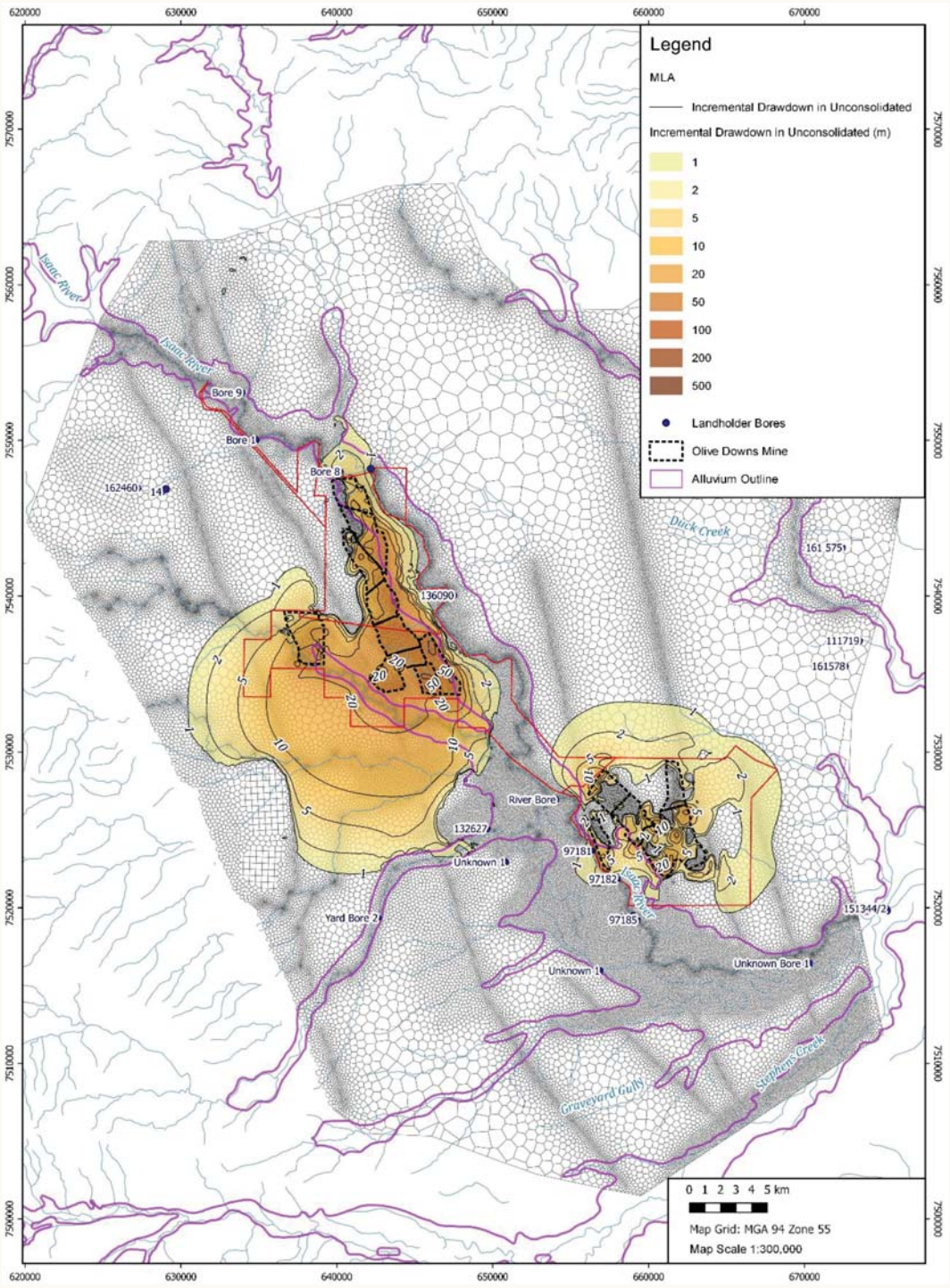
Maximum cumulative groundwater drawdown within the coal seams extends up to 13 km from mine operations, and is influenced by the extent of the geological unit.

Assessment of cumulative impacts associated with the approved Bowen Gas Project was also undertaken as a sensitivity analysis in Appendix D.

Based on the modelling results, cumulative groundwater drawdown extents from the Bowen Gas Project are predicted to be greater than depressurisation and drawdown produced by the Project alone (Appendix D).

Subsidence

No underground mining operations are proposed as part of the Project. Therefore surface subsidence caused by underground goafing would not occur. Any residual subsidence associated with dewatering and depressurisation of groundwater from the surrounding formations at the Project site (i.e. deep Permian coal measures) and to a far lesser extent in the overlying Quaternary, Tertiary and Triassic formations would be negligible and immeasurable (Appendix D).



Incremental Drawdown in Unconsolidated for Modification Mine Plan

PRN-16-02_EIS_Sect4_022B

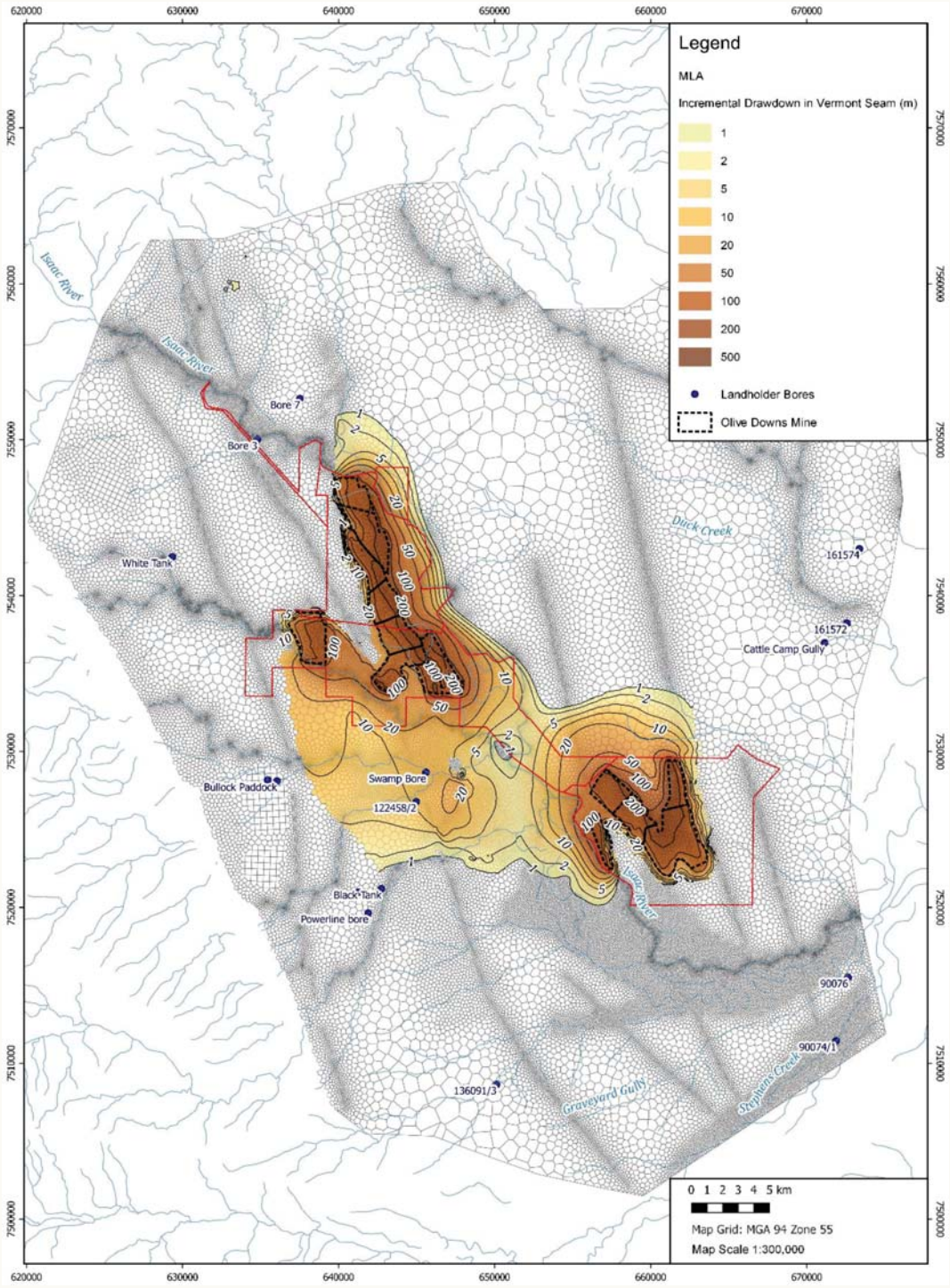
Source: Hatch (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Groundwater Model - Maximum Incremental Drawdown Predictions (Unconsolidated)

Figure 4-17a



Incremental Drawdown in Unconsolidated for Modification Mine Plan

PRN-16-02_EIS_Sect4_028B

Source: Hatch (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Groundwater Model - Maximum Incremental Drawdown Predictions (Vermont Seam)

Figure 4-17b

Final Voids

Post-mining inflows to the final voids would comprise three contributing sources:

- incident rainfall;
- runoff (albeit from a reduced reporting catchment); and
- reducing (with time) groundwater inflows (from the Permian groundwater system as it recovers and adjacent waste rock emplacement infiltration).

Water would be lost from the final voids through evaporation.

A final void water recovery analysis, including predicted groundwater inflows from the groundwater model (Appendix D), has been conducted as part of the Surface Water Assessment (Appendix E). The model results for the long-term water levels simulated in the final voids show the following (Appendix E):

- Pit ODS3 void:
  - The water level reaches equilibrium between 80 m AHD and 90 m AHD after 200 years and generally remains at these levels throughout the remainder of the simulation.
  - The maximum modelled water level is around 82 m below the void of Pit ODS3 overflow level, and around 100 m below the level at which overflows would reach the receiving environment.
  - Salt accumulates within the void of Pit ODS3 at an average rate of around 5,000 tonnes per year. The void becomes hyper-saline (>35,000 mg/L) after around 550 years of simulation.
- Pit ODS7/ODS8 void:
  - The water level reaches equilibrium between 20 m AHD and 30 m AHD after 150 years and generally remains at these levels throughout the remainder of the simulation.
  - The maximum modelled water level is around 130 m below the void of Pits ODS7/ODS8 void overflow level, and around 145 m below the level at which overflows would reach the receiving environment.
  - Salt accumulates within the void of Pits ODS7/ODS8 void at an average rate of around 3,800 tonnes per year. The void becomes hyper-saline (>35,000 mg/L) after around 550 years of simulation.
- Pit WIL5 void:
  - The water level reaches equilibrium between 55 m AHD and 70 m AHD after 100 years and generally remains at these levels throughout remainder of the simulation.
  - The maximum modelled water level is around 85 m below the void of Pit WIL5overflow level, around 90 m below the level at which overflows would reach the receiving environment.
  - Salt accumulates within the void of Pit WIL5 at an average rate of around 3,000 tonnes per year. The void approaches hyper-salinity (>35,000 mg/L) by the end of the 600 year simulation.

Further, the post-mining flood modelling undertaken by Hatch (2018b) identified that based on the final landform design, flood waters would not enter any of the final voids in events up to and including the PMF event (Appendix F).

The final void modelling indicates that the expected water levels are below the full supply levels for each void, and the voids would remain as long-term groundwater sinks (Figures 4-18a and 4-18b) (Appendix D).

4.3.4 Mitigation Measures, Management and Monitoring

Water Flow Management Measures

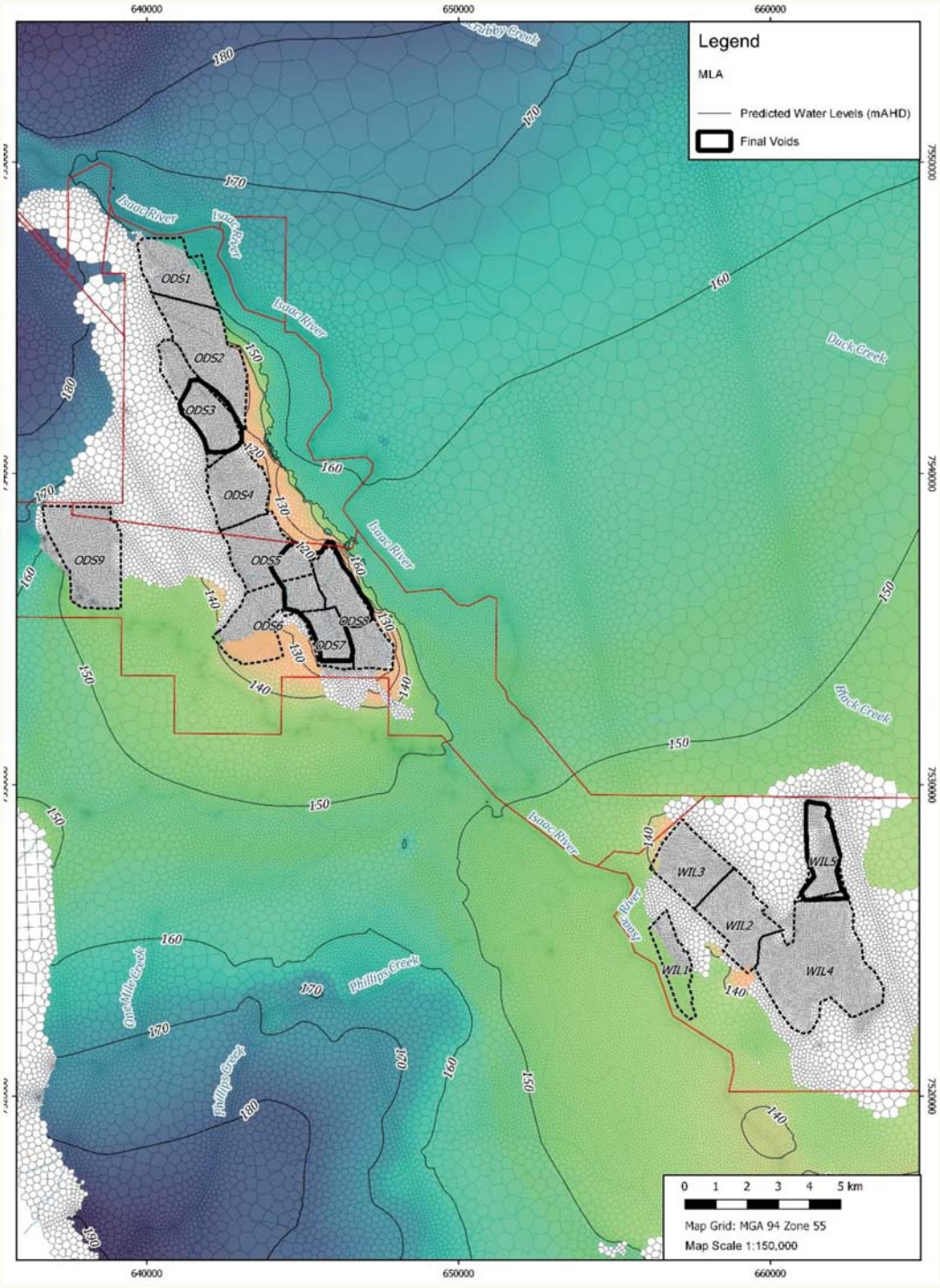
Up-Catchment Diversions

Surface water runoff control practices to prevent up-catchment runoff water from entering the open cut mining areas would be generally adopted for the Project. Details of up-catchment runoff water control structures (including the Ripstone Creek Diversion) to be developed for the Project are discussed in Section 2.7.2 and the locations shown on Figures 2-3 to 2-9.

Sediment Dams

Sediment dams would be designed based on Best Practice Sediment and Erosion Control Guideline (IECA, 2008) for flows with an ARI of between 3 months and 1 year.

As described in Section 5, sediment dams would be retained until the revegetated surface of the waste rock emplacements are stable and runoff water quality reflects runoff water quality from similar undisturbed areas, at which time these controls would be removed and the areas would be free-draining.



Predicted Groundwater Levels in Unconsolidated (Layer 1 and 2)– Post Mining Equilibrium

PRN-16-02_EIS_Sect4_023C

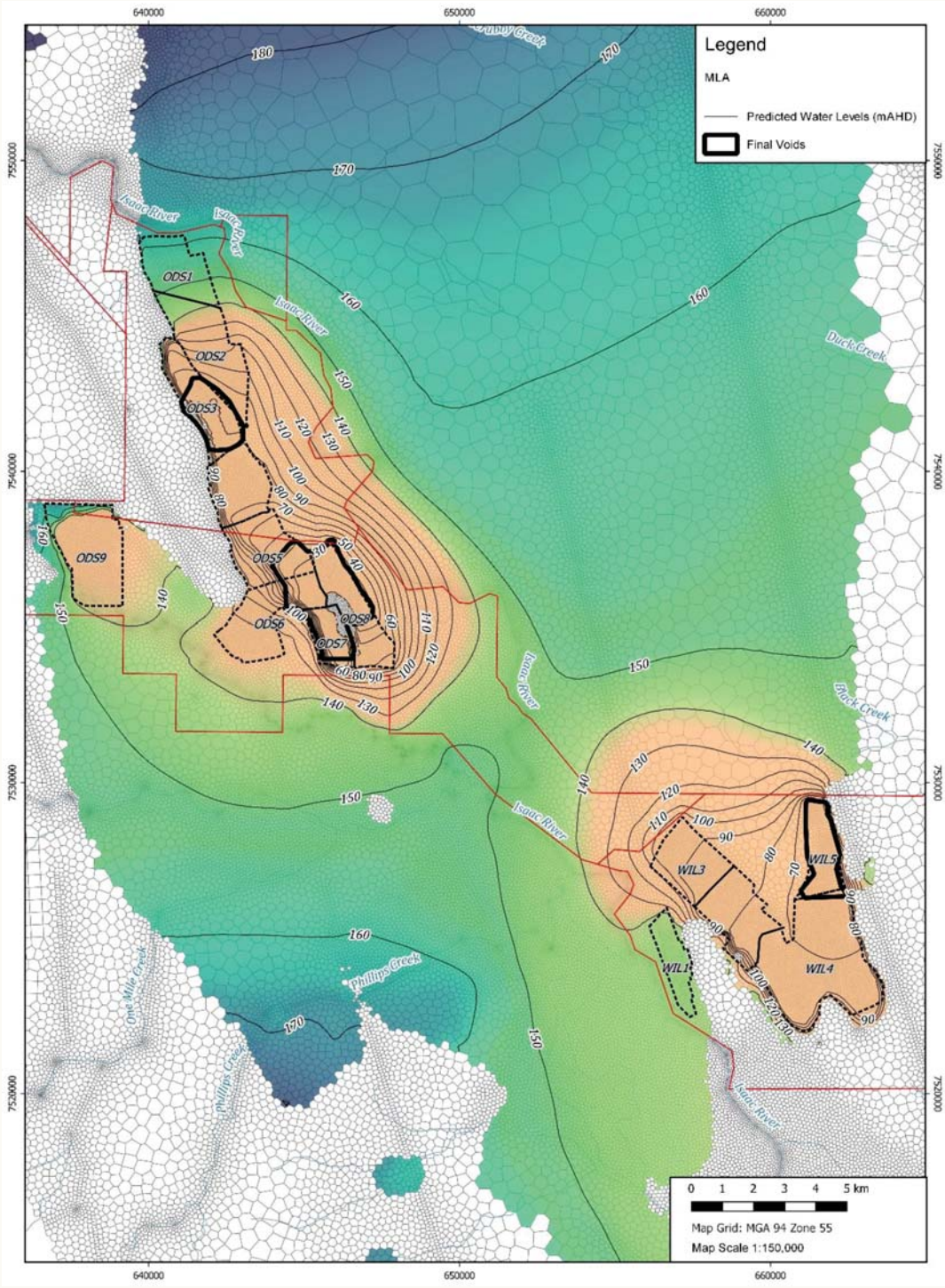
Source: HydroSimulations (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Numerical Groundwater Model – Predicted Groundwater Levels Post-Mining Equilibrium (Unconsolidated)

Figure 4-18a



Predicted Groundwater Levels in Vermont Seam (Layer 7) – Post Mining Equilibrium

PRN-16-02_EIS_Sect4_028B

Source: HydroSimulations (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Numerical Groundwater Model – Predicted Groundwater Levels Post-Mining Equilibrium (Vermont Seam)

Figure 4-18b

Controlled Releases

Controlled water release conditions have been developed for releases to the Isaac River and Ripstone Creek, based on the DEHP *Guideline Model Mining Conditions*. The water balance model has been configured to simulate these release conditions, using salt measured as EC as the target parameter. The proposed water release conditions are provided in Table 4-17, based on flow and EC monitoring at the Deverill gauging station on the Isaac River, and the proposed Project controlled release points (P9, P20, P33, P46 and WROM).

The proposed controlled releases strategy comprises a number of mine affected water dams which will have the ability to discharge water to the Isaac River through a gravity pipe system. There are four proposed release points at the Olive Downs South domain and one at the Willunga domain. However, due to the progressive mining activities from north to south at the Olive Downs South domain, it is likely that only two of the four dams would operate simultaneously. It is noted that the proposed controlled release conditions (Table 4-17) are for combined releases from the release points (e.g. under very high flow rates in the Isaac River, a combined controlled release rate from the release points of 5.0 m^3/s is proposed).

The controlled release point dams would be constructed as aboveground turkey's nest type dams around 5 m deep. Each would be constructed above the natural surface to provide sufficient driving head for gravity flow. The gravity flow solution is preferred because it allows for an efficient controlled release mechanism and can provide significant flow capacity during the relatively short timeframes under which the Isaac River flow regime would allow the opportunity to release to the receiving environment and meet the relevant water quality objectives. Potential pump solutions to supplement gravity flow system would be considered during the detailed design process.

Outlet pipes from the controlled release point dams would be constructed under the highwall emplacement and would connect to open drains approximately 5 m wide at the base with 1:3 side batters. The open drains would report to existing drainage lines or overland flow paths within the Project MLAs that ultimately flow into the Isaac River. These open drains would incorporate measures to reduce water velocities to less than 1 m/sd after the pipe outlet to minimise erosion risk. Such measures would include gabion rock structures below the outlet pipe invert to absorb energy and reduce flow velocities.

EC has been continuously monitored and recorded at the Deverill gauging station since August 2011. The monitoring data has been analysed and a relationship between EC and discharge (expressed as runoff depth) has been developed and is presented in the Surface Water Assessment (Appendix E). The flow-EC relationship for the Isaac River has been incorporated into the water balance model. Further details of the controlled released modelling are provided in Appendix E.

Water Supply and Licensing (Surface Water)

As described in Section 2.7.7, the water balance model results show that there is a greater than 90% probability that an annual water allocation of 2,250 ML would be sufficient to meet all site demands, in any one year across the Project life (Appendix E). Pembroke intends to source this external water demand from SunWater via the Project water pipeline.

If, during operations, there was a risk that the licence allocation could be exceeded, the site water demands could be adjusted accordingly (e.g. reduce dust suppression demand) or alternative water harvesting measures on-site could be implemented, to avoid and/or minimise any impacts on regional water availability.

Table 4-17
Proposed Controlled Release Conditions

Flow Rate	Receiving Water Flow Criteria (Isaac River*)	Maximum Release Rate (Controlled Release Points Combined Flows^)	Electrical Conductivity Limit (At Release Point)
Medium	4 m^3/s	0.5 m^3/s	1,000 µS/cm
	10 m^3/s	1.0 m^3/s	1,200 µS/cm
High	50 m^3/s	2.0 m^3/s	4,000 µS/cm
	100 m^3/s	3.0 m^3/s	6,000 µS/cm
Very High	300 m^3/s	5.0 m^3/s	10,000 µS/cm

Source: Appendix E.

* Deverill Gauging Station.

^ P9, P20, P33, P46 and WROM. Note: P44 and WMIA are designated release points, but are not part of the overall controlled release strategy.

Licensing for Associated Water (Groundwater) and Underground Water Impact Report

Underground water rights would be exercised for the life of the Project. As described in Section 4.3.3, the aquifers affected by the Project are partitioned according to the two units of the Isaac Connors Groundwater Management Area (GMA), including the Isaac Connors Alluvium Groundwater Sub-Area, as delineated in the *Water Plan (Fitzroy Basin) 2011*.

The Groundwater Assessment (Appendix D) provides a summary of the predicted groundwater take (inflows) requiring licensing. Over the life of the Project, groundwater licensing would vary and involve allocation of up to (Appendix D):

- 623 ML/year for the alluvium; and
- 1,199 ML/year for sub-artesian aquifers.

Post-mining, there would be evaporation from the lakes that would form within the final voids. The results indicate that at equilibrium post closure, groundwater licensing requirements would reduce and involve allocation of approximately:

- 146 ML/year for the alluvium; and
- 183 ML/year for sub-artesian aquifers.

Pembroke would prepare an Underground Water Impact Report (UWIR) prior to the commencement of mining in accordance with Chapter 3 of the Water Act. The UWIR would be based on the information contained in the Groundwater Assessment (Appendix D), and would describe, make predictions about and manage the impacts of underground water extraction by the Project.

Adaptive Management

The results of the Surface Water Assessment (Appendix E) represent the application of the adopted mine water management system rules over the mine life.

Over the life of the Project, there would be numerous options for adaptive management of the mine water management system to accommodate climatic conditions. For example, temporary adjustments to pumping arrangements could be made to accommodate very wet or dry periods. These alternative management approaches would be used to reduce the risks to the Project associated with climatic variability and could include, for example:

- advanced dewatering within the proposed open cut pit extents; and
- use of chemical or other dust suppressants to reduce the amount of water required for dust suppression.

Surface Water Monitoring Program

Monitoring of upstream, onsite and downstream water flows (and storage levels and controlled release volumes) would assist in demonstrating that the site water management system is effective in meeting its objective to protect the integrity of local and regional water resources and allow for early detection of any impacts and appropriate corrective action.

The surface water monitoring protocols would:

- be implemented to comply with the Project EA;
- provide valuable information on the performance of the water management system; and
- facilitate adaptive management of water resources on the site.

Monitoring of surface water levels and flows would continue to be undertaken based on data from DNRME streamflow gauges in the Isaac River catchment area as well as data from the ISDS monitoring station installed by Pembroke on the Isaac River, downstream of the Project.

Groundwater Level and Pressure Monitoring

Recording of groundwater levels from existing monitoring bores and VWPs would continue and would enable natural groundwater level fluctuations (such as responses to rainfall) to be distinguished from potential groundwater level impacts due to depressurisation resulting from proposed mining activities. Several bores within the mine footprint would continue to be monitored until they are destroyed as the mine progresses.

The existing groundwater monitoring network would be consolidated to remove bores in close proximity to each other (e.g. S6 and S10) and augmented with additional proposed monitoring locations around the open cut pit footprint and proposed coal reject emplacements/ILF cells.

Bores fitted with automatic loggers would record on a daily basis with others manually dipped on a quarterly basis. Subject to accessibility, quarterly groundwater level monitoring would also be conducted on privately-owned landholder bores predicted to be impacted by drawdown associated with the Project (Section 4.3.3).

Groundwater Level Triggers and Data Review

All site groundwater monitoring bores are located within the zone of predicted groundwater level change due to the Project. Therefore, changes in groundwater levels at the site bores would be compared to predicted groundwater trends to evaluate any deviations from the model predictions.

Impact assessment criteria for the site would be documented within a UWIR.

Each year, an annual review of groundwater level trends would be conducted by a suitably qualified person. The review would assess the change in groundwater levels over the year, compared to historical trends and impact assessment predictions.

Groundwater Model Validation

Every five years, the validity of the groundwater model predictions would be assessed and, if the data indicates significant divergence from the model predictions, the groundwater model would be updated for simulation of mining.

Water Management Plan

A Water Management Plan would be prepared cognisant of the DES guideline for the *Preparation of water management plans for mining activities* (DERM, 2010) and would include, but not necessarily be limited to:

- a description of the water management system for the Project;
- corrective actions and contingency procedures for emergencies; and
- a program for monitoring and review of the effectiveness of the Water Management Plan.

Further detail on the Water Management Plan is presented in Section 4.2.4.

Erosion and Sediment Control Plan

An Erosion and Sediment Control Plan would be developed and implemented throughout construction and operations for the Project (Section 4.2.4).

The Erosion and Sediment Control Plan would be reviewed and revised by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and management of stormwater.

Receiving Environment Monitoring Plan

A REMP would be developed for the Project in accordance with the model mining conditions. The REMP would be implemented to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. Further detail on the REMP is provided in Section 4.1.4.

4.4 FLOODING AND REGULATED STRUCTURES

Potential flooding impacts related to the Project have been considered in the Flood Assessment prepared by Hatch (2018b) (Appendix F). The Flood Assessment has been peer reviewed by Hydro Engineering and Consulting Pty Ltd (HEC) (Mr Tony Marszalek) (Attachment 4).

The modelling results from the Flood Assessment have also been used in the Geomorphology Assessment prepared by Fluvial Systems (2018) (Attachment A to Appendix E).

The relevant environmental objective for flooding and regulated structures is described in Section 4.4.1. A description of existing environmental values associated with flooding, including past flood studies and existing/approved structures relevant to flooding is provided in Section 4.4.2. Section 4.4.3 describes the potential flooding impacts related to the Project including cumulative impacts and Section 4.4.4 outlines the proposed mitigation measures, management and monitoring.

Regulated structures (including dams and levees) are described in detail in Section 4.4.5.

The Surface Water Assessment (Appendix E) provides details of the mine affected water dams and a description is provided in Section 4.3.

4.4.1 Environmental Objective

The environmental objective relevant to flooding and regulated structures, as described in the Terms of Reference for the Project, is:

> *The construction and operation of the project should aim to ensure the risk of, and the adverse impacts from flooding hazards or dam failure are avoided, minimised or mitigated to protect people, property and the environment.*

4.4.2 Description of Environmental Values

The Project is located within the headwaters of the Isaac River catchment of the greater Fitzroy Basin (Figures 2-12 and 2-19).

The environmental values for water quality and water resources are described in Sections 4.2.2 and 4.3.2.

Past Flood Studies and Existing Approved Structures

Various flooding and surface water related reports in the Isaac River catchment were reviewed and considered in the Flood Assessment for the Project, including:

- *Flood Hydrology Technical Report – Red Hill Mining Lease EIS* (URS, 2013a);
- *Flood Impact Assessment Report – Isaac Plains Mine Extension Development Project EAR* (WRM, 2016a);
- *Flood Modelling Report – Grosvenor G200s Coal Mine Expansion Project EAR* (Alluvium, 2016);
- *Olive Downs North Environmental Management Plan* (MEMS, 2005);
- *Surface Water Report – Red Hill Mining Lease EIS* (URS, 2013b);
- *Surface Water Report and Flood Assessment – Caval Ridge Coal Mine Project EIS* (URS, 2009);
- *Surface Water Impact Assessment – Lake Vermont Mine Northern Extension Project EIS* (WRM, 2016b); and
- *Water Resource Report – Millennium Expansion Project EIS* (MetServe, 2010).

The Flood Assessment (Appendix F) presents the current flood risk for a range of annual exceedance probabilities (i.e. 50%, 20%, 10%, 5%, 2%, 1%, 0.1%) up to the PMF for potentially affected waterways including the Isaac River, Ripstone Creek, North Creek, Boomerang Creek, One Mile Creek and Phillips Creek.
The flood hydrology model includes the main branch and tributaries of the Isaac River covering an area of approximately 9,601 km^2 and consists of 90 sub-catchments (Figure 4-19a).

The hydrology model has been calibrated against data at the Deverill gauge station for five historical flood events (i.e. August 1998, February 2008, December 2010, February 2016 and March 2017). The calibration results for the developed flood hydrology model were considered to be satisfactory (Appendix F).

Based on the review of past flood studies for surrounding mines/projects, three existing or approved levees were identified in the region (i.e. Olive Downs North, Lake Vermont and Poitrel) however, only the approved Olive Downs North levees were located at/within the hydraulic model extent in the Flood Assessment (Figure 4-19b).

While it is recognised that the Olive Downs North levees are yet to be constructed, the cumulative flood modelling undertaken as part of this assessment has demonstrated that, with the exception of localised stream level, velocity and power increases predicted in areas adjacent the approved levee alignment, the potential impact of the Olive Downs North levees alone is considered to be negligible, and any downstream effects at the Deverill gauging station (located more than 3 km downstream) would be immeasurable (Appendix F).

All dams and levees proposed or existing on the Project site have been listed and described in the Surface Water Assessment (Appendix E) and Flooding Assessment (Appendix F), respectively.

4.4.3 Potential Impacts

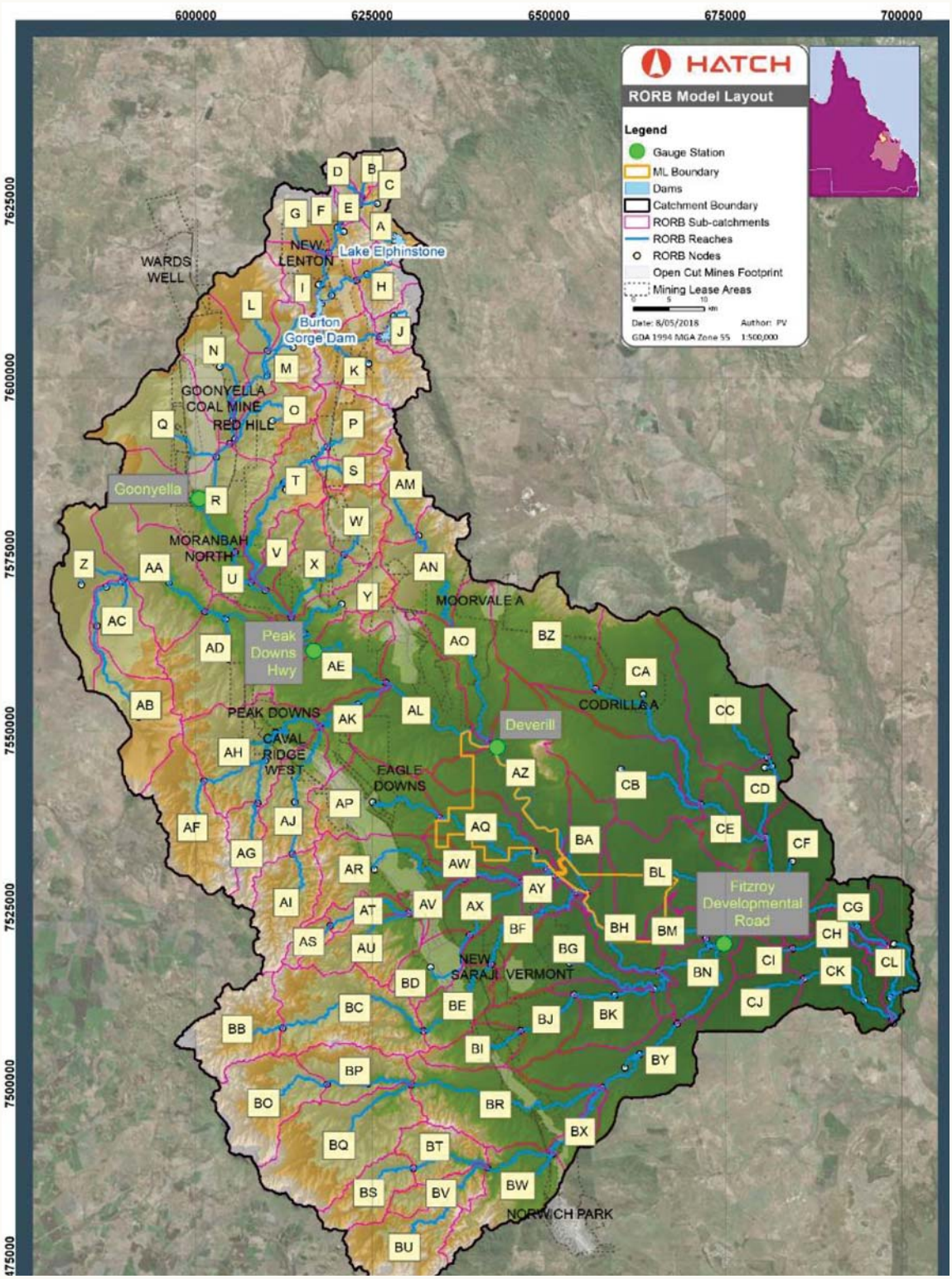
The Flood Assessment (Appendix F) describes the current flood risk for a range of annual exceedance probabilities up to the PMF for potentially affected waterways, and assesses (through flood modelling) how the Project may potentially change flooding characteristics and be affected by floods.

Design flood hydrographs for events with AEPs of 50%, 20%, 10%, 5%, 2%, 1% and 0.1%, as well as the PMF, were developed based on design rainfalls and the calibrated hydrology model (Appendix F). In accordance with the requirements of the Terms of Reference, the PMP was used to estimate the peak flow for the PMF in the Isaac River (Appendix F).

Three cases were modelled by Hatch (2018b) (Appendix F):

- the base case (pre-mining/approved infrastructure);
- the developed case (during operations – all infrastructure); and
- the post-mining case (permanent stable landforms with temporary levees removed).

The impact of the Project on flood levels, flow velocity and stream geomorphology for each of the above cases has been evaluated (Appendix F and Attachment A to Appendix E) and is summarised below.



PRN-16-02_EIS_Sect4_007D

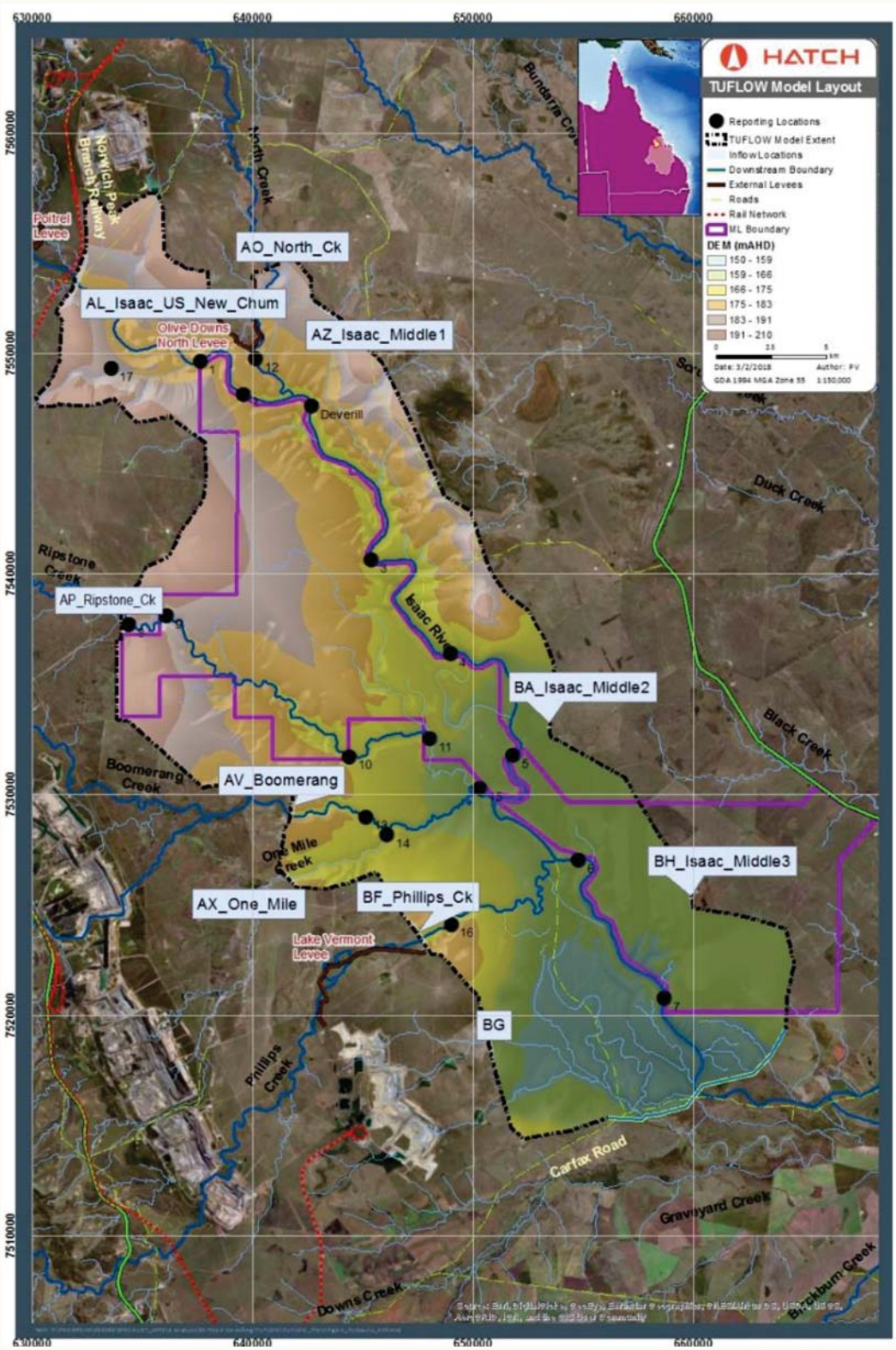
Source: Hatch (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Flood Model Extent - Hydrology Model

Figure 4-19a



PRN-16-02_EIS_Sect4_027B

Source: Hatch (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Flood Model Extent - Hydraulic Model

Figure 4-19b

For comparative purposes, the developed case flood extents for the 50% AEP and 2% AEP are shown on Figures 4-20a and 4-20b, and the changes in afflux between the base case and the developed case for the 2% AEP (i.e. 1 in 50 years) are shown on Figure 4-21.

It is noted that where the Project rail spur is located near the Isaac River (Figures 4-20a and 4-20b) and where it crosses associated tributaries, it would be elevated with culverts to minimise impacts to the flooding regime. Where required, the elevated rail structure would consist of spans between piers supporting the rail track. Based on the rail infrastructure design to minimise such impacts, the predicted impacts of the rail spur on the existing flooding regime (including afflux) would be negligible.

Flood Levels

The Project would excise part of the Isaac River floodplain during operation, which has the potential to increase flood levels in areas of the floodplain adjacent to and potentially upstream of the Project. Figure 4-21 shows the "wet now dry" areas along the western side of the Isaac River, north of Ripstone Creek, and the out-of-pit emplacement east of the Deverill gauging station.

As shown on Figure 4-21, the peripheral areas that are predicted to be potentially 'dry now wet' by flooding are generally associated with afflux due to the out-of-pit emplacement in the north-east (i.e. Deverill property), the bend in the Isaac River adjacent the permanent highwall emplacement to the south-east of the Olive Downs South domain, and areas adjacent and upstream of the Ripstone Creek diversion.

It is however recognised that post-mining, the temporary levees would be removed and the floodplain area excised significantly reduced (Figures 4-22a and 4-22b). Importantly, the post-mining flood modelling results show that water would not enter the final voids located behind the permanent highwall emplacements in events up to and including the PMF event (Appendix F).

Hatch (2018b) considered the risk of the Project increasing flood levels and velocities in the Flood Assessment (Appendix F) and concluded that the Project is not considered to result in any significant change to the existing flood risk for surrounding privately-owned properties or infrastructure (Appendix F).

There are negligible changes in flood flow behaviour at the location of proposed raw water pipeline and ETL between existing and developed scenarios (Appendix F). All roads adjacent to Isaac River are subject to flooding under existing conditions. However, as a result of the Project, the proposed access road located in the north-east of the Project might be subject to flooding more frequently (Appendix F).

A summary of the model predicted afflux changes on the neighbouring/ private properties within the Project area are provided in Table 4-18.

Table 4-18
Predicted Afflux Changes at Neighbouring/Private Properties

Property Name	Annual Exceedance Probability			
	50%	2%	1%	0.1%
Olive Downs	Neg.	Up to 1.4m*	Up to 1.8m*	Up to 3.2m*
Winchester Downs	Neg.	Neg.	Neg.	Neg.
Wynette	Neg.	Up to 0.2m*	Up to 0.3m*	Up to 0.8m*
Vermont Park	Up to 0.2m*	Up to 1.9m*	Up to 2.0m*	Up to 3.4m*
Seloh Nolem	Neg.	Neg.	Neg.	Up to 0.2m*
Coolibah	Neg.	Up to 0.1m*	Up to 0.2m*	Up to 0.5m*
Willunga	Neg.	Up to 1.1m*	Up to 1.2m*	Up to 1.2m*
Leichardt	Neg.	Neg.	Neg.	Neg.
Old Bombandy	Neg.	Neg.	Neg.	Neg.

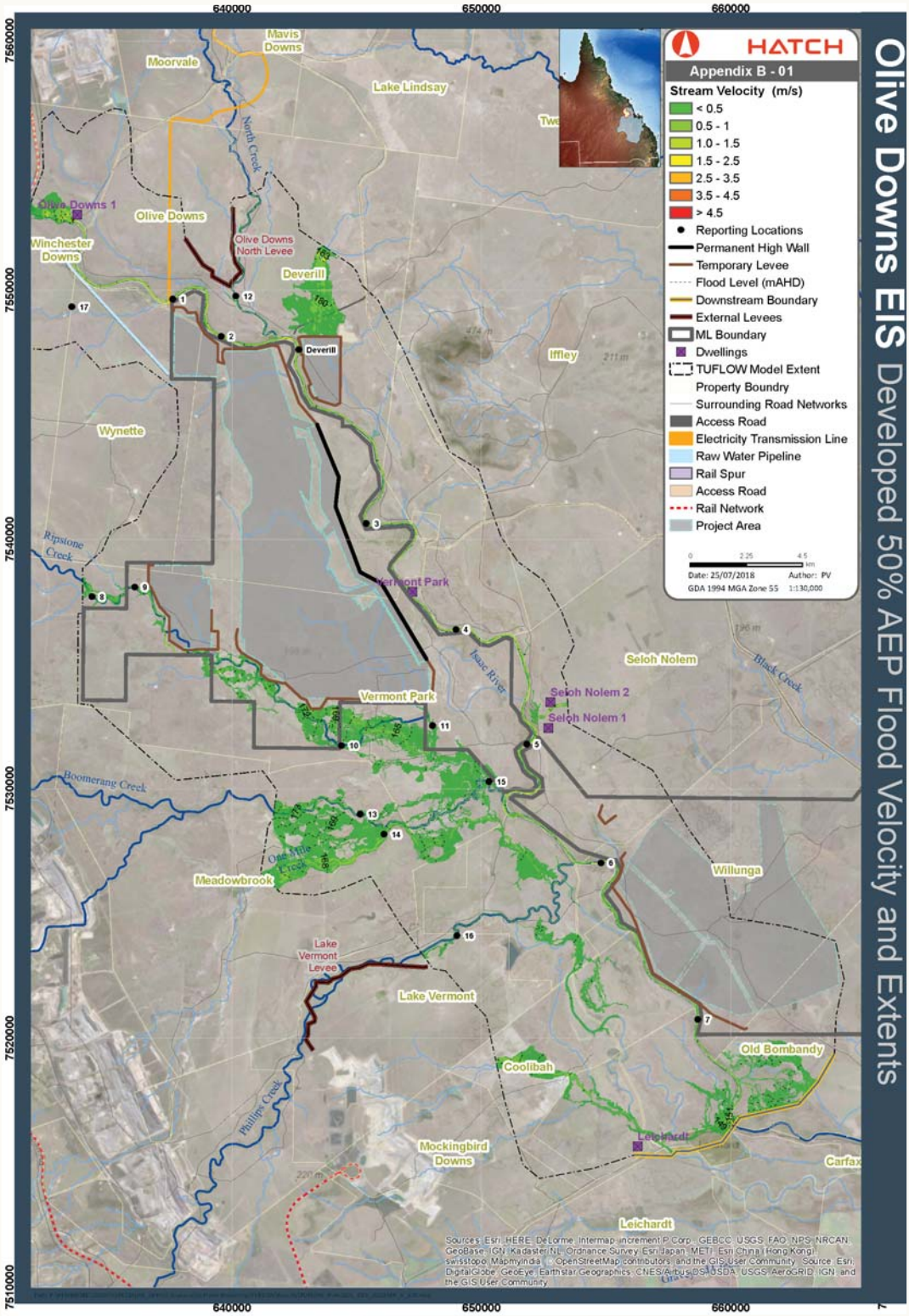
Source: after Appendix F.
Neg. = Negligible (Less than 0.1 m)
* Within Existing flood prone areas.

Flow Velocity

The averages of maximum stream velocity values along the Isaac River for 50%, 2%, 1% and 0.1% AEPs are between 1.3 m/s to 2.1 m/s. The average of maximum stream velocity along Isaac River for PMF is estimated to be 2.3 m/s (Appendix F).

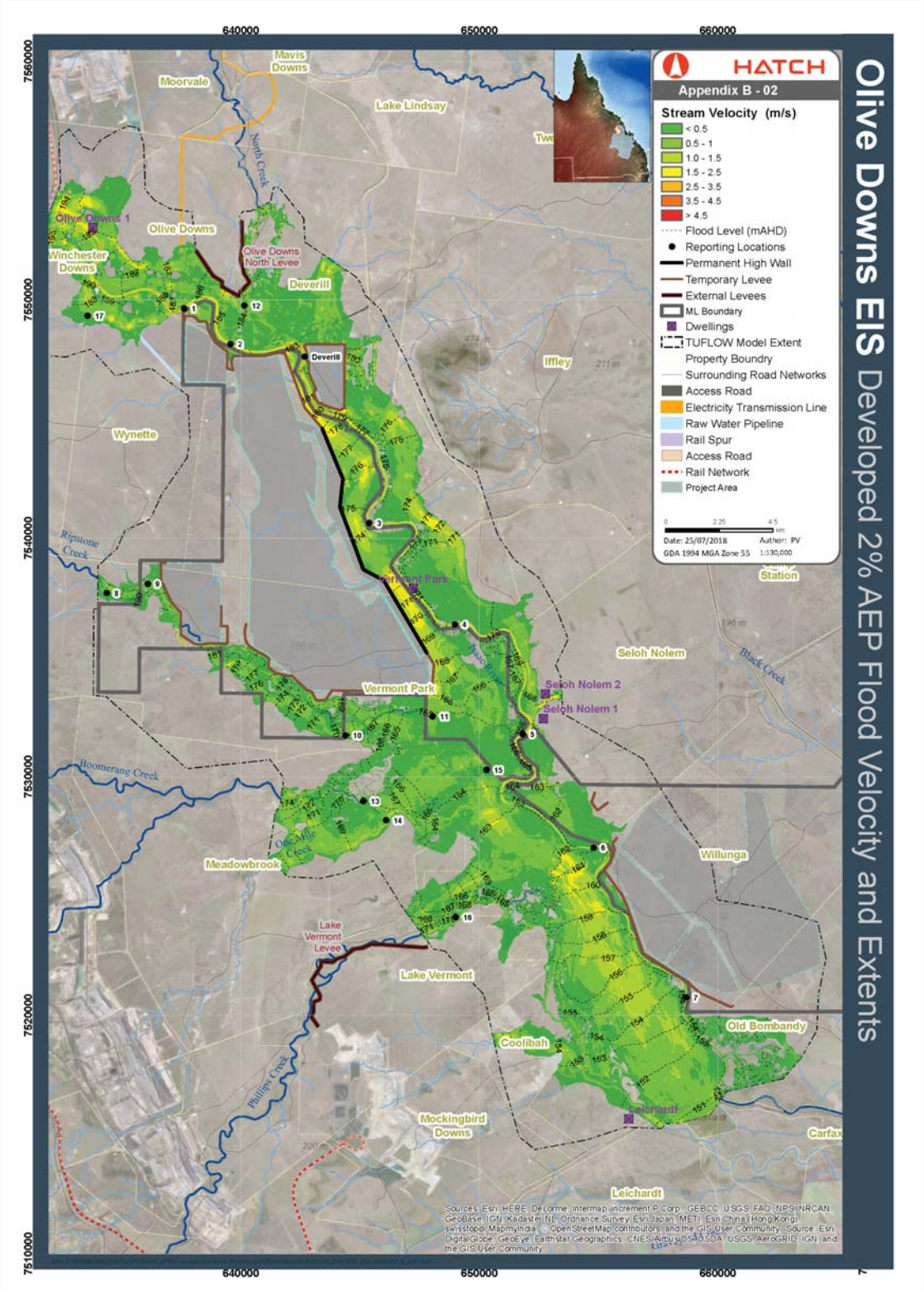
Based on the Developed Case modelling results, the averages of maximum stream velocity values along Isaac River for 50%, 2%, 1% and 0.1% AEPs would be between 1.5 m/s to 2.2 m/s (Appendix F).

The changes in flow velocity up to and including the 0.1% AEP event are therefore predicted to be relatively small in most areas adjacent the Project, with absolute flow velocities similar to areas downstream in the natural section of the stream (Figures 4-22a and 4-22b).



PRN-16-02_EIS_Sect4_009D

Source: Hatch (2018)

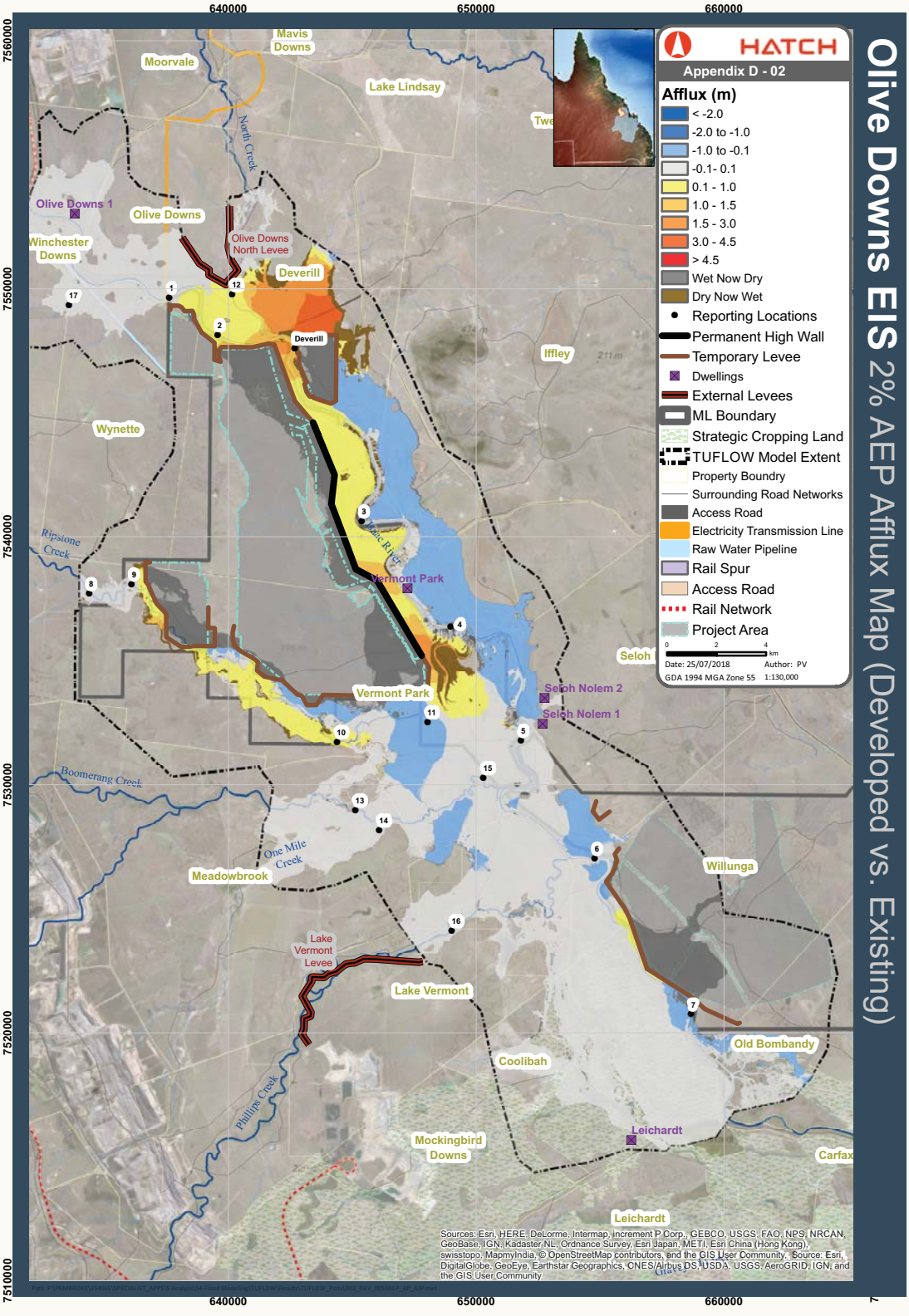


PRN-16-02_EIS_Sect_0268

Source: Hatch (2018)

Developed Case Flood Model Predictions (2% AEP)

Figure 4-20b



PRN-16-02_EIS_Sect3_0088

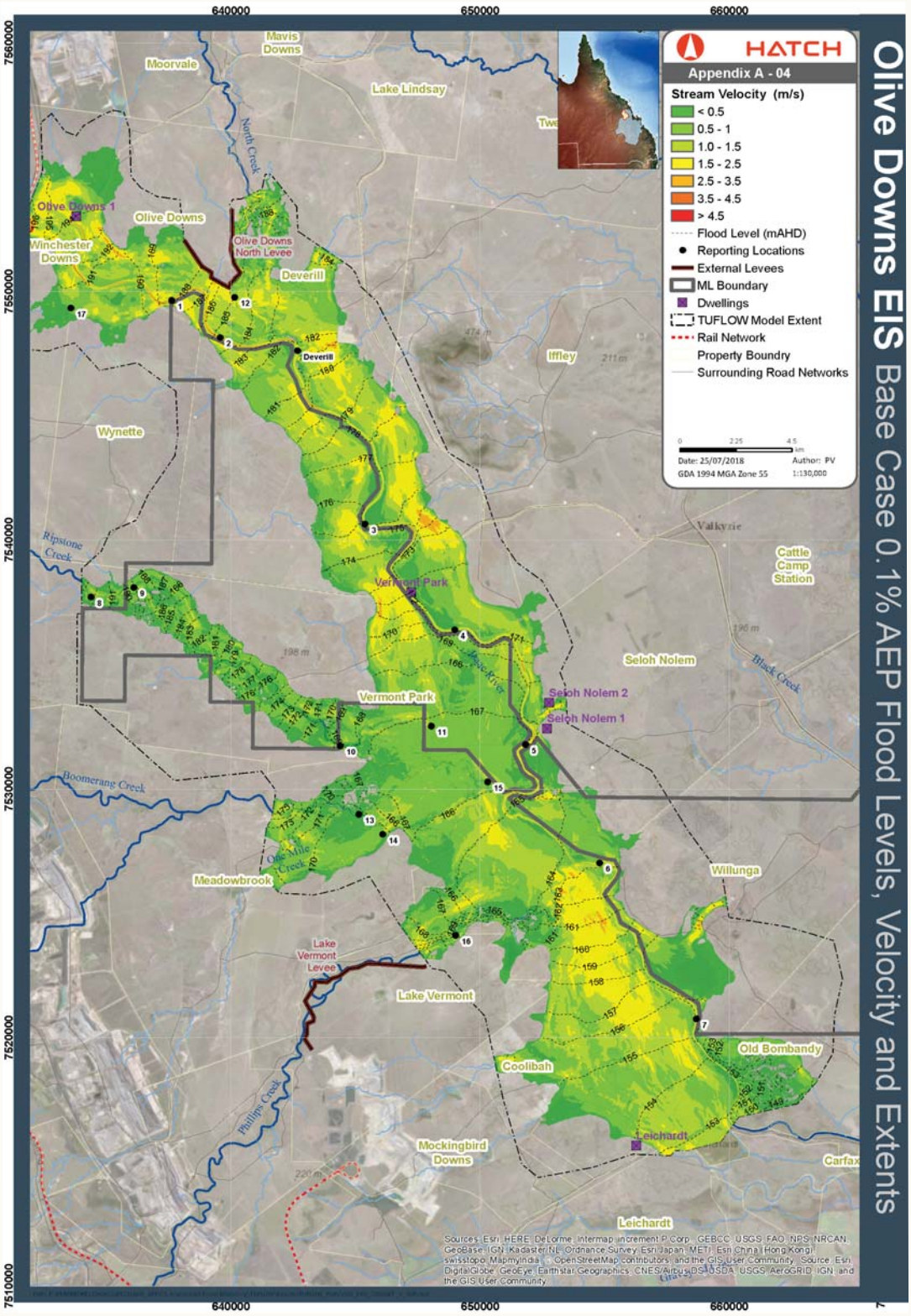
Source: Hatch (2018)

PEMBROKE

OLIVE DOWNS PROJECT

Developed Case Flood Model Predictions (2% AEP) – Afflux and Property Ownership

Figure 4-21



PRN-116-02_EIS_Sect4_008C

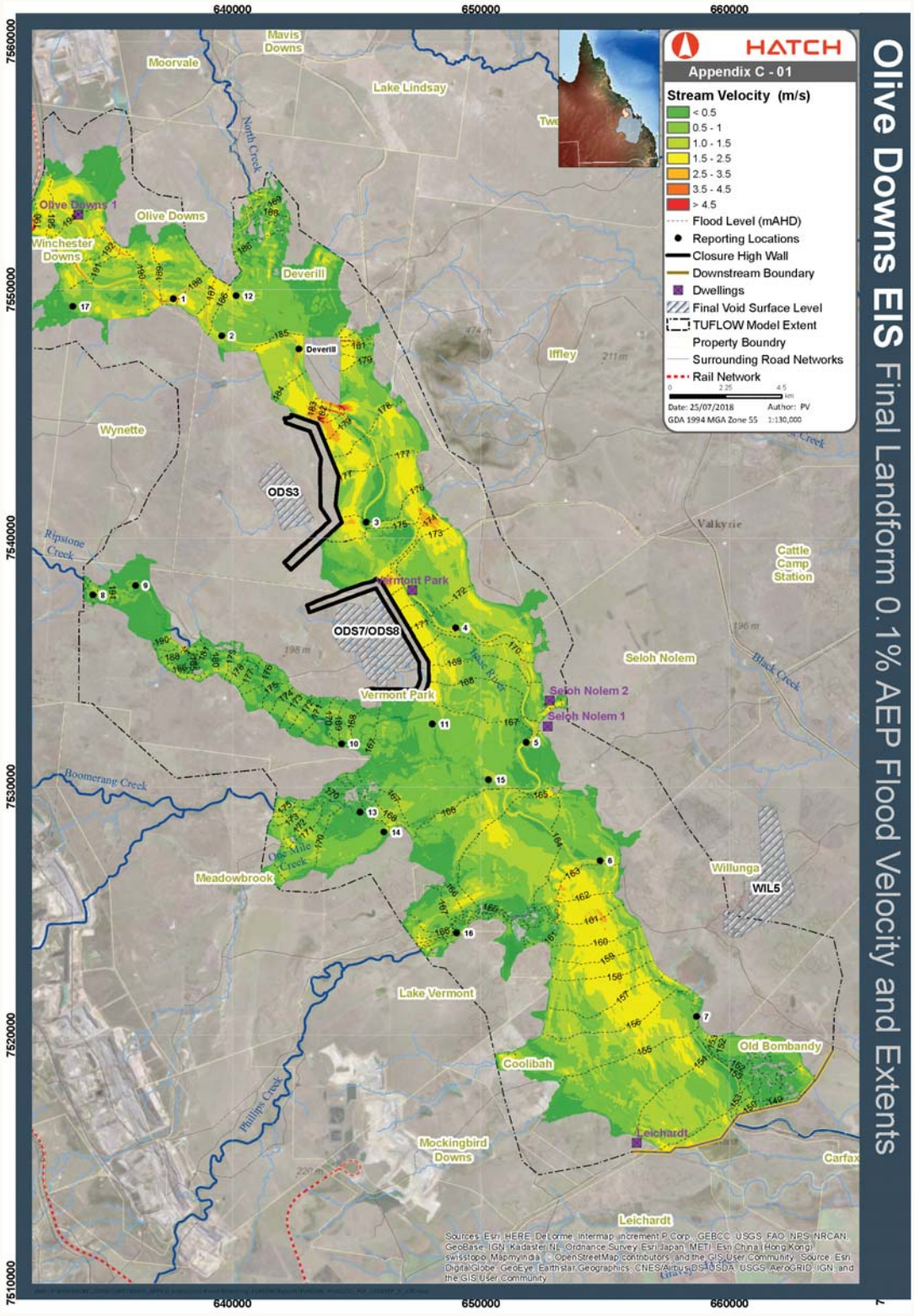
Source: Hatch (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Base Case Flood Model Predictions (0.1% AEP) – Velocity and Extents

Figure 4-22a



PRN-16-02_EIS_Sect4_025B

Source: Hatch (2018)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Final Landform
Flood Model Predictions (0.1% AEP) –
Velocity and Extents

Figure 4-22b

It is noted that model predicted flow velocities along the approved Olive Downs North levee are lower than previous estimates, and thus it is unlikely that additional erosion protection would be required on this levee (Appendix F).

Stream Power and Bed Shear Stress

Generally, the modelled bed shear stresses are less than 100 newtons per square metre (N/m²), although most values in the central channel area of the Isaac River are close to 100 N/m². The channel bed is bare sand, so would be mobile under these shear stresses (Appendix F).

As expected, the banks of the Isaac River are generally well vegetated and stable, with occasional areas on the outside of bends showing evidence of scour. This is considered part of the normal process of channel migration and adjustment (Appendix F).

Under the developed case, some locations would have higher values of bed shear stress on the areas of the floodplain impacted by confinement, reaching 50 N/m² for the 2% AEP design flood event (Appendix F). The maximum permissible shear stress method suggests that these floodplain surfaces, if maintained with complete and dense vegetation cover should remain stable (Appendix F). More detailed assessment of stream power and bed shear stress has been provided in the geomorphology assessment (Fluvial Systems, 2018) (Attachment A to Appendix E) and the conclusions are summarised below.

Stream Geomorphology

The risk of erosion of the Isaac River channel and floodplain was assessed by Fluvial Systems (2018) using the method of maximum permissible bed shear stress and velocity assessment, with the hydraulic variables modelled as part of the Flood Assessment (Appendix F). The assessment of the most critical areas found that while there could be isolated areas subject to somewhat higher risk of scour compared to the existing situation, the overall risk of rapid and significant geomorphic change in the Isaac River due to the Project was low (Attachment A to Appendix E).

Cumulative Impacts

The Flooding Assessment (Appendix F) considered any existing and proposed structures that may affect flood behaviour, as well as structures proposed as part of the Project. Hatch (2018b) concluded that there are no known projects in the planning or development phase that might result in additional structures on the floodplain in the vicinity of the Project.

Cumulative impacts on flooding are not expected to lead to any adverse impacts on human populations, property or other environmental or social values (Appendix F).

4.4.4 Mitigation Measures, Management and Monitoring

Provided the Project is developed in accordance with the features and control strategies described below, the flooding impacts of the proposed Project on people, property and the environment are considered to be avoided, minimised or mitigated.

Flood Management Infrastructure Design

The following types of flood management infrastructure would be constructed for the Project (Section 2):

- temporary flood levees; and
- permanent highwall emplacements.

Identification of potential flood protection works for the Project was based on the following key criteria:

- 0.1% AEP design event flood protection for open cut pits in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DEHP, 2016b);
- 1% AEP design event flood protection for operational infrastructure other than open cut pits; and
- PMP design event flood protection for the closure final landform.

Temporary Flood Levees

Construction of temporary flood levees (or sufficiently robust waste rock emplacements) (Figures 2-3 to 2-9) is required to provide immunity for infrastructure and mining operations to flood levels during a 0.1% AEP flood event, if such an event was to occur during the course of the Project.

Each temporary flood levee would be installed progressively and in advance of the open cut mining operational areas it would protect.

The temporary flood levee in the north-east of the Olive Downs South domain would be removed or reshaped once the open cut is backfilled and rehabilitated in the northern areas to provide additional flood storage areas adjacent to the Isaac River to reduce flood velocities and stream power (Figure 2-6). Similarly, the temporary flood levees in the south and south-west of the Olive Downs South domain adjacent to Ripstone Creek would be removed or reshaped once the waste rock emplacements are rehabilitated (Figures 2-8).

The temporary flood levee in the west of the Willunga domain would also be removed or reshaped once Pit WIL1 is backfilled and the waste rock emplacements rehabilitated (Figure 2-7).

Permanent Highwall Emplacements

The construction of permanent highwall emplacements to the east and south-east of the proposed Olive Downs South domain open cut pits adjacent to the Isaac River floodplain are required to provide immunity to flood levels up to at least a 0.1% AEP flood event (Figures 2-3, 2-4, 2-6 and 2-8).

The permanent highwall emplacements would generally be approximately 300 m to 400 m wide and approximately 25 m high. In contrast, the PMF event flood level in the vicinity of the permanent highwall emplacements would generally be below 6 m.

No permanent highwall emplacements are proposed for the Willunga domain.

Section 2.10 describes the final integrated landform following the removal of the temporary flood levees post-mining.

Revegetation of Flood Management Infrastructure

During rehabilitation of the Project, vegetation would be established as soon as practicable on the outer batters of the temporary flood levees and permanent highwall emplacements to prevent slope face degradation (Section 5).

Ripstone Creek Diversion

The Ripstone Creek Diversion has been designed in consideration of the *Water Act 2000* and the *Environmental Protection Act 1994*, and to, as far as possible, replicate the natural hydraulic behaviour of the Ripstone Creek waterway.

An assessment of the potential impacts of the diversion was undertaken as part of the Flooding Assessment (Appendix F).

Hatch (2018b) concluded that by comparing the results of the flood modelling with the ACARP guidelines for the Bowen Basin, the diversion would not change the hydraulic behaviour of the waterway significantly.

Monitoring

The Project flood management infrastructure would be inspected by a suitably qualified and experienced person once per year between the months of May and October (inclusive) (i.e. in advance of the wet season). In addition, a visual inspection of the flood management infrastructure would be carried out following major flood events (e.g. 10% AEP or greater) to identify any potential issues with erosion, settlement or slumping.

Geomorphic monitoring would include topographic survey of the Isaac River channel and floodplain, repeated every year for 3 years, and then either every 5 years, or after every flood event exceeding the 5 year ARI event (e.g. 20% AEP or greater). This would be done using LiDAR technology, flown when the flow is very low. A Before-After, Control-Intervention (BACI) monitoring design would be used, with tolerable limits of change in the intervention reaches set by the observed degree of change in control reaches.

Mitigation measures would be triggered by unexpectedly large changes in channel morphology identified through monitoring along the Isaac River. The most appropriate response would need to be assessed at the time.

A monitoring strategy for the Ripstone Creek Diversion has also been developed and includes monitoring prior to construction, during construction, during operation and at relinquishment (Appendix F).

Monitoring would include:

- photographic reference points;
- aerial imagery;

- historic and LiDAR surveys;
- visual assessment (using a modified version of the Index of Diversion Condition);
- vegetation surveys; and
- flow event analysis.

The frequency of monitoring would be governed by a risk framework developed as part of the detailed design of the diversion.

Deverill Gauging Station

During the operational and post-mining phases, the proposed out-of-pit emplacement near the Deverill Gauge could cause changes to the gauging stations rating curve. Therefore, the rating curve would either be adjusted regularly in consultation with DNRME or otherwise relocated further upstream (i.e. 5 km upstream) to the next best confined flow path which is relatively free of influence.

4.4.5 Regulated Structures

A preliminary assessment of the Consequence Category of the proposed regulated structures (dams and levees) for the Project has been undertaken by a 'suitably qualified and experienced person' in accordance with the failure to contain criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (Version 5.0) (DEHP, 2016b) (Appendices E and F). All proposed mine affected water dams which overflow internally (i.e. would not result in an uncontrolled release to the receiving environment) have been assigned a preliminary category of 'low' consequence due to the low risk of significant consequence in the event of a failure to contain or dam break (Appendix E).

There are only three mine affected water dams that could possibly report (in an overflow event) to the receiving environment (i.e. P44, WROM and WMIA) (Appendix E). These dams have been assessed against Table 1 of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (Version 5.0) (DEHP, 2016b) and have been assigned a 'low' consequence category for the failure to contain criteria based on the predicted water quality results from the water balance model (Appendix E).

All proposed temporary levees have been assigned a preliminary category of 'low' consequence due to the low risk of significant consequence in the event of a failure to contain (Appendix F).

Mitigation Measures and Management

Notwithstanding the 'low' consequence categories, Pembroke would implement a number of mitigation and management measures including:

- operational measures that would allow for the practical limitations of being able to redistribute stored volumes across the containment system (including operability of equipment under extreme weather conditions);
- annual inspections to assess the condition and adequacy of all components of the regulated structures; and
- establishing and maintaining a register of regulated structures.

4.5 AIR QUALITY

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken by Katestone Environmental (2018) and is presented as Appendix G.

The environmental objective and performance outcomes for air quality are provided in Section 4.5.1. A description of the proposed air quality objectives is provided in Section 4.5.2. Section 4.5.3 describes the potential air quality impacts of the Project, including cumulative impacts, and Section 4.5.4 outlines proposed air quality mitigation measures, management and monitoring.

Estimated greenhouse gas emissions contributions as a result of the Project are discussed in Section 4.5.5.

4.5.1 Environmental Objectives and Performance Outcomes

The environmental objective relevant to air quality, as described in the Terms of Reference for the Project, is:

> *The environmental objective to be met under the EP Act is that the activity will be operated in a way that protects the environmental values of air.*

The Project would achieve the following performance outcome as identified in Part 3, Schedule 5, Table 1 of the EP Regulation:

> *2 All of the following—*
>
> *(a) fugitive emissions of contaminants from storage, handling and processing of materials and transporting materials within the site are prevented or minimised;*

(b) contingency measures will prevent or minimise adverse effects on the environment from unplanned emissions and shut down and start up emissions of contaminants to air;

(c) releases of contaminants to the atmosphere for dispersion will be managed to prevent or minimise adverse effects on environmental values.

4.5.2 Description of Environmental Values

Air Quality Objectives

Air quality objectives are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the potential air emissions generated by the Project and the applicable air quality objectives/criteria.

Concentrations of Suspended Particulate Matter

Mining activities during the life of the Project have the potential to generate particulate matter (i.e. dust) emissions in the form of:

- Total Suspended Particulate (TSP) matter;
- Particulate matter with an equivalent aerodynamic diameter of 10 micrometres (µm) or less (PM_{10}) (a subset of TSP); and
- Particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$) (a subset of TSP and PM_{10}).

Mining activities generate particles in all the above size categories, with the majority generally larger than 2.5 µm. Fine particles (less than 2.5 µm) are typically generated through combustion processes (Appendix G). Smaller particles can be more harmful to human health as the particles can be trapped in the noise, mouth or throat, or drawn into the lungs (Appendix G).

In Queensland, air quality is managed under the EP Act, the EP Regulation and the Environmental Protection (Air) Policy 2008 (EPP [Air]).

Table 4-19 summarises the air quality objectives in the EPP (Air) for protection of human health and wellbeing that are relevant to the Project.

Dust Deposition

The *Application requirements for activities with impacts to air* guideline (DEHP, 2017c) states that a dust deposition limit of 120 milligrams per square metre per day (mg/m²/day), averaged over one month is frequently used in Queensland. This is consistent with the guideline for dust deposition described in DES' *Model Mining Conditions* guideline (DEHP, 2017d).

Other Air Pollutants

Emissions of other air pollutants would also arise from mining operations associated with diesel powered equipment used on-site and on-site blasting.

Emissions from diesel powered equipment and blasting may include carbon monoxide (CO), oxides of nitrogen (NO_x) and other pollutants such as sulphur dioxide (SO_2) (Appendix G).

The emission of these and other pollutants generated from diesel consumption and blasting activities at mine sites are considered to be too small to generate any significant off-site pollutant concentrations and were therefore not assessed further in the Air Quality and Greenhouse Gas Assessment (Appendix G).

Table 4-19
Goals for Ambient Air Quality

Pollutant	Environmental Value	Averaging Period	Air Quality Objective/Criteria (µg/m³)	Number of Days of Exceedance Allowed per Year
$PM_{2.5}$	Health and wellbeing(1)	24 hour	25	N/A
		Annual	8	N/A
PM_{10}		24 hour	50(3)	5
TSP		Annual	90	N/A
Dust deposition	Amenity guideline(2)	Monthly	120 mg/m²/day	N/A

After: Appendix G.

Notes:

µg/m³ = micrograms per cubic metre. mg/m²/month = milligrams per square metre per month.

1 Air quality objective sourced from the EPP (Air).

2 As per DES' *Application requirements for activities with impacts to air* and *Model Mining Conditions* guidelines, not an air quality objective from the EPP (Air).

3 Not more than 5 days per year above the objective.

Adopted Project Goals

The pollutants relevant to the Project and corresponding criteria as identified in the EPP (Air) objectives and in relevant Queensland guidelines are presented in Table 4-19.

The air quality goals typically relate to the total dust burden in the air and not just the dust generated from the Project. Background particulate matter concentrations and dust deposition levels therefore need to be considered when using these goals to assess potential cumulative impacts.

Existing Air Quality

There are a number of dust sources in the vicinity of the Project that contribute to ambient air quality, including natural sources (e.g. wind erosion of non-vegetated areas, pollen and grass seeds) and anthropogenic sources (e.g. existing mines in the region, vehicle travel on unpaved roads and agricultural activities) (Appendix G).

An air quality monitoring station was installed at the Project site to measure meteorology and TSP, PM_{10} and $PM_{2.5}$. While the monitoring station was installed in early March 2017, the station was impacted by a severe weather event in late March 2017 (Cyclone Debbie) and the equipment was out of order until mid-July 2017 (Appendix G).

Katestone Environmental (2018) considered the relatively low amount of data available from the monitoring station at the time of assessment insufficient to characterise the existing air quality of the Project area for assessment purposes (Appendix G).

Katestone Environmental (2018) therefore derived background air quality for the Project area based on publicly available air quality monitoring information, as described below.

PM_{10}

Long-term continuous PM_{10} monitoring data is available from the DES monitoring station located in Moranbah. Katestone Environmental (2018) reviewed the data available between 2011 and 2016 and determined a background 24 hour average PM_{10} concentration based on the highest 70th percentile 24 hour average recorded (excluding 2012, which was affected by localised construction activity) (Appendix G).

TSP and $PM_{2.5}$

Katestone Environmental (2018) reviewed a number of sources of monitoring data in the region to determine background TSP and $PM_{2.5}$ levels, including the Caval Ridge EIS (BHP Billiton Mitsubishi Alliance, 2010) and the Moranbah South EIS (Anglo American Metallurgical Coal, 2015) (Appendix G).

Background levels of TSP and $PM_{2.5}$ were determined from nine months of data recorded in Moranbah in 2012 by BHP Billiton Mitsubishi Alliance (Appendix G).

Dust Deposition

Katestone Environmental (2018) sourced the background dust deposition level from data described in the Moranbah South EIS (Anglo American Metallurgical Coal, 2015). The maximum rolling annual average value was used for the assessment (Appendix G).

Background Air Quality for Assessment Purposes

Adopted background air quality levels for the Project are provided in Table 4-20

Table 4-20
Estimated Background Air Quality Levels

Pollutant	Averaging Period	Units	Adopted Background Level
TSP	Annual	µg/m³	27.5
PM_{10}	24 hour	µg/m³	27.2
$PM_{2.5}$	Annual	µg/m³	3.6
	24 hour	µg/m³	4.3
Dust deposition	Monthly	mg/m²/day	71

After: Appendix G.

Sensitive Receptors

There are six sensitive receptors in the vicinity of the Project. These sensitive receptors are all isolated homesteads. Each of the sensitive receptors is shown on Figure 1-2.

It is noted the closest sensitive receptor to the Project, “Vermont Park”, is rented by Pembroke and is not occupied.

4.5.3 Potential Impacts

Assessment Methodology

Modelling Scenarios

Potential air quality impacts were assessed for Years 2027, 2043, 2066 and 2085. These scenarios were selected to represent a range of potential impacts over the life of the Project (Figures 2-3 to 2-9) with reference to the location of the operations and the potential to generate dust in each year.

Emission Inventories

Key activities that would generate emissions include waste rock removal, ROM coal extraction, truck haulage emissions, wind erosion from exposed areas and material handling (including conveying). Air quality emission inventories were prepared for the selected years in consideration of the anticipated mining activities for each year.

The air quality emission inventories were developed using recognised and accepted methods including emission rate approximation based on National Pollutant Inventory emissions estimation technique handbooks and the United States Environmental Protection Agency AP-42 emission handbooks (Appendix G).

The estimated dust emissions reflect the use of a range of dust mitigation measures that would be adopted for the Project. These measures are described in Appendix G and Section 4.5.4.

Meteorology

As described in Section 4.5.2, Katestone Environmental (2018) considered the relatively low amount of data available from the monitoring station at the time of assessment insufficient to characterise the site-specific meteorology of the Project area for assessment purposes (Appendix G).

The last five complete years of observations at the Bureau of Meteorology monitoring station in Moranbah (Moranbah Airport) (2012 to 2016) were analysed to determine a representative year to be used in the dispersion modelling (Appendix G).

Based on the analysis, the wind speed, wind direction and temperature in 2015 were the closest to the average for the period 2012 to 2016 (Appendix G).

Katestone Environmental (2018) used The Air Pollution Model (a prognostic meteorological model) and CALMET (a diagnostic meteorological model) to generate a three-dimensional meteorological dataset for the Project area suitable for use with the CALPUFF dispersion model.

Dispersion Modelling

Dispersion modelling was conducted using the CALPUFF dispersion model. The CALPUFF dispersion model is an advanced non-steady-state dispersion modelling system (Appendix G).

A full description of the dispersion model, meteorology, emission inventories and modelling outputs is provided in Appendix G.

Cumulative Impacts

Mining activities and wind erosion emissions associated with the Project have been considered in the Air Quality and Greenhouse Gas Assessment (Appendix G) along with background dust contributions from non-mining sources and other mines in the region for a comprehensive cumulative assessment.

Suspended Particulate Matter

Predicted Maximum 24 hour $PM_{2.5}$ Concentrations

All sensitive receptors are predicted to experience cumulative 24 hour $PM_{2.5}$ levels below the EPP (Air) objective of 25 µg/m³ (Appendix G).

Predicted Annual Average $PM_{2.5}$ Concentrations

All sensitive receptors are predicted to experience cumulative annual average $PM_{2.5}$ concentrations below the EPP (Air) objective of 8 µg/m³ (Appendix G).

Predicted Maximum 24 hour PM_{10} Concentrations

The EPP (Air) objective is for maximum 24 hour average PM_{10} concentrations not to exceed 50 µg/m³ for more than five days per year from cumulative sources (Table 4-19).

Katestone Environmental (2018) modelled and presented both maximum and sixth highest 24 hour average PM_{10} concentration predictions in Appendix G. Isopleth diagrams illustrating sixth highest 24 hour average PM_{10} concentrations for Year 2043 are presented on Figure 4-23. Consistent with the EPP (Air) objective, consideration of whether the predicted sixth highest 24 hour average concentrations exceed 50 µg/m³ is provided below.

With the implementation of management measures described in Section 4.5.4, all sensitive receptors are predicted to experience 24 hour average PM_{10} levels below the EPP (Air) objective (i.e. concentrations should not exceed 50 µg/m³ for more than five days per year).

Predicted Annual Average TSP Concentrations

All sensitive receptors are predicted to experience cumulative annual average TSP concentrations below the EPP (Air) objective of 90 µg/m³ (Appendix G).

A range of particulate matter isopleth diagrams are presented in Appendix G including proposed Project $PM_{2.5}$, PM_{10} and TSP emissions for all modelled scenarios and all assessed averaging periods.

Dust Deposition

All sensitive receptors are predicted to experience cumulative monthly average dust deposition levels below the guideline of 120 mg/m²/day (Appendix G).

A range of dust deposition level isopleth diagrams are presented in Appendix G including predicted Project monthly average dust deposition levels for all modelled scenarios.

4.5.4 Mitigation Measures, Management and Monitoring

Air quality management measures and monitoring for the Project would be documented in an Air Quality Management Plan to be prepared for the Project prior to the commencement of construction.

Dust Management Measures

General dust mitigation measures that would be implemented for the Project to minimise dust generation are summarised in Table 4-21.

In addition to water sprays during train load-out (i.e. coal moisture regulation), Pembroke would design the train load-out facility consistent with the dust management strategies identified for new facilities in QR Network's (2010) *Coal Dust Management Plan* (refer Section 2.5.9), including:

- automated loading of train wagons to prevent overloading;
- sill beam brushes to remove coal on the outside faces of the train wagons;
- veneering system to prevent coal dust generation during transit to port; and
- use of spill pit to recover spilt coal under the train load out.

Table 4-21
General Project Dust Control Measures

Activity	Key Dust Control Measures
Wheel-generated dust and grading	• Watering of haul road surfaces. • Chemical suppressant.
Drilling	• Dust suppression systems.
Wind erosion of exposed areas	• Progressive rehabilitation.
Wind erosion of ROM coal stockpiles	• Water sprays.
CHPP conveyors	• Water sprays on transfer points.
Train loading	• Water sprays.
Crushing	• Enclosure of infrastructure.

After: Appendix G.

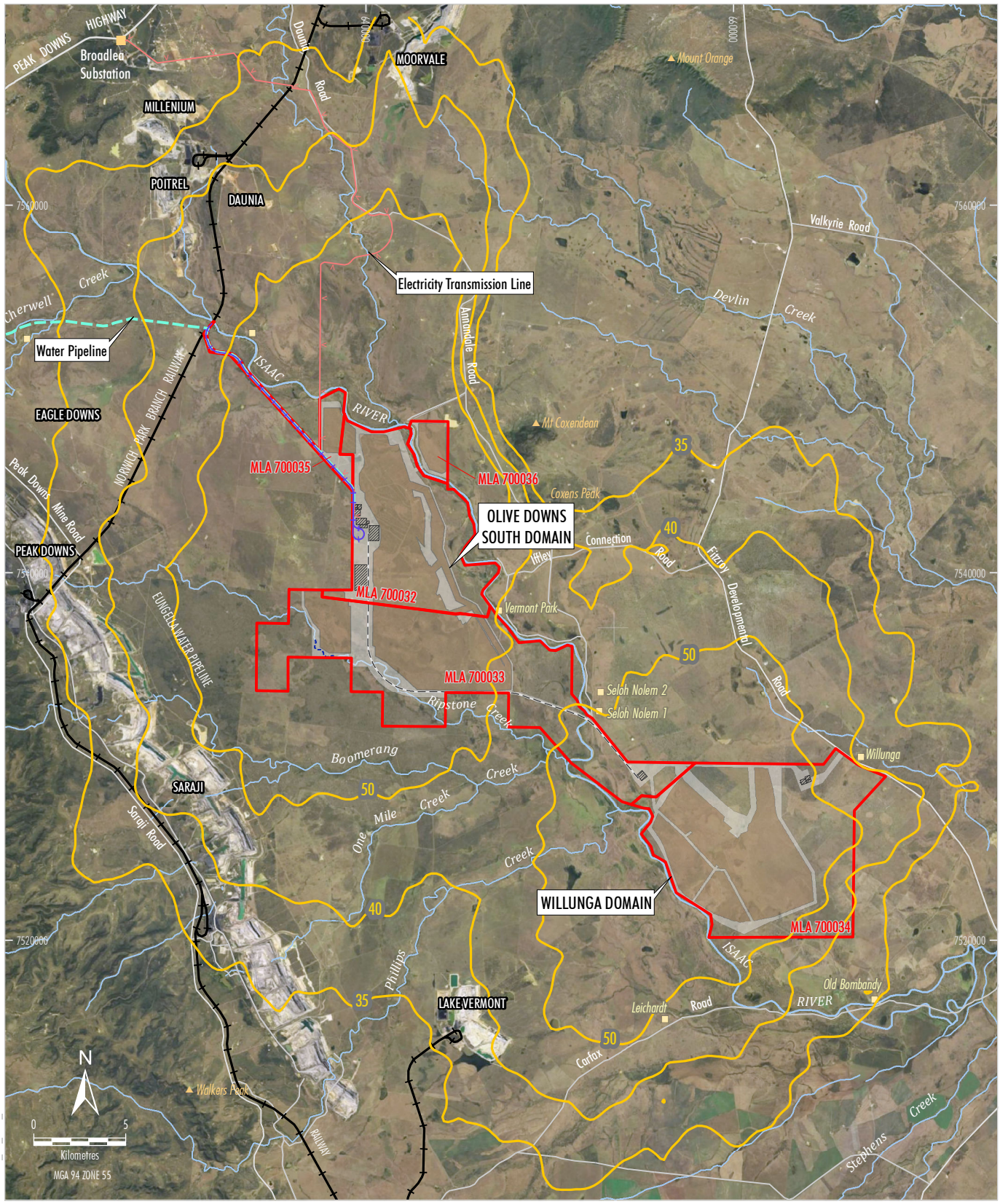
Coal would also be tested for dustiness and dust management would be adjusted accordingly based on the results of testing.

Pembroke would also implement proactive and reactive dust control measures. These measures would include the use of weather forecasting and real-time measurement of dust levels and meteorological conditions to modify mining operations as required in order to achieve compliance with applicable air quality objectives at the nearest privately-owned receivers.

Modifying mining operations could include the application of additional dust controls, an increase in the intensity of applied dust controls, reducing the intensity of particular operations or halting particular operations.

Dispersion modelling indicates modifications to operations would likely only be required during a small range of meteorological conditions that may occur during the early morning or late at night. These conditions occur infrequently and would therefore not materially affect mine scheduling (Appendix G).

With the proposed dust management measures in place, including proactive and reactive dust control measures that are considered good or best practice, it is reasonable to expect that the air quality objectives would be met during the operation of the Project (Appendix G). Given the flexibility and robustness of the proposed mitigation measures, this would be the case even with additional dust generating activities in the region (e.g. new or expanded mining operations).



PRN-16-02_EIS_Sect4_212B

LEGEND

- Mining Lease Application Boundary
- Railway
- Dwelling
- Proposed Electricity Transmission Line
- Proposed Rail Spur and Loop
- Proposed Water Pipeline
- Proposed Creek Diversion
- Out-of-Pit and In-Pit Waste Rock Emplacement
- Infrastructure Area
- Key Infrastructure Component
- Overland Conveyor
- Air Quality Contour ($\mu g/m^3$)

Source: Geoscience Australia - Topographical Data 250K (2006)
Department of Natural Resources and Mines (2016)
Orthophotography: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT
24-hour Average PM_{10} Contours - 2043

Figure 4-23

Blast management measures to minimise the off-site generation of dust and fumes would be detailed in a Blast Management Plan to be prepared for the Project. Blast management measures may include product selection, review of prevailing meteorology and review of ground conditions.

Monitoring

Meteorological data and TSP, PM_{10} and $PM_{2.5}$ levels would continue to be monitored on an ongoing basis at the existing monitoring site at the Project for the implementation of operational dust controls.

A network of dust deposition gauges would also be installed.

If monitoring indicates any unexpected exceedances of air quality objectives, an investigation would be conducted by Pembroke, including additional dust monitoring if required (Appendix G).

4.5.5 Greenhouse Gas Emissions

Emission Scenarios

The National Greenhouse Accounts (NGA) Factors document published by the DEE defines three scopes (Scope 1, 2 and 3) for different emission categories. These categories are based on whether the emissions generated are from “direct” or “indirect” sources.

Scope 1 emissions encompass the direct sources from the Project (e.g. on-site fuel use and mining activity) (DEE, 2017).

Scope 2 emissions are indirect emissions associated with purchased electricity (i.e. Scope 2 emissions are physically produced by the burning of fuels at a power station) (DEE, 2017).

Scope 3 emissions are other indirect emissions (e.g. attributable to the extraction, production and transport of fuels consumed) (DEE, 2017).

For the purpose of this assessment, Scope 1 and Scope 2 emissions associated with the Project have been quantified (Appendix G).

Scope 1 and 2 greenhouse gas emission sources identified from the operation of the Project are the on-site combustion of diesel fuel, emissions of methane from the exposed coal seams, emissions from the use of explosives and on-site consumption of electricity (Appendix G).

Land clearing was also considered, however progressive rehabilitation of the open cuts and waste emplacements would offset incremental land clearance over the life of the Project. Greenhouse gas emissions from land clearance have therefore not been quantified (Appendix G).

Estimating Greenhouse Gas Emissions

Estimated quantities of materials contributing to greenhouse gas emissions for the Project are presented in Appendix G.

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the Project, emissions factors obtained from the NGA Factors (2017) are required. These are presented in Appendix G.

A summary of estimated annual CO_2-e emissions due to the operations of the Project is presented in Appendix G.

Contribution of Greenhouse Gas Emissions

Estimated annual Scope 1 and Scope 2 greenhouse gas emissions from the Project are presented in Appendix G.

The estimated annual average Scope 1 and Scope 2 greenhouse gas emissions for the life of the Project is 773 kilotonnes carbon dioxide equivalent (kt CO_2-e). This represents a contribution of approximately 0.3% to the annual Australian greenhouse gas emissions and 1.1% of annual greenhouse gas emissions of Queensland (Appendix G).

4.6 SOCIAL VALUES

A Social Impact Assessment (SIA) was undertaken for the Project by Elliott Whiteing (2018), and is presented in Appendix H.

Potential impacts of the Project on the social values of the local and regional communities were identified through direct engagement with potentially affected stakeholders, and the analysis of potential impacts against the attributes of the existing social environment.

A description of the existing social values is provided in Section 4.6.2. The potential impacts of the Project on social values are described in Section 4.6.3, while consideration of appropriate management measures, mitigation and monitoring is considered in Section 4.6.4.

4.6.1 Environmental Objectives and Performance Outcomes

The environmental objectives relevant to social values, as described in the Terms of Reference for the Project, are:

(a) *avoid or mitigate/manage adverse social impacts arising from the project*

(b) *capitalize on opportunities potentially available for local industries and communities*

(c) *create a net economic benefit to the location, region and state.*

4.6.2 Description of Environmental Values

The *Strong and Sustainable Resource Communities Act 2017* (SSRC Act) sets out consistent mandatory requirements for SIA under the SDPWO Act and EP Act, to be regulated by the Queensland Coordinator-General.

The SSRC Act's object is to ensure that residents of communities in the vicinity of large resource projects benefit from the construction and operation of those projects. This is supported by three key elements which are:

- prohibition of 100 percent fly-in fly-out (FIFO) workforce arrangements on operational large resource projects;
- prevention of discrimination against locals in the future recruitment of workers; and
- the requirement for SIA.

The SSRC Act applies to 'large resource projects' that have a 'nearby regional community'. A 'large resource project' is a resource project for which an EIS is required or that holds a site-specific environmental authority under the EP Act, and has a workforce of 100 or more workers, or a smaller workforce as decided by the Coordinator-General.

A 'nearby regional community' is a town any part of which is within a 125 km radius of the main access to a large resource project, or a greater or lesser radius decided by the Coordinator-General, and has a population of more than 200 people, or a smaller population decided by the Coordinator-General.

The SSRC Act requires preparation of a SIA for large resource projects. The SIA prepared as part of this EIS has been prepared in accordance with the SSRC Act, and in consideration of the DSDMIP's *Social Impact Assessment Guideline* (2018).

Social Impact Assessment Study Area

The SIA study area was defined with reference to the *Strong and Sustainable Resource Communities Act 2017* (SSRC Act) requirement to consider potential social impacts and benefits for nearby regional communities within a 125 km radius of the Project's entrances (Figure 4-24).

The local study area was defined as including the communities of Moranbah, Dysart, Middlemount, Nebo and Coppabella, with a comprehensive baseline and impact assessment provided for local towns and the Isaac LGA (Appendix H).

It was considered unlikely that significant material impacts or benefits would accrue to any towns within the 125 km radius but more than an hour's drive away and, as such, these towns were not assessed in detail (Appendix H).

The Mackay LGA and the Mackay Isaac Whitsunday (MIW) region were considered with respect to the labour force and business supply chains, with consideration of labour availability in the Central Queensland region included (Appendix H).

Stakeholder Engagement and Community Consultation Program

Consultation undertaken specifically for the Project has included both targeted consultation undertaken for the SIA, as well as a broader consultation program for the EIS (Section 1.4), both of which informed the SIA (Appendix H). Stakeholders consulted as part of the SIA included:

- the SIA unit within the Office of the Coordinator-General;
- Isaac Regional Council;
- local community members and businesses;
- landholders in the vicinity of the Project;
- social and health infrastructure providers;
- Barada Barna people;
- Queensland Health;
- emergency service providers;
- Department of Communities, Child Safety and Disability Services; and
- Department of Education and Training.

PRN-16-02_EIS_Sect4_2068

LEGEND

- Mining Lease Application Boundary
- Major Road
- Railway
- Port

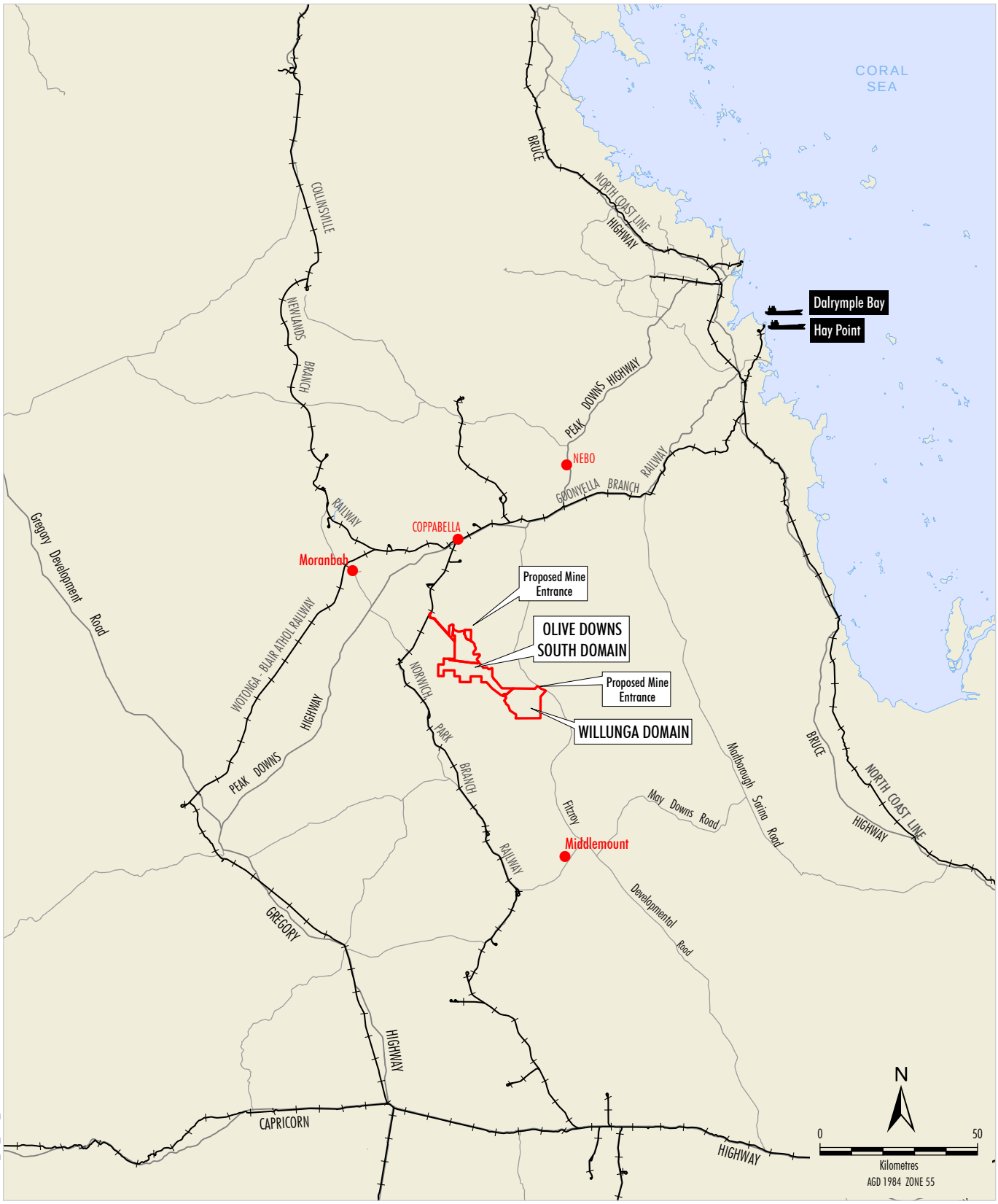
Source: Geoscience Australia - Topographical Data 250K (2006)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Social Impact Assessment Study Area

Figure 4-24a



PRN-16-02_EIS_Sect4_228A

LEGEND

- Mining Lease Application Boundary
- SIA Local Communities of Interest
- Major Road
- Railway
- Port

Source: Geoscience Australia - Topographical Data 250K (2006)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Potentially Affected Communities within SIA Study Area

Figure 4-24b

Consultation was conducted through meetings, community workshops in Moranbah, Nebo, Middlemount and Dysart, an online community survey (promoted through local media, the Isaac Regional Council and social media), phone calls and interviews. Consultation was undertaken during 2017 and early 2018.

Consultation with local communities and stakeholders indicated that they were generally positive about the Project, given its commitments to local employment and co-operation with local stakeholders (Appendix H).

Key issues raised included locally-based employment, encouragement of Project-led population growth, the importance of local businesses participating in Project supply chains, and the need for co-operation with stakeholders to maintain access to the capacity of social infrastructure (Appendix H). Table 4-22 summarises the assessment considerations discussed with the stakeholders as part of the SIA consultation.

A Public Consultation Report is provided in Attachment 5 of this EIS that provides a comprehensive description of all consultation conducted for the Project (in addition to the consultation conducted for the SIA described above). The Public Consultation Report lists the stakeholders consulted, the intent of the meeting and key outcomes and the date of consultation. A summary of the consultation process conducted by Pembroke prior to the EIS lodgement is provided in Section 1.4.

The stakeholder engagement process undertaken as part of the SIA is described in detail in Appendix H.

Population and Demography

The Isaac LGA had an estimated resident population (ERP) of 20,940 people at the 2016 Census which was a decrease of some 1,648 people or 7.3% since 2011 (Appendix H).

Each local community within the SIA study area experienced a decrease in population during 2011-2016. Moranbah's population declined from 8,965 to 8,735 (2.6%) and the Broadsound-Nebo Statistical Area 2 (SA2) experienced a decrease of 13.9%, which substantially led the Isaac LGA's decrease. Coppabella has experienced the largest percentage decrease at 24.35% (Appendix H).

Population decreases during 2011-2016 resulted from contraction in both direct local employment (the result of mining industry redundancies and an increase in FIFO employment), and indirect employment (as businesses supported by construction and mining had less capacity to employ) (Appendix H).

Community Values

Based on respondent's views communicated during the SIA consultation process (Appendix H), the residents of the local communities of Moranbah and Dysart agreed that their communities are resilient, family orientated and cohesive.

The results indicate a very strong sense of community throughout the towns within the study area (Appendix H).

Indigenous social values include traditional owners' cultural values (relevant to past and present relationships with the land and waters), and social values relevant to community wellbeing and economic participation, including (Appendix H):

- a strong focus on improving Indigenous people's capacity and opportunities for employment, and business development;
- active involvement in the protection of cultural heritage; and
- training and employment opportunities to restore social and economic wellbeing in the Indigenous community.

A detailed description of the existing social environment of the local and regional communities is provided in Appendix H.

Social Baseline Characteristics Summary

Table 4-23 presents a summary of the social baseline characteristics identified as part of the SIA.

The identification of social baseline characteristics relied upon a number of sources, including:

- ABS census data and other relevant reports;
- feedback from stakeholders during consultation;
- research and analysis conducted by the government agencies and industry bodies;
- other SIA's prepared for relevant mining projects in the region; and
- other relevant published reports.

Table 4-22
SIA Considerations Discussed with Stakeholders

Stakeholder	SIA Consideration
OCG	• Scope of SIA and stakeholder engagement process. • Regulatory process. • Queensland Government agency engagement. • SIA guidelines. • Impact assessment findings and significance evaluation. • Management plans.
Isaac Regional Council	• Scope of assessment. • Workforce recruitment, management and accommodation. • Community values, trends and issues. • Changes to the housing market. • Impacts on community facilities and service access. • Local employment and training needs. • Local supply issues. • Road safety and community safety issues. • Management strategies.
Landholders	• Land ownership and use. • Access, connectivity and amenity. • Property impacts and mitigations.
Barada Barna people	• Indigenous land use and community goals. • Employment and business capacity and opportunity.
Community members and groups – Moranbah, Dysart, Middlemount, Nebo and Coppabella	• Workforce composition. • Local employment and training opportunities. • Impacts / benefits to community values. • Housing impacts. • Access to community and health services. • Local supply issues. • Road safety.
Local businesses	• Local and regional supply opportunities. • Effects on local business and economic vitality. • Labour draw and workforce impacts. • Economic development.
Social infrastructure providers and non-government organisations	• Community health and safety. • Mental health. • Service capacity. • Changed access/demand for health and medical services. • Effects on community services and facilities.
State agencies • Queensland Health • Queensland Police Service • Queensland Ambulance Services • Queensland Fire and Rescue Service • (Former) Department of Communities, Disability and Child Safety • Department of Education and Training	• Workforce profile and labour availability. • Skill gaps and training opportunities. • Business opportunities. • Indigenous training, employment and business opportunities. • Social and health infrastructure capacity. • Emergency service capacity and demand. • Vulnerable population groups. • Social housing. • Cumulative impacts.

Source: After Appendix H.

Table 4-23
Summary of Social Baseline Characteristics

Baseline Indicator		Findings	SIA Study Area	Moranbah	Dysart	Middlemount	Nebo	Coppabella
Demography and Housing	Population	The Isaac LGA experienced a decrease in population during 2011-2016, in line with cyclical trends.	20,940 in Isaac LGA	8,735	2,991	1,841	753	466
	Indigenous Community	There were 744 Indigenous people in the Isaac LGA.	3.6%	3.9	4.5	3.5	4	4.7
	Non-resident population	In 2017 the full time equivalent population of the Isaac LGA was estimated at 31,835 people, of whom 33.2% were non-resident workers.	N/A	2,190	1,605	1,250	440	NA
	Age	Median ages were lower than the Queensland average.	32 for Isaac LGA	30	31	30	35	38
	Families	There were higher than average proportions of couple families with children in the study area.	73.9% for Isaac LGA	76.2	72	80.7	68.9	64.9
	Unoccupied dwellings	Between the five towns, there were more than 2,210 unoccupied dwellings.	34.5%	29.2%	41.0%	43.9%	39.7%	41.6%
	Housing rental	The study area had very high percentages of rental tenure, in part due to mining companies' ownership of housing.	63.5%	76.6%	69.2%	94.9%	44.2%	77.8%
	Asking rents Houses July 2018	Median weekly rents were lowest in Dysart and highest in Moranbah.	n/a	$290/wk	$170/wk	$250/wk	$2,600/wk	n/a
	Rental vacancy rate	Rental vacancy rates have declined in the past three years.		0.8%	5.76%	1.8%	8.2%	n/a
	Building approvals	Building approvals values peaked in both Isaac LGA and Mackay LGAs during 2012-2013 and have declined sharply since.						
	Workforce Accommodation Village (WAV) Beds	There are several WAVs in the LGA, with an average occupancy rate of 57.1% and a spare capacity in 2017 of around 7,930 beds.						
Social Advantage and Disadvantage	Advantage	Socio-economic Indices for Areas (SEIFA) scores declined for all towns except Coppabella during 2011-2016.	987 (Isaac LGA)	1,011	956	988	964	1,018
	Incomes (Household)	Average weekly incomes in the study area were above the Queensland average, but generally dropped over the five years 2011-2016.	n/a	2,421	2,152	2,405	1,710	2,328
	Cost of living	Moranbah and Mackay had higher scores than the Brisbane comparator for the 'all items less housing' cost of living index. Moranbah's housing costs were lower than for the Brisbane region, due the recent normalisation of housing prices.						

Table 4-23 (Continued)
Summary of Social Baseline Characteristics

Baseline Indicators		Findings
Community Health and Safety	Health indicators	Risks to population health in the Isaac LGA include behaviours (including smoking, drinking and injury), an increasing rate of mental health service presentations and lack of access to specialist practitioners and birthing services in the LGA.
	Community safety	Isaac LGA's rate of offences against the person has remained stable over the five years, whilst the rate of offences against property has dropped, as has the rate of total offences. Isaac LGA's offence rates were substantially lower than the Regional and State averages. Consultation participants (including community service providers and police) provided anecdotal evidence of an increase in domestic and family violence, influenced by the economic downturn, and drug and alcohol use.
	Road Safety	The cumulative traffic volumes of mining projects have led to ongoing road safety issues in the Isaac LGA, with particular concern about the Peak Downs Highway's poor safety record.
	Unemployment	There were very low rates of unemployment in the Isaac LGA, Moranbah and Broadsound-Nebo SA2 compared to the Queensland average. Indigenous unemployment as measured by the 2016 Australian Bureau of Statistics (ABS) Census was higher than the non-Indigenous rate (2.3% compared to 2.0% in the Isaac LGA), but more than three times higher in the MIW region, and particularly high among Indigenous women.
	Mining Employment	Comparison of the 2016 and 2011 ABS Censuses based on place of work indicates that the number of coal mining jobs located in the Isaac LGA contracted considerably between 2011 and 2016, with a loss of 3,772 jobs (equivalent to 40% of the total).
	Occupations	The Isaac LGA's largest occupational group at the time of the 2016 ABS Census was machinery operators and drivers at 23.7%, followed by technicians and trades workers at 20.7%.
Business and Industry	Economic strengths	Isaac LGA's economic strengths include significant thermal and metallurgical coal deposits; a long standing agricultural industry; strong international export market focus for coal, agriculture, aquaculture, sugar cane and beef.
	Business profile	98% of Isaac LGA's registered businesses were small businesses with fewer than 20 employees in June 2016. Both Isaac LGA and the Mackay SA4 zone experienced a decline in the number of businesses between 2014/15 and 2015/16. There are at least six Indigenous businesses in the Isaac LGA and 16 in the Mackay LGA.

Source: After Appendix H.

4.6.3 Potential Impacts

Appendix H provides a detailed assessment of the potential positive and negative impacts of the Project on the existing social environment, including impacts on:

- employment;
- population;
- housing;
- social infrastructure
- local business participation;
- community values;
- community wellbeing;
- cumulative impacts; and
- the potential impacts of Project closure.

Elliott Whiteing (2018) concluded that the Project would have a range of social impacts and benefits, primarily accruing in the Isaac LGA, but with employment opportunities and benefits for businesses extending to other regions including the Mackay LGA.

Pembroke would recruit from within the Isaac LGA and from other Queensland regions. Employees from outside the region would be encouraged to live within local towns including Moranbah, Dysart, Middlemount and Nebo (Appendix H). Non-local employees who choose to commute would stay in existing workforce accommodation villages in Coppabella or Moranbah, or in rental accommodation, subject to availability (Appendix H).

Social impacts and benefits in the Isaac LGA would be likely to include (Appendix H):

- temporary population increases during construction of approximately 440 full-time equivalent (FTE) employees during 2019-2020 and 300 FTE employees during 2028, with consequent demands for local health services, emergency services, Council services and facilities, and the road network;
- population increases in the Isaac LGA during operations, in the order of:
  - at least 300 people, and up to 600 people, in 2020;
  - up to 1,300 people by 2032; and
  - up to 1,755 people during the first 14 to 15 years of operation;
- consequent impacts on social resources during operations, including:
  - potential for Project-induced inflation to increase the cost of housing if additional stock is not made available;
  - increased demand for health service provision, school enrolments, childcare places and community services; and
  - labour draw, staff turnover and potential for wage inflation;
- creation of an estimated 500 to 700 construction jobs in 2019 to 2020 and 300 to 500 construction jobs around 2028;
- locally-based employment for Isaac LGA residents, including a focus on gender equity in the Project workforce;
- the availability of 480 operational jobs in 2020 and 960 jobs by 2021, with potential for an increase to 1,300 jobs in 2033 which would be ongoing until around 2050, and would then decline;
- employment and training opportunities for Indigenous people;
- immigration of Project personnel and families to the Isaac LGA, contributing to population growth and community vitality;
- benefits for local and regional businesses from both Project supply opportunities and expenditure by Project personnel and households; and
- potential for supply opportunities for Indigenous businesses.

The Project is also likely to support social resilience and sustainability in Isaac LGA communities by (Appendix H):

- offering long term, locally-based employment enabling skills development;
- enabling population growth and stability;
- supporting workforce integration with local communities; and
- increasing demand for local and regional businesses' offerings.

Elliott Whiteing (2018) assessed the significance of the predicted social benefits and impacts. The significance assessment is summarised in Table 4-24 and described in detail in Appendix H. The level of significance (low to very high) reflects the level of risk or benefit for social resources that support quality of life and social sustainability, e.g. secure employment, business prosperity, housing affordability, social infrastructure access or community cohesion.

Table 4-24
Social Benefits and Impacts Significance Assessment Summary

Impact/Opportunity	Stakeholders	Mitigation/Enhancement[1]	Residual Risk/Benefit
Employment			
Creation of an estimated 500 construction jobs in 2019 to 2020, 700 jobs in 2020 to 2021 and 300 to 500 jobs around 2027. Local and regional construction companies have capacity and would be significant contributors to the construction workforce.	Construction employees in the Isaac, Mackay and other LGAs. Heavy and civil construction companies in the Isaac and Mackay LGAs.	Businesses and industry engagement and procurement strategies.	High
Increased availability of mining jobs in Isaac LGA, in the order of 5% more jobs by 2021, with a potential increase of up to 7.5% on 2017 availability in 2033.	Existing employed, underemployed and unemployed mining workers, and new recruits to mining.	Recruitment strategy. Supporting settlement strategy. Housing and Accommodation Management. Community development and investment.	High
If local people fill 25% of Project jobs by 2020, 120 Isaac LGA residents would be employed. Achievement of 50% local employment (240 people in 2020) is also within range given estimated labour capacity in the LGA.	Employees and families.		High
Additional employment would be available to local and regional residents with a doubling of the workforce in 2021, offering greater choice for local workers and a range of social benefits.	Employees (local and across other Queensland regions), families and Isaac region communities.		High
In accordance with its agreement with the Barada Barna, the Project aims to employ at least nine Indigenous employees during Years 1 to 10 of operations; 14 Indigenous employees in Years 11 to 15; and 28 to 30 Indigenous employees from Year 16. Indigenous families would benefit from access to greater disposable income, and Indigenous role models would create a greater culture of employment.	Barada Barna Aboriginal Corporation. DATSIP. Indigenous employment support agencies and programs.	Recruitment strategy.	High
The Project is aiming for 20% female employment upon commencement of operations, which would see 96 women employed in 2020, and 192 in 2021.	Women, including young women yet to enter the workforce. Employment support agencies and programs.	Recruitment strategy. Supporting parents.	High
Population Growth			
Construction would see a temporary population increase of approximately 440 people full time equivalent (average over 2019 to 2021) or approximately 2% during 2019 to 2021 with consequent demands for local health services. A smaller population increase and demand on local health services would result from the second construction phase in 2027, in the order of 1.0 to 1.5%.	IRC. Health services. Workforce accommodation village providers.	Engagement strategies. Healthy workplace strategy.	Medium
A full time equivalent workforce of 340 non-local workers during the first construction period would see an increase of approximately 306 men in the LGA, equivalent to a 2.5% increase in the male population and increasing gender imbalance in the Moranbah area, and potentially changes to feelings of safety. For the second construction period, this increase would be lower at approximately 200 additional males.	Moranbah residents.	Recruitment strategy. Workforce Management.	Medium

Table 4-24 (Continued)
Social Benefits and Impacts Significance Assessment Summary

Impact/Opportunity	Stakeholders	Mitigation/Enhancement[1]	Residual Risk/Benefit
A direct population increase of at least 300 people in the LGA is likely in 2020 as the result of Project operations, with a direct increase of up to 600 people possible, contributing to population growth and community activity levels.	IRC. Health services. Local Schools and Department of Education. Moranbah District Support Services and Dysart Community Support Group.	Recruitment strategy. Supporting community involvement strategy.	Medium
Inclusive of population growth during 2020, the second year of operations may result in a population increase in the Isaac LGA of between 650 and 1,300 people, however the higher number is more likely to be realised in ensuing years. The increase would be distributed between the towns, and contribute to reversal of population decline.	IRC. Health services. Local Schools and Department of Education.	Recruitment strategy. Community development and investment. Housing and accommodation management.	High
In 2033, with a workforce of 1,300 people, 25% new local workers would see a population increase of approximately 878 people or 3.1% (inclusive of previous Project-induced growth). With 50% new locals, the total increase could reach 1,755 people or 6.2% of the projected population in 2033. This will contribute to stable and sustainable population growth in the LGA.	IRC. Health services. Queensland Health. Local Schools and Department of Education.	Recruitment strategy. Community development and investment. Housing and accommodation management.	High
Housing			
Assuming 10% of construction workers settle in Moranbah this would represent 25 to 30% of listed available rental stock (as at October 2017). If there was no increase in rental stock, this could cause a small increase in rental prices, but from a low (affordable) base.	Moranbah renters.	Planning for workforce housing needs. Workforce accommodation villages.	Low
There is potential for Project-induced demand pull inflation to increase the cost of housing (purchase and rental), particularly in the context of cumulative demands. If 50% of personnel were new Isaac residents by 2021, and no additional rental stock was available, significant rental cost inflation and displacement of low income households could result.	Low to moderate income households; key workers; IRC and local businesses.	Increasing housing availability. Monitoring and reporting.	Medium
Project personnel's demand for housing purchase would contribute to incremental housing cost increases. This could be experienced as a negative impact for local people who wish to enter the housing market.	Young people and key workers seeking local home ownership.	Increasing housing availability. Monitoring and reporting.	Low
Housing price increases would be positive for locals needing to recoup losses on housing purchases.	Residents encumbered by large mortgages and low equity.	Increasing housing availability.	Medium
Social Infrastructure			
Non-resident workers typically make significant demands on hospital out-patient services and General Practitioners. At approximately 340 full time equivalent non-local personnel during the first period of construction, this may be a noticeable increase, however local health services are experienced in dealing with fluctuating demands.	Moranbah and Dysart hospitals and General Practitioners.	Access to health services. Engagement strategies.	Low

Table 4-24 (Continued)
Social Benefits and Impacts Significance Assessment Summary

Impact/Opportunity	Stakeholders	Mitigation/Enhancement[1]	Residual Risk/Benefit
Demands on ambulance and fire services would be experienced in relation to traffic accidents, work place accidents, patient transport from work sites and workforce accommodation villages to hospitals and population increases, in the context of constrained capacity.	Moranbah, Dysart and Middlemount Queensland Ambulance Service.	Emergency response arrangements. Monitoring and reporting.	Medium
The number of non-local workers will require consideration in planning for IRC services such as water supply and waste management, and with respect to policing.	IRC. Queensland Police Service.	Engagement strategies. Emergency response arrangements.	Medium
Population increases resulting from the Project will require commensurate increases in health service provision levels (e.g. hospital, general practicioners, specialists, allied and community health services and mental health services). Competition for access to general practicioners may be experienced until supply increases with demand.	IRC. Health services and Queensland Health.	Access to health services. Healthy workplace. Monitoring and reporting.	Medium
A small increase in school enrolments may occur during 2019 to 2020 (a maximum of 30, most likely in Moranbah). During 2020 to 2021 an increase in enrolments would result, potentially in the order of 60 to120 enrolments across the LGA. This is generally within schools' current capacities.	Local schools and Department of Education.	Engagement strategies. Monitoring and reporting.	Medium
At the upper level if the 'new local' population build strongly, up to 230 enrolments could be required. If sudden and unexpected, this could challenge schools' capacity. The Project will provide advice to the Department of Education on numbers of new local workers during the first three years of operation.	Local Schools and Department of Education.	Engagement strategies. Monitoring and reporting.	Low
Population growth will induce incremental increased demand for community services which are already working at capacity, potentially extending wait times for service access.	Moranbah & District Support Services. Dysart Community Support Group.	Community development and investment.	Medium
Project-induced demands for childcare are likely to be within local capacity, but cumulative demands may result in shortages. Employment equity is constrained by a lack of overnight care options.	IRC, childcare centres and family day care providers.	Supporting parents.	Low
The increase in population attributable to the Project will introduce additional people who could contribute through volunteerism.	Community cultural and sporting organisations in IRC towns.	Supporting settlement. Community involvement.	High
Businesses			
Construction will offer diverse supply opportunities for capable businesses in the Isaac and Mackay LGAs, and for business in other regions such as the Rockhampton LGA. Some personnel expenditure with local businesses is also expected.	Businesses dependent on mining industry construction.	Engagement and capacity building. Procurement strategies.	High
During operations, local and regional businesses would derive substantial benefits from both Project supply opportunities and expenditure by Project personnel and their households.	Businesses in the Isaac and Mackay LGAs.	Engagement and capacity building. Procurement strategies.	High
Indigenous businesses will be targeted and will have opportunities to supply the Project, with potential for long term supply opportunities.	Indigenous business owners and employees.	Indigenous business participation.	High

Table 4-24 (Continued)
Social Benefits and Impacts Significance Assessment Summary

Impact/Opportunity	Stakeholders	Mitigation/Enhancement[1]	Residual Risk/Benefit
Impacts such as loss of staff and wage inflation may result for some businesses, particularly in the intensive hiring period during the first two years of operations.	Business owners and customers.	Training and workforce development.	Medium
Community Wellbeing and Resilience			
The Project will make an incremental increase to volumes of traffic using local and State roads which are heavily trafficked and in poor condition in places, including an increase in the volume of traffic on the Peak Downs Highway near workforce accommodation villages.	Coppabella residents, other motorists.	Engagement. Workforce Management.	Low
The Project's local employment focus will support social resilience by increasing demand for local businesses' offerings, supporting development of the Isaac LGA's skills base and increasing the pool of people who will participate in community and sporting activities.	IRC; Isaac LGA communities, business and organisations.	Engagement. Procurement strategies.	High
Pembroke has an agreement with the Barada Barna Aboriginal Corporation which includes ongoing financial contributions to Barada Barna Aboriginal Corporation. Dependent on Barada Barna Aboriginal Corporation decisions, this could result in funding for Barada Barna Aboriginal Corporation's planned training centre.	Barada Barna; Indigenous young people and jobseekers.	Indigenous training and employment.	High
There is potential for reduced amenity for neighbouring landholders due to noise, blasting and dust impacts.	Landholders and employees.	Engagement.	Low
The Project is likely to have a positive impact on population stability, by increasing local job opportunities keeping people in the LGA, attracting new workers and their families, and inspiring confidence in the towns' futures. This will lead to higher social capital and participation.	IRC, Isaac LGA communities, business and organisations.	Engagement. Workforce Management Planning for workforce housing needs.	High
The ability to earn above-average incomes over an extended period would be a significant benefit for contractors and employees, and particularly for young people, women and Indigenous people who may be new to the mining industry.	Project employees including Indigenous young people, previously unemployed people, women and their families and jobseekers.	Recruitment strategy. Training and workforce development.	High
Both direct Project expenditure and other consumption effects will provide additional employment opportunities, increasing the size and stability of local populations.	IRC; Isaac LGA communities, business and organisations.	Recruitment strategy. Workforce Management.	High

[1] Mitigation and enhancement measures are described in detail in Appendix H.

Source: After Appendix H.

Cumulative Impacts

Elliott Whiteing (2018) conducted a cumulative assessment of potential social impacts in consideration of the existing operations and the following new or proposed Projects in the region:

- Red Hill Mining Lease Project;
- Saraji East Mining Lease Project;
- Byerwen Coal Project;
- New Lenton Project;
- China Stone Coal Project; and
- Carmichael Coal Mine and Rail Project.

The cumulative assessment was limited by uncertainties in the timing of execution of the regional projects, whether certain projects would obtain necessary approvals and workforce and accommodation assumptions.

The assessment concluded that potential cumulative impacts during construction and operation of the Project would include:

- concern about rising numbers of non-local workers in the Isaac LGA;
- an increase in traffic on local and state roads in the Isaac LGA;
- an appreciable increase in demand for local health services;
- cumulative demands on Council infrastructure such as water and waste water systems, roads, parks and municipal services;
- labour draw away from other businesses and industries that are dependent on construction labour and skills;
- population growth of several thousand people in the Isaac LGA, with potential for significant growth in Moranbah and Dysart in particular;
- the availability of 1,500 to 3,800 jobs in the Isaac LGA, and potential for very large numbers of jobs from the Carmichael Coal Mine and Rail Project and China Stone Coal Project which would be relevant at inter-regional level;
- severe impacts on housing availability and cost;
- potential for change to social dynamics as a result of increasing numbers of non-residential workers;
- ongoing increased demands for Council, health, social and emergency services infrastructure in the LGA;
- the need for road network upgrades;
- increased employment rates, labour force participation and household wellbeing; and
- significant benefits for local and regional businesses, but also significant negative impacts related to labour draw and the likelihood of mining labour and skills shortages.

4.6.4 Mitigation Measures, Management and Monitoring

Mitigation and management measures for potential impacts of the Project on social values were derived following the assessment of the level of significance attributed to respective identified potential impacts.

The mitigation and management measures were identified through direct consultation with the community, the examination of the potential impacts of the Project and stakeholder negotiations (Appendix H).

Consistent with the DSDMIP's *Social Impact Assessment Guideline* (2018), a Social Impact Management Plan (SIMP) has been prepared as part of the SIA (Appendix H). The SIMP includes management strategies for:

- Community and stakeholder engagement management: Strategies to build on Pembroke's current community and stakeholder engagement processes to facilitate the establishment of a working partnership with the communities in which it operates.
- Workforce management: Strategies for local and equal opportunity employment recruitment and identifies important partnerships, such as with Skills Queensland, to address skills gaps and training requirements.
- Housing and accommodation: Strategies to meet the accommodation requirements of the Project.
- Local business and industry: Strategies to inform local business of the goods and service provision opportunities and raise awareness of Pembroke's compliance requirements of business to secure contracts.
- Health and community wellbeing: Strategies to minimise existing and potential impacts upon residents of the Isaac LGA.

Collectively, the five management strategies will:

- mitigate the Project's social impacts on local communities and stakeholders;

- maximise local employment and encourage non-local employees to move to local communities; and
- ensure that opportunities associated with the Project deliver long-term benefit for local communities.

Further detail on the objectives and key actions for each of the management strategies is provided below.

Community and Stakeholder Engagement Management Strategy

The objectives of the Community and Stakeholder Engagement Management Strategy are to:

- identify stakeholders, issues and information needs, and provide a clear forward program for engaging stakeholders;
- ensure a range of opportunities are provided for engagement between stakeholders and the Project;
- provide a framework for developing strong and co-operative relationships with local communities and stakeholders;
- ensure Project planning and delivery are informed by stakeholder views; and
- ensure engagement supports adaptive management of social impacts.

Table 4-25 summarises the actions for the Community and Stakeholder Engagement Management Strategy.

Workforce Management Strategy

The objectives of the Workforce Management Strategy are to:

- ensure equitable access to Project employment for local residents, women and Indigenous people;
- employ and develop a skilled workforce which includes local residents and people who would like to move to local towns;
- promote a holistic approach to supporting workforce health and wellbeing;
- support workforce participation in local community life; and
- minimise the potential for antisocial or disruptive workforce behaviour in local communities.

Table 4-26 summarises the actions for the Workforce Management Strategy.

Housing and Accommodation Management Strategy

The objectives of the Housing and Accommodation Management Strategy is to minimise impacts on local housing affordability and access, whilst supporting employees from outside the Isaac LGA to settle locally, by:

- identifying and planning for workforce housing needs;
- working with IRC and State Government partners with a goal to increase the availability of housing for Project personnel;
- facilitating housing options which allow existing local residents to take up Project employment;
- supporting personnel to relocate to local towns; and
- ensuring high quality workforce accommodation is available to non-local personnel.

Table 4-27 summarises the actions for the Housing and Accommodation Management Strategy.

Health and Community Wellbeing Management Strategy

The objectives of the Health and Community Wellbeing Management Strategy are to:

- provide a framework for communication with social infrastructure providers and Queensland Government agencies to minimise Project impacts on social infrastructure access;
- maximise alignment and co-operation with local stakeholders on identified Project impact areas; and
- describe the Project's contribution to local health and community wellbeing priorities.

Table 4-28 summarises the actions for the Health and Community Wellbeing Management Strategy.

Local Business and Industry Content Management Strategy

The objectives of the Local Business and Industry Content Management Strategy are to:

- maximise local awareness of the Project's supply opportunities and build relationships with local businesses;
- provide the framework for full, fair, and reasonable opportunity for local, regional and Indigenous businesses to participate in the supply chain;

- achieve and maximise Indigenous business participation; and
- align major contracts and contractors to the Project's Local Content Strategy.

Table 4-29 summarises the actions for the Local Business and Industry Content Management Strategy.

Monitoring Framework

Pembroke would monitor the performance and effectiveness of the SIMP so that commitments are delivered and management objectives are achieved. Monitoring would be initiated during the construction period for relevant works (Appendix H).

The primary data sources for performance monitoring include (Appendix H):

- internal records, e.g.:
  - workforce composition, health and safety statistics and training participation rates;
  - community and stakeholder management records; and
  - social investment data;
- consultation on social conditions, e.g.:
  - community values and perceptions;
  - community safety, and Police and emergency services demand; and
- demand for social infrastructure.

Table 4-25
Community and Stakeholder Engagement Management Strategy Key Action Summary

Stakeholders	Pre-construction	Construction	Operations (Years 1-3)
All	Establish detailed plan and program for community and stakeholder engagement.	Implement community and stakeholder engagement program for construction. Review engagement program and update for operations.	Implement community and stakeholder engagement program for operations. Review engagement program in Year 3 and update for Years 6-10.
IRC	Meetings to discuss SIA SIMP, housing strategies and other items identified in Section 6.6.3	Regular meetings. Liaison regarding housing availability and other items identified in Section 6.6.3	Regular meetings.
Landholders	As agreed with individual landholders.		
Indigenous stakeholders	Consult with BBAC regarding Indigenous participation strategies.	Implement Indigenous participation strategies	Implement Indigenous participation strategies and Training Partnership
Local communities	Community workshops CRG Charter development and recruitment strategy Establish Project communication lines and website Develop Complaints Management Process	Project hotline, email, website and social media Regular project updates Annual Project info / drop in sessions CRG Meetings Moranbah from 2019 and Dysart/Middlemount from 2020	
Businesses and Industry groups	Establish ICN Gateway portal Pre-construction business briefings	Participation in Regional Industry Network (RIN) Forums Pre-operation business briefings, and potentially tender readiness workshops	Regular engagement with suppliers (see Section 6.7.3) Participation in CRGs
DSDMIP and DET	SIA CARG presentation Liaison regarding businesses register and skills analysis	Partnerships to facilitate access to business capacity building	Partnerships to facilitate skills analysis and training responses
Queensland Health and local health services	SIA CARG presentation	Participation in CRGs Liaise as agreed to monitor service usage	Advanced notice of in-migrating personnel and families Participation in CRGs

Table 4-25 (Continued)
Community and Stakeholder Engagement Management Strategy Key Action Summary

Stakeholders	Pre-construction	Construction	Operations (Years 1-3)
Police and Emergency Services	Protocol development Seek participation on CRG	Site orientation Participation in CRGs Liaise as agreed to implement protocols and monitor service usage	Protocol review meetings Site orientations Liaise as agreed to implement protocols and monitor service usage
All local schools and Department of Education	Advice on any construction families settling locally	Participation in CRGs	Advance notice of in-migrating operations workforce and expected number of new families

Source: After Appendix H.

Table 4-26
Workforce Management Strategy Key Action Summary

Stakeholders	Pre-construction	Construction	Operations (Years 1-3)
Recruitment	Establish recruitment partners network for promotion of employment opportunities. Briefings for local and regional construction companies	Develop recruitment policy, strategy and procedures for operations. Workforce planning and analysis for operations. Consultation with Government agencies and industry networks on skills gaps and training partnerships.	Implement recruitment strategy including recruitment from and to the Isaac region. Advertise all jobs through recruitment network and local media.
Training and Workforce Development	Consult with training providers regarding local needs, capacities and training offers. Develop Training Strategy including Apprenticeship and Traineeship Program.	Initiate training and development partnerships. Implement training strategy in advance of operations phase. Monitor quarterly contractor reports on local employment and diversity.	Implement training and professional development strategy. Monitor employment and workforce diversity statistics quarterly.
Indigenous Training and Employment	Refine Indigenous Participation Strategy in consultation with BBAC. Ensure Indigenous businesses are aware of potential opportunities to supply the construction phase.	Implement Indigenous Participation Strategy. Develop Indigenous Employment Strategy for operational phase.	Implement Indigenous Participation Strategy and Indigenous Employment Strategy, and monitor implementation.
Supporting parents	Notify childcare centres to advise of workforce ramp-up.	Provide register of childcare options and contract details to construction contractors.	Consult personnel staff about childcare needs. If necessary, collaborate with other stakeholders to identify and support childcare solutions.
Healthy workplace	Evaluate WAV providers' support for workforce wellbeing.	Articulate commitments to a healthy workplace to construction contractors and require personnel education about minimising demands on local services.	Implement Healthy Workplace Strategy and monitor outcomes.
Supporting community involvement	No action required.	Plan for community involvement initiatives for operations.	Initiate actions to involve new local and non-local personnel in community life.
Workforce Management and On-boarding	Develop Code of Conduct. Develop on-boarding package for construction phase.	Implement on-boarding package for construction phase. Monitor workforce incident reports.	Implement on-boarding package for operations phase. Monitor workforce incident reports.

Source: After Appendix H.

Table 4-27
Housing and Accommodation Management Strategy Key Action Summary

Stakeholders	Pre-construction	Construction	Operations (Years 1-3)
Planning for workforce housing needs	Contract WAV providers and agree management protocols for workforce health, fatigue management and conduct codes.	Require construction contractor to identify and monitor any workforce housing needs. Consult IRC and EDQ about local housing market capacity.	Identify which existing local and new local personnel will require housing arrangements.
Increasing housing availability	Monitor housing availability Require construction contractors to monitor employees' local housing arrangements.	Promote Project schedule and anticipated housing needs. Consult with IRC, DHPW and EDQ about housing availability and the need to stimulate supply. If required, develop and implement a strategy to increase supply in collaboration with IRC and EDQ.	Identify personnel housing needs and match to supply. Implement agreed strategies to increase housing supply/personnel access to housing. Monitor housing indicators (cost and vacancy rate).
Supporting settlement	Consult with MDSS and DCSG about capability and interest in provision of settlement support.	Develop a housing register for operations. Develop local community profiles for promotion to applicants. Develop housing policies and settlement incentives.	Partner with MDSS and DCSG to provide settlement, integration and support services. Promote and support personnel involvement in volunteering. Implement housing policies and settlement incentives.
Workforce Accommodation Villages	Consult with IRC regarding WAV use. Seek and evaluate tenders for construction workforce accommodation.	Seek and evaluate tenders for operational workforce accommodation.	Monitor personnel numbers in WAVs. Monitor personnel satisfaction with WAVs and take corrective action if required.

Source: After Appendix H.

Table 4-28
Health and Community Wellbeing Management Strategy Key Action Summary

Stakeholders	Pre-construction	Construction	Operations (Years 1-3)
Access to health services	Consult health services providers (see Section 6.6.3) regarding potential workforce demand and collaborative responses Advise local hospitals GPs and dentists of workforce ramp-up Consult IRC regarding the adequacy of essential services such as refuse facilities, waste management, and water and waste water infrastructure	Initiate contract with local doctors for workplace-related medical appointments for operation personnel Promote use of 13 HEALTH	Advise local hospitals and GPs of workforce ramp-up Employ qualified staff with to manage minor health issues and promote a healthy workplace Contract an EAP provider Promote a healthy workplace and culture Monitor demands on health services with Queensland Health agencies Co-operate in initiatives to support the health of Project personnel and other community members.

Table 4-28 (Continued)
Health and Community Wellbeing Management Strategy Key Action Summary

Stakeholders	Pre-construction	Construction	Operations (Years 1-3)
School enrolments	Communicate with Moranbah schools and the Department of Education and Training regarding the Project schedule	Communicate with all local schools and the Department of Education and Training regarding the Project schedule and expected workforce ramp-up	Monitor demand for school enrolments and regularly communicate with schools
Emergency response arrangements	Liaise with Queensland Police, Ambulance and fire and Emergency Services to advise on workforce ramp-up, accommodation arrangements and code of conduct	Site orientation and contacts Incident management, wide load and call-out protocols	Annual review of protocols Site orientations Ensure access to property access gates on Project land
Community development and investment	Draft Community Development and Investment Strategy and consult with IRC Consult with potential partner agencies for provision of community integration and support services	Finalise Community Development and Investment Strategy Establish and implement Community Investment Fund Develop partnership agreements with BBAC, MDSS and DCSG	Implement Community Partnerships Implement Community Development Fund

Source: After Appendix H.

Table 4-29
Local Business and Industry Content Management Strategy Key Action Summary

Stakeholders	Pre-construction	Construction	Operations (Years 1-3)
Engagement and capacity building	Establish an ICN Gateway Portal Co-operation with key stakeholders to conduct supplier market analysis Develop Local, Regional and Indigenous Businesses Register Develop Local Content Strategy Business briefings	Articulate Project commitments to local content in construction contracts Require Principal and major contractors to implement and monitor a Local Business and Industry Participation Plan Conduct business briefings and promote access to capacity building programs	Tendering preparation workshops Annual business and industry briefings
Procurement strategies	Update Local, Regional and Indigenous Businesses Register Promote supply opportunities through established network Develop Local Content Strategy and procurement procedures	Articulate Local Content Strategy requirements to contractors Track and report local expenditure in line with QRC Code of Practice requirements	Review and implement Local Content Strategy Track and report local expenditure in line with QRC Code of Practice requirements Review Local Content Strategy and evaluate outcomes in Year 3
Indigenous business participation	Identify Indigenous businesses and establish contacts Facilitate and support delivery of a tender readiness program for Indigenous businesses	Facilitate and support delivery of a tender readiness program for Indigenous businesses in preparation for operations	Review and update Indigenous businesses register Implement Local Content Strategy including Indigenous business participation actions

Source: After Appendix H.

Data collection, monitoring and reporting will include consideration of locally-specific impacts and benefits, e.g. how many dwellings were required in each town to house project workers and families, and employees' towns of origin and settlement. This will enable the Project and stakeholders to ensure management strategies respond to the distribution of impacts.

The Project's Internal Coordination Committee would track implementation of the SIMP and review key performance measures quarterly, to facilitate continual improvement of strategies and practices. Data on social indicators would be tracked and reported to the Community Reference Group (CRG) as available, including quarterly tracking of housing indicators (Appendix H).

Monitoring data on delivery of the SIMP would be reported at each CRG meeting, and a report against performance measures and social indicators would be presented to IRC and the CRGs annually (Appendix H).

4.7 ECONOMICS

An Economic Assessment was undertaken for the Project by Gillespie Economics (2018) and is presented in Appendix I. The Economic Assessment was prepared in accordance with the *Economic Impact Assessment Guideline* (DSD, 2017).

The regional impact analysis component of the Economic Assessment was conducted at three different scales to assess the potential impact of the Project on the local, regional and Queensland economies. The local economy adopted for the Project is the Isaac LGA. The combined Mackay Regional Council and the Whitsundays Regional Council region (MW Region) were adopted as the regional economy for the Project.

The regional impact analysis is primarily concerned with the effect of a proposal on an economy in terms of specific indicators, such as gross regional product, gross regional income and employment. The economic impact assessment is based on computable general equilibrium modelling developed by Cadence Economics.
The computable general equilibrium model assesses the wider economic impacts of the Project at two levels (Appendix I):

- Direct impacts — the economic gains associated with the Project (e.g. increased demand associated with construction and mining operations and output generated by coal production).
- Indirect impacts — the economic gains in related upstream or downstream industries and the economic losses associated with 'crowding out' of activity in other sectors of the economy as a result of the Project.

The computable general equilibrium analysis was undertaken under three different labour supply assumptions (i.e. low, medium and high). The results for the medium case labour supply assumption are reported in this section.

A description of the environmental values including a summary of the existing local, regional and Queensland economies is provided in Section 4.7.2. The potential impacts of the Project on the local, regional and Queensland economies are described in Section 4.7.3. The proposed mitigation and management measures are provided in Section 4.7.4.

4.7.1 Environmental Objectives and Performance Outcomes

The environmental objectives relevant to economics, as described in the Terms of Reference for the Project, are:

(a) *avoid or mitigate/manage adverse social impacts arising from the project*

(b) *capitalize on opportunities potentially available for local industries and communities*

(c) *create a net economic benefit to the location, region and state.*

4.7.2 Description of Environmental Values

The following description of values relevant to the Isaac LGA, MW Region and Queensland economies, is a summary of the detail provided in Appendix I.

The population of the Isaac LGA is approximately 22,000. In addition to the resident population, approximately 11,000 resource sector workers travel to the Isaac LGA to work and are housed in temporary accommodation (Appendix I).

In contrast to the population of Queensland, both the Isaac LGA and the combined Isaac LGA and MW Region experienced population decline between 2012 and 2016 of approximately 8% and 1.5% respectively (Appendix I).

Historically, the Isaac LGA economy has been driven by the mining sector. The mining sector makes up approximately 61% of employment, 73% of wages and salaries, 78% of value-added, 79% of output, 91% of regional exports and 81% of imports. The next most significant sectors for employment are agriculture, forestry and fishing, accommodation and food services, and construction (Appendix I).

While the mining sector is still the most significant sector in the combined Isaac LGA and MW Region, its relative significance declines in the more diversified economy. The next most significant sectors for employment are retail trade, health care and social assistance, and accommodation and food services (Appendix I).

For Queensland, the mining sector makes up approximately 2% of employment, 4% of wages and salaries, 7% of value-added, 7% of output, 32% of regional exports and 10% of imports (Appendix I).

4.7.3 Potential Impacts

The regional impact analysis in Appendix I included consideration of the impacts of the Project on the Isaac LGA, MW Region and Queensland economies (Figure 4-25).

Gross Product

The projected impact on the Isaac LGA gross product peaks at approximately $1,455 million in 2037. This peak is due to the higher levels of activity within the Isaac LGA associated with peak production at the Project and the flow-on benefits of purchasing inputs to operate the Project (Appendix I).

The projected impact on the Queensland gross product peaks at approximately $1,865 million in 2040 (Appendix I).

Gillespie Economics estimates the Project would increase gross product in the Isaac LGA, MW Region and Queensland economies up to 2050 by some $8.0 billion, $212 million and $10.1 billion, respectively (Appendix I).

Employment and Income

As described in Section 2.1.6, employment and other opportunities expected to be generated by the Project include:

- a Project operational workforce of up to approximately 1,300 on-site personnel, when ROM production reaches 20 Mtpa (i.e. from 2034) (an average of 1,000 over the life of the Project);
- a construction workforce of up to 700 people during the construction of the Olive Downs South domain mine infrastructure area in the initial years of the Project (an average of 500 over the entire construction period); and
- a construction workforce in the order of 200 people during the construction of the Willunga domain mine infrastructure area and expansion of the Olive Downs South domain mine infrastructure area around Year 10 of the Project.

The Project is also projected to result in indirect employment impacts associated with related upstream or downstream industries and any 'crowding out' of activity in other sectors of the economy (Appendix I).

Considering these direct and indirect employment impacts, the additional net employment in the Isaac LGA and Queensland is projected to peak at 748, and 1,383 fulltime equivalent jobs, respectively (Appendix I).

The projected growth in employment would be accompanied by an average increase in wages in the Isaac LGA of approximately 12% (Appendix I).

The Project would result in modest average increases in wages in the MW Region (0.3%) and in Queensland (0.2%) (Appendix I).

Other Potential Economic Impacts

The summary of other potential economic impacts below is further detailed in Appendix I.

Potential Contraction in Other Sectors

The Project would create increased demand for labour during both the construction and operation phases.

Where labour resources in an economy are limited and the mobility of in-migrating labour from outside the economy is restricted, increased demand for labour resources (e.g. the Project) may drive up local and regional wages. In these situations, there may be a reduction in economic activity in other sectors of the local and regional economy. This potential impact is considered in the Computable General Equilibrium (CGE) modelling.

Housing Impacts

The Project would create increased demand for accommodation during both the construction and operation phases.

PRN-16-02_EIS_Sect4_207B

LEGEND

- Mining Lease Application Boundary
- Major Road
- Railway
- Port

Source: Geoscience Australia - Topographical Data 250K (2006); Department of Natural Resources and Mine (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Mackay, Isaac and Whitsunday Local Government Areas

Figure 4-25

Where housing supply is insufficient to meet demand, even temporarily, this may manifest itself in increased property prices and higher rent prices. While this may be seen as beneficial for property owners, it can adversely affect existing tenants, particularly those on lower incomes who can be priced out of the market.

Pembroke would develop a housing and accommodation strategy that includes the provision of a range of housing types (Appendix H). This is expected to limit impacts associated with increased house prices described above.

End of Mine Life

The establishment and operation of the Project would stimulate demand in the local, regional and Queensland economy, for up to 80 years, leading to increased business turnover in a range of sectors and increased employment opportunities. Conversely, the cessation of the mining operations in the future would result in a contraction in local, regional and Queensland economic activity.

The magnitude of the local, regional and Queensland economic impacts of cessation of the Project would depend on a number of interrelated factors at the time, including the movements of workers and their families, alternative development opportunities, and economic structure and trends in the economy at the time.

New mining resource developments in the region would help broaden the region's economic base and buffer against impacts of the cessation of individual activities. In this respect, the local and regional area is highly prospective with considerable coal resources.

4.7.4 Mitigation Measures and Management

Pembroke would work in partnership with the Isaac Regional Council and the local community so that the benefits of the projected economic growth in the region are maximised and impacts avoided or mitigated, as far as possible.

As discussed in Section 4.6.4, Pembroke would development and implement five Management Plans for the Project that include proposed mitigation and management measures for the following key components relevant to economic values:

- Community and stakeholder engagement: Strategies to build on Pembroke's current community and stakeholder engagement processes to facilitate the establishment of a working partnership with the communities in which it operates.
- Workforce management: Strategies for local and equal opportunity employment recruitment and identifies important partnerships, such as with Skills Queensland, to address skills gaps and training requirements.
- Housing and accommodation: Strategies to meet the accommodation requirements of the Project.
- Local business and industry: Strategies to inform local business of the goods and service provision opportunities and raise awareness of Pembroke's compliance requirements of business to secure contracts.
- Health and community wellbeing: Strategies to minimise existing and potential impacts upon residents of the Isaac LGA.

In addition, Pembroke would liaise with the DATSIP and Skills Queensland to match the skills required by the Project with those of Indigenous residents where the opportunities exist.

The local business and industry component of the management plans would include adoption of the Queensland Resources and Energy Sector Code of Practice for Local Content (Queensland Resource Council, 2013).

As described in Section 4.6.4, prior to completion of mining at the Project, Pembroke would develop a Demobilisation Strategy in consultation with employees, contractors, state and local governments and other project partners.

4.8 TRANSPORT

4.8.1 Environmental Objectives and Performance Outcomes

The environmental objectives relevant to transport, as described in the Terms of Reference for the Project, are:

(a) maintain the safety and efficiency of all affected transport modes for the project workforce and other transport system users

(b) avoid or mitigate impacts on the condition of transport infrastructure

(c) ensure any required works are compatible with existing infrastructure and future transport corridors.

4.8.2 Road Transport

A Road Transport Assessment for the Project was undertaken by GTA Consultants (2018) and is presented as Appendix J.

It is noted that the *Guidelines for Assessment of Road Impacts of Development* (DTMR, 2006) was superseded on 3 July 2017. As such, the Road Transport Assessment was prepared in accordance with the DTMR (2017) *Guide to Traffic Impact Assessment*.

The following subsections provide a description of the existing road transport infrastructure, an assessment of the potential road transport impacts associated with the Project on the local and regional road network along with relevant mitigation measures and management for road transport.

Existing Infrastructure and Values

State Controlled Roads

The major road transport routes in the vicinity of the Project are the Peak Downs Highway, located approximately 15 km to the north-west of the Project, and Fitzroy Developmental Road, located to the east of the Project (Figure 4-26).

Fitzroy Developmental Road runs directly along the Project eastern boundary at the Willunga domain and would provide access to the Willunga infrastructure facilities in the south-east of the Project extent (Figure 4-26).

Local Roads

The Iffley Connection Road (including Vermont Park Road), and Annandale Road are located to the east of the Olive Downs South domain and provide access from the Deverill, Iffley, Vermont Park, and Seloh Nolem properties to the Fitzroy Developmental Road and the Peak Downs Highway (via Daunia Road) respectively (Figure 4-26).

Both Annandale Road and Iffley Connection Road are unsealed roads, while Daunia Road is a sealed road (Appendix J).

Carfax Road, an unsealed road, runs east-west to the south of the Project, connecting the Fitzroy Developmental Road with Dysart (Figure 4-26).

Existing Road Traffic Volumes

Available traffic flow data on the road network surrounding the Project was reviewed as part of the Road Transport Assessment and the existing road traffic volumes are low (Appendix J).

Traffic counts were undertaken at these intersections in January 2018 to identify the existing traffic volumes (Appendix J).

Details of existing road traffic volumes are provided in Appendix J.

Road Capacity

Level of Service (LOS) is a qualitative measure describing operational conditions within a traffic stream (in terms of speed, travel time, freedom to manoeuvre and overtake, safety, comfort and convenience) and their perception by motorists and/or passengers (DTMR, 2017).

Table 4-30 outlines the LOS criteria as identified in the *Guide to Traffic Impact Assessment* (DTMR, 2017) (Appendix J).

Table 4-30
Level of Service Criteria

Level of Service	Description
A	Good operation
B	Acceptable delays and spare capacity
C	Satisfactory
D	Near capacity
E	At capacity, requires other control mode

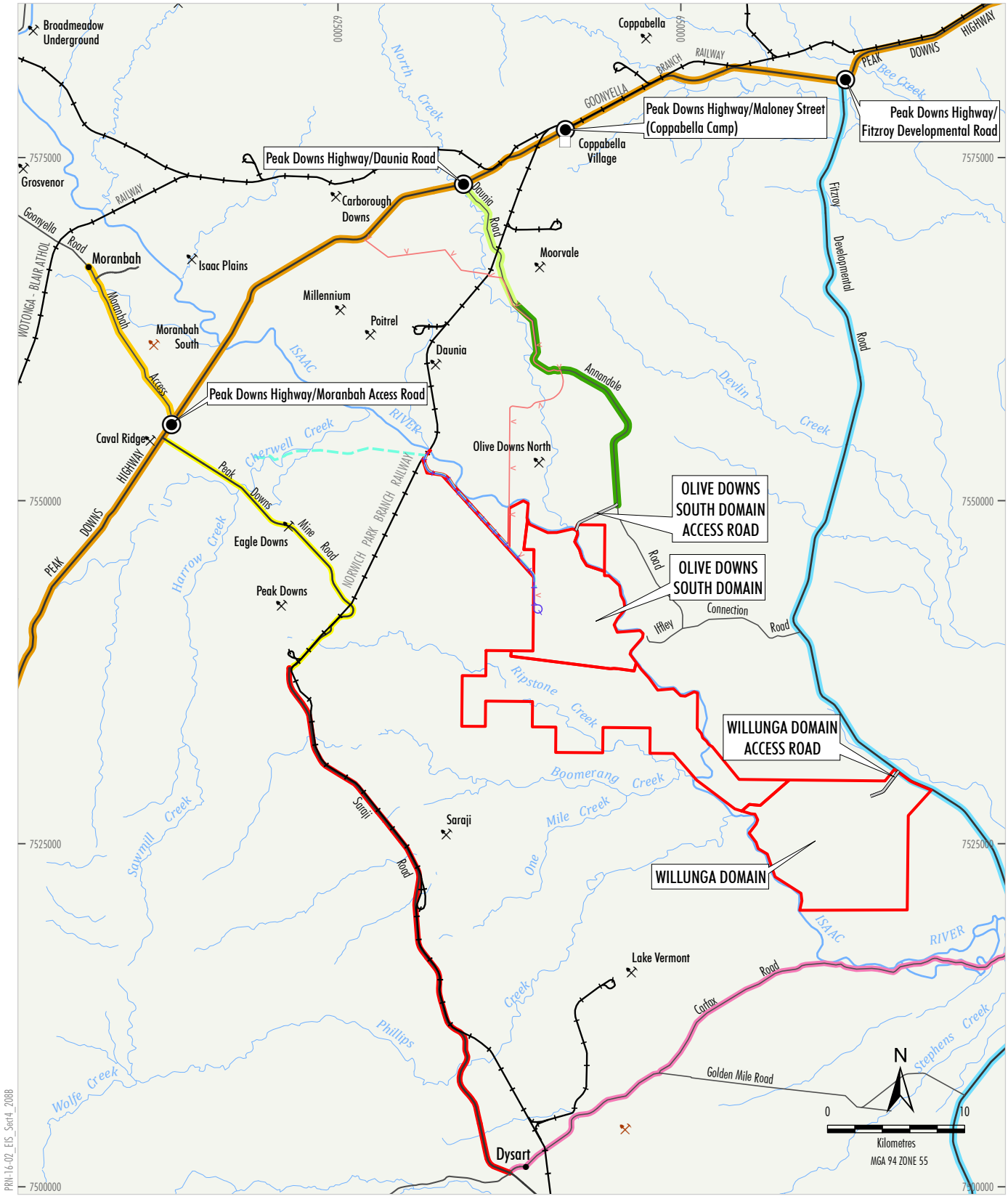
Source: DTMR (2017).

The existing LOS on the existing roads surrounding the Project ranges from A to C (Appendix J). A LOS of 'D' is considered to be the operational threshold for 'acceptable' link performance (Appendix J).

Road Safety

A review of DTMR road accident data in the vicinity of the Project for the period between 2012 and 2017 has been undertaken by GTA Consultants (2018) as a component of the Road Transport Assessment. The review of the DTMR accident data found that it was representative of typical rural road network and no extraordinary trends were identified (Appendix J).

The site inspection conducted by GTA Consultants in January 2018 did not identify any existing road safety issues on the major road transport routes in the vicinity of the Project (Appendix J).



PRN-16-02_EIS_Sect4_208B

LEGEND

- Mining Lease Application Boundary
- Railway
- Proposed Access Road
- Proposed Electricity Transmission Line
- Proposed Rail Spur and Loop
- Proposed Water Pipeline
- Intersection

Source: Geoscience Australia - Topographical Data 250K (2006)
Department of Natural Resources and Mines (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Existing Road Network

Figure 4-26

Potential Impacts

Access Road

The main vehicle access route to the Olive Downs South domain is proposed to be via Daunia Road (off the Peak Downs Highway), connecting to Annandale Road and then a new intersection and access road constructed to the mine infrastructure area (including a crossing of the Isaac River) (Figure 4-26).

The proposed alignment of the new access road to the Olive Downs South domain follows the existing driveway and Isaac River crossing on the Deverill property, before entering the Iffley property within MLA 700032.

Both Daunia Road and Annandale Road are unsealed gravel roads approximately five m wide. These roads would be widened (up to 8 m) where required, and the pavement upgraded to cater for the design loading of vehicles using the access route and in compliance with Isaac Regional Council requirements. These works would be conducted by the Isaac Regional Council through a road infrastructure arrangement with Pembroke.

The detailed designs for the road upgrade would be prepared in consultation with the Isaac Regional Council.

12-hour tube counts were undertaken to observe the traffic currently utilising Annandale Road proximate to the proposed site access. Results of the tube count and a site inspection (undertaken by GTA on 10 January 2018) indicate that there is minimal traffic currently using Annandale Road (Appendix J).

As such it is expected that, following the construction of this access and upgrade of Annandale Road, the majority if not all of the traffic utilising Annandale Road would be Project-related traffic. As such, a basic left turn and right turn treatment from Annandale Road to the site access is expected to be sufficient (Appendix J).

Notwithstanding, the detailed design process would take into consideration any potential impacts on road users, change in LOS and potential impacts to project traffic.

A new three-way intersection off Fitzroy Developmental Road is proposed to provide access to the Willunga domain (Plate 4-1).

The intersection with the Fitzroy Developmental Road would be constructed in accordance with DTMR (2014) *'Road Planning and Design Manual (Edition 2) – Volume 3: Supplement to Austroads Guide to Road Design Part 4A'*. Furthermore, the lighting at the Willunga Domain Access Road and Fitzroy Development Road intersection would be designed and constructed in accordance with the relevant Australian Standards in consultation with the DTMR. The indicative form for the new access intersection is provided in Plate 4-1.

Pembroke would install permanent flood lighting at the new intersection, and street lighting along the extent of Annandale Road that is subject to the proposed upgrade. This would minimise the risk of accidents occurring at these locations. The lighting requirements at these locations would be identified during detailed design of the road upgrades and intersection design, in consultation with the Isaac Regional Council and DTMR.

GTA Consultants (2018) conducted a site inspection of the proposed intersection and confirmed that there were no constraints which could interfere with achieving the required minimum sight distances outlined in DTMR (2014).

Project Traffic Generation

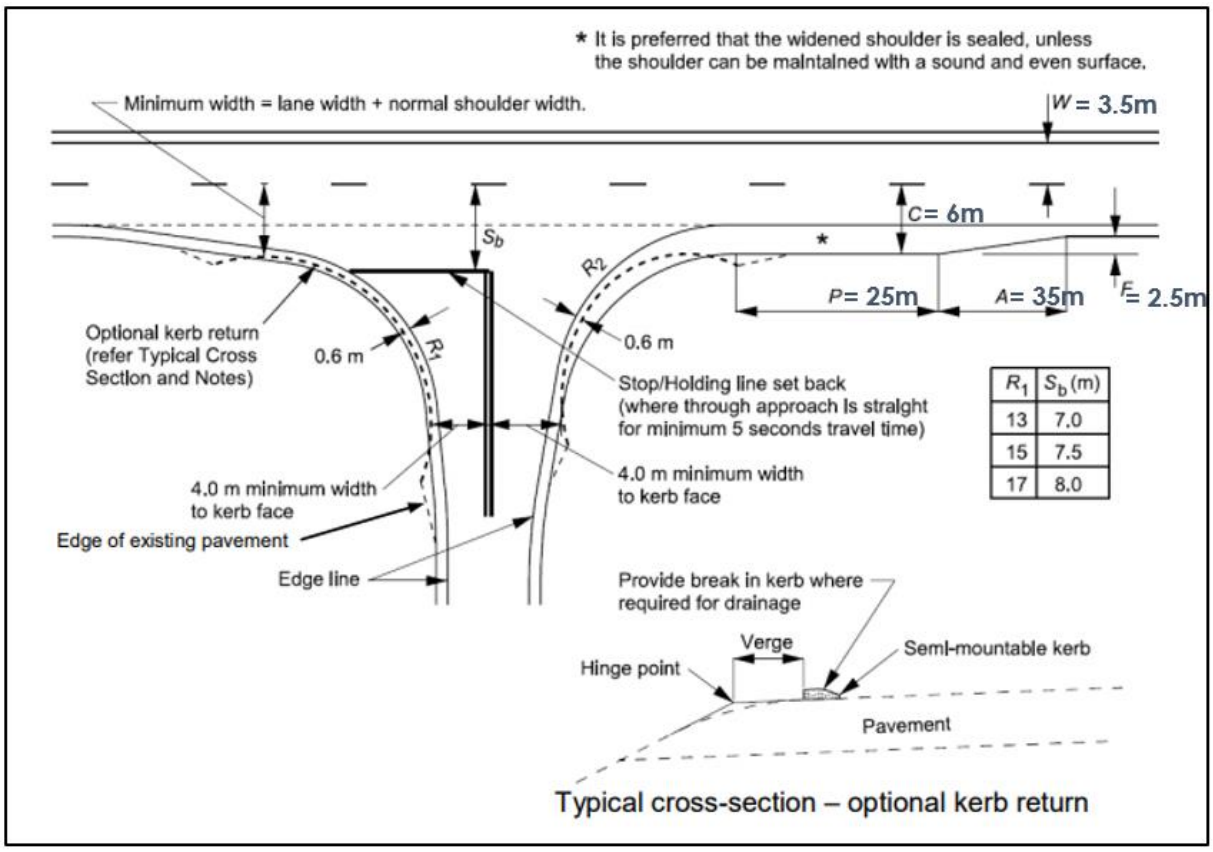
Growth rates obtained from historical data detailed within the annual average daily traffic segment reports indicate that Peak Downs Highway and Fitzroy Developmental Road have experienced negative growth for various road sections over the past five to ten years (Appendix J). This is likely attributed to a slowdown in mining within the wider region (Appendix J).

Notwithstanding, a conservative growth rate of 2% per annum (linear) has been adopted to inform the basis of future traffic forecasts, to reflect typical background traffic growth in the absence of major project developments (Appendix J).

In consideration of the Project schedule and proposed workforce projections, the Road Transport Assessment focused on assessing the potential impact of the Project during the years identified in Table 4-31.

Table 4-31
Project Years Assessed

Year	Project Activities
2020	Peak construction period at Olive Downs South domain.
2027	Construction commences at Willunga domain with Olive Downs South domain operational.
2028	Peak operational workforce for the Project.



R_1	S_b (m)
13	7.0
15	7.5
17	8.0

Plate 4-1 Fitzroy Developmental Road – Indicative Intersection Form

The Project workforce is assumed to approach and depart the Project from and to the following locations (Appendix H):

- Coppabella – 12%;
- Moranbah – 50%;
- Dysart – 19%;
- Middlemount – 11%; and
- Nebo – 8%.

Heavy vehicle movements associated with deliveries would be highest during the construction period, and all deliveries would come from Mackay (Appendix J).

Table 4-32 presents the predicted traffic flows in 2020, 2027 and 2028 on key roads including additional Project traffic and estimated background traffic growth (Appendix J).

The traffic generations detailed in Table 4-32 assume the following:

- 100% of the Project workforce travelling from Coppabella accommodation village would travel via bus;
- 25% of the Project workforce travelling from Moranbah would travel via bus; and
- 10% of the commuting workforce would carpool.

Given that the Project workforce would not permanently reside in the mine camps, the “Project + Baseline” values identified in Table 4-32 also takes into consideration traffic movements associated with employees travelling to their usual place of residence at the completion of their roster. This would include road traffic to and from Mackay, Nebo, Dysart and Middlemount.

The forecast LOS as a result of baseline plus Project generated traffic is above the minimum operational LOS of D, as identified in DTMR’s *Guide to Traffic Impact Assessment* (DTMR, 2017), and GTA Consultants (2018) concludes that there would be no significant impact to the road network as a result of Project generated traffic (Appendix J).

Inputs and Outputs

A detailed breakdown of the construction and operation inputs and outputs has been included in Table 4-33.

Table 4-32
Predicted Peak Cumulative Traffic Generation

Road Name	Road Segment	2020		2027		2028	
		Base (PCU/h)	Project + Baseline (PCU/h)	Base (PCU/hr)	Project + Baseline (PCU/h)	Base (PCU/h)	Project + Baseline (PCU/h)
Peak Downs Highway (Clermont - Nebo)	Between Moranbah turn-off & Dysart turn-off	499	723	564	746	573	753
	Peak Downs Hwy West of Isaac River	483	819	546	1132	554	1163
	West of Coppabella	636	1083	718	1383	730	1427
	East of Coppabella	579	687	654	695	665	887
	East of Bee Creek	700	808	790	940	803	937
	North of Braeside Road	665	773	751	900	763	897
Peak Downs Highway (Nebo - Mackay)	Retreat Hotel Permanent Counter	725	725	818	880	832	850
Fitzroy Developmental Road (Dingo - Mt Flora)	Valkyrie Permanent Counter	183	248	207	509	210	596

Source: Appendix J.
PCU/h = passenger car units per hour.

Table 4-33
Project Transport Requirements for Inputs and Outputs

Inputs	Quantity (tonnes per day)	Number of Loads (per day)	Vehicle type	Origin	Destination
Road Base Gravel	630	10	B-Doubles	Mackay	Project
Fill Material	270	5	B-Doubles	Mackay	Project
Other Construction Materials	1,100	5	B-Double	Mackay	Project
		20	Semi-Trailer	Mackay	Project
		10	Other	Mackay	Project
Operational Materials	550	10	Semi-Trailer	Mackay	Project
		2	B-Double	Moranbah	Project
Outputs	**Quantity (tonnes per day)**	**Number of Loads (per day)**	**Vehicle type**	**Origin**	**Destination**
Operational and Construction Wastes	Refer to Section 4 (Table 4-44) for specific waste stream volumes.	10	Semi-Trailer	Project	Mackay
		2	B-Double	Project	Moranbah

Source: Pembroke (2018)

Road Intersection Performance

Project traffic generation has the potential to increase delays at intersections along the road network used by Project workforce and visitors/deliveries.

The Road Transport Assessment (Appendix J) includes an assessment of the potential impact of the Project on the performance and safety of key intersections, identified on Figure 4-26, in accordance with the *Road Planning & Design Manual (Edition 2) – Volume 3* (DTMR, 2016).

The intersection assessment undertaken indicates that no intersection upgrades are required at the Peak Downs Highway/Moranbah Access, Peak Downs Highway/Maloney Street and Peak Downs Highway/Fitzroy Developmental Road intersections.

This is also the case for the right turn treatment at the Peak Downs Highway/Daunia Road intersection; however, an upgrade of the Peak Downs Highway/Daunia Road intersection to a full auxiliary lane is required for the left turn treatment in 2027 to cater for project generated traffic (Appendix J).

Road Safety and Efficiency

The Road Transport Assessment (Appendix J) found that the accident history in the vicinity of the Project was representative of typical rural road network and no extraordinary trends were identified. GTA Consultants (2018) considers that the Project would result in no changes to the type and rate of accidents (Appendix J).

Railway Level Crossings

One level crossing has been identified along Daunia Road and no level crossings were identified along Peak Downs Highway and Fitzroy Developmental Road. The level crossing identified along Daunia Road is located approximately 6 km south of the Peak Downs Highway.

The Australian Level Crossing Assessment Method is operated by rail operator (i.e. Aurizon), it is Pembroke's understanding that access to the model is not made public. As such, the relevant Project traffic data would be provided to Aurizon to allow assessment of the potential impacts on this level crossing using the Australian Level Crossing Assessment Model.

The Project rail spur and rail loop would not require the development of any new level crossings.

The Project would result in an increased number of trains travelling along the Goonyella Branch Railway, with a peak of up to eight product coal trains per day being loaded for the Project. This could result in increased traffic delays at the level crossings located along the Goonyella Branch Railway between the Project and the port. However, it is anticipated that the Project would not have a significant impact on these rail level crossings as the number of coal trains associated with the Project would only be minimal in comparison to the large number of trains that travel along this network on a daily basis.

It is noted that:

- The *Network Development Plan 2016 – 2017* (Aurizon, 2017) states that the current (FY2016) coal throughput of the Goonyella Branch Railway is 121.5 Mtpa.
- The Project proposes up to 14 Mtpa of product coal to be transported along the Goonyella system.
- This represents an increase of only 12.5% of the current coal throughput along the rail network.

Road Condition

Traffic generation associated with the Project has the potential to increase impacts on road pavement of key roads used by heavy vehicles, workforce and visitors/deliveries.

A pavement impact assessment was prepared by GTA Consultants (2018) in accordance with the *Guide to Traffic Impact Assessment* (DTMR, 2017) and the *Guide to Pavement Technology Part 2: Pavement Structural Design* (Austroads, 2017) as part of the Road Transport Assessment (Appendix J).

Based on the predicted traffic movements associated with the Project, impacts greater than 5% have not been identified for any section of the Peak Downs Highway or Fitzroy Developmental Road. On this basis, and as per the methodology detailed in GTIA, assessment of contributions has not been undertaken, with the pavement impacts of the Project considered insignificant.

Pembroke has commenced discussions with DTMR and agreed that the Pavement Impact Assessment would be reviewed and updated as required.

Mitigation Measures and Management

Parts of Annandale Road, from Daunia Road to the Olive Downs South domain mine access road, would be upgraded by the Isaac Regional Council, in accordance with a road infrastructure arrangement with Pembroke.

With the exception of these upgrades, the existing road system would satisfactorily accommodate the expected future traffic generated by the Project without need for additional specific measures.

Pembroke is preparing a Road Use Management Plan in accordance with DTMR's *Guideline for Preparing a Road-use Management Plan* (2018).

The Road Use Management Plan will build on the Road Transport Assessment (Appendix J) to describe how road impacts of Project traffic, especially heavy vehicles, will be managed throughout the life of the Project.

The Road Use Management Plan will describe the management of road safety risks, impacts on structures and pavement condition, congestion and intersection performance and impacts of Project access to State roads.

Pembroke will consult with relevant stakeholders during the development of the Road Use Management Plan, including DTMR, the Isaac Regional Council, Queensland Police and emergency services.

Management strategies (which would be further detailed in the Road Use Management Plan) that Pembroke would consider implementing include (Appendix J):

- operation of lighting on-site would be in accordance with the relevant Australian Standards;
- discourage staff from using roads that do not form part of the preferred access routes to the sites;
- sponsorship of driver reviver rest areas to deal with driver fatigue;
- developing policy on how long drivers can operate a vehicle and how many breaks they require; and
- limiting overtime and developing safe driving plans.

4.8.3 Rail Transport

Existing Infrastructure and Values

Rail transportation in the region is serviced by the Norwich Park Branch Railway which runs generally north-south approximately 10 km to the west of the Project (Figure 4-26).

This branch forms part of the Goonyella Branch Railway line which transports coal from the Bowen Basin to Hay Point and DBCT south-east of Mackay (Figure 1-1).

Regionally, the Moorvale, Millennium, Peak Downs, Saraji and Lake Vermont mines, have spurs and loops, branching off the Norwich Park Branch Railway line (Figure 4-26).

As part of the Project, a new rail spur is proposed to be constructed from the Project to connect to the Norwich Park Branch Railway (Figure 4-26) for the transport of product coal.

Several railway stops and junctions are located along the Norwich Park Branch Railway immediately up-line and down-line of the proposed new rail spur including (up-line): Winchester; Peak Downs Junction; Harrow; Saraji Junction; and Dysart, and (down-line): Red Mountain; Millennium Junction; Ingsdon; and Coppabella.

Potential Impacts

The Project rail spur and rail loop would be approximately 19 km in length, connecting to the main line between the Red Mountain (down-line) and Winchester (up-line) railway stops. The Project rail spur would not cross any existing roads.

Up to approximately 15 Mtpa of product coal would be transported by rail to the port for export.

It should be noted that coal from the Willunga Domain would be transported to the rail loop via the overland conveyor. The alignment of the overland conveyor between the ROM coal handling and crushing facilities at the Willunga domain and the CHPP at the Olive Downs South domain is shown on Figures 2-1 and 2-2. A conceptual cross-section of the overland conveyor to be constructed across the Isaac River and Ripstone Creek is shown on Figure 2-26.

Based on a “Goonyella-based” train configuration with 126 wagons and a total payload of 10,800 t, an average of four product coal trains would be loaded per day for the Project at full development.

Based on a “Blackwater-based” train configuration with 98 wagons and a total payload of 8,200 t, an average of five to six product coal trains would be loaded per day for the Project at full development.

However, to allow for cargo assembly for loading of ships to meet the required performance standards at the port, a peak of up to eight product coal trains per day may be required at times.

The Project would result in an increased number of trains travelling along the Goonyella Branch Railway, with a peak of up to eight product coal trains per day being loaded for the Project. This could result in increased traffic delays at the level crossings located along the Goonyella Branch Railway between the Project and the port.

However, it is anticipated that the Project would not have a significant impact on these rail level crossings, since the number of coal trains associated with the Project would only be minimal in comparison to the large number of trains that travel along this network on a daily basis. It should be noted that:

- The *Network Development Plan 2016 – 2017* (Aurizon, 2017) states that the current (FY2016) coal throughput of the Goonyella Branch Railway is 121.5 Mtpa.

- The Project proposes up to 15 Mtpa of product coal to be transported along the Goonyella system.
- This represents only 12.5% of the current coal throughput along the rail network.

Mitigation Measures and Management

The Project rail spur would be designed and constructed in consultation with Aurizon to minimise potential impacts on the existing environment in accordance with relevant guidelines, including the *Guide for Development in a Railway Environment* (Department of Infrastructure and Planning, 2010).

4.8.4 Air Transport

Existing Infrastructure and Values

Mackay Airport is the nearest major regional airport servicing the region and currently accommodates for more than 800,000 passengers per year. Mackay Airport is a commercial business owned and operated by North Queensland Airports Group who is responsible for the management and operations of the airport.

Moranbah Airport is a public airport located approximately 5 km south-east of the township and is approved to facilitate approximately 500,000 passenger movements per year.

Brisbane Airport is the nearest major city airport and is operated by the Brisbane Airport Corporation and currently caters for more than 20 million passengers per year.

Potential Impacts

The Project construction and operational workforce would increase the number of users of the Mackay, Moranbah and Brisbane Airports.

As described in Section 2.1.6, employment and other opportunities expected to be generated by the Project include:

- a Project operational workforce of up to approximately 1,300 on-site personnel, when ROM production reaches 20 Mtpa (i.e. from 2034) (an average of 1,000 over the life of the Project);
- a construction workforce of up to 700 people during the construction of the Olive Downs South mine infrastructure area in the initial years of the Project (i.e. 2019 to 2021) (an average of 500 over the entire construction period); and
- a construction workforce in the order of 200 people during the construction of the Willunga domain mine infrastructure area and expansion of the Olive Downs South domain mine infrastructure area around Year 10 of the Project.

The operational hours at the Project would be 24 hours a day, seven days a week. Construction rosters are expected to be 12 hour shifts with 21 days on and seven days off. Operational rosters are expected to be:

- mining operations on a 12.5 hour shift, seven days on, seven days off; and
- senior management and administration staff working a daytime shift, five days on, two days off.

It is estimated that only approximately 10% of the Project workforce would use air transport to commute to the Project and these personnel would fly from Brisbane into the following airports:

- Mackay Airport – 70%; and
- Moranbah Airport – 30%.

Based on the distribution above, and proportion of the workforce expected to utilise each airport (e.g. 10% of the overall workforce using air transport, 70% of which would utilise Mackay), the estimated incremental increase in the number of people using the airports servicing the Project area is summarised in Table 4-34. This increase is expected to occur upon the commencement on construction and operation respectively.

Table 4-34
Estimated Incremental Increase in People using Airports Servicing the Project Locality

Airport	Construction	Operations
Mackay	35	91
Moranbah	16	38
Brisbane	51	129

The estimated incremental increase in the number of people using the airports servicing the Project locality is small (less than 1% of the capacity of each airport) and therefore is not expected to have any significant impact on the capacity of the airports.

Mitigation and Management Measures

To minimise impacts on existing regional air infrastructure, the Project would prioritise recruitment of people from the Isaac Regional Council LGA in the first instance, before seeking candidates from other areas.

4.9 NOISE AND VIBRATION

A Noise and Vibration Assessment for the Project was undertaken by Renzo Tonin Ron Rumble (2018) and is presented as Appendix K.

The environmental objective for noise and vibration is provided in Section 4.9.1. Section 4.9.2 provides a description of the environmental values and assessment criteria. Section 4.9.3 provides a description of the potential impacts based on the modelling results. Section 4.9.4 outlines proposed mitigation measures, management and monitoring for the Project.

Noise Measurement

The assessed noise levels presented in Appendix K and summarised in this section are typically expressed in A-weighted decibels (dBA). The logarithmic dBA scale simulates the response of the human ear, which is more sensitive to mid to high frequency sounds and relatively less sensitive to low frequency sounds. Table 4-35 provides information on common noise sources in dBA for comparative reference.

Measured or predicted noise levels are expressed as statistical noise exceedance levels (L_{AN}), which are the levels exceeded for a specified percentage of the interval period. For example, L_{A10} is the noise level that is exceeded for 10% of the sampling period and is also considered to be the average maximum noise level.

The equivalent continuous noise level (L_{Aeq}) refers to the steady sound level, which is equal in energy to the fluctuating levels recorded over the sampling period.

4.9.1 Environmental Objectives and Performance Outcomes

The environmental objective relevant to noise and vibration, as described in the Terms of Reference for the Project, is:

> *The environmental objective to be met under the EP Act is that the activity will be operated in a way that protects the environmental values of the acoustic environment.*

The Project would achieve the following performance outcome as identified in Part 3, Schedule 5, Table 1 of the EP Regulation:

> *2 The release of sound to the environment from the activity is managed so that adverse effects on environmental values including health and wellbeing and sensitive ecosystems are prevented or minimised.*

Table 4-35
Relative Scale of Various Noise Sources

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 to 130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Internal demolition work (jackhammer)	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
80	Loud	Garbage disposal at 1 m, shouting at 1 m	Urban daytime noise
70	Loud	Vacuum cleaner at 3 m, normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	-
50	Moderate to quiet	Dishwasher next room, wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	-
0 to 10	Silent	Threshold of hearing	-

After: United States Department of the Interior (1994) and Richard Heggie Associates (1995).

4.9.2 Description of Environmental Values

Acoustic Quality Objectives

Potential noise and vibration emissions generated by the Project and the applicable noise objectives/criteria are described below.
Reno Tonin Ron Rumble (2018) has identified a range of legislation, policy, guidelines and standards relevant to identifying values and managing potential noise and vibration impacts of the Project. These include:

- the EP Act;
- the EP Regulation;
- the Environmental Protection (Noise) Policy 2008 (EPP [Noise]);
- DES' *Model Mining Conditions* guideline (DEHP, 2017d);
- DES' *Application requirements for activities with noise impacts* guideline (DEHP, 2017e); and
- EcoAccess Guidelines.

Operational Noise

Mobile equipment and fixed plant used for the Project would generate operational noise.

Acoustic Quality Objectives for sensitive receptors are detailed in Schedule 1 of the EPP (Noise). The objectives are aimed at protecting the qualities of the acoustic environment that are conducive to human health and wellbeing for individuals to sleep, study or learn, be involved in recreation, including relaxation and conversation and protecting the amenity of the community.

These are provided in the form of both outdoor and indoor levels for the daytime and evening and indoor noise levels for the night-time (Appendix K).

In addition to the Acoustic Quality Objectives specified in Schedule 1, Section 10 of the EPP (Noise) includes a method for determining noise criteria based on increases to background noise levels (background creep) (Appendix K).
DES's *Model Mining Conditions* guideline (DEHP, 2017d) provides a different method for determining noise criteria based on background noise levels (Appendix K).

Renzo Tonin Ron Rumble (2018) notes application of the various applicable sections of the EPP (Noise) and DES' *Model Mining Conditions* guideline (DEHP, 2017d) results in differing Acoustic Quality Objectives/noise limits for operational noise. Renzo Tonin Ron Rumble has therefore adopted noise limits based on the background creep noise limits described in Section 10 of the EPP (Noise), consistent with a recent Land Court of Queensland judgement (Appendix K).

The EcoAccess Guideline *Planning for Noise Control* (DEHP, 2016c) provides a sleep disturbance criterion for the night-time period (Appendix K).

The EcoAccess Guideline *Assessment of Low Frequency Noise* (Queensland Environmental Protection Agency, 2004) provides guidance regarding the assessment of low frequency noise, including a low frequency noise criterion (Appendix K).

The relevant external noise limits that have been adopted for the Project based on the EPP (Noise) and other relevant guidelines described above are provided in Table 4-36.

Table 4-36
Noise Limits Adopted for the Project

Category	Time Period	Acoustic Quality Objectives
Operations	Day	35 dBA $L_{Aeq, adj, 15min}$
	Evening	35 dBA $L_{Aeq, adj, 15min}$
	Night	35 dBA $L_{Aeq, adj, 15min}$
Sleep disturbance	Night	52 dBA maxL_p
Low frequency	All periods	55 dBZ

After: Appendix K.
Day (7 am to 6 pm),
Evening (6 pm to 10 pm),
Night (10 pm to 7 am).
maxL_{pA} = maximum instantaneous noise level.
dBZ = Z-weighted decibels.

Blasting

Overpressure (or airblast) is reported in linear decibels (dBL) and is the measurable effect of a blast of air pressure, including generated energy that is below the level of human hearing. Ground vibration is the measurable movement of the ground surface caused by a blast and is measured in millimetres per second (mm/s).

DES' *Model Mining Conditions* guideline (DEHP, 2017d) provides overpressure and vibration limits (Appendix K). These limits are presented in Table 4-37.

Blasting would generally be limited to the hours of 6.00 am to 6.00 pm and would generally not take place on public holidays.

Table 4-37
Overpressure and Vibration Limits Adopted for the Project

Blasting Emission	Blast Overpressure and Vibration Limits	
	7.00 am to 6.00 pm	6.00 pm to 7.00 am
Overpressure	115 dB (Linear) Peak for 9 out of 10 consecutive blasts initiated and not greater than 120 dB (Linear) Peak at any time	Either no blasting, or limits justified by proponent no less stringent than the limits for 7.00 am – 6.00 pm
Vibration (peak particle velocity)	5 mm/s peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10 mm/s peak particle velocity at any time	Either no blasting, or limits justified by proponent no less stringent than the limits for 7.00 am – 6.00 pm

After: Appendix K.
dB = decibels.

Road Noise

DTMR's *Transport Noise Management Code of Practice* (DTMR, 2013) provides a noise limit of 68 dBA ($L_{10,\ 18hr}$) at sensitive receptors for existing roads and road upgrades.

Rail Noise

Queensland Rail (QR) details Planning Levels for airborne noise from railway activities (train movements) in its *Safety and Environmental Management System*. The Planning Levels are 65 dBA ($L_{Aeq,\ 24hr}$) and a single event maximum of 87 dBA maxL_{pA}.

Existing Noise Environment

Four unattended noise loggers were deployed for a period of nine days in August 2017 to measure the existing background noise levels in the vicinity of the Project. Attended noise monitoring was also carried out at three locations in August 2017 to complement the unattended monitoring (Appendix K).

A summary of the representative background levels determined from the unattended noise monitoring is provided in Table 4-38. Data obtained at logger location L4 was corrupt and has therefore not been presented.

Further detail regarding baseline noise monitoring, including monitoring locations and ambient noise levels recorded at each of the unattended and attended noise monitoring sites is presented in Appendix K.

Table 4-38
Representative Background Noise Levels

Logger	L_{A90} (dBA)		
	Day	Evening	Night
L1	25	20	20
L2	30	25	19
L3	28	22	18

After: Appendix K.

Sensitive Receptors

There are six sensitive receptors in the vicinity of the Project. These sensitive receptors are all isolated homesteads. Each of the sensitive receptors is shown on Figure 1-2.

It is noted the closest sensitive receptor to the Project, "Vermont Park", is rented by Pembroke and is not occupied.

4.9.3 Potential Impacts

Operational Noise

Noise Modelling

An acoustic model was developed that simulates the components of the Project using noise source information (i.e. sound levels and locations) and predicts noise levels at relevant receptor locations. The model considers meteorological effects, terrain and noise attenuation (Appendix K).

Modelled mobile equipment and fixed plant noise levels are provided in Appendix K.

Potential noise impacts were assessed for Years 2027, 2043, 2066 and 2085. These scenarios were selected to represent a range of potential impacts over the life of the Project (Figures 2-3 to 2-9) with reference to the location of the operations and the potential to generate noise in each year.

Assessment of Meteorological Conditions

As described in Section 4.5.1, the data captured to date from the on-site meteorological station is considered insufficient for modelling purposes. As such, prevailing meteorological conditions were determined based on meteorological data sourced from the Bureau of Meteorology station in Moranbah (Appendix K).

Analysis of long-term meteorological data identified that wind is not a significant feature of the area. That is, source to receiver winds of less than or equal to 3 m/s do not occur for 30% of the time in any assessment period (day, evening or night) in any season (Appendix K).

In the absence of specific meteorological data in the Project area, it has conservatively been assumed that temperature inversions are a feature of the area. Default temperature inversion parameters have therefore been adopted in the modelling to determine potential impacts under adverse meteorological conditions (Appendix K).

Assessment of Feasible and Reasonable Noise Mitigation Measures

A number of iterative steps were undertaken to develop noise mitigation measures for the Project, including the following (Appendix K):

1. Preliminary noise modeling of scenarios representative of various stages of the Project (including stages when noise levels would be expected to be greatest at sensitive receptors) to identify the potential for noise exceedances.
2. Evaluation of various combinations of noise management and mitigation measures to assess the relative effectiveness of each measure.
3. Review of the effectiveness of the measures and assessment of their feasibility by Pembroke.
4. Adoption of management and mitigation measures to appreciably reduce noise emissions associated with the Project.

Adopted management and mitigation measures are described in Section 4.9.4.

Noise Modelling Results

With the implementation of management measures described in Section 4.9.4, all sensitive receptors are predicted to comply with the relevant noise limits during the day, evening and night for all modelling cases throughout the life of the Project (Appendix K). The predicted noise levels under adverse meteorological conditions are presented in Table 4-39.

Table 4-39
Predicted Operational Noise Levels ($L_{Aeq, 15min}$) During Adverse Meteorological Conditions

Sensitive Receptor	Predicted Operational Noise Levels $L_{Aeq, 15min}$ (dBA) (All Periods)			
	Year 2027	Year 2043	Year 2066	Year 2085
Vermont Park	24	35	35	34
Seloh Nolem 1	15	33	34	31
Seloh Nolem 2	15	35	34	34
Old Bombandy	-	25	21	17
Willunga	7	29	28	32
Leichhardt	-	28	24	18

After: Appendix K.

Predicted noise contours for 2066 under adverse meteorological conditions (i.e. maximum extent of predicted impacts) are shown on Figure 4-27. Noise contour diagrams for each modelled scenario under both neutral and adverse meteorological conditions are provided in Appendix K.

Consideration of Low Frequency Noise and Sleep Disturbance

The predicted noise from the Project complies with the low frequency goals at sensitive receptors throughout the life of the Project (Appendix K). In addition, the sleep disturbance is unlikely to be exceeded at any location (Appendix K).

Blasting

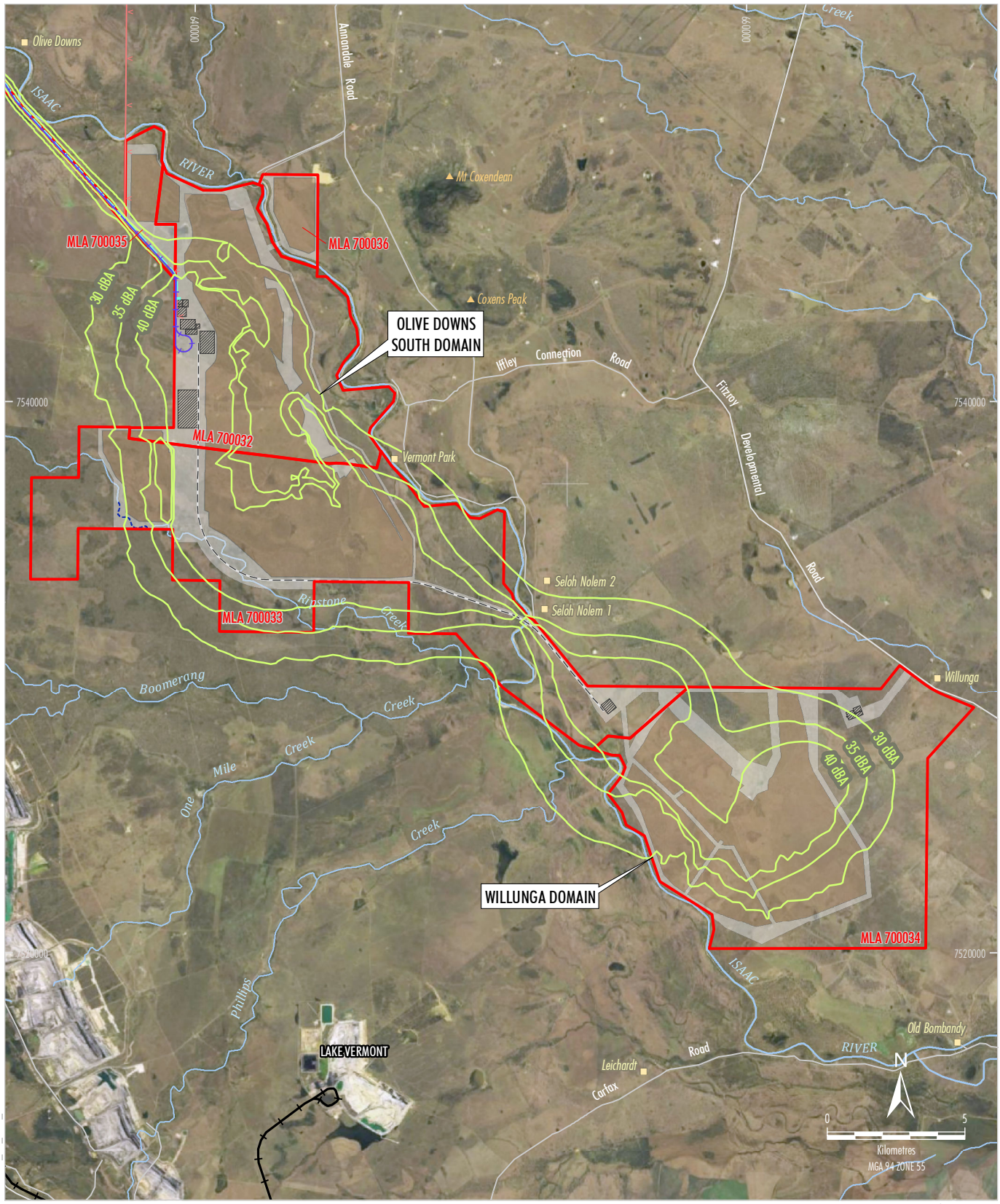
The blasting assessment in Appendix K predicts overpressure and vibration levels would be below the relevant criteria at all sensitive receptors for the life of the Project.

Blast designs may be adjusted when blasting in Pit ODS8 within 2 km of the “Vermont Park” residence, as described in Section 4.9.4.

Road Noise

Road noise levels associated with the Project along Annandale Road and Fitzroy Development Road were predicted.

Road noise levels along Annandale Road are predicted to be less than 50 dBA ($L_{10, 18hr}$) at the closest sensitive receiver (approximately 180 m from the road) (Appendix K).



PRN-16-02_EIS_Sect4_211C

LEGEND

- Mining Lease Application Boundary
- Railway
- Dwelling
- Proposed Electricity Transmission Line
- Proposed Rail Spur and Loop
- Proposed Water Pipeline
- Proposed Creek Diversion
- Out-of-Pit and In-Pit Waste Rock Emplacement
- Infrastructure Area
- Key Infrastructure Component
- Overland Conveyor
- $L_{Aeq\ (15\ minute)}$ Noise Contour

Source: Renzo Tonin (2018), Geoscience Australia - Topographical Data 250K (2006), Department of Natural Resources and Mines (2016) Orthophotography: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Noise Contours - Year 2066
Netural Meteorological Conditions

Figure 4-27

Road noise levels along Fitzroy Development Road are predicted to be less than 55 dBA ($L_{10, 18hr}$) at the closest sensitive receiver (approximately 50 m from the road) (Appendix K).

Road noise levels are therefore predicted to comply with the relevant road noise limit throughout the life of the Project (Appendix K).

Rail Noise

Rail transport noise levels are predicted to comply with the relevant rail noise limit at the closest sensitive receiver (approximately 1.5 km from the rail spur) based on a peak of 16 train movements per day (i.e. 8 unloaded and 8 loaded trains) (Appendix K).

4.9.4 Mitigation Measures, Management and Monitoring

Noise and vibration management measures and monitoring would be documented in a Noise Management Plan and Blast Management Plan to be prepared for the Project prior to the commencement of construction.

Operational Noise

Noise Mitigation Measures

Identification of noise mitigation measures required to meet the noise limits at the nearest sensitive receptors was incorporated into the Noise and Vibration Assessment.
To reduce noise emissions at the nearest sensitive receptors throughout the life of the Project, Pembroke would enclose a portion of the overland conveyor and utilise low noise idlers. This would significantly reduce noise levels from the overland conveyor, as described in Appendix K.

Under neutral meteorological conditions no additional mitigation is predicted to be required in the 2027, 2043 and 2066 modelling scenarios.

In the 2085 modelling scenario under both neutral and adverse meteorological conditions, certain mobile plant items operating in the vicinity of the Vermont Park residence would be treated with sound suppression equipment as required to achieve compliance with the relevant noise criterion at this sensitive receiver.

In the 2066 modelling scenario under adverse meteorological conditions only, certain mobile plant items operating in the vicinity of the Vermont Park residence would be treated with sound suppression equipment as required to achieve compliance with the relevant noise criterion at this sensitive receiver.

Pembroke would also implement proactive and reactive noise control measures. These measures would include the use of weather forecasting and real-time measurement of meteorological conditions and noise levels to modify mining operations as required in order to achieve compliance with applicable noise limits at the nearest sensitive receptors.
Modifying mining operations could include reducing the intensity of particular operations, relocating particular operations or halting particular operations.

With the proposed noise management measures in place, including proactive and reactive noise control measures that are considered good or best practice, it is reasonable to expect that the noise objectives would be met during the operation of the Project. Given the flexibility and robustness of the proposed mitigation measures, this would be the case even with additional noise generating activities in the region (e.g. new or expanded mining operations).

Noise Monitoring

As described above, real-time meteorological and noise monitoring would be undertaken at locations representative of the nearest sensitive receptors to assist in implementing operational controls.

Indicative proposed monitoring locations are provided in Section 6.

4.10 LAND

The environmental objective and performance outcomes for land resources are provided in Section 4.10.1. Section 4.10.2 describes the environmental values relating to land resources in the vicinity of the Project. Section 4.10.3 describes the potential impacts and Section 4.10.4 outlines proposed mitigation measures and management for land at the Project.

A Soil and Land Suitability Assessment was undertaken by GT Environmental (GTE) (2018a) and is presented in Appendix M.

The Soil and Land Suitability Assessment has been prepared in accordance with the recognised industry standards and has been aligned with the requirements and recommendations specified by the Terms of Reference.

4.10.1 Environmental Objectives and Performance Outcomes

The environmental objectives relevant to land, as described in the Terms of Reference for the Project, are that the:

(a) *activity is operated in a way that protects the environmental values of land including soils, subsoils, landforms and associated flora and fauna*

(b) *choice of the site, at which the activity is to be carried out, minimises serious environmental harm on areas of high conservation value and special significance and sensitive land uses at adjacent places*

(c) *location for the activity on a site protects all environmental values relevant to adjacent sensitive use*

(d) *design of the facility permits the operation of the site, at which the activity is to be carried out, in accordance with best practice environmental management.*

The Project would achieve the following performance outcome as identified in Schedule 5, Part 3, Table 1 of the EP Regulation:

2 All of the following—

(a) activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land;

(b) areas disturbed will be rehabilitated or restored to achieve sites that are—

(v) safe to humans and wildlife; and

(vi) non-polluting; and

(vii) stable; and

(viii) able to sustain an appropriate land use after rehabilitation or restoration;

(c) the activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants;

(d) the application of water or waste to the land is sustainable and is managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

4.10.2 Description of Environmental Values

Topography and Landforms

The Project is located in the Isaac Connors Sub-catchment Area of the Fitzroy Basin under the *Water Plan (Fitzroy Basin) 2011.*

The landscape of the Project site includes level plains to gently undulating to flat plains with elevations of approximately 200 m AHD. The overall elevation of the Project site ranges from 150 m AHD in the low-lying southeast of the Project to 200 m AHD in the higher areas to the north of the Project site (Queensland Government, 2016).

Although the topography of the Project site is relatively flat, a cluster of mountains approximately 5 km east of the Olive Downs South domain (Mt Coxendean, Coxens Peak and Iffley Mountain) reach elevations of 310 m AHD to 471 m AHD and the Harrow and Cherwell Ranges, 15 km to 20 km west of the Project, reach elevations of 400 m AHD to 500 m AHD.

Land Use

As described in Section 2, the Project is located within the Bowen Basin region of Central Queensland, within the Isaac Regional Local Government Area, where open cut coal mining is a key land use. A number of existing and approved coal mines, including Moorvale, Daunia, Poitrel, Millennium, Eagle Downs, Peak Downs, Saraji and Lake Vermont surround the Project.

Coal and petroleum (e.g. coal seam gas) mining exploration activities have been conducted within the Project site and surrounds for decades and continues.

Eight properties are located within MLA 700032, MLA 700033, MLA 700034, MLA 700035and MLA 700036:

- Winchester Downs;
- Wynette;
- Iffley;
- Deverill;
- Vermont Park;
- Seloh Nolem;
- Willunga; and
- Old Bombandy.

Cattle grazing on native pastures is conducted on these properties. A limited amount of pasture improvement has occurred on the Old Bombandy property with the establishment of Leucaena in some paddocks.

All properties within the Project area have been largely cleared through past agricultural practices; however, some tracts of remnant vegetation exist, particularly along the riparian corridor of the Isaac River.

As described in Section 2.1.5, the Project site is:

- Located within zones identified and mapped as Regional Landscape and Rural Production Area under the Mackay, Isaac and Whitsunday Regional Plan (Department of Local Government and Planning, 2012), but generally outside zones mapped as good quality agricultural land (parts of the Project rail spur and water pipeline cross mapped good quality agricultural land).
- Located within the Western Cropping Zone, but outside areas of regional interest under the RPI Act (i.e. not located within a Priority Agricultural Area, Priority Living Area, Strategic Cropping Area or Strategic Environmental Area).
- Not located within any areas considered to be high quality agricultural land.
- Not located across any designated sites under the Planning Act.
- Not located within any living areas in regional communities.

Regional Plan

The Project is located within the Mackay Isaac Whitsunday Regional Plan 2012 (the Regional Plan) (Department of Local Government and Planning, 2012). The Regional Plan is a State planning instrument under chapter 2 of the Planning Act.

The Regional Plan establishes a vision and direction for the region to 2031, and provides strategies to inform future decision making, which aim to:

- address regional economic, social and environmental issues;
- identify strategic infrastructure and service needs and priorities;
- support economic prosperity and employment opportunities;
- highlight and respond to climate change concerns;
- recognise environmental values;
- support consolidated growth within established regional centres and townships;
- focus public, private and community sector responses to key regional issues; and
- align efforts across agencies and all levels of government.

It is noted that development within a Mining Lease or Specific Purpose Mining Lease, does not need to consider the Planning Act, associated regulations, planning schemes and policies (Attachment 3). Project components located outside a Mining Lease or Specific Purpose Mining Lease (i.e. the western part of the water pipeline and the ETL) have been designed to achieve the relevant policies of the Regional Plan. For example, the water pipeline and ETL, and the Project more generally, have been designed to:

- Minimise impact on primary production and not compromise human health, current and future resource use opportunities, regional landscape values or ecosystem function and services.
- Allow for future uses of the Project site following rehabilitation.
- Protect the region's best agricultural land.
- Minimise exposure to pest plants and pest animals.
- Maintain the integrity of areas with high ecological significance.
- Protect the environmental values and water quality of surface water and groundwater, wetlands and their associated buffers.
- Protect riparian areas.
- Minimise air and noise emissions on sensitive places.
- Minimise adverse impacts on the regional natural resources.

In addition, the Social Impact Assessment prepared as part of this EIS (Appendix H) has included genuine community engagement and consultation to inform the potential impacts the Project would have on the Isaac LGA and local communities. Further, by targeting local employment and not relying on a FIFO workforce, the Project would improve the long-term viability of the nearby resource communities.

Regional Planning Interests Act

The Queensland *Regional Planning Interests Act 2014* (RPI Act) manages development on areas of regional interest in Queensland. These include priority agricultural areas, priority living areas, strategic cropping areas (formerly Strategic Cropping Land) and strategic environmental areas. The Project is not located within an area of regional interest. The closest areas of regional interest are:

- priority agricultural areas – located approximately 110 km southwest of the Project;
- priority living areas – located approximately 75 km southwest of the Project;
- strategic cropping areas – located approximately 2 km south of the Project; and
- strategic environmental areas – located approximately 300 km west of the Project.

As the Project would not impact any areas of regional interest, approval under the RPI Act is not required.

Local Planning Schemes

The Project is located within the Isaac Regional Council. This region is governed by three different planning schemes being the Belyando Planning Scheme 2009, the Nebo Planning Scheme 2008 and the Broadsound Planning Scheme 2005. The Project is predominately located within the Broadsound Planning Scheme, with the western part of the water pipeline located within the Belyando Planning Scheme.

The Broadsound and Belyando Planning Schemes provide frameworks for managing development in a way that seeks to achieve ecologically sustainable.

The Project is located within Rural Preferred Use areas in both Planning Schemes.

The Broadsound Planning Scheme identifies the coal resources within the Olive Downs South and Willunga domains, and further, identifies these areas as being *Key Resource Areas*.

The Broadsound Planning Scheme does not identify any *Conservation Preferred Use Areas*, *State Forests*, or *Good Quality Agricultural Land* within the Olive Downs South or Willunga domains.

The Project rail spur and water pipeline corridors would cross areas identified as *Good Quality Agricultural Land* in both the Broadsound and Belyando Planning Schemes, however the Soil and Land Suitability Assessment found that these areas were, in fact, only suitable for grazing with moderate limitations (Appendix M).

The Planning Schemes identify outcomes for development that should be achieved, for example (amongst others):

- maintaining the environment;
- areas of ecological significance are conserved;
- water quality is not significantly affected;
- wildlife corridors are protected;
- protects good quality agricultural land;
- protects and enhances the predominant rural scale, intensity, form and character;
- maintains rural amenity;
- traffic generated by the development does not impact adversely on the local road network;
- is located and designed in ways that minimise the need for flood and landslide mitigation, and to protect people and premises from such natural events;
- has water supply, stormwater disposal, sustainable effluent and waste disposal and power, to appropriate standards, adequate for the “use”; and
- does not impact adversely on infrastructure.

It is noted that development within a Mining Lease or Specific Purpose Mining Lease, does not need to consider the Planning Act, associated regulations, planning schemes and policies (Attachment 3). Project components located outside a Mining Lease or Specific Purpose Mining Lease (i.e. the western part of the water pipeline) have been designed to achieve the relevant outcomes of the Planning Schemes.

Soils

A Soil and Land Suitability Assessment prepared by GTE (Appendix M) was undertaken for the Project. Soils surveys were undertaken across the Project site (including the rail and pipeline corridors) to identify and assess the principal soil types and their relative distribution.

Twelve (12) soil mapping units (SMUs) (C1, C2, S1, S2, R1, R2, L1, L2, B1, B2, A1 and A2) were identified across the Project site on the basis of 1010 investigation sites (incorporating 192 detailed sites and 818 observation sites). The SMUs and investigation sites across the Olive Downs South and Willunga domains can be seen of Figure 4-28. Further detail for SMUs, observation sites and investigation sites (including within the rail and pipeline corridors) is available in Appendix M.

The Project site includes areas of flat to gently undulating plains dominated by uniform and gradational clays (C1 and C2), gently undulating plains dominated by sandy duplex with gradational sandy loams (S1, S2, R1, R2, L1 and L2), relic alluvial plains and low-lying plains (B1 and B2) and recent alluvial floodplain and active channels with stratified loamy sands (A1 and A2).

The majority of the Project site is shown as 'No Known Occurrence' with respect to Acid Sulfate Soils (ASS). Field observations reported very low indicators in ten SMUs of neutral and neutral to alkaline pH. It is highly unlikely the SMUs contain ASS and potential acid sulphate soils (PASS) (GTE, 2018b).

Soil Condition

A broad range of soil physical and chemical constraints for agricultural land use were identified within the Project site, including (Appendix M):

- limited water holding capacity;
- salinity;
- dispersive subsoils;
- nutrient deficiencies; and
- accessibility.

Further detail on the condition of soils is provided in Appendix M.

Land Suitability

Land suitability mapping for the Project has been completed by GTE (2018a) and is presented in Appendix M.

Land suitability for the Project site was primarily based upon classifications provided within the Land Suitability Assessment Technique (LSAT) Guidelines within the *Technical Guidelines for Environmental Management of Exploration and Mining in Queensland* (DME, 1995).

The *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM, 2015) were utilised to assess land suitability classes and Agricultural Land Classes (ALCs). The *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM, 2015) and *Regional Land Suitability Frameworks* (DSITI and DNRM, 2013) give detailed information on appropriate land uses and associated limitations.

The five standard land suitability classes defined within the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM, 2015) are presented below (Appendix M):

- Class 1 – Suitable land with negligible limitations.
- Class 2 – Suitable land with minor limitations.
- Class 3 – Suitable land with moderate limitations.
- Class 4 – Unsuitable land with severe limitations.
- Class 5 – Unsuitable land with extreme limitations.

Further description of land use classifications is detailed in Appendix M.

Land Suitability for Cropping

Land suitability assessment for cropping followed the framework and methodology prescribed in:

- the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM, 2015); and
- the *Regional Land Suitability Frameworks for Queensland* (DSITI and DNRM, 2013).

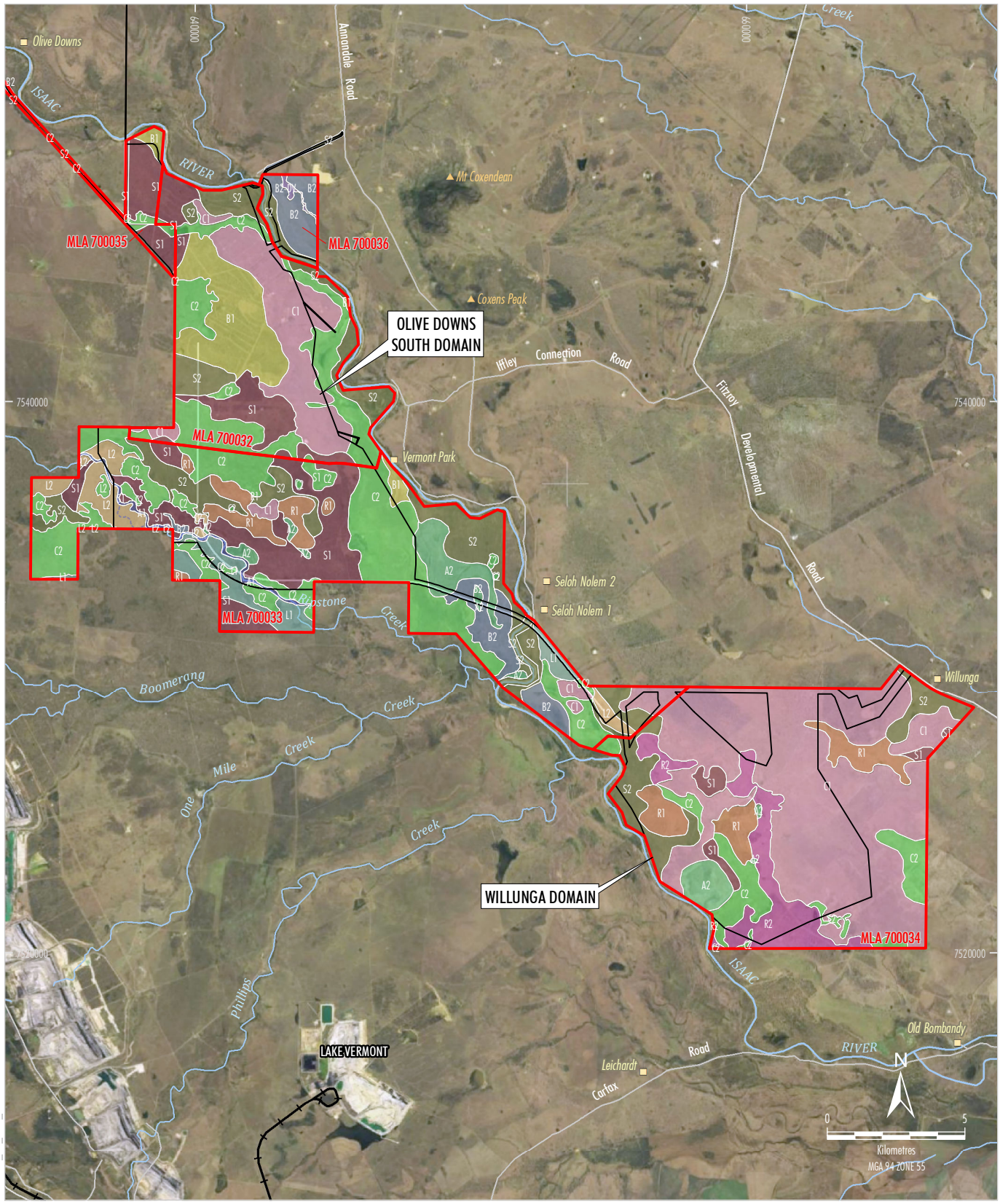
A summary of the spatial extent of the mapped land suitability classes for cropping within the Project disturbance footprint is provided in Table 4-40.

Table 4-40
Land Suitability – Cropping

Land Suitability Class	Area (ha)	SMU
1	-	-
2	-	-
3	-	-
4	8,983	C1, S1, S2, R1, R2, B1
5	7,244	C2, L1, L2, B2, A1, A2

Source: After Appendix M.

Note: Mapping did not include the ETL corridor.



PRN-16-02_EIS_Sect4_203C

LEGEND

- Mining Lease Application Boundary
- Indicative Extent of Project Disturbance
- Railway
- Dwelling
- Proposed Creek Diversion

Soil Mapping Units

- A1
- A2
- B1
- B2
- B2-DV
- C1
- C2
- L1
- L2
- R1
- R2
- S1
- S2

Source: Geoscience Australia - Topographical Data 250K (2006)
Department of Natural Resources and Mines (2016)
Orthophotography: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Soils Mapping Units

Figure 4-28

No Class 1, 2 or 3 lands were identified within the Project disturbance footprint. All land was assessed to be Class 4 or Class 5 due to inherent soil and landscape constraints that directly limit cropping success (Appendix M).

Land Suitability for Grazing

Land suitability assessment for grazing within the Project site followed the framework and methodology prescribed in the *Technical Guidelines for Environmental Management of Exploration and Mining in Queensland* (DME, 1995).

A summary of the spatial extent of the mapped land suitability classes for grazing within the Project disturbance footprint is provided in Table 4-41.

Grazing land limitations in general, are one class lower (i.e. better) than the cropping classes.

The suitability of the land within the Project area for beef cattle grazing is assessed as marginal to suitable with moderate limitations. Limitations such as moisture, nutrients and salinity have less impact on maintaining native pastures compared with establishing cropping lands.

Table 4-41
Land Suitability – Grazing

Land Suitability Class	Area (ha)	SMU
1	-	-
2	-	-
3	15,755	C1, S2, C2, S1, R1, R2, L1, L2, B1, B2
4	472	A1, A2
5	-	-

Source: After Appendix M.

Note: Mapping did not include the ETL corridor.

Observations of the Project site vegetation and current agricultural land use displayed successful beef cattle grazing activities already established on-site.

Agricultural Land Class

ALCs are based on a simple hierarchical scheme that is applicable across Queensland. It allows the interpreted land evaluation data to indicate the location and extent of agricultural land that can be used for a wide range of land uses with minimal land degradation.

ALCs for the Project site are defined as part of the Isaac Region Shire Planning Scheme, due for completion in 2018 based upon the existing Belyando, Broadsound and Nebo Shire Planning Schemes.

Three classes of agricultural land and one class of non-agricultural land are defined in the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM, 2015):

- Class A – crop land;
  - A1 – broadacre crops;
  - A2 – horticultural crops only;
- Class B – limited crop land;
- Class C – pasture land;
  - C1 – grazing of sown or native pastures;
  - C2 – grazing of native pastures;
  - C3 – light grazing of native pastures; and
- Class D – non-agricultural land.

The classes indicate the range of land use choice, the range of land use limitations and land degradation hazard. Further definition and description of ALC is provided in Appendix M.

ALC mapping within the Project disturbance footprint has been prepared by GTE (2018a) and is documented in Appendix M. Table 4-42 presents the extent of ALC (and corresponding SMUs) in the Project disturbance footprint.

Table 4-42
Agricultural Land Classification

Class	Area (ha)	SMU
Total A	-	-
Total B	**6,112**	C1, S2
C1	-	-
C2	9,743	C2, S1, R1, R2, L1, L2, B1, B2
C3	472	A1, A2
Total C	**10,215**	**-**
Total D	-	-

Source: After Appendix M.

Note: Mapping did not include the ETL corridor.

The ALC mapping generally reflects the LSC mapping, in that the Project site is suitable for cattle grazing, with limited suitability for cropping.

SMU C1 covers the majority of the Willunga domain and is also present in the northern half of the Olive Downs South domain. SMU S2 is typically located in the vicinity of the Isaac River and a significant proportion of this land would not be disturbed by the Project.

Regional Frameworks Assessment

The land suitability assessment determined that two SMUs (C1 and S2) have limited cropping potential. All other SMUs identified were considered suitable for beef cattle grazing activities, and therefore were not considered further against the *Regional Land Suitability Frameworks for Queensland* (DSITI and DNRM, 2013).

SMU C1 has been assessed as marginally suitable to unsuitable, with limitations for wetness being the most severe. Marginal cropping land uses may include Maize, Millet, Oat, Sorghum, Triticale and Wheat. The use of additional engineering and/or agronomic improvements may improve the potential for limited broadacre and horticultural cropping.

SMU S2 has been assessed as suitable, with limitations for soil water availability being the most severe. SMU S2 is considered suitable for dryland cropping land uses which may include Barley, Chickpea, Maize, Millet, Oat, Sorghum, Triticale and Wheat.

Stock Route Network and Reserves

There are two areas designated as Stock Routes (Reserves) that would be intersected by the Project pipeline and rail spur. These areas cover the following lots (Figure 2-17):

- Pipeline:
  - Lot 9 GV33.
- Rail spur and pipeline:
  - Lot 15 CNS111.

Strategic Cropping Areas

The Soils and Land Suitability Assessment prepared by GTE (Appendix M) included a desktop review of Strategic Cropping Areas within the Project site. The desktop review concluded that no land mapped as a Strategic Cropping Area was located within the Project site (Figure 2-14). The closest Strategic Cropping Area to the Project is located approximately 1 km south and southwest of the Willunga domain. Development of the Project is not predicted to significantly change the flooding characteristics in these nearby Strategic Cropping Areas (Appendix F).

The SMUs were also assessed against the Western Cropping Zone criteria for Strategic Cropping Areas, based on field and laboratory information. The Strategic Cropping Area criteria for the Western Cropping Zone includes:

- Slope – Equal to or less than 3%;
- Rockiness – Equal to or less than 20% for rocks greater than 60 mm in diameter;
- Gilgai – Less than 50% of land surface being gilgai of greater than 500 mm in depth;
- Soil Depth – Equal to or greater than 600 mm;
- Soil Wetness – Has favourable drainage;
- Soil pH – Rigid Soils – 0.30-0.60, pH within 5.1-8.9 and Non-rigid Soils – 0.30-0.60, pH greater than 5.0;
- Salinity – Chloride is less than 800 mg/kg at 0.6 m depth; and
- Soil Water Storage – Equal to or greater than 100 mm to a soil depth or soil physio-chemical limitation of equal to or less than 1,000 mm.

GTE (2018) concluded that all of the SMUs failed on criteria such as gilgai, soil wetness, soil pH and soil water storage. Based upon this assessment for the Project site, no SMUs could be demonstrated to meet the requirements for Strategic Cropping Areas.

Priority Agricultural Areas

PAAs are areas of regionally significant agricultural production that are identified in a regional plan. Identifying PAAs ensures that resource activities that seek to operate in these areas do not unreasonably constrain, restrict or prevent on-going agricultural operation.

Desktop review of the Project site compared to the Queensland Government Development Assessment Mapping System confirmed that no PAA was located within the Project site, and the nearest areas were situated approximately 100 km to the south (GTE, 2018a).

Native Title and Indigenous Land Use Agreement

The Project is located within the Barada Barna People (QC2016/007) Native Title Determination Area registered with the National Native Title Tribunal (NNTT) (2016), and within areas subject to private Indigenous Land Use Agreements (ILUAs) QI2011/031 and QI2012/062 between the Barada Barna People and petroleum mining companies (Arrow and QGC, respectively) (Figure 2-15).

Pembroke has formed an ILUA and a CHMP with the Barada Barna People to manage the risk of harm to Aboriginal cultural heritage by activities associated with the Project.

Existing Resource Tenements

As described in Section 2.2.1, the Project MLAs are located within (Figure 2-16):

- Parts of MDLs 3012, 3013, 3014 and 3025.
- Parts of EPCs 649, 676, 688, 721, 850, 1949 and 1951.

Parts of the water pipeline and ETL (located outside a mining lease application for the Project) are located within MDLs 183, 277 and 495 and EPCs 649 and 755.

Petroleum tenements overlapping the Project area and surrounds include (Figure 2-16):

- PLA 488 (across the Project MLA areas);
- PLs 222 and 223 (across the infrastructure corridors); and
- ATPs 759, 1031 and 1103 (across the Project MLA areas and infrastructure corridors).

Contaminated Land

A Contaminated Land Site Inspection was undertaken by GTE (2018b) for the Project (Attachment 1 of Appendix M).

The preliminary site investigation included an assessment of the Project site, including its history, a contaminated land database search and site inspection.

The preliminary site investigation covered the Project site (including the Olive Downs South domain, Willunga domain and associated linear infrastructure areas); however, it excluded the Old Bombandy property located at the south of the Project site (Figure 2-17).

The DES's Environmental Management Register (EMR) and Contaminated Land Register (CLR) were searched on 15 March 2017, 31 January 2018 and 1 February 2018 for any records of contaminated or potentially contaminated lands occurring on or near the Project site. No records were identified (GTE, 2018b).

Based on the site inspection, fifteen points of interest were identified including a cattle dip, a cattle yard with potential spray race unit, gas extraction wells, retention ponds, unlabelled and labelled drums, generators and above ground storage tanks (Figure 4-29).

4.10.3 Potential Impacts

Topography and Landforms

The Project would alter the topography and landforms within the Project site. Some topographic changes would be temporary (i.e. temporary bunds/levees and drains) while others would be permanent (i.e. rehabilitated landforms) (Section 5).

Waste rock mined during the development of the Project would be progressively placed behind the advancing open cut operation (i.e. progressive backfill of open cut pits) as well as being placed in out-of-pit emplacements. At the cessation of mining, four final voids would remain (Section 5).

The out-of-pit waste rock emplacements would result in the creation of a number of elevated landforms, which would have elevations of up to 315 m AHD.

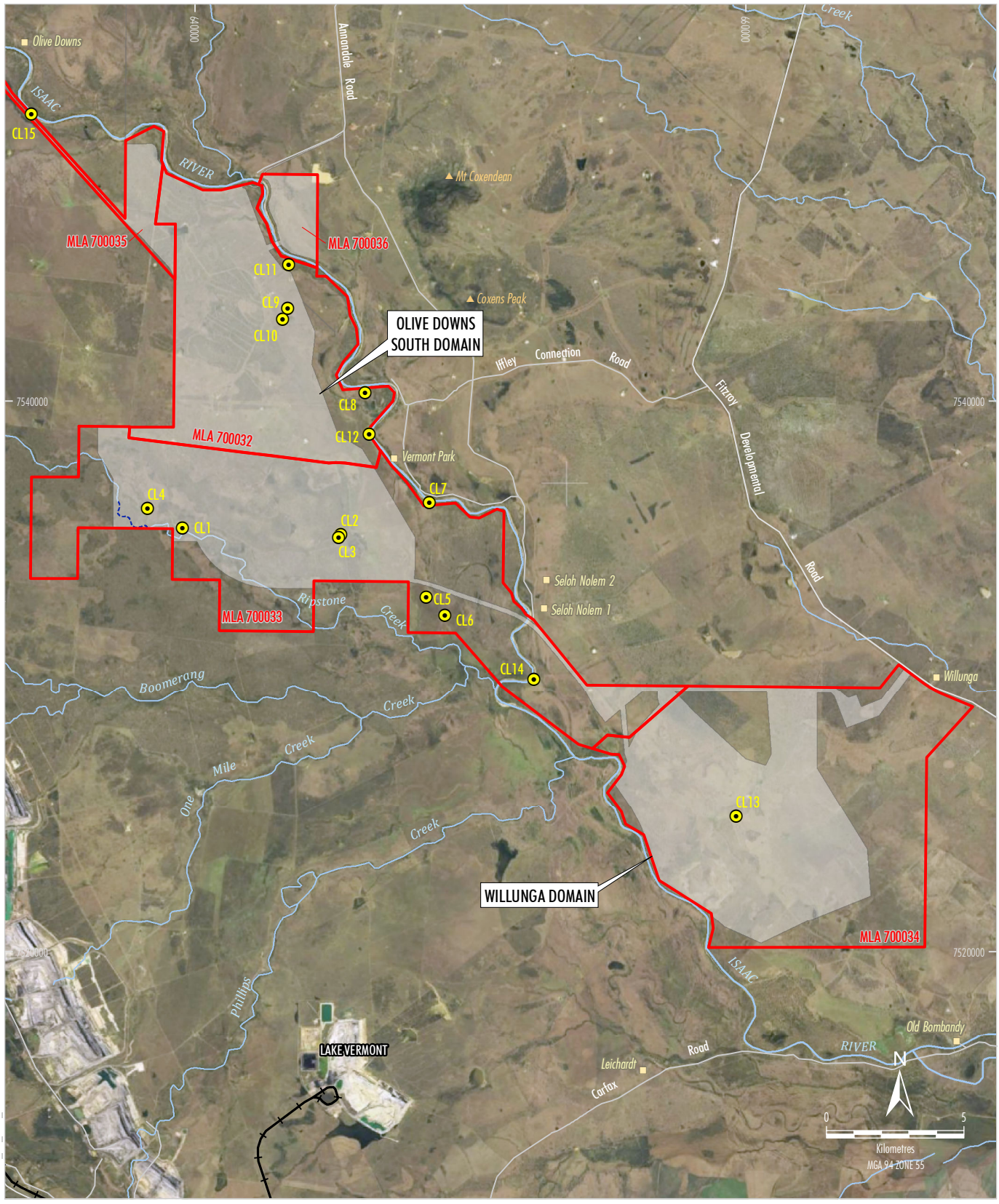
This would be similar to or lower than the existing elevated landforms in the vicinity of the Project (e.g. the mountains to the east, and the Harrow and Cherwell Ranges to the west), which have elevations between 310 m AHD and 500 m AHD.

Direct views of the elevated Project landforms are not expected to be significant from nearby dwellings given the large separation distances and presence of intervening vegetation. Table 4-43 presents the distances from the nearby dwellings to the highwall emplacement and/or out-of-pit waste rock emplacements.

The Vermont Park dwelling is the closest privately-owned dwelling to the Project. It is located on the eastern side of the dense riparian corridor along the Isaac River. A photo looking west across the Isaac River from the Vermont Park dwelling towards the Project area is shown in Plate 4-2.

Although the highwall emplacement would be constructed within 1 km of the Vermont Park dwelling, visual impacts from this 25 m high landform are not anticipated to be significant given the intervening vegetative screening.

The larger out-of-pit waste rock emplacements would be located at least 5 km from the privately-owned dwellings. As visual prominence diminishes with distance, and in consideration of intervening vegetation, it is expected that the visual impact of the elevated Project landforms would not be significant at nearby dwellings.



PRN-16-02_EIS_Sect4_209B

LEGEND

- Mining Lease Application Boundary
- Indicative Extent of Project Disturbance
- Railway
- Proposed Creek Diversion
- Dwelling
- Contaminated Land Point of Interest

Source: Geoscience Australia - Topographical Data 250K (2006)
Department of Natural Resources and Mines (2016)
Orthophotography: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Contaiminated Land Points of Interest

Figure 4-29

Table 4-43
Approximate Distances from Project to Nearby Dwellings

Dwelling	Olive Downs South Domain Highwall Emplacement (~25 m above ground level)	Olive Downs South Domain Out-of-pit Emplacements (~130 m above ground level)	Willunga Domain Out-of-pit Emplacements (~80 m above ground level)
Vermont Park	900 m	5 km	14 km
Seloh Nolem 1	5 km	9 km	6 km
Seloh Nolem 2	5 km	9 km	7 km
Willunga	>20 km		7 km
Old Bombandy			7 km
Leichhardt			7 km

Plate 4-2
Vermont Park Looking West

The overland conveyor would be located approximately 700 m from the closest privately-owned dwelling (Seloh Nolem 1). The conveyor would generally be 1 m to 2 m above ground level. At a distance of at least 700 m, visual impacts from the overland conveyor are not expected to be significant.

The Willunga domain mine infrastructure area would be at least 4 km from the closest dwelling. Infrastructure at the Willunga domain would reach heights of approximately 18 m. At distances of 4 km or greater, visual impacts from the mine infrastructure areas are not expected to be significant.

The Olive Downs South domain mine infrastructure area would be at least 8 km from the closet dwelling. Infrastructure at the Olive Downs South domain would reach heights of 20 to 30 m. At distances of 8 km or greater, visual impacts from the mine infrastructure areas are not expected to be significant.

A range of lesser topographic changes would be associated with the construction of roads, water management infrastructure and erosion and sediment control features over the life of the Project.

Soils

Potential impacts of the Project on soils would relate primarily to:

- disturbance of soil resources (e.g. through the development of the open cut mining areas);
- alteration of soil structure beneath infrastructure and roads (i.e. compaction);
- possible soil contamination resulting from spillage of fuels, lubricants and other chemicals;
- increased erosion and sediment movement due to exposure of soils during construction; and
- alteration of physical and chemical soil properties (e.g. structure, fertility and permeability) due to soil stripping and stockpiling operations.

Management of soil resources is described in Section 4.10.4.

Land Use

The Project would result in the progressive disturbance or alteration of existing agricultural lands in the short term. The total impact to the properties associated with the development of the Project is summarised in Table 4-44.

Although cattle grazing could continue to co-exist in areas adjacent to the mining operation, the land within the Project footprint would not sustain this existing land use while mining operations are conducted. As shown in Tables 4-40 and 4-41, the Project site has been identified as:

- Land Suitability Class 4 (unsuitable land with severe limitations) or Class 5 (unsuitable land with extreme limitations) for cropping.
- Land Suitability Class 3 (suitable land with moderate limitations) or Class 4 (unsuitable land with severe limitations) for grazing.

In the long-term, the disturbed areas of the Project site would be rehabilitated to the proposed post-mining land suitability class as detailed in Table 4-45.

Stock Route Network and Reserves

As described in Section 4.10.2, there are two areas designated as Stock Routes (Reserves) that would be intersected by the Project pipeline and rail spur, within MLA 700035 (Figure 2-17).

While the pipeline would be buried (and therefore would not impede the use of these lots as Stock Routes), the rail spur would reduce the area of the Travelling Stock Route within Lot 15 CNS111 by approximately 6 ha (or approximately 2% of the lot size).

The impact is not likely to significantly impact the use of the Stock Routes. It is also noted that the Stock Route within Lot 15 CNS111 does not connect to any other Stock Route and is therefore not expected to be widely used. Notwithstanding the above, the rail spur would be fenced to prevent access by stock. Pembroke will engage with DNRME and the IRC regarding the potential impacts to the stock route network and any mitigation measures considered necessary.

Table 4-44
Area of Project within Properties

Property Name	Approximate Area of Total Property (ha)	Approximate Area of Property within Disturbance Footprint (ha)	Approximate Percentage of Property within the Disturbance Footprint
Winchester Downs	21,100	28	<1%
Wynette	5,850	471	8%
Iffley	25,650	4,815	19%
Deverill	6,450	492	8%
Vermont Park	16,650	4,455	27%
Seloh Nolem	8,650	319	4%
Willunga	18,200	5,112	28%
Old Bombandy	11,050	527	5%

Table 4-45
Proposed Post Mining Land Suitability Classes

Disturbance Type	Proposed Post Mining Land Suitability Class
Out-of-pit and in-pit waste rock emplacement areas	Class 3 to 4 – Grazing Class 5 – Cropping
Final Voids	Unsuitable for grazing and cropping
Mine Infrastructure Area	Same classes as pre-mining
Linear infrastructure	**Pipeline, ETL and Access Road** Same classes as pre-mining **Railway** Class 5 – Cropping/Grazing

No other reserves would be impacted by the Project.

Existing Resource Tenements

The Project open cut pits would intersect coal seams proposed to be targeted by the Bowen Gas Project within PLA 488 (i.e. the Rangal Coal Measures). Mining of the coal measures by the Project would result in the release of coal seam gas reserves that may have otherwise been extracted by the Bowen Gas Project.

These competing interests are managed through commercial agreements, as described in Section 4.10.4.

The Project infrastructure corridors have been designed to minimise impacts on overlapping coal exploration tenements. Specifically:

- The Project rail spur is located outside MDL 183.
- The Project water pipeline is not expected to sterilise any coal resources where it traverses MDL 183, EPC 755 and MDL 277.
- EPCs 1949 and 1951, which would be traversed by the Project rail spur and water pipeline, are not considered to contain any recoverable coal resources that would be sterilised by Project infrastructure.
- The ETL has been co-located with an existing ETL within an existing easement that crosses MDL 495.

Contaminated Land

Proposed Land Use

Proposed land uses that may result in land becoming contaminated are known as 'Notifiable Activities' and are listed in Schedule 3 of the EP Act.

The Project would include the construction of mine infrastructure areas. As a result, the following Notifiable Activities are relevant to the Project:

- 7 – Chemical storage (other than petroleum products or oil under item 29).
- 15 – Explosives production or storage.
- 24 – Mine wastes.
- 29 – Petroleum product or oil storage.
- 37 – Waste storage, treatment or disposal.

Inappropriate storage, handling and management of chemicals, explosives and wastes could result in land at the Project becoming contaminated and listed on the EMR or CLR.

Pembroke would implement appropriate mitigation measures and management (Section 4.10.4) to prevent or reduce the potential for contamination as a result of the Project.

Unexpected Occurrences of Land Contamination

Over the life of the Project, unexpected soil contamination may be identified as a result of inappropriate waste management strategies.

If evidence of unexpected contamination is identified, work would cease in that area and action taken to appropriately delineate the contaminated soil or fill material.

Examples of such material may include (but are not limited to):

- buried or hidden rubbish, including containers that may have held chemicals or oil;
- previously unidentified fill material, other than waste rock (i.e. ash); or
- odorous or oily stained soil or fill material.

In accordance with the EP Act, this material would be managed or remediated and validated under supervision of a suitably qualified person. DES would be notified by telephone, as well as by written notification within 24 hours of detection and advised of appropriate remedial action.

Known Occurrences of Land Contamination

A risk assessment was conducted for points of interest within or nearby to proposed disturbance areas, which classified three of the points of interest as greater than low risk. Prior to disturbance of these three points of interest, additional investigations would be conducted to determine the type and extent of contamination, and if required, the sites would be adequately remediated by appropriately qualified specialists.

The remaining points of interest within or nearby to proposed disturbance areas were assessed as low risk, requiring field observation during disturbance works only.

4.10.4 Mitigation Measures and Management

Soils and Erosion Potential

General soil resource management practices would include the stripping and stockpiling of soil resources for use in rehabilitation. The objectives of soil resource management for the Project would be to:

- identify and quantify potential soil resources for rehabilitation (Appendix M);
- optimise the recovery of useable soil reserves during soil stripping operations;
- manage soil reserves so as not to degrade the resource when stockpiled; and
- establish effective soil amelioration procedures to maximise the availability of soil reserves for future rehabilitation works.

Soil stripping and handling measures would be undertaken in accordance with a Topsoil Management Plan to be developed for the Project.

A topsoil inventory would be maintained during the life of the Project and detailed in the Topsoil Management Plan. The topsoil inventory would account for the volumes and locations of topsoil to be progressively stripped, stockpiled and reapplied.

Recommended topsoil stripping depths, a preliminary topsoil balance and further detail regarding topsoil management measures are detailed in Section 5.3.2 and Appendix M.

Prior to the completion of rehabilitation, surface runoff from the waste rock emplacements would be directed to dedicated sediment dams within the Project water management system. The sediment dams would be designed and operated to allow sediment to settle and accumulated water to be used within the site or released in accordance with EA conditions for the Project (Section 4.2).

During mine operations, erosion and sediment control structures would be designed and installed in accordance with the *Best Practice Erosion and Sediment Control* (IECA, 2008) and *Soil Erosion and Sediment Control Engineering Guidelines for Queensland Construction Sites* (Institute of Engineers Australia [IEAust] [Queensland], 1996).

Erosion and sediment control structures would not be removed until disturbed areas have been stabilised.

Land Use

Agricultural land resource management at the Project would include the following key components:

- minimisation of disturbance to agricultural lands, where possible;
- management of soil resources within the Project site so that they can be used for rehabilitation; and
- inclusion of agricultural lands in the Project rehabilitation strategy.

The Project site would be rehabilitated to achieve the land suitability classes described in Table 4-42. Further detail on the rehabilitation and final land use for the Project is described in Section 5.

The area of agricultural land disturbed by the Project at any one time would be minimised so that beneficial agricultural uses (i.e. cattle grazing) could continue to be undertaken on available grazing land within the Project footprint.

Existing Resource Tenements

Pembroke has engaged with Arrow Energy, the holder of PLA 488 that overlaps parts of MLA 700032 and MLA 700033, regarding the terms of a Joint Development Plan in accordance with the *Mineral and Energy Resources (Common Provisions) Act 2014* (MERCP Act). The Joint Development Plan will be formed as part of the mining lease application process for the Project and will describe the activities proposed to be carried out in the overlapping tenure area by the mining and petroleum lease holders.

Under the MERCP Act, coal production with a mining lease has a ‘right of way’ within ‘initial mining areas’, subject to notification requirements and compensation (if required), over coal seam gas activities. The MERCP Act also includes provisions for a mining lease holder to pay compensation to the coal seam gas tenement holder in certain circumstances.

Accordingly, impacts to PLA 488 would be appropriately managed through the MERCP Act.

The Project water pipeline would traverse a small part of the northern extent of MDL 183, however it is not expected to result in sterilisation of coal resources.

Contaminated Land

Measures used to prevent or reduce the potential for contamination of land from fuel, oils and chemical storage would include the following:

- hydrocarbon and chemical storage areas would be designed and bunded in accordance with Australian Standard (AS) 1940:2017 *The storage and handling of flammable and combustible liquids*;
- spill kits located adjacent to all petroleum and chemical storage areas and mobile spill kits installed on service vehicles;
- a register of spill kits would be maintained and all kits inspected for completeness at least quarterly;
- training of appropriate staff in the prevention of spills and the use of spill kits;
- explosives storage would be managed in accordance with AS 2187:2006 *Explosives – Storage, transport and use*; and
- waste oil and other chemicals would be stored in contained areas to minimise contamination risk.

Waste management strategies are discussed in detail in Section 4.14.

Topography and Landforms

The final landform and land use for the Project has been developed in consideration of the existing pre-mine topography and landforms in the Project site and surrounds.

Although direct views of the Project landforms and infrastructure are not expected to be significant from nearby dwellings (Section 4.10.3), visual screening to mitigate visual impacts during operations (e.g. through tree planting) would be considered by Pembroke, if requested by a nearby landholder. Rehabilitation of the elevated Project landforms and decommissioning of Project infrastructure is expected to minimise any visual impacts in the long term.

Further detail on the final landform design and associated concepts is provided in Section 5.

Land Tenure

Prior to the commencement of any occupation, activity or construction upon any lands, all appropriate land tenure would be secured and all necessary approvals and/or consents from all parties holding a lawful interest in the lands within the Project disturbance footprint would be obtained.

4.11 CULTURAL HERITAGE

The environmental objective and performance outcomes for cultural heritage are provided in Section 4.11.1. Section 4.11.2 describes the environmental values relating to cultural heritage in the vicinity of the Project. Section 4.11.3 describes the potential impacts and outlines proposed mitigation measures and management for cultural heritage at the Project.

4.11.1 Environmental Objectives and Performance Outcomes

The environmental objective relevant to cultural heritage, as described in the Terms of Reference for the Project, is:

> *The construction and operation of the project should aim to ensure that all reasonable and practicable measures to ensure the project does not harm Aboriginal cultural heritage are carried out, and the nature and scale of the project does not compromise the cultural heritage significance of a heritage place or heritage area.*

4.11.2 Description of Environmental Values

The environmental values relevant to cultural heritage that are to be protected during the Project include:

- recognition of cultural heritage sites and landscape features;
- respect for knowledge, culture and traditions; and
- conservation of items or areas of cultural significance.

Indigenous Cultural Heritage

The Barada Barna People are the determined native title holders of the land within and surrounding the Project. Native title was determined to exist in small parts of the Project area, along the rail spur and water pipeline corridor, and along the Isaac River, by the Federal Court in the Barada Barna People's Native Title Determination (QC2008/011). Native title is extinguished over the remainder of the Project area.

The Barada Barna Aboriginal Corporation RNTBC, which holds native title on trust for the Barada Barna People, is also the Aboriginal Party for the area of the Project under the ACH Act.

No Aboriginal cultural heritage sites within the Project footprint are recorded on the Department of Aboriginal and Torres Strait Islander Partnerships' (DATSIP) Aboriginal and Torres Strait Islander Cultural Heritage Register.

Non-Indigenous Cultural Heritage

A Non-Indigenous Cultural Heritage Assessment was undertaken for the Project by Converge Heritage and Community (Converge) (2018) and is presented in Appendix N.

The assessment was prepared in consideration of the relevant principles and criteria contained in *The Burra Charter of Australia International Council on Monuments and Sites* (The Burra Charter) (Australia International Council on Monuments and Sites Inc, 2013) and the *Queensland Heritage Act 1992* (QH Act).

Historical Overview

The following historical overview is a summary of the history detailed in Appendix N.

German explorer Ludwig Leichhardt was the first European to enter the northern Bowen Basin. Leichhardt spent January and February 1845 camped in and exploring the region that he later named Peak Downs and noted the presence of coal after his party attempted to sink a waterhole, however this was not of prime concern, as he sought areas for pastoral use.

Gold and copper were the first minerals to be extracted from the Bowen Basin mineral field in large quantities. Although the existence of coal had been known since Leichhardt's first explorations, the absence of reliable transport infrastructure retarded development of this resource.

With the extension of the railways into central Queensland before the end of the nineteenth century the 'impetus for extending coal mining' in the area grew.

By 1990 Queensland had taken the mantle of Australia's largest coal producing state and by 1997 two thirds of Queensland's $10 billion production of coal came from the Bowen Basin.

Located 191 km west of Mackay, the township of Moranbah has developed as the main town near the Project area.

Although the town was planned with a 'community focus', Moranbah was beset by a number of early difficulties. For the early residents Moranbah was not a welcoming location to live. The town resembled a 'construction site' and many of the employees and their families had to live in one of the two short term caravan parks established as temporary housing.

With the growth in mining operations the town continued to develop and by the late 1990s Moranbah was 'a slow and easy-going place' with 'a shopping centre, hospital, library, banks, video rental stores, a travel agency, churches, and even a modest zoo'. By 1996, a small pensioner housing development, a high school and increased home ownership showed that some residents in the town had come to see Moranbah as home.

In the early 1900s, the Project area was part of the 'Islington Holding' and surrounding runs in the District of Leichardt. It was used for running cattle and was said to have had permanent water in the Isaac River. The character of the pastoral run was described as 'open downs, basalt formations, black and brown soil, first class pastoral country, with moderately timbered forest lands.

The Islington run was later consolidated and became known as 'Olive Downs' by the 1940s. It was used for pastoral purposes until the early 1970s. Improvements on the property are described in the QSA run files as tanks, dams, a homestead and outbuilding (likely outside the current project area), access tracks, sand spears (bores), a mill, stockyards and a dip.

Further discussion on the early European settlement and the pastoral history of relevance to non-Indigenous cultural heritage items in the vicinity of the Project is provided in Appendix N.

Non-Indigenous Heritage Values of Relevance to the Project

Converge Heritage and Community (2018) (Appendix N) completed historical and archival research and review of heritage registers prior to their survey of the Project site.

No items of significance were identified on the following heritage lists within the Project site (Appendix N):

- World Heritage List;
- National Heritage List;
- Commonwealth Heritage List;
- Queensland Heritage Register;
- Local Heritage Register;

- Register of National Estate (former); or
- Register of the National Trust Queensland.

Eight potential non-Indigenous cultural heritage sites were identified during the survey, including (Figure 4-30):

- cattle ramp;
- cattle yards;
- graves;
- two separate sets of water infrastructure;
- two separate water pumps with associated infrastructure; and
- steam boilers.

Based on the results of the field work and the desktop assessment (including run files), there is the possibility that further sites may be identified in the Project area. The types of sites which may be extant include (Converge, 2018):

- additional grave site/s;
- evidence of former homestead site/s;
- tanks, bores, dams;
- stockyard and/or dip sites;
- historic fence lines; and
- evidence of early mining.

Due to the relatively obtrusive nature of visible heritage evidence, it is considered to be unlikely that additional heritage items would be present in the Project area.

Notwithstanding, recommendations have been made in the event that previously unidentified heritage evidence is encountered during the life of the Project.

This assessment considers that regardless of there being no heritage sites listed within the Project site, there may be unidentified sites (in addition to the potential sites listed above). These sites may include places of historical heritage, landscape and/or archaeological potential, which, if found, may require further assessment under the provisions of the QH Act. Such places may include burials or other evidence of historic land use in the Project site.

4.11.3 Potential Impacts, Mitigation and Management Measures

Indigenous Cultural Heritage

Under section 87 of the ACH Act, a CHMP is required to be prepared by Pembroke in accordance with the requirements of Part 7 of the ACH Act.

Pembroke has formed a CHMP with the Barada Barna Aboriginal Corporation. The CHMP was entered into in mid-June 2018 and has been submitted for approval pursuant to section 107 of the ACH Act by the Department of Aboriginal and Torres Strait Islander Partnerships.

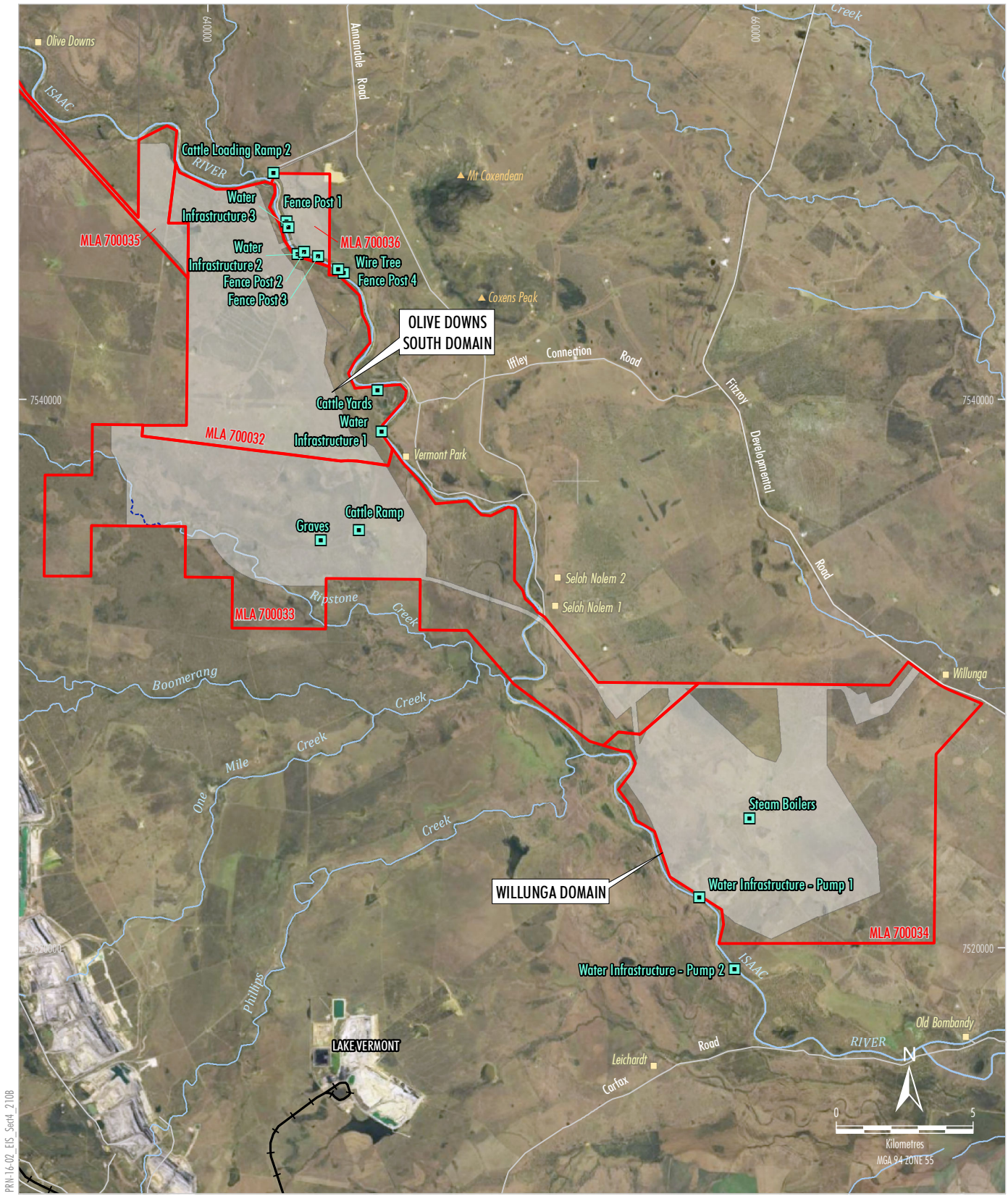
The CHMP provides for the engagement of the Barada Barna Aboriginal Party prior to the commencement of any ground disturbance works, which allows for an assessment of the cultural heritage values within the proposed area of disturbance, and for the development of appropriate management strategies.

The CHMP applies to all land within the Project area (excluding the ETL corridor, which is covered by a separate CHMP between Energy Queensland and the Barada Barna Aboriginal Party) and includes the following provisions:

- Establishment of a Coordinating Committee comprised of representatives from Pembroke and the Barada Barna Aboriginal Party for the purposes of coordination, implementation, management and future conduct of matters arising in relation to the CHMP.
- Reporting of discovery of any Aboriginal Cultural Heritage within the Project area.
- Process for obtaining approval for Project works and cultural heritage management, (through a Cultural Heritage Survey Report).
- Procedures in relation to the discovery of any human remains.
- Access to the Project area and surrounding areas covered by the CHMP.

The Project would be constructed and operated in accordance with the above provisions, to ensure compliance with the duty of care under the ACH Act.

Pembroke has also formed an ILUA with the Barada Barna Aboriginal Corporation. The ILUA meets the compliance requirements of the NT Act and provides consents to the conduct of the Project and the grant of all leases and other approvals, authorities and tenures necessary or incidental for the carrying out of the Project.



PRN-16-02_EIS_Sect4_2108

LEGEND

- Mining Lease Application Boundary
- Indicative Extent of Project Disturbance
- Railway
- Proposed Creek Diversion
- Dwelling
- Non-Aboriginal Cultural Heritage Site

Source: Geoscience Australia - Topographical Data 250K (2006)
Department of Natural Resources and Mines (2016)
Orthophotography: Google Image (2016)

PEMBROKE

OLIVE DOWNS COKING COAL PROJECT

Non-Indigenous Cultural Heritage Sites

Figure 4-30

Non-Indigenous Cultural Heritage

The assessment has identified eight potential non-Indigenous cultural heritage sites, three of which would be directly impacted by the Project.

Whilst the sites identified within the Project area tell a collective story about the pastoral history of the landscape, individually, they do not have sufficient heritage value to consider inclusion on a local heritage register. None of the identified sites are considered to be of heritage significance.

Only one of these sites (the graves) is considered to have some significance. As a grave, the site has some value, however it is not a historical grave.

The Terms of Reference for the Project specifically requires that the graves be managed as part of the Project, therefore management recommendations are provided below.

Known Sites within the Project Area

Converge (2018) recommended management measures for known non-Indigenous cultural heritage material. In accordance with these recommendations, Pembroke would:

- Avoid impacting identified sites where possible.
- Where avoidance is not possible, a heritage recording (compliant with the Draft EPA Guidelines for Archival Recording) would be made depending on the nature of the site (i.e. level of significance). At a minimum, this would be conducted for the grave site.
- Management of the grave site would be undertaken in consultation with family members, and the grave would be relocated to a nearby cemetery or location of their choosing.

Potential for Further Sites and Places to Exist within the Project Area

It is considered that there is low potential for further historic and archaeological places/items to exist within the Project area.

Notwithstanding, as a cautionary approach, a process for managing historic cultural heritage material which may be located during further development within the Project area is provided in Appendix B of the Converge (2018) report (Appendix L).

Additionally, Pembroke would demonstrate diligence whilst undertaking works within the Project area, particularly during any clearing or construction phases associated with initial preparation.

All staff or contractors of Pembroke would be informed of their obligations to look for and avoid impacting on any non-Indigenous cultural heritage material until it has been properly assessed.

Cumulative Impacts

The Project is not expected to impact cultural heritage values and as a result, cumulative impacts with nearby projects would not be expected to occur.

4.12 HAZARDS AND COMMUNITY SAFETY

Appendix O describes the potential hazards and safety risks associated with the Project in the form of a preliminary risk assessment in accordance with Australian Standard/New Zealand Standard (AS/NZS) International Standards Organisation (ISO) 31000:2009 *Risk Management – Principles and Guidelines* (ISO 31000:2009) and International Electrotechnical Commission (IEC)/ISO 31010:2009 *Risk Management – Risk Assessment Techniques*. Other risk assessment standards and handbooks considered include:

- *Control of Risk Management Practices - Recognised Standard 02* prepared by the Queensland Department of Natural Resources and Mines;
- MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* (New South Wales Department of Trade and Investment, 2011); and
- Handbook 203:2006 *Environmental Risk Management – Principles and Process* (HB 203:2006).

The objective of the Preliminary Risk Assessment (Appendix O) was to identify the on-site and off-site risks posed by the Project to people, their property and the environment and assess the identified risks using applicable qualitative criteria. This assessment considers hazardous materials, natural events, wildlife hazards (i.e. animal attacks) and hazards away from the Project.

4.12.1 Environmental Objectives and Performance Outcomes

The environmental objectives relevant to hazards and community safety, as described in the Terms of Reference for the Project, are:

(a) *the risk of, and the adverse impacts from, natural and man-made hazards are avoided, minimized or managed and mitigated to protect people and property*

(b) *the community's resilience to natural hazards is enhanced*

(c) *development involving the storage and handling of hazardous materials are appropriately located, designed and constructed to minimise health and safety risks to communities and individuals and adverse effects on the environment.*

4.12.2 Description of Environmental Values

Land within the Project area is used predominately for cattle grazing. The land has been largely cleared through past agricultural practices, however, some tracts of remnant vegetation exist, particularly along the riparian corridor of the Isaac River.

Within the vicinity of the Project, residential dwellings are located on the Vermont Park, Seloh Nolem, Willunga, Old Bombandy and Leichhardt properties.

4.12.3 Hazard Identification and Risk Assessment

Hazardous Substances

A number of hazardous substances would be used during the construction and operation of the Project, including hydrocarbons, explosives and other chemicals.

Hydrocarbons and Chemicals

Hydrocarbons would be primarily used for fuel (diesel and petrol), oil, grease and lube.

Diesel is classified as a combustible liquid by AS 1940:2017 (Class C1) for the purpose of storage and handling, however it is not included as a dangerous good under the criteria of the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (National Transport Commission, 2017). Diesel has the potential to cause damage to soils and aquatic ecosystems in the event of a spill.

The storage and use of diesel is a hazard associated with the Project. Section 2.5 describes the maximum stored quantity of diesel at the Project. Diesel would be stored in self-bunded tanks within the mine infrastructure areas.

Oil is classified as a combustible liquid by AS 1940:2017 (Class C2). Oils, lube and greases would be used and recovered during plant and vehicle servicing. The maximum stored quantity of oils, lube and greases is described in Section 2.5.

Waste hydrocarbons and oil filters would be collected, stored and removed from site by licensed contractors during operation of the Project.

The storage of chemicals (e.g. caustic soda, paints and solvents) would be undertaken in accordance with AS 1940:2017. Spill control kits would be located at all chemical storage areas and within storage vehicles.

Explosives

The Project would require the use of explosives, including initiating products and detonators, ammonium nitrate fuel and oil emulsion explosives.

As described in Section 2.4.3, explosives magazines would be located in both the Olive Downs South and Willunga domains. The Olive Downs South domain explosives magazine would initially be located to the east of the ILF cells and relocated to the northern side of the mined open cut as mining progresses to the south.

A second explosives magazine in the Willunga domain would initially be stored in the south-west of the infrastructure area and be relocated to the southern side of the mined open cut as mining progresses to the north.

The explosives magazine would be fenced, signed and maintained in accordance with AS 2187.1:1998 *Explosives – Storage, Transport and Use.*

A list of hazardous materials and the maximum stored quantities for the Project are described in Section 2.5.

Natural Events

Natural events may result in hazardous situations within the Project area and the surrounding locality. Such natural events include, but are not limited to, bushfires, floods and wildlife hazards (e.g. snake bites, animal attacks) (Appendix O).

Bushfires

The State Planning Policy Interactive Mapping System (Department of State Development, Manufacturing, Infrastructure and Planning, 2018) identifies the potential bushfire risk for the Project area and surrounds. The mapping identified that part of the Project area is within the 'Medium Potential Bushfire Intensity' area. The remainder of the Project area is outside of the 'Potential Impact Buffer' for bushfires.

Pembroke would implement fire prevention measures during operation of the Project to reduce the likelihood and impact of bushfires, including:

- construction and maintenance of fire breaks;
- provision and maintenance of firefighting equipment around the Project; and
- provision of firefighting equipment training for staff.

Flooding

Due to the proximity of the Project to the Isaac River and the surrounding topography, flooding poses the greatest risk from natural events. Section 4.4 and Appendix F describe in detail the associated risk of flooding at the Project and the implementation of flooding mitigation and management measures to reduce potential impacts during construction, operation and decommissioning phases of the Project.

Landslide

As described in Section 2.2, the general landscape of the Project area includes gently undulating, to flat plains, with overall elevations ranging from 150 m in the south-east of the Willunga domain to 200 m in the higher areas to the west and north-west of the Project area. Therefore, the risk of landslide was assessed to be low.

Wildlife Hazards

Terrestrial fauna and aquatic ecology assessments were conducted for the Project (Appendices B and C). Dangerous animals identified include, but are not limited to, snakes, feral pig and cats.

Hazards Away from the Project

The Project has the potential to cause hazards away from the Project (off-site hazards), through:

- alteration to water quality (Section 4.2 and Appendices D and E);
- alteration of flood characteristics (Section 4.4 and Appendix F); and
- alteration of the natural bushfire regime.

Appendix O provides a preliminary risk analysis for the Project. The majority of the residual risk levels for the Project identified in the preliminary risk analysis were classified as tolerable, with four risks classified as 'As Low As Reasonably Practicable' (ALARP).

4.12.4 Hazard Mitigation and Management Measures

A number of hazard mitigation and management measures would be described in the management plans for the Project. Management plans identified as part of the preliminary risk assessment include:

- Air Quality Management Plan;
- Blast Management Plan;
- Cultural Heritage Management Plan;
- Social Impact Management Plan;
- Water Management Plan; and
- Rehabilitation and Mine Closure Management Plan.

The following processes and measures would be implemented at the Project to reduce the risk of impacts on health, safety and the environment associated with the Project:

- Development and implementation of a Risk Management System.
- Hazardous substances (including, hydrocarbons, chemicals and explosives) would be transported, stored and handled in accordance with relevant legislation, standards and guidelines.
- The management of all chemicals would be conducted in accordance with the relevant safety data sheet.
- Training of vehicle and equipment operators would be undertaken to allow for safe and stable operation of the equipment and emergency response procedures would be implemented in the event of an incident.
- Hazardous wastes would be collected, stored and removed from site by licensed contractors.
- Regular inspections would be conducted to maintain the structural integrity of hazardous substance storage tanks and bunds.
- Spill control kits would be located at all chemical storage areas and within storage vehicles.

- Pembroke would liaise with relevant community emergency services and implement community engagement processes.
- The explosives magazines would be fenced, signed and maintained in accordance with AS 2187.1:1998.

Further to the mitigation and management measures described above, Pembroke would prepare an Emergency Response Procedure in consultation with emergency services (e.g. Queensland Police Service, Queensland Fire and Emergency Service). The Emergency Response Procedure would be implemented in the event of an incident to maintain the well-being of personnel, contractors and the public.

Pembroke would perform a risk study specific to hazardous chemicals stored on-site during the detailed design phase of the Project, in accordance with relevant standards and codes.

The Emergency Response Procedure would describe the actions that would be implemented if the following incidents were to occur:

- injury or illness;
- fire;
- unintended initiation of explosives;
- loss of containment of hazardous substance;
- natural event (e.g. flooding, bushfire, cyclone);
- vehicle accident; and
- unapproved discharge off-site.

4.13 BIOSECURITY

4.13.1 Environmental Objectives and Performance Outcomes

The environmental objectives relevant to biosecurity, as described in the Terms of Reference for the Project, are:

(a) the spread of weeds and pest animals and vector agents impacts are/is minimised

(b) existing weeds and pests are controlled.

4.13.2 Description of Environmental Values

Exotic Flora and Restricted Plants

Introduced flora species occur within the Project area and are likely due to the high level of past clearance and the current land use (e.g. grazing) (Appendix A).

A total of 73 introduced plant species were recorded from the Project locality. Eleven of these are identified as Category 3 Restricted Matter species listed under the Queensland *Biosecurity Act, 2014.* These include:

- Rubbervine (*Cryptostegia grandiflora*);
- Harrisia Cactus (*Harrisia martini*);
- Bellyache Bush (*Jatropha gossypiifolia*);
- Lantana (*Lantana camara*);
- Creeping Lantana (*Lantana montevidensis*);
- Common Pest Pear (*Opuntia stricta*);
- Velvety Tree Pear (*Opuntia tomentosa*);
- Parkinsonia (*Parkinsonia aculeata*);
- Parthenium (*Parthenium hysterophorus*);
- Fireweed (*Senecio madagascariensis*); and
- Prickly Acacia (*Vachellia nilotica* subsp. *indica*).

With the exception of Harrisia Cactus, each of these introduced species is also listed weeds of national significance (WoNS) (Appendix A).

These exotic flora species are identified in areas suffering some form of disturbance, mostly clearing for cattle grazing, and were heavily concentrated in the agricultural grasslands (Appendix A).

In particular, the areas shown on Figure 4-1 as agricultural grasslands dominated by buffel grass (*Cenchrus ciliaris*) contain the highest abundance of weeds throughout the Project area. The distribution of WoNS throughout the Project area is provided in detail within the regional ecosystem profiles attached to Appendix A.

Introduced and Restricted Animals

As outlined in Section 4.1, seven introduced fauna species were recorded within the Project locality (Appendix B), of which the following four species are listed as restricted matters under the Queensland *Biosecurity Act 2014*:

- Feral Cat (*Felis catus*) –Categories 3, 4 and 6 Restricted Matter;
- Domestic Dog (*Canis lupus familiaris*) – Categories 3, 4 and 6 Restricted Matter;
- European Rabbit (*Oryctolagus cuniculus*) – Categories 3, 4, 5 and 6 Restricted Matter; and
- Feral Pig (*Sus scrofa*) – Categories 3, 4 and 6 Restricted Matter.

As most of the Project area contains scattered patches of remnant vegetation surrounded by agricultural land, feral animals already have access to (and have been recorded within) most habitat types (Appendix B).

4.13.3 Potential Impacts

Exotic Flora and Restricted Plants

Exotic flora can degrade native vegetation communities and *Novel Biota and their Impact on Biodiversity* is a key threatening process under the EPBC Act. Without weed management, there is a potential for existing exotic WoNS (and Restricted Matters) to become more prevalent or for new weeds to be introduced into the area.

Activities that could spread weeds during construction and operation include soil disturbance, vehicle movements and movement of soil. Disturbed areas (including those undergoing rehabilitation) provide a substrate in which weed species may grow (Appendix A).

Introduced and Restricted Animals

Introduced fauna species have corresponding key threatening processes under the EPBC Act, namely, *Competition and Land Degradation by Rabbits*; *Predation by Feral Cats*; *Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs.*

Activities associated with the Project may provide increased refuge and scavenging resources (e.g. discarded food scraps) for these species, unless appropriately managed to discourage exotic animals (Appendix B).

4.13.4 Mitigation Measures and Management

Consistent with the general biosecurity obligations outlined by the Isaac Regional Council Local Government Biosecurity Plan, Pembroke would manage the Project so that it does not result in the spread of pests, diseases or contaminants. Pembroke would:

- take all reasonable and practical steps to prevent or minimise each potential biosecurity risk;
- minimise the likelihood of the risk causing a biosecurity event and limit the consequences of such an event; and
- prevent or minimise the adverse effects the risk could have and refrain from doing anything that might exacerbate the adverse effects.

The following measures would be implemented at the Project in order to control and limit the spread of pests and weeds:

- vegetation clearance procedures;
- progressive rehabilitation;
- feral animal control strategies;
- weed management; and
- development of a Weed and Pest Management plan.

These measures are outlined below.

Vegetation Clearance Procedures

Vegetation clearance procedures would be adopted for the Project and include the following measures to control and limit the spread of pests and weeds:

- Boundaries of areas to be cleared, and those not to be cleared, would be defined during construction and operation.
- An internal Ground Disturbance Permit would be required prior to any clearing so that clearing activities are authorised prior to disturbance.
- Clearing of native vegetation would be undertaken progressively over the life of the mine and only in areas required for mining activities within the following year. This would have the effect of minimising the area of exposed land.
- Pre-clearance flora and fauna surveys would be undertaken by suitably experienced and qualified persons.
- A suitably trained and qualified person would be present during the clearing of habitat.

Rehabilitation

The Project area (e.g. waste emplacements and infrastructure areas) would be progressively rehabilitated and revegetated, so the post-mining landforms are safe and stable. Rehabilitation would commence within two years of areas becoming available.

Rehabilitation procedures to be adopted for the Project are discussed in detail in Section 5.

Feral Animal Control Strategies

Feral animals would be discouraged at the Project by maintaining a clean, rubbish-free environment. Appropriately qualified persons would be engaged to undertake pest animal monitoring in the Project area.

Feral animal control strategies (e.g. baiting and trapping) would be implemented in the Project area in accordance with relevant standards to maintain low abundance of declared animals.

The following threat abatement plans would be relevant:

- *Threat Abatement Plan for Competition and Land Degradation by Rabbits* (DEE, 2016).
- *Threat Abatement Plan for Predation by Feral Cats* (DotE, 2015).
- *Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (Sus scrofa)* (DEE, 2017).
- *Threat Abatement Plan for the Biological Effects, Including Lethal Toxic Ingestion, Caused by Cane Toads* (SEWPaC, 2015).

Pembroke would also develop and implement a Weed and Pest Management Plan for the Project. This plan would detail the specific measures to control individual pest species identified within the Project area in accordance with Schedule 1 of the *Biosecurity Regulation, 2016*.

Control measures will be implemented upon commencement of the Project and would be the responsibility of mine staff or appropriate Pest Control Contractor(s) as required. All personnel involved in feral animal control will be required to hold relevant and valid licences/permits, including any relevant chemical licences for pesticide use. Primary controls to be undertaken include shooting (for pigs), trapping (for dogs and cats) and ground baiting (for rabbits).

Monitoring of feral animals (including pigs, dogs, rabbits and cats) will be undertaken every two years by an appropriately qualified contractor. If the results of these surveys indicate that a control program is necessary, such a control program will be implemented and monitored.

Weed Management

Weed management (prevention, monitoring and control) would be undertaken to lessen the abundance and species of weeds in the Project area and minimise the potential for weeds to spread into adjacent habitat areas. Weeds that are present on-site would be identified by regular surveys (of tracks, revegetation [rehabilitation] areas and topsoil stockpiles, etc.).

Restricted Matters plants listed under the *Biosecurity Act 2014* would be specifically targeted for control. Pembroke would comply with relevant legal obligations associated with the control, supply, sale, keeping and transport of Restricted Matters in Queensland.

Weed prevention techniques would be implemented in the Project area and include washdown of machinery when moving from weed infested areas. Weed control techniques would be implemented in the Project area as required. Physical removal and chemical application are the main weed control methods available.

Weed and Pest Management Plan

A Weed and Pest Management Plan would be developed by Pembroke prior to construction in consideration of the 'desired outcomes' identified in the *Mackay Regional Council Biosecurity Plan 2017 – 2021* (Mackay Regional Council, 2017) and the *Whitsunday Biosecurity Plan 2017 – 2020* (Whitsunday Regional Council, 2017). These include:

- Desired outcome 1: Prevention and early intervention.
- Desired outcome 2: Monitoring and assessment.
- Desired outcome 3: Awareness and education.
- Desired outcome 4: Effective management systems.
- Desired outcome 5: Strategic management framework and management.
- Desired outcome 6: Commitment, roles and responsibilities.

The Project Weed and Pest Management Plan would include the following measures:

- identification of feral animal populations and weed infestations;
- strategies for preventing spread of feral animals (i.e. maintaining a clean, rubbish-free environment) and weeds (i.e. machinery wash-down, boot scrubbing facilities, appropriate disposal of weed material);
- prioritisation of treatment of weed infestations or weed species and ongoing treatment regimes (as necessary);
- appropriately qualified persons would be engaged to undertake pest animal monitoring;

- recommended feral animal control strategies (e.g. baiting and trapping) and weed removal strategies (including those appropriate for aquatic habitats); and
- feral animal and weed monitoring protocols and follow-up control methods and protocols.

The procedure for controlling and monitoring weeds will be implemented every six months (or at other times when rainfall conditions are favourable to weed outbreaks) as determined by Pembroke.

4.14 WASTE MANAGEMENT

This section identifies potential waste streams that are likely to be produced over the life of the Project. The potential impacts caused by the waste streams and proposed mitigation measures, management and monitoring are outlined in Sections 4.14.3 and 4.14.4, respectively.

The Project has been designed to minimise the use of resources and generation of wastes throughout all phases (e.g. construction, operations and decommissioning), and to ensure compliance with the relevant legislation relating to waste.

The management of waste (non-mineral) across the Project is governed by Queensland legislation, including:

- EP Act;
- EP Regulation; and
- WRR Act.

The EP Act defines 'waste' as anything that is:

> *left over, or unwanted by-product, from an industrial, commercial, domestic or other activity; or surplus to the industrial, commercial, domestic or other activity generating the waste*.

For further detail regarding waste management legislation refer to Attachment 3.

Section 65 of the EP Regulation states:

> *(1) Regulated waste is waste that—*
>
> *(a) is commercial or industrial waste, whether or not it has been immobilised or treated; and*
>
> *(b) is of a type, or contains a constituent of a type, mentioned in schedule 7, part 1.*
>
> *(2) Waste prescribed under subsection (1) includes—*
>
> *(a) for an element—any chemical compound containing the element; and*
>
> *(b) anything that contains residues of the waste.*
>
> *(3) However, waste is not regulated waste if it is mentioned in schedule 7, part 2.*

4.14.1 Environmental Objectives and Performance Outcomes

The environmental objective relevant to waste, as described in the Terms of Reference for the Project, is:

> *The environmental objective to be met under the EP Act is that any waste transported, generated or received as part of carrying out the activity is managed in a way that protects all environmental values*

The Project would achieve the following performance outcome, as stated in Schedule 5, Part 3, Table 1 of the EP Regulation:

> *1 Both of the following apply—*
>
> *(a) waste generated, transported or received is managed in accordance with the waste and resource management hierarchy in the Waste Reduction and Recycling Act 2011;*
>
> *(b) if waste is disposed of, it is disposed of in a way that prevents or minimises adverse effects on environmental values.*

4.14.2 Sources of Waste

The primary source of waste to be produced at the Project is excavated waste (i.e. overburden and interburden) and fine and coarse rejects from the CHPP. Other wastes (regulated and non-regulated) expected to be produced at the Project include the following:

- recyclable waste;
- refurbishable items;
- green waste;
- scrap metal;
- personal protective equipment (PPE);
- air filters;
- timber and wooden pallets;
- waste oils;
- engine oil/fuel filters;
- empty waste oil containers;
- hydrocarbon contaminated material;
- waste greases;
- paints;
- miscellaneous chemicals;
- batteries;

- ozone depleting substances; and
- tyres.

Construction

The predominant waste streams likely to be produced during the construction phase of the Project include general waste (i.e. non-Class 1, 2 and 5 plastics, food scraps), recyclable wastes (i.e. Class 1, 2 and 5 plastics, scrap steel, etc.), refurbishable items (i.e. pipes, fittings, etc.), waste oils/grease (from machinery and vehicle maintenance), sewage (from offices and workshops) and tyres (from light and heavy vehicles). The management strategies for these waste streams are outlined in Section 4.14.4.

It is anticipated that construction of the Project components to support the planned maximum Stage 1 production rate would take approximately 18 to 24 months upon grant of all required approvals. Further, construction stages (i.e. Willunga domain construction and Olive Downs South domain peak production construction) would produce similar volumes and types of waste. During this time a number of materials would be brought to and stored on-site. Any waste resulting from the storage and use of these materials would be managed in accordance with Queensland and Commonwealth Government legislation and policy requirements.

Operations

The waste produced during the operations phase of the Project would be similar to those produced during construction (with the addition of waste rock and coal rejects) with generally increased quantities.

Waste rock produced during the operations phase of the Project would be reused as part of the progressive rehabilitation of the site (i.e. to backfill open cut pits).

The operations phase of the Project would result in the largest quantity of regulated wastes of all three phases (construction, operations and decommissioning). The predominant regulated wastes that would be produced during operations would include waste oils, empty waste oil containers, waste grease, and sewage. The management strategies for these waste streams are outlined in Section 4.14.4.

Two sewage treatment plants would be located on-site within the Olive Downs South and Willunga domain mine infrastructure areas to treat all sewage produced at the Project.

The two sewage treatment plants would be designed in accordance with relevant regulatory requirements.

Further detail on the sewage treatment plants and effluent irrigation is provided in Section 2.6.4.

Decommissioning

Infrastructure at the Project would be decommissioned in accordance with the Rehabilitation and Mine Closure Plan to be developed for the Project and would, in general, be dismantled or demolished and removed. Where possible, decommissioning would be phased throughout the life of the Project. During decommissioning, all efforts would be made to follow the waste and resource management hierarchy using waste disposal as a last option. Areas of potential contamination would be investigated and managed/remediated if required (Section 4.10 and Appendix M).

Section 5 describes further the rehabilitation objectives and decommissioning of the Project.

Waste Inventory

Table 4-46 identifies the significant waste streams expected to be produced for the construction and operational phases of the Project. Estimated quantities listed for each waste are on an annual basis and were predicted based on Pembroke's experience and the amount of waste produced at similar sized coal mine operations in Queensland.

Table 4-46 also describes the attributes of the waste stream that influence the potential for dispersion. Pembroke would manage the waste streams to reduce the potential for dispersion.

Table 4-46 also provides a qualitative risk ranking associated with the relevant waste stream. A preliminary risk assessment for the Project was conducted (Appendix O) and includes preventative and mitigating measures for potentially hazardous waste streams.

Table 4-46
Estimated Maximum Wastes Produced by the Project (per annum)

Waste Type/Waste Category	Form	Source	Approximate Quantity (per annum)		Attributes that may Affect Dispersal	Risk of Causing Environmental Harm*	Management Strategies (Waste Management Hierarchy Level)^
			Construction	Operations			
Non-regulated							
Excavated waste (i.e. overburden, interburden)	Solid	Mining activities	N/A	12 – 300 Mbcm	Potential for erosion and saline runoff	Low	Placed within the in mined out voids of the open cut pits (when space becomes available) behind the advancing mining operations (g) or placed in out-of-pit waste rock emplacements (g).
Coal rejects (i.e. coarse and fine rejects)	Solid/Liquid	Mining activities	N/A	0.1 – 5.5 Mt	Potential for erosion, saline runoff. Low potential for acid formation	Low	Fine rejects would be dewatered in the ILF cells (f). During the initial phase of the Project (before in-pit emplacement becomes available), coarse rejects would be disposed at out-of-pit emplacements buried by at least 10 m of waste rock and fine rejects would be temporarily stored in the ILF cells. In-pit emplacement would be utilised when space becomes available (g).
General waste (i.e. food scraps, non-Class 1 [PET], 2 [HDPE] and 5 [PP plastics])	Solid	Kitchenettes, crib rooms, administration areas, workshop, etc.	1,500 m^3	2,500 m^3	Putrescible and attractive to fauna	Low	Stored on-site in bins for regular transport off-site by a licensed waste transport contractor to a licensed landfill (g).
Recyclable waste (i.e. aluminium, steel cans, Class 1, 2 and 5 plastics, paper towels, paper and cardboard)	Solid	Kitchenettes, crib rooms, administration areas, workshop etc.	430 m^3	1,200 m^3	Small in size and light in weight	Low	Stored on-site in bins for regular transport off-site by a licensed waste transport contractor for recycling (d). Confidential papers would be segregated into locked paper bins for shredding and recycling (d).

Table 4-46 (Continued)
Estimated Maximum Wastes Produced by the Project (per annum)

Waste Type/Waste Category	Form	Source	Approximate Quantity (per annum)		Attributes that may Affect Dispersal	Risk of Causing Environmental Harm*	Management Strategies (Waste Management Hierarchy Level)^
			Construction	Operations			
Refurbishable items (i.e. pipe work and associated components and fittings, wing nuts, conveyor rollers and belt)	Solid	CHPP and workshops	<15 t	<40 t	Rust formation	Low	Items would be stockpiled within a designated area. If condition is acceptable, items would be reused directly (c). Where items are at the end of their life, they would be collected and disposed of as appropriate (g). Where items are contaminated with hydrocarbons, they would be managed as regulated waste.
Green waste (i.e. grass, cleared timber and weeds)	Solid	Clearing of vegetation	210 ha#	210 ha#	Attractive to fauna	Low	Mulched and/or placed in timber stacks for reuse on-site during rehabilitation (c). Waste vegetation would be burned where appropriate (g).
Scrap metal (i.e. stainless steel, aluminium and any item considered to be metal [ferrous or non-ferrous] including machine and vehicle parts)	Solid	Construction activities, infrastructure maintenance and workshops	150 m^3	200 m^3	Rust formation	Low	Smaller items would be placed in scrap metal skips for collection by a licensed contractor. Larger items would be left in an accessible location where specific collection arrangements can be made. All grease and oils are to be removed prior to placement in skips. A licensed contractor would remove all scrap metals for segregation at a licensed recycling facility (d).
PPE and other small items (i.e. gloves, hard hats, safety glasses and face masks)	Solid	Bathhouse and contractor facilities	<60 kg	<120 kg	Light weight and small in size	Low	Equipment that is not deemed damaged would be reused (c). Only sufficiently used/damaged PPE would be disposed of (g).
Air filters (i.e. engine air filters)	Solid	Vehicle and machinery maintenance at workshops	<2 t	<2 t	N/A	Low	Air filters would be temporarily stored in the appropriate air filter skip/bin. Final disposal would be off-site (g).

Table 4-46 (Continued)
Estimated Maximum Wastes Produced by the Project (per annum)

Waste Type/Waste Category	Form	Source	Approximate Quantity (per annum)		Attributes that may Affect Dispersal	Risk of Causing Environmental Harm*	Management Strategies (Waste Management Hierarchy Level)^
			Construction	Operations			
Timber/wooden pallets (i.e. reusable pallets)	Solid	Workshop and administration areas	<2 t	<2 t	N/A	Low	Pallets that are reusable would be returned to the supplier (c). The remainder would be sent to general waste (g).
Mine affected water	Liquid	Any water that has been used or potentially contaminated by mining operations, including mine runoff water, groundwater seepage into pit, or water that has been used at the CHPP	Refer to Appendix E for mine affected water volumes.	Refer to Appendix E for mine affected water volumes.	Liquid	Low	Mine affected water would be reused (c) for dust suppression and construction and/or road maintenance around the Project. Discharge to the Isaac River would be subject to meeting water quality release limits specified in an EA for the Project. Further water management strategies are discussed in Sections 4.2, 4.3 and Appendix E.
Regulated							
Waste oils	Liquid	Machinery and vehicle maintenance and workshop	400 kL	1,400 kL	Liquid	Medium	Collection and storage for transport by a licensed regulated waste contractor to a regulated waste receiver for reuse (c), recycling (d) or disposal (g).
Engine oil/fuel filters	Solid/Liquid	Vehicle and machinery maintenance at workshop	4,000	12,000	Liquid contents	Medium	Collection and storage in sealed oil filter disposal pod. Transportation by a licensed regulated waste contractor to a licensed regulated waste receiver for treatment (solvent wash) to recover oil (c).
Waste grease (i.e. from machinery)	Liquid	Workshop, large machinery maintenance	<100 kL	<200 kL	Liquid	Medium	Stored in tanks or appropriately sealed containers in a designated bunded area. Transported by a licensed regulated waste contractor to a licensed regulated waste receiver for treatment, recycling (d) or disposal (g).

Table 4-46 (Continued)
Estimated Maximum Wastes Produced by the Project (per annum)

Waste Type/Waste Category	Form	Source	Approximate Quantity (per annum)		Attributes that may Affect Dispersal	Risk of Causing Environmental Harm*	Management Strategies (Waste Management Hierarchy Level)^
			Construction	Operations			
Sewage	Liquid	Offices and workshops	<100 kL	<120 kL	Liquid	Medium	During construction there would be temporary ablution blocks which would not be connected to a sewage system and would require pumping out by licensed contractor. Once the sewage treatment plants are operational, within the mine infrastructure areas, the effluent would be treated by a package sewage treatment plant (f) and disposed via irrigation or reused within the site water management system.
Empty waste oil containers	Solid	Workshop	<4 t	<10 t	N/A	Medium	All drums would be segregated and sealed prior to collection by a licensed regulated waste contractor and transported to a licensed waste receiver where drums and containers would be rinsed and recycled (d).
Paints (i.e. general paint, air dried insulating varnish)	Liquid/Gas	Industrial area infrastructure and workshop	<1 t	<1 t	Liquid	Medium	Transported to a designated sealed and bunded area for collection by a licensed regulated waste contractor and transported to a licensed regulated waste receiver for treatment (f) and disposal (g).
Hydrocarbon contaminated material (i.e. oily rags)	Solid/Liquid	Workshop servicing trucks and light/heavy vehicles	<4 t	12 t	Liquid contents	Medium	Collection and storage in regulated sealed disposal bin. Transported by a licensed regulated waste contractor to a licensed regulated waste receiver for appropriate disposal (g).
Miscellaneous chemicals (i.e. engine coolant, solvents, sealants, etc.)	Liquid/Gas	Workshop and administration	20 kL	50 kL	Liquid	Medium	Transported to a designated sealed and bunded area for collection by a licensed regulated waste contractor and transported to a licensed regulated waste receiver for treatment and disposal (g).

Table 4-46 (Continued)
Estimated Maximum Wastes Produced by the Project (per annum)

Waste Type/Waste Category	Form	Source	Approximate Quantity (per annum)		Attributes that may Affect Dispersal	Risk of Causing Environmental Harm*	Management Strategies (Waste Management Hierarchy Level)^
			Construction	Operations			
Batteries (i.e. dry cell, gel cell, lead acid)	Solid	Operation of portable electrical equipment (radios, phones, etc.) within the workshop and other areas	<1 t	<1 t	Liquid contents	Medium	Segregation and storage within dedicated containers in battery storage area for collection by a licensed regulated waste transport contractor to a licensed regulated waste facility for recycling (d) or disposal (g).
Ozone depleting substance (i.e. refrigerants and air conditioning substances)	Liquid/Gas	Air conditioning units, fridges and cars throughout site	200 kg	800 kg	Liquid/Fumes	High	Ozone depleting substances would be contained at the source in cylinders and returned to the supplier for reuse and recycling (c)(d).
Tyres (i.e. light and heavy vehicle tyres)	Solid	Tyres from light and heavy vehicles	180	280	N/A	Low	Segregation and storage in a designated area with no grass or other flammable material within a 10 m radius. Tyres would be transported off-site to a supplier for re-treading where practicable (c) or disposed on-site in a designated tyre disposal area in the backfilled pit (g).

* In consideration of potential hazards, toxicity and dispersal mechanisms.

^ Waste Management Hierarchy as defined in section 9 of the WRR Act: (c) waste reuse; (d) waste recycling; (f) treat waste before disposal; (g) waste disposal. The measures identified above will be implemented only once waste avoidance and reduction measures have been exhausted.

The average annual disturbance of land (i.e. green waste) assuming the life of the Project is 79 years.

4.14.3 Potential Impacts

Key waste management risks associated with the Project include inappropriate storage or disposal of waste material that have the potential to impact on the following environmental values:

- health and wellbeing of the workforce and community;
- water quality for agricultural use and aquatic flora and fauna;
- the biological integrity and diversity of ecosystems and processes; and
- suitability of the land for a beneficial post-mining land use.

Potential impacts of waste generated by the Project during all three phases of the Project include:

- groundwater and surface water contamination caused by release or spills of solid or liquid waste either directly to receiving waters or indirectly via runoff from waste contaminated sites;
- degradation of native flora and fauna habitat as a result of inappropriate storage and management of waste;
- land contamination caused by spills or inappropriate waste disposal;
- littering due to unsuitable storage and containment measures for general waste;
- hygiene issues (including odour) associated with the storage, treatment and disposal of putrescibles waste;
- increased vermin and potential spread of disease due to inappropriate storage and disposal of waste;
- reduced visual amenity due to improper storage of waste;
- decreased air quality due to odours and airborne contaminants;
- increased fire hazards due to poorly managed waste storage;
- increased pressure on existing waste management infrastructure; and
- risks to human health and safety through poor management of hazardous materials.

Cumulative Impacts

The total waste produced at the Project (that would require disposal off-site, as part of the Isaac Regional Council Waste Reduction and Recycling Plan [2016]) is expected to be minor when compared to the total volume of waste already being disposed as part of this scheme.

Considering the above, local scale impacts are expected to be minor, and impacts to the wider region are expected to be negligible.

4.14.4 Mitigation Measures, Management and Monitoring

Pembroke would manage the waste produced at the Project in accordance with the waste and resource management hierarchy as stipulated in the WRR Act. If waste must be disposed of, Pembroke would do so in a way that prevents or minimises adverse effects on environmental values.

The management methods identified below aim to minimise the potential environmental impacts associated with waste generation at the Project.

Best practice waste management strategies have been selected with consideration of the waste management hierarchy outlined in the WRR Act.

Control strategies that would be implemented across the Project to effectively manage wastes include:

- operating procedures to define the location and size of the waste storage areas, the management for each type of waste and methods of dealing with accidents, spills, and other incidents that may impact on waste management;
- designated waste collection areas would be located on-site for storage of wastes prior to disposal;
- waste produced at the Project would be collected and transported to the mine infrastructure area;
- segregation of wastes into general waste, recyclable waste, and hazardous waste;
- removal of all general waste from site as part of the Isaac Regional Council Waste Reduction and Recycling Plan; and
- recyclable and hazardous material would be managed as described in Table 4-46.

Waste Management Program

A Waste Management Program would be developed and implemented at the Project. It would define and describe the objectives and measures for protecting or enhancing environmental values from impacts by waste.

The Waste Management Program would address the principles of the waste and resource management hierarchy in accordance with the WRR Act and would include proposed methods for waste management at the Project to achieve the highest possible level of waste management.

Waste Management Principles

Pembroke would minimise the impact of waste on the environment and the community by committing to adopt the appropriate waste management principles.

The application of the waste management hierarchy is an underlying principle of all waste management in Queensland. The waste management hierarchy identifies the most preferred to the least preferred waste management option:

- avoid or reduce;
- reuse;
- recycle;
- recover energy;
- treat; and
- dispose.

Waste Avoidance or Reduction

Where possible, raw materials would be delivered in bulk form. Where bulk delivery is not feasible, consideration shall be given to the purchase of products based on minimalist packaging and use of biodegradable materials. Pembroke would also consider the use of alternative products to ensure that unnecessary waste is not produced.

Pembroke would reduce the amount of waste being produced at the Project by limiting the amount of materials transported to and stored on-site.

Waste Reuse and Recycling

A recycling program would be established and promoted, encouraging the recycling of waste materials such as paper, cardboard, scrap metal and air filters.

Waste oils and metals (including metal drums) would be managed in accordance with the Commonwealth *Product Stewardship Arrangements for Oil Administrative Guidelines* (Commonwealth Department of the Environment and Heritage, 2005).

Waste streams would be reused wherever ongoing health, safety and reliability can be ensured.

Waste Recovery

Waste recovery is not proposed to be undertaken at the Project.

Treatment

Two sewage treatment plants would operate to service the administration facilities, bathhouses and workshops within the mine infrastructure areas.

The sewage treatment plants would be operated automatically and would include pumps, wells, alarms, venting, and chemical and safety equipment.

The sewage treatment plants would be designed to meet wastewater effluent quality requirements.

Sewage treatment would occur on-site at the Project. Effluent produced from the sewage treatment plants would either be treated and returned to mine water dams for later mine consumption (provided the recycled water complies with the standards under section 18AE of the Queensland *Public Health Regulation, 2005*) or used for land application via irrigation systems.

The irrigation area would be within the Project mining lease areas and prescribed setback distances, but strategically positioned outside of areas potentially impacted by flooding (Section 4.4 and Appendix F) to reduce the potential for dispersion off-site.

The irrigation area would be positioned to optimise exposure to sunlight and wind, increasing the rate of evapotranspiration. Evapotranspiration increases the operational capacity of the irrigation system, minimising the potential for pooling and runoff of effluent.

Other design parameters considered for the design of the irrigation system, include, selection of an irrigation area with soils that exhibit low potential for erosion and increased drainage capacity. These design parameters would optimise the operation of the irrigation systems and reduce potential for dispersion off-site.

Pembroke would also consider the proximity of the irrigation area to existing groundwater users to reduce potential of effluent seepage to groundwater sources.

Effluent would not be irrigated immediately prior to expected rainfall or if pooling of water was evident at the site, to reduce the potential for runoff contamination.

Disposal

Where disposal is required, Pembroke would endeavour to minimise the quantity and/or volume of such waste materials. Waste that is not able to be disposed on-site would be transferred to a suitably licensed waste disposal facility by a registered waste carrier.

Waste would be disposed on-site in a way that prevents or minimises adverse effects on environmental values.

Collection and Storage

Designated waste collection areas would be located on-site for storage of waste prior to disposal. Waste produced at the Project operations would be collected and transported to the mine infrastructure area where:

- waste would be segregated into general waste, recyclable waste and hazardous waste;
- general waste would be collected in bins;
- waste oils, chemicals, batteries and other hazardous or regulated substances would be stored in bunded areas or on bunded pallets;
- recyclable waste would be separated and stored for collection; and
- scrap tyres would be stockpiled in accordance with DEHP Operational Policy *Disposal and Storage of scrap tyres at mine sites* (DEHP, 2014c). To minimise the risk of fire, tyre stockpiles would be:
  - less than 3 m high and 200 m^2 in area;
  - more than 10 m from any other tyre storage area; and
  - more than a 10 m radius from any grass.

Different forms of waste (i.e. metals, paper, oils, batteries, general waste, etc.) would be stored on-site according to waste stream, taking into consideration public health, hygiene and safety standards. For example, flammable material or combustible liquid wastes would be stored in facilities designed to meet the AS 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids*.

Bins located within offices and workshops would be appropriately labelled to avoid cross-contamination and ensure separation of different waste streams. Also, bins would be emptied regularly into the relevant skip to keep vermin and pest numbers to a minimum.

As stated above, Pembroke would develop a Waste Management Plan which would be implemented at the Project.

Hazardous waste would be stored in a separate storage area to ensure that all hazardous waste is managed to prevent environmental harm.

Cleaner Production

Cleaner production means the continuous application of an integrated preventative environmental strategy to processes, products and services to increase efficiency and reduce risks to people and the environment.

Cleaner production techniques could be implemented during all phases of the Project through:

- Input substitution: This refers to the use of less polluting raw and adjunct materials and the use of process auxiliaries (such as lubricants and coolants) with a longer service lifetime.
- Product selection: Wherever practicable, non-hazardous products are selected in preference to hazardous materials.
- Improved operation and maintenance: This involves the selection and use of the most appropriate and practicable fixed and mobile equipment for use in coal extraction, transportation and processing, and high levels of maintenance to ensure items are operating efficiently.
- Reuse of resources: Resources that would otherwise be classified as wastes (e.g. wooden pallets, cleared vegetative material, waste water, metals) are reused on-site.
- Technology modifications: This includes improving process automation, process optimisation, equipment redesign and process substitution.
- Closed-loop recycling: Where a product is recycled and used again in the same form (e.g. wooden pallets).

Pembroke would contribute to cleaner production outcomes by applying the following aspects to the Project:

- limiting the extent of ground to be disturbed during construction and operations (i.e. minimising the disturbance footprint of the Project);
- selecting the most efficient and practical coal extraction and processing technology to ensure the appropriate energy intensity and production efficiency;
- selecting the most efficient and productive machinery and equipment throughout the life of the Project to minimise the purchase of machinery and equipment;
- selecting the most appropriate processes during operation and maintenance, such as the reuse of runoff for dust suppression, and the recycling of effluent from the sewage treatment plant for reuse or irrigation; and
- recycling appropriate materials (i.e. glass, paper, cardboard, timber and Class, 1, 2 and 5 plastics).

Waste Monitoring and Auditing

The waste streams, quantities produced and implemented management practices would be recorded by Pembroke over the life of the Project. The following activities would be undertaken during the auditing of waste production and management:

- assessment of the wastes being produced compared to the predicted waste streams and quantities (Table 4-46);
- identify potential improvement in waste management practices (including establishment of reduced waste targets where possible);
- monthly inspection reports about waste storage systems and transportation would be prepared and sent to the senior management team;
- inspections of the waste storage areas would occur on a regular basis to ensure that all waste is appropriately stored and separated;
- monitor the implementation and success of the Waste Management Plan; and
- monitor compliance with relevant Commonwealth and Queensland legislation.

Employees would be required to notify employers within 24 hours of becoming aware of an incident that has potential to cause, or threaten to cause, material or serious environmental harm. This notification would be delivered verbally or in writing in accordance with the DEHP guideline *The Duty to Notify of Environmental Harm*.

Waste Rock Management

Approximately 9,000 Mbcm of waste rock would be mined over the life of the Project. The annual volumes of waste rock generated during the Project are provided in Table 2-4.

Olive Downs South Domain

Initially, the waste rock produced by mining at the Olive Downs South domain would be placed in out-of-pit waste rock emplacements located immediately to the north-west and east of the open cut mining area (i.e. to establish the highwall emplacements).

Construction of the waste rock emplacement within MLA 700036 (east of the Isaac River) would only occur during periods when there is low or no flow within the Isaac River. It is anticipated that haulage to this waste rock emplacement would be limited to the dry season (nominally April to October).

When sufficient space is created within the mined-out areas, subsequent waste rock would be placed within in-pit waste rock emplacements.

As open cut mining areas are developed in the central and southern areas of the Olive Downs South domain, the waste rock would be placed in out-of-pit waste rock emplacements located immediately to the west (Figures 2-3, 2-4, 2-6 and 2-8). When sufficient space is created within the mined-out areas, waste rock would be placed within in-pit waste rock emplacements at the Olive Downs South domain.

Willunga Domain

Initially, the waste rock produced by mining at the Willunga domain would be placed in out-of-pit waste rock emplacements located immediately to the south and south-west of the open cut mining area.

When sufficient space is created within the mined-out areas, waste rock would be placed within in-pit waste rock emplacements at the Willunga domain.

Waste Rock Geochemistry

A geochemistry assessment has been prepared by Terrenus (2018) (Appendix L).

Based on the geochemical testwork, waste rock is expected to:

- be overwhelmingly NAF with excess ANC and have a negligible risk of developing acid conditions; and
- generate relatively low-salinity surface run-off and seepage with low soluble metals concentrations.

Where waste rock is used for construction purposes, this would be limited (as much as practicable) to unweathered Permian sandstone materials, as these materials have been found to be more suitable for construction and for use as embankment covering on final landform surfaces.

It is noted that some waste rock materials are expected to be sodic (to varying degrees) with potential for dispersion and erosion (to varying degrees).

Where highly sodic and/or dispersive waste rock is identified, the material would be selectively handled so that it does not report to final landform surfaces, where practicable, and would generally not be used in construction activities. In general, tertiary waste rock has been found to be unsuitable for construction use or on final landform surfaces (ACARP, 2004).

However, in the absence of such selective handling, waste rock emplacements would be constructed with short and low (shallow) slopes (indicatively, slopes less than 15% and less than 200 m long), and progressively rehabilitated to minimise erosion.

Coal Rejects Management

Approximately, 120 Mt of coarse rejects and 36 Mt of fine rejects would be produced over the life of the Project. The annual volumes of coal rejects generated during the Project are provided in Table 2-4.

A description of the initial rejects storage facilities and ILF cells is provided in Section 2.4.6.

By comparison to the life of mine waste rock material (approximately 8,824 Mbcm), the total proportion of rejects would be less than 2%.

A geochemistry assessment has been prepared for the Project by Terrenus (2018) (Appendix L). Appropriate management practices have been recommended and would be adopted for the handling and placement of rejects as summarised below.

Validation testwork of actual coal reject materials from the CHPP as the Project develops would be undertaken, particularly during the first year of CHPP operation following commissioning and following commencement of mining at the Willunga domain.

Coarse Rejects

The proposed strategy for the disposal of coarse reject material is to truck from the CHPP to dispose within in-pit disposal areas (below existing ground level) and later bury with waste rock (generally within three months of placement).

Coarse rejects disposed into the open cut pit would be placed below the expected final (post-closure) groundwater level and buried by at least 5 m (cover thickness) of waste rock.

The emplacement design for the initial rejects storage facility involves placement of coarse rejects in layers to a total depth of approximately 10 m, which would then be covered with an appropriate capping layer and rehabilitated.

Fine Rejects

The proposed strategy for disposal of fine rejects is for the thickened material to be pumped to solar drying ponds in the infrastructure area, where flocculants would be added (i.e. ILF cells) and water would be recovered and recycled in the CHPP.

Dewatered and dried fine rejects would be excavated and trucked for disposal within the in-pit disposal area (below existing ground level) and later buried by waste rock (generally within three months of placement).

The dried fine rejects disposed into the pit would be placed below the expected final (post-closure) groundwater level and buried by at least 5 m (cover thickness) of waste rock.

Natural Resource Use Efficiency

Water

The sources of water used at the Project would be supplied according to the following priority (excluding potable water supplies):

- mine water supplied from pit dewatering (including groundwater inflows);
- recycled process water recovered from the CHPP;
- surface runoff water captured and stored within the mine water dam and process water dam; and
- water supply 'make-up' sourced from the Eungella Pipeline.

This priority would ensure that Pembroke utilises all water that is available on-site before obtaining water from other sources, therefore ensuring the efficient use of this resource at the Project.

Water management is discussed further in Sections 2.7 and 4.3 and Appendix E.

Energy

Electricity supply for the Project would be provided from the existing regional power network via construction of a 66kV ETL from the Broadlea Substation, and an on-site switching/substation located at the Olive Downs South domain mine infrastructure area.

Pembroke would limit energy usage to that which is essential for the Project to progress. Pembroke would implement measures so that energy is not wasted through unnecessary activities.

As detailed in Attachment 3, Pembroke would be subject to annual reporting obligations in relation to:

- GHG emissions;
- energy production;
- energy consumption; and
- any other information specified under the NGER Act.