ARROW BOWEN PIPELINE

EPBC MNES Threatened Species Dossiers

November 2013

Table of Contents

Tables

Figures

Glossary

ABP	Arrow Bowen Pipeline
DERM	Queensland Department of Environment and Resource Management
DoE	Department of the Environment, previously DSEWPaC
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EHP	Queensland Department of Environment and Heritage Protection, previously DERM
EPBC	*Environmental Protection and Biodiversity Conservation Act 1999*
KP	Kilometre Point
NC Act	*Queensland Nature Conservation Act 1992*
RE	Regional Ecosystem
ROW	Right of Way
SAT	Spot Assessment Technique

1 Flora

1.1 *Dichanthium queenslandicum* (King Blue-grass)

1.1.1 Conservation status

Queensland: Vulnerable under NC Act

National: Endangered under EPBC Act (transferred from Vulnerable to Endangered in February 2013)

1.1.2 Description

Dichanthium queenslandicum is a perennial grass growing to 80 cm tall. Its culms are solitary or rarely branched, erect, glabrous, smooth with a single groove, 4–5-noded with nodes prominently hairy. Leaf sheaths are hirsute with the hairs arising from wart-like projections. Inflorescences are single racemes of paired spikelets to 10 cm long. Sessile spikelets are bisexual, dorsally compressed, and straw-coloured to pale mauve. Pedicelled spikelets are male and straw-coloured to pale mauve (DSEWPaC, 2013a).

King Blue-grass is similar to other native *Dichanthium* species with which it may grow (e.g. *D. setosum*, *D. sericeum, D. fecundum, D. tenue*) and introduced pasture species such as *D. aristatum* and *D. annulatum*, and can be difficult to identify in the field. Critical differences between *D. queenslandicum* and other *Dichanthium* species are in leaf sheath hairiness, grain (seed) length, number of anthers, and length of lemma of lower sterile floret and spikelet length. Because of these close resemblances it is likely that the species is sometimes overlooked in surveys.

1.1.3 Distribution

King Blue-grass is found in central and southern Queensland in three disjunct centres of distribution: in the Hughenden district; from around Nebo south to Monto and west to Clermont and Rolleston; and on the southern Darling Downs in the Dalby district. (Queensland Herbarium 2009 cited in DSEWPaC 2013a). King Blue-grass occurs within the South Eastern Queensland, Brigalow Belt South, Brigalow Belt North, Central Mackay Coast, Desert Uplands, Mitchell Grass Downs and Einasleigh Uplands Bioregions; and the South East Queensland, Condamine, Border Rivers Maranoa-Balonne, Burnett Mary, Fitzroy, Burdekin, Mackay Whitsunday, Southern Gulf and Desert Channels Natural Resource Management Regions (Queensland Herbarium 2009 cited in DSEWPaC 2013a). The current extent of occurrence is estimated to be 245 km^2, which has declined from 1100 km^2 since 1997 (Accad et al. 2008), and only small remnants remain (Butler 2007). However, this does not include loss of local populations through inappropriate grazing regimes and invasion of grasslands by exotic species such as Parthenium (*Parthenium hysterophorus*), and pasture improvement practices using exotic grasses such as Buffel Grass (*Pennisetum ciliare*) (Fensham 1999).

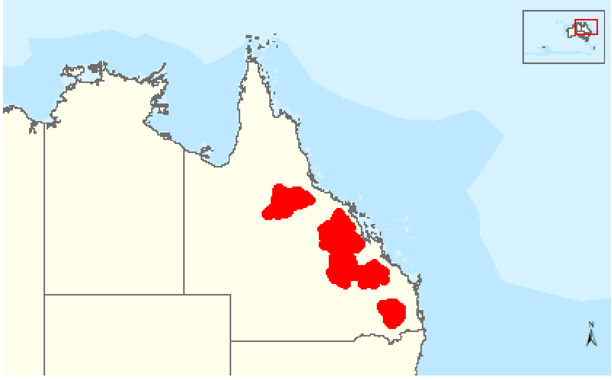


Figure 1 Distribution of *Dichanthium queenslandicum*.

Source (DSEWPaC 2013a)

1.1.4 Habitat

King Blue-grass occurs in natural tussock grass communities on black cracking clays (vertosols), mainly in association with other *Dichanthium* and *Bothriochloa* species. A number of other grass genera such as *Panicum, Eriochloa, Aristida, Astrebla* and *Paspalidium* are normally also present (Simon 1982, Fletcher 2001). As this habitat is coincident with high quality agricultural land (for both cropping and grazing), it has been substantially cleared and fragmented within the overall distribution (DSEWPaC 2013b).

A number of populations occur in areas of remnant vegetation as defined under the Queensland *Vegetation Management Act 1999* and are therefore protected from broad-scale vegetation clearing. The distribution of King Blue-grass overlaps with the following EPBC Act-listed threatened ecological communities (DSEWPaC 2013b):

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Weeping Myall Woodlands

- Natural Grasslands on Basalt and Fine-textured Alluvial Plains of Northern New South Wales and southern Queensland
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin.

1.1.5 Ecology

King Blue-grass is a perennial tussock grass 40 to 80 cm tall, with mainly unbranched culms. Nodes are distinctly hairy and internodes glabrous. Inflorescences are single racemes up to 10 cm long, bearing paired spikelets, one bisexual and sessile and the other male and pedicillate. The peak flowering period is March, usually after significant summer rainfall.

1.1.6 Survey effort and methods undertaken for ABP

Surveys were conducted by random meander searches within and adjacent to the ROW at 22 sites containing potential King Blue-grass habitat. Good flowering specimens were collected for verification by Queensland Herbarium botanists.

The survey effort undertaken in potential habitat of King Blue-grass is summarised in Table 1.

Table 1 Completed ABP surveys for King Blue-grass

Number of sites surveyed*	**Sites with *D. queenslandicum***	**Conclusion**
22	1 (7 individual occurrences in a 200 m by 50 m area)	Further populations could be present in similar habitat in grassland or grassy woodland. Currently mapped population could be avoided by a minor route change to the north if a suitable buffer can be maintained between the ROW and (a) *D. queenslandicum* population to the south and (b) RE 11.5.15 (endangered) to the north.

* Based on number of sites within REs 11.8.11, 11.8.5, 11.3.21, and 11.9.3, which are found on cracking clay soils and potentially can contain *D. queenslandicum.*

1.1.7 Threats

Threats to King Blue-grass include (DSEWPaC 2013a):

- loss of habitat through clearing for agriculture (especially for cropping) and resource industry infrastructure (mining, CSG) and associated roads
- grazing – continuous heavy grazing can lead to reductions in population size
- invasive weeds such as :
  - Parthenium (*Parthenium hysterophorus*)
  - Parkinsonia (*Parkinsonia aculeata*)
  - Buffel Grass (*Pennisetum ciliare*)

- altered fire regimes resulting from changes to community composition and fuel dynamics (especially Buffel Grass: Miller et al. 2010).

1.1.8 Recovery actions

No recovery plan has been prepared for King Blue-grass. A draft recovery plan has been developed for the 'Bluegrass (*Dichanthium* spp.) dominant grassland of the Brigalow Belt Bioregions (north and south)' endangered ecological community, 2007–2011 (Butler 2007). The Department of the Environment (DoE) (DSEWPaC 2013a) has identified the following recovery actions for King Blue-grass.

Research priorities

Research priorities that would inform future regional and local priority actions include:

- Design and implement a monitoring program or, if appropriate, support and enhance existing programs.
- More precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes.
- Undertake survey work in suitable habitat and potential habitat to locate any additional populations / occurrences / remnants.
- Undertake seed germination and / or vegetative propagation trials to determine the requirements for successful establishment.
- Identify optimal fire regimes for regeneration (vegetative regrowth and / or seed germination), and response to other prevailing fire regimes.
- Establish the grazing threshold of the species to determine what grazing management practices are consistent with sustaining populations of this species.

Regional and local priority actions

The following regional priority recovery and threat abatement actions can be undertaken to support the recovery of King Blue-grass.

Habitat loss, disturbance and modification

- Monitor known populations to identify key threats.
- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
- Identify populations of high conservation priority.
- Ensure there is no disturbance in areas where King Blue-grass occurs, excluding necessary actions to manage the conservation of the species / ecological community.
- Investigate formal conservation arrangements, management agreements and covenants on private land.

- For crown and private land, investigate and / or secure inclusion in reserve tenure if possible.
- Manage any other known, potential or emerging threats, including mining practices, grazing, weed invasion and climate change.

Invasive weeds

- Develop and implement a management plan for King Blue-grass for the control of Parthenium and Parkinsonia in the region.
- Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on King Blue-grass.

Trampling, browsing or grazing

- Develop and implement a stock management plan for roadside verges and travelling stock routes.

Conservation Information

- Raise awareness of King Blue-grass within the local community, for example distribute fact sheets / information brochures or conduct field days in conjunction with known industry or community interest groups.
- Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.
- Enable recovery of additional sites and / or populations.
- Undertake appropriate seed collection and storage.
- Investigate options for linking, enhancing or establishing additional populations. Implement national translocation protocols (Vallee et al. 2004) if establishing additional populations is considered necessary and feasible.

1.1.9 ABP survey results

One population of King Blue-grass, comprising seven small clusters of plants growing in a 200 m by 100 m area, was recorded just south of the mainline from KP 75.5 to 75.8. It was identified in a Mountain Coolabah (*Eucalyptus orgadophila*) open woodland (RE 11.8.5), with a grassy understorey dominated by exotic species such as Buffel Grass, Indian Blue Couch (*Bothriochloa pertusa*) and Red Natal Grass (*Melinis repens*). Plants were recorded outside the proposed ROW from 25 m to 150 m south of the alignment. Additional small populations of King Blue-grass could be present in this section of the pipeline, and further surveys have been recommended to establish their full extent and explore route revisions (Ecosure 2012).

Potential habitat for the species occurs in RE 11.8.5 as well as RE 11.8.11 which occur on cracking clay soils. A total of 49.78 ha of RE 11.8.5 and RE 11.8.11 occurs within the ROW (Table 2).

Table 2 Extent of *Dichanthium queenslandicum* habitat within the ROW based on field verified RE mapping

RE Code	Short description	Potential habitat in ROW(ha)	RE in 5 km buffer (ha)	% of buffer*	Critical habitat in ROW (ha)
11.8.5	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks	42.47	9636.93	0.44	0
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	7.31	4765.30	0.15	0
	Other REs containing suitable habitat in the 5 km buffer	0	1058.38	0	-
	Total	49.78	15460.61	0.32	0

1.1.10 Impacts of ABP on King Blue-grass

1.1.10.1 Potential impacts without mitigation

Potential impacts on King Blue-grass from the pipeline construction could include:

- direct loss of individuals through clearing within the ROW
- spread of weeds
- reduction in habitat suitability through soil compaction and plant community change caused by shifts in grazing patterns (both native animals and stock) and fire regimes.

1.1.10.2 Assessment of potential impacts with mitigation

If any King Blue-grass individuals must be cleared for construction, the individual would be translocated adjacent to a corresponding individual outside the ROW.

Weed risks will be managed in accordance with a weed management plan, which will incorporate weed hygiene measures to avoid introduction of new weeds and spread of existing weeds, weed control works before, during and after construction, and a monitoring program to evaluate the effectiveness of weed management and trigger contingency measures if performance criteria are not met.

Fire risks will be managed in accordance with an emergency response plan, which will manage activities that could cause fires and identify resources and emergency responses to any fire incident. Arrow will implement a no-burning policy for the project.

Suitable conditions for the natural re-establishment of the species within the ROW will be restored through re-spreading of topsoil and ripping to reduce effects of compaction.

The potential impacts to King Blue-grass from construction of the ABP and the mitigation measures to reduce the risk of impacts are listed in Table 3.

Table 3 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on King Blue-grass

IMPACT	Raw Risk before mitigation*	Mitigation measures	Residual Risk after mitigation*
DIRECT IMPACTS			
Removal of habitat Removal of potential grassland /open woodland habitat on vertosols	M	- minimise clearing of remnant grassland / open woodland vegetation on vertosols - use existing cleared corridors where possible - rehabilitate the ROW following construction - clearly mark out areas to be cleared and retained	L
Loss of individuals Individuals removed in ROW during clearing and construction	L	- conduct further surveys to determine the presence of King Blue-grass in areas of potential habitat within the ROW and map extent of populations - clearly mark out areas to be cleared and retained - avoid clearing of identified populations (including ancillary activities such as access tracks), where possible - rehabilitate the ROW after construction - reseed areas of the ROW within or adjacent to identified populations with local provenance King Blue-grass seed	L
INDIRECT IMPACTS			
Changes in water quality Impacts to water leading to changes in habitat downstream	NA	- no mitigation measures for water quality recommended for this species as it is not dependent on riparian /wetland habitats	NA
Changes in hydrology Changes in hydrology of waterways caused by damming, changes in morphology or diversions	NA	- no mitigation measures for hydrology recommended for this species as it is not dependent on riparian / wetland habitats	NA
Soil degradation Compaction and other damage to vertosols, leading to poor regrowth, erosion and sediment loss	L	- consider slashing in some sections of the ROW as an alternative to clearing (to retain native grass rootstocks) - scarify or rip ROW after construction and before respreading topsoil to reduce soil compaction, improve water infiltration and promote vegetation regrowth - consider slashing of grass understorey in sections of ROW to reduce impacts on soil structure - develop and implement an erosion and sediment control plan	L
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of populations	L	- minimise areas of remnant vegetation to be cleared - use existing cleared corridors where possible - rehabilitate the ROW following construction	I
Increase in weed abundance -increased competition with native plant species -smothering of native vegetation -increased fuel loads and risk of wildfires	L	- develop and implement a Weed Management Plan - implement site weed hygiene protocols - control weeds in the ROW before, during and after construction - monitor to evaluate the effectiveness of weed management	L
Fire -damage to plants	L	- implement a no-burning policy for the project - develop and implement a emergency response plan, which will manage activities that could cause fires and identify resources and emergency responses for any fire incident	L

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High, NA- Not applicable

1.1.11 Evaluation under MNES significant impact guidelines

Under the EPBC Act, an action is likely to have a significant impact on an Endangered species if it affects an important population of the species. Under the EPBC Significant Impact Guidelines, an important population is a population that is necessary for the long-term survival and recovery of a species. This may include populations identified in recovery plans, and / or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity
- populations that are near the limit of the species range (DSEWPaC 2009).

Although only one small population of *Dichanthium queenslandicum* was identified in the ROW during field surveys, this population was found in open grassy *Eucalyptus orgadophila* woodland (RE 11.8.5) and additional populations may be located if further surveys are conducted in similar habitats including RE11.8.11.

Will the action lead to a long-term decrease in the size of an important population of a species?

No King Blue-grass is currently recorded in the ROW, but further surveys will be conducted to confirm previous results. The population of *Dichanthium queenslandicum* adjacent to the ROW is possibly important locally and regionally. However, there is no information available on the population size and the species has not been researched (DSEWPaC 2013a). On current survey results, no long term decrease is expected.

Will the action reduce the area of occupancy of an important population of a species?

The ABP ROW does not intersect areas of habitat with high likelihood of containing *D. queenslandicum* (i.e. natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin), although open grassy woodlands (e.g. RE 11.8.5 and 11.8.11) can also support the species. No population of this species is currently confirmed within the area of disturbance.

Will the action fragment an existing important population into two or more populations?

Based on current information, the action is not likely to have a direct effect on a population However, an existing population adjacent to the ROW occurs in seven discrete patches separated by areas dominated by exotic grasses, so it already occurs in a fragmented landscape. It is unlikely that short term impacts associated with construction within the 40 m ROW will result in increased fragmentation of this grass species. The majority of the ROW (except for a 7 m wide track) will be rehabilitated after construction using native grasses, shrubs and trees, further reducing fragmentation effects.

Will the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for *Dichanthium queenslandicum* under the EPBC Act. In accordance with the EPBC Act, the habitat within the project site is not considered to be critical to the survival of *Dichanthium queenslandicum*.

Will the action disrupt the breeding cycle of an important population?

No disruption to the breeding cycle is considered likely from the Action. No populations are identified as being present within the area of disturbance.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Approximately 49.78 ha of potential habitat for *D. queenslandicum* occurs within the ROW and may be temporarily disturbed. However, no populations of this species were found in the ROW. Rehabilitation of the ROW will re-establish suitable habitat and the residual impact is not likely to cause the species to decline.

Will the action result in establishment of harmful invasive species becoming established in the species' habitat?

A Weed Management Plan will be prepared and implemented before, during and after construction to manage the risk of weeds. Construction of the pipeline is not expected to change the distribution of weeds or pest species. The action is unlikely to result in the establishment of harmful invasive species.

Will the action result in the introduction of disease(s) that may cause the species to decline?

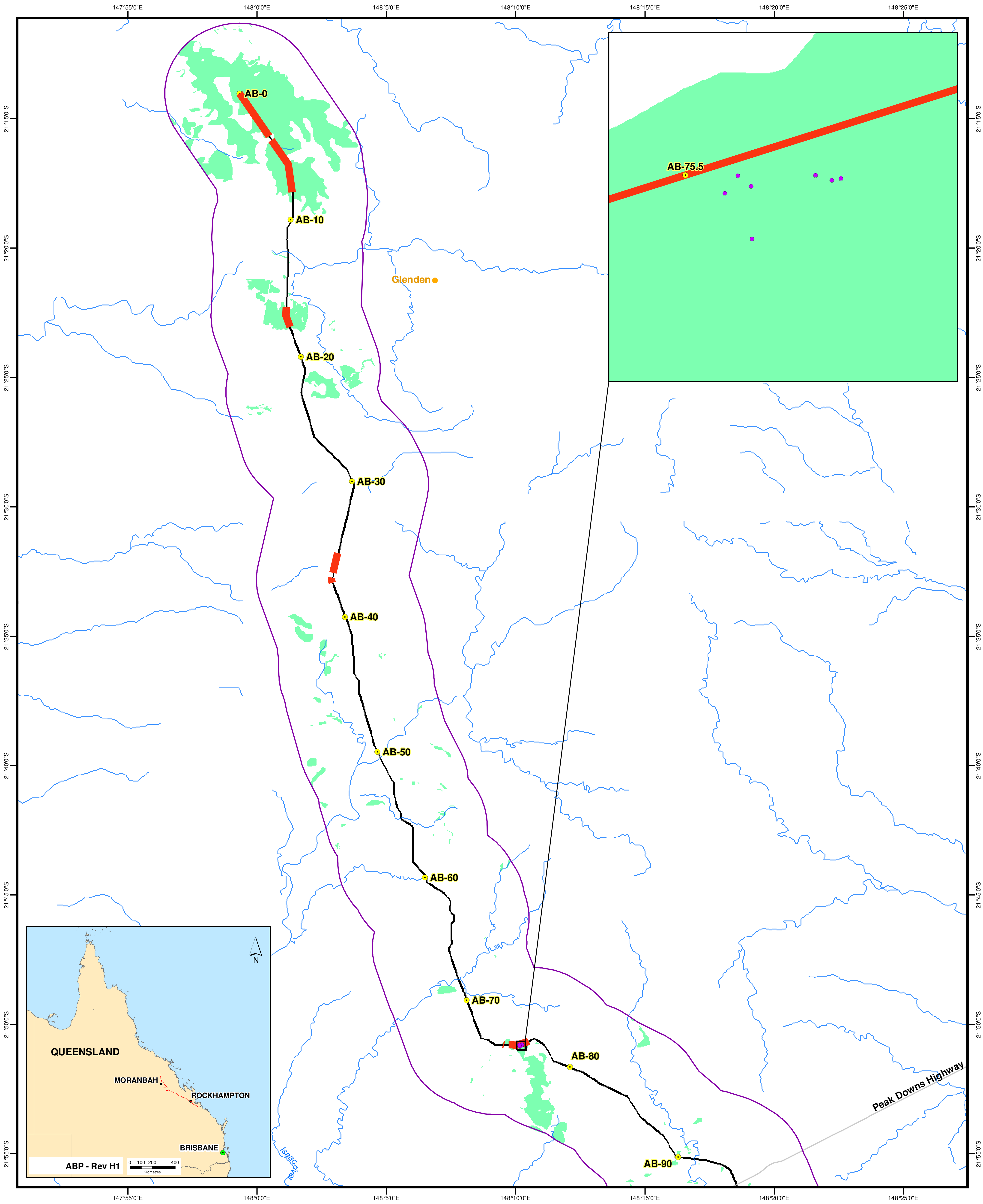
The project is unlikely to introduce disease that may cause the species to decline. Although there are several fungal diseases known to affect *Dichanthium* species these do not generally cause major damage. There are no known diseases specific to *D. queenslandicum*.

Will the action interfere substantially with the recovery of the species?

There is currently no published recovery plan for *D. queenslandicum*. No populations are currently known within the ROW, but 49.78 ha of potential habitat are present. Any populations that are found as a result of further survey will be avoided wherever possible, or any individuals located within the ROW will be replanted adjacent to other individuals adjacent to the ROW.

1.1.12 Conclusion

Dichanthium queenslandicum was identified in only one small area adjacent to the ROW during field surveys. With the implementation of mitigation and avoidance measures (including route revision), it is unlikely that habitat clearance will have a significant overall impact on *D. queenslandicum*. Indirect impacts are expected to be limited as the action will require only temporary impacts on potential habitat during construction. Provided that mitigation measures outlined in management plans are effectively implemented, direct or indirect impacts on King Blue-grass are not expected to affect populations.



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●	*Dichanthium queenslandicum* Survey Records
~	Waterway or Coast Line
—	Main roads
—	ABP - Rev H1
🟥	Potential Habitat in ROW (Field Verified)
🟩	Potential Habitat in Buffer (from State RE Mapping)
☐	Buffer (5 km)

Dichanthium queenslandicum

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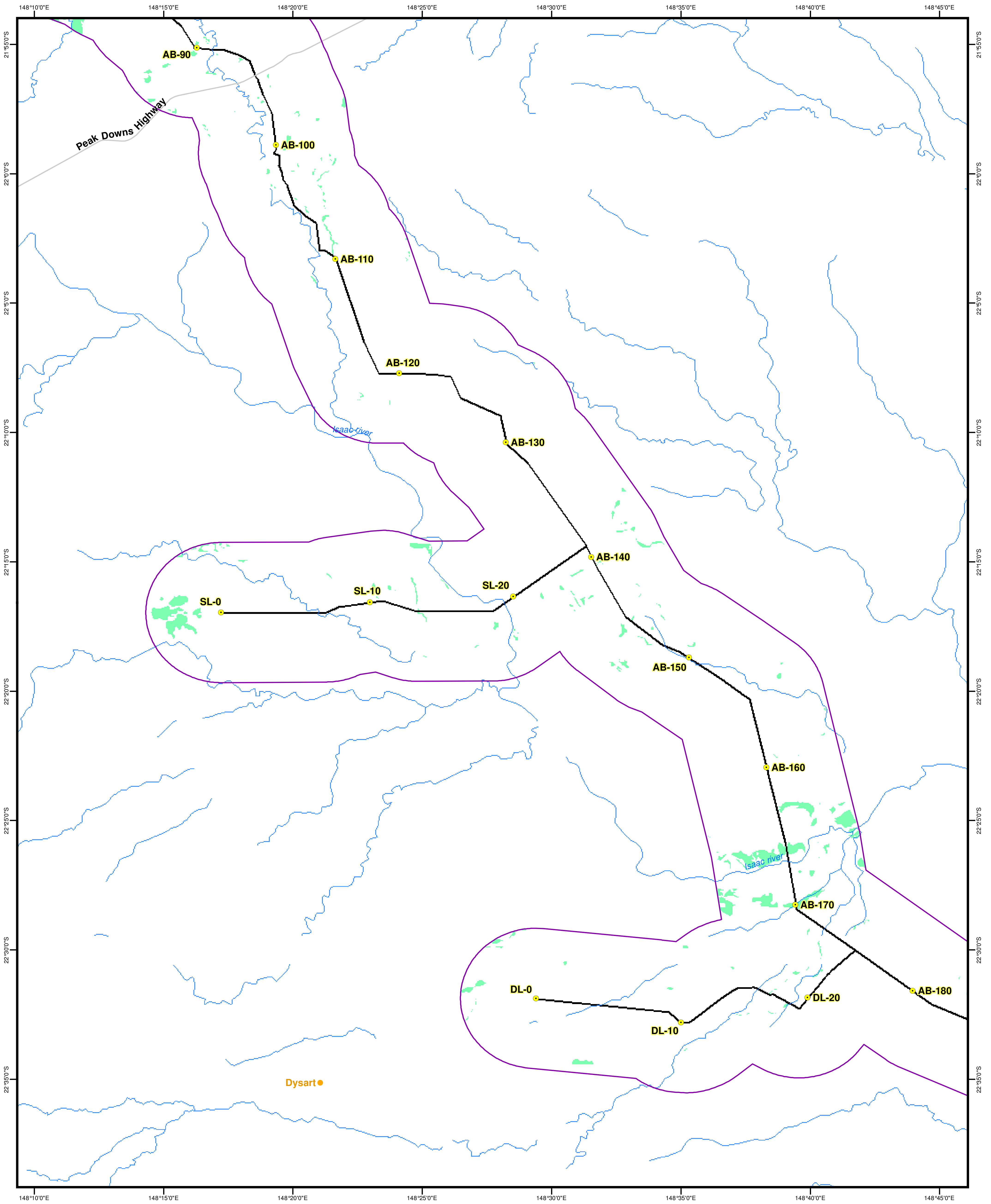
Revision H1

Page 1 of 7

A3



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🟩	Potential Habitat in Buffer (from State RE Mapping)
☐	Buffer (5 km)

Dichanthium queenslandicum

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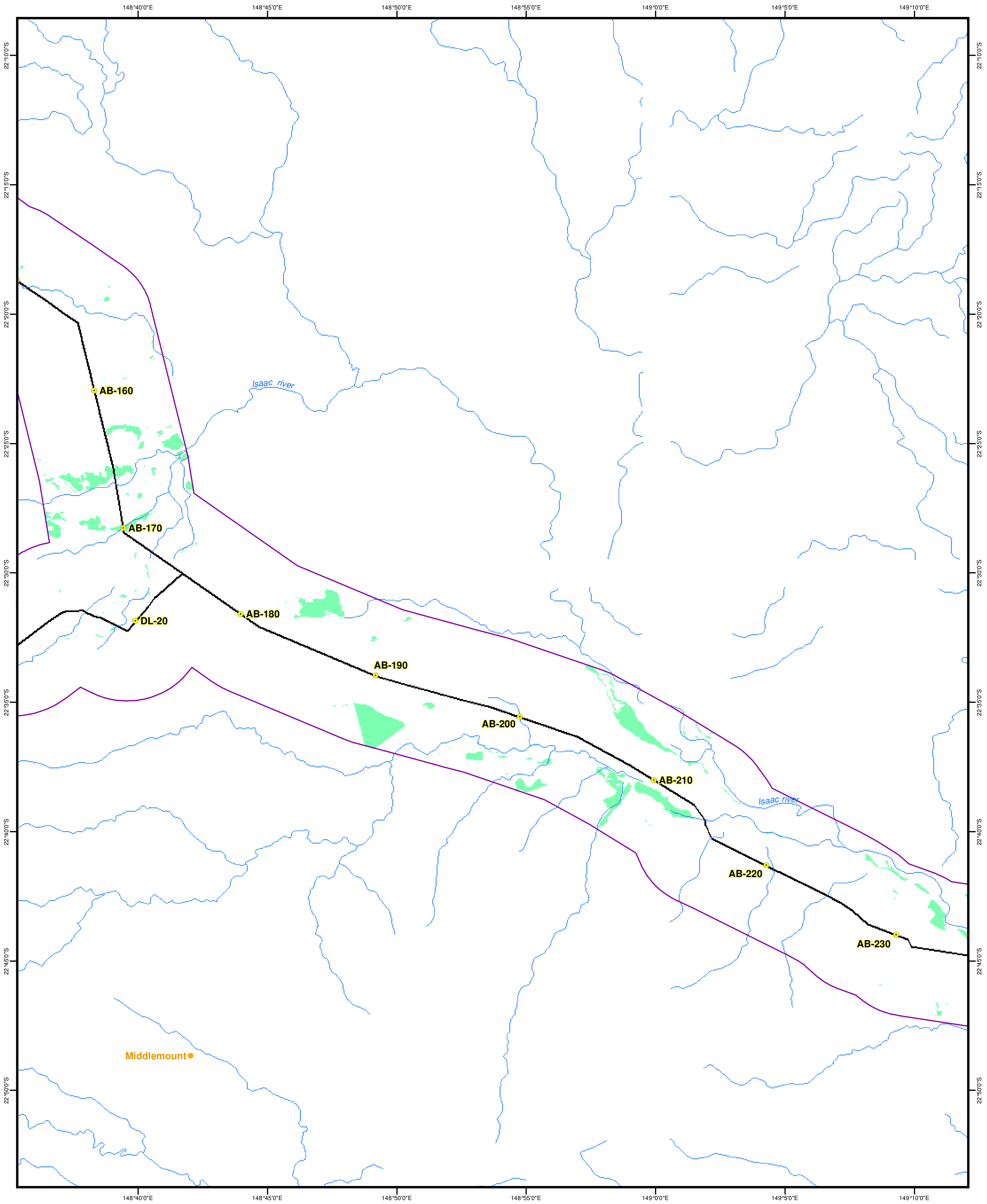
Revision H1

Page 2 of 7

A3



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🟩	**Potential Habitat in Buffer (from State RE Mapping)**
☐	**Buffer (5 km)**

Dichanthium queenslandicum

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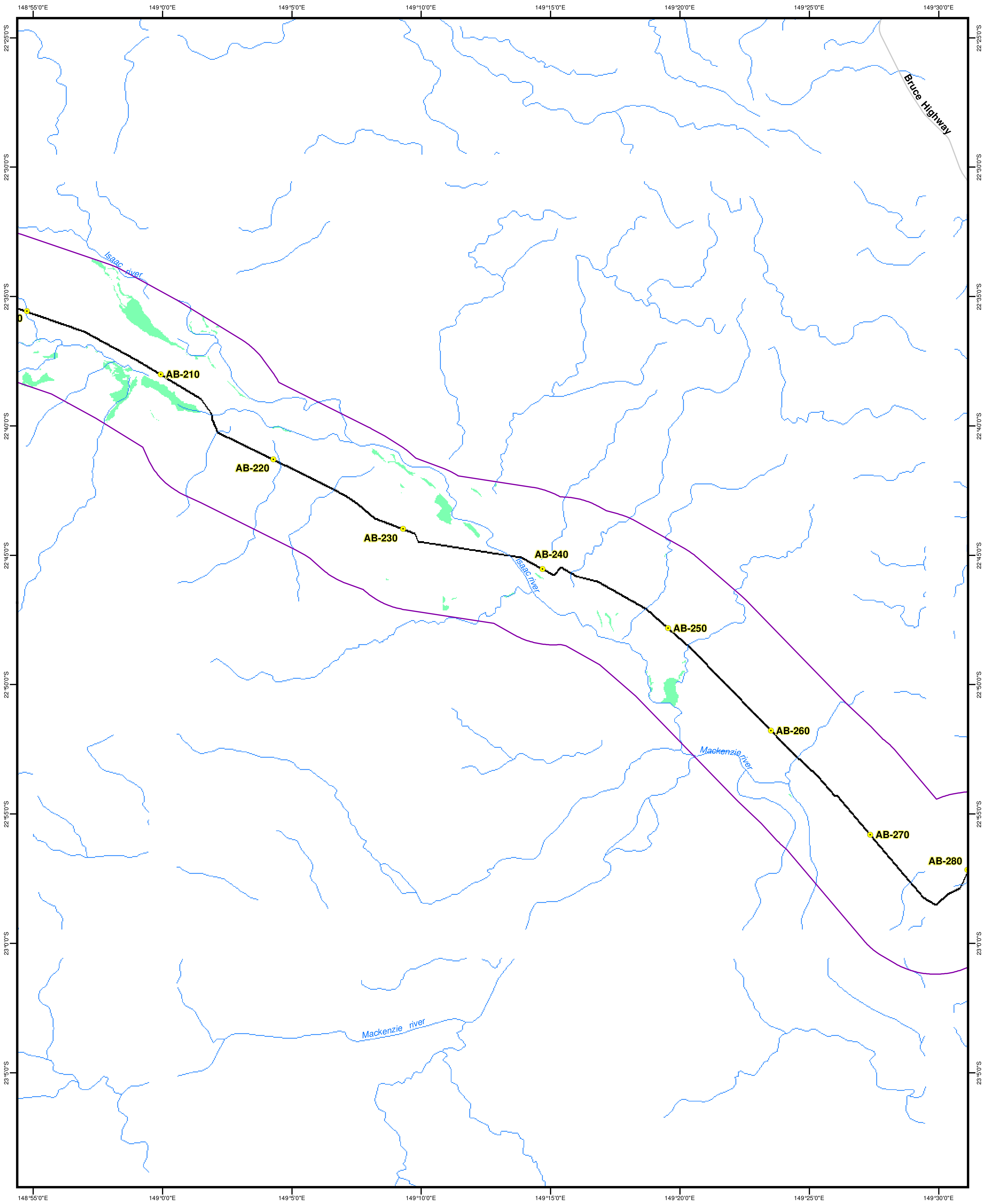
Arrow Bowen Pipeline
Revision H1

Page 3 of 7

A3



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Dichanthium queenslandicum

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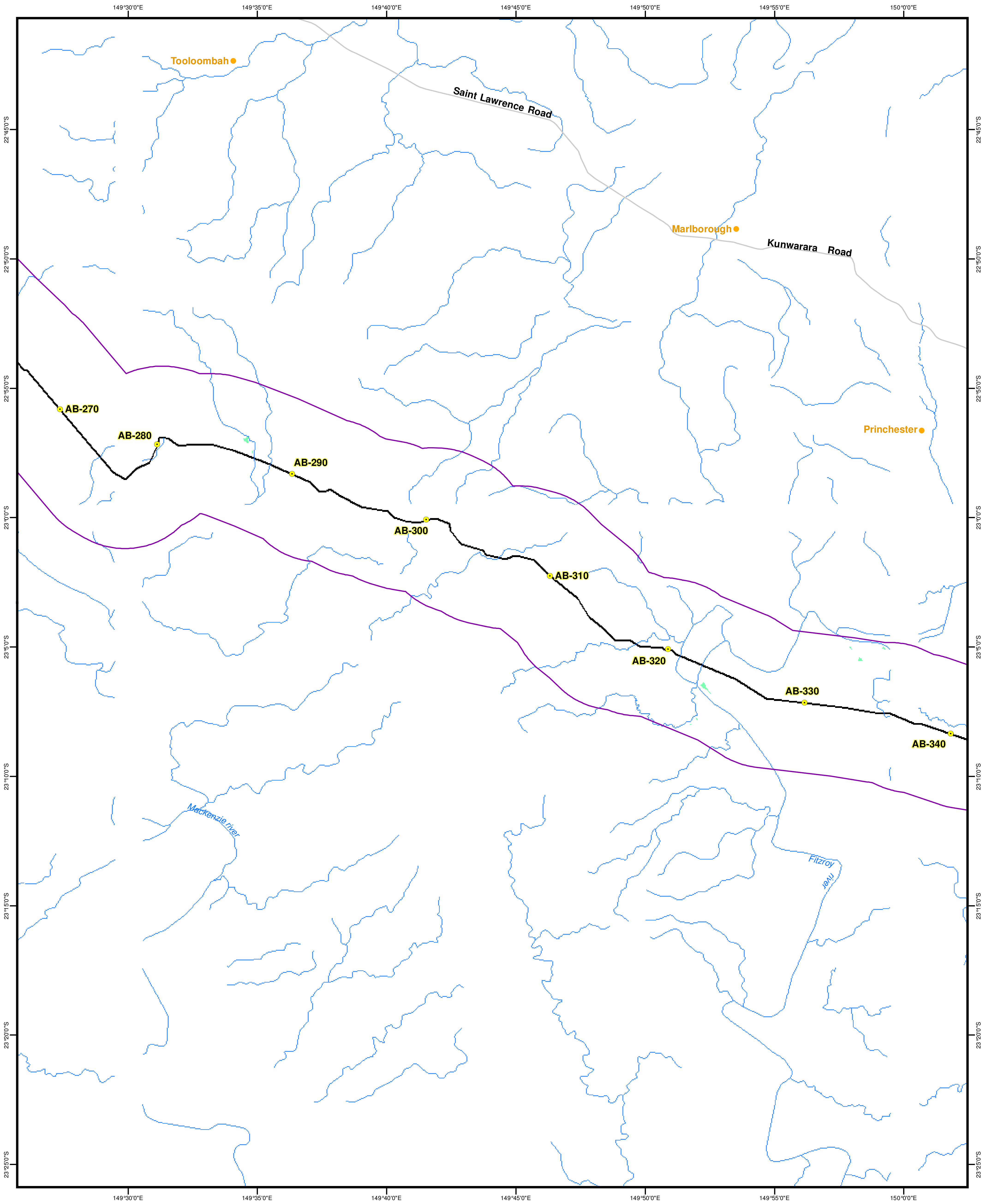
Arrow Bowen Pipeline
Revision H1

Page 4 of 7

A3



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- ~ Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ☐ Buffer (5 km)

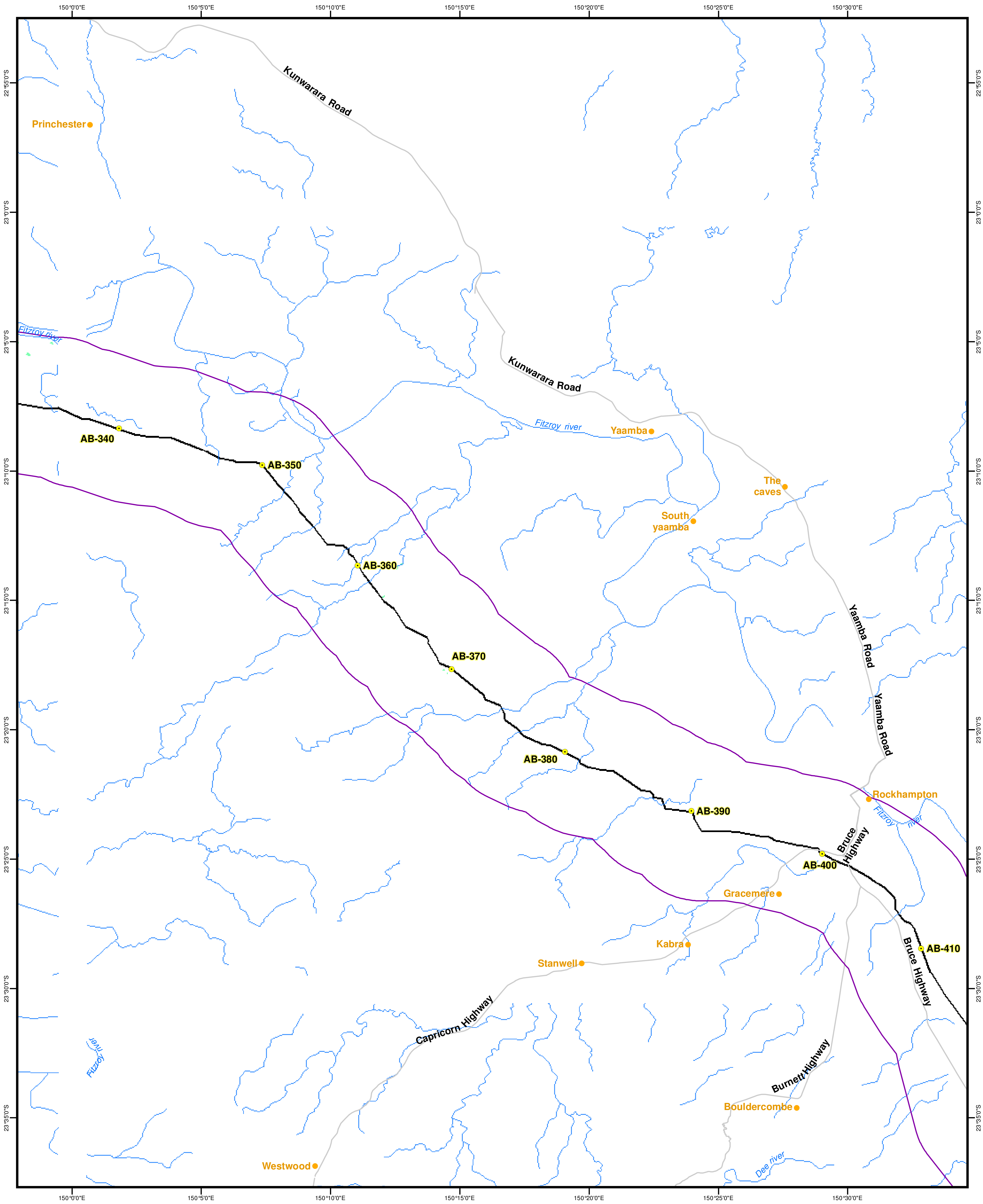
Dichanthium queenslandicum

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 5 of 7

A3



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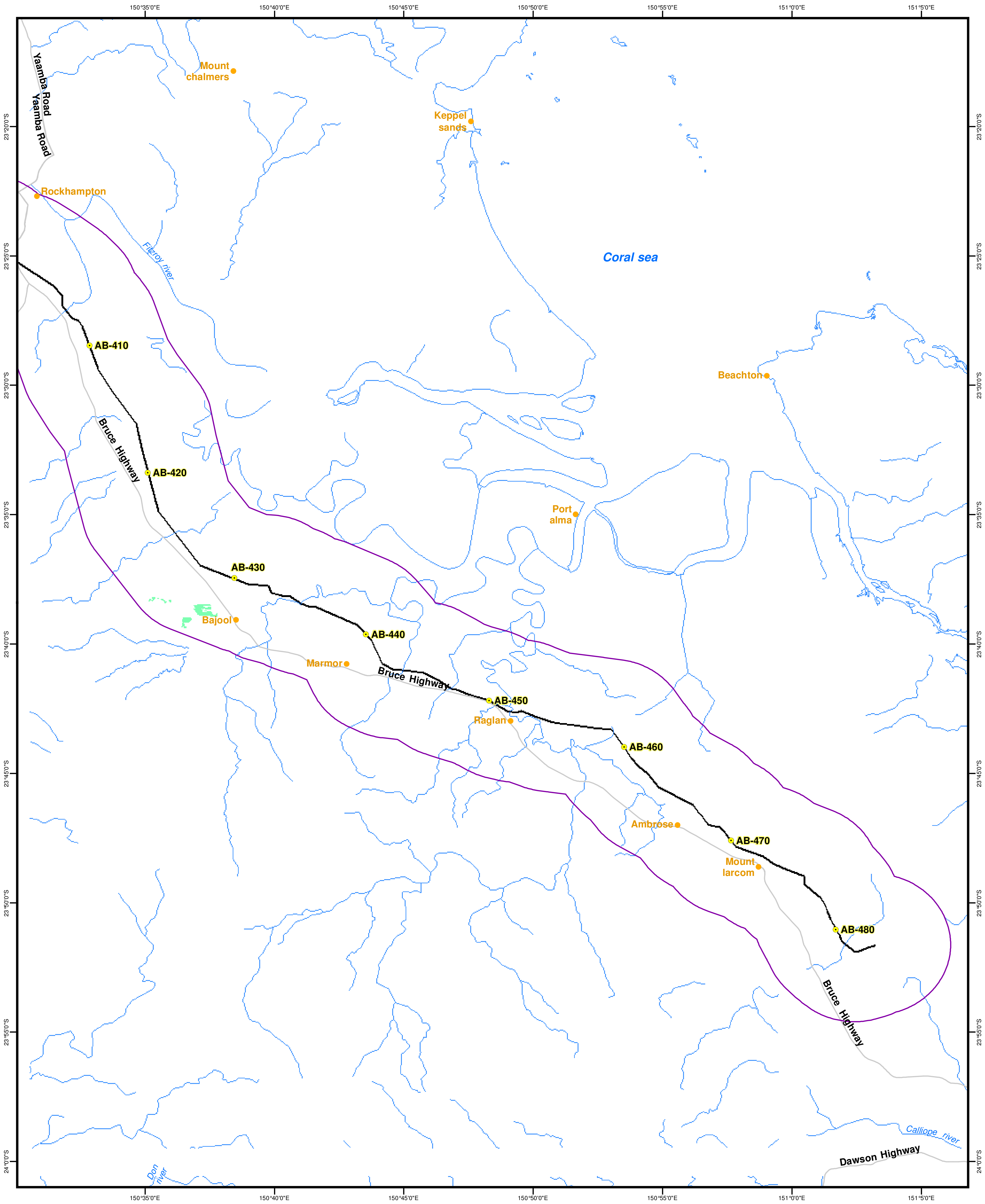
Dichanthium queenslandicum

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 6 of 7

A3



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- ☐ Buffer (5 km)

Dichanthium queenslandicum

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 7 of 7

A3

1.2 *Eucalyptus raveretiana* (Black Ironbox)

1.2.1 Conservation status

Queensland: Vulnerable under the NC Act

National: Vulnerable under the EPBC Act

1.2.2 Description

Eucalyptus raveretiana, Family Myrtaceae (Black Ironbox), is a medium-sized tree to 25 m. The bark is rough on the trunk and largest branches, slightly furrowed, hard and dark grey. Most branches are smooth, white, grey or pale blue. Adult leaves are stalked, lance-shaped, 8–15 cm long, 1–3.5 cm wide, dark green on upper surface and much paler below. Flowers are formed in terminal clusters, with 7 buds per umbel. Flower buds are diamond-shaped, 3–4 mm long when mature, on stalks 2–4 mm long. Fruit is hemispherical, approximately 2 mm long and wide, with the 3 or 4 valves prominently exserted. *Eucalyptus raveretiana* is similar in appearance to *E. howittianum* , but is distinguished by the valves of the fruit, which are prominently projecting. Black Ironbox has the smallest fruit of any eucalypt (Brooker & Kleinig, 2004; CPBR, 2006). The species is reported to have glandular pith in the branchlets.

1.2.3 Distribution

Eucalyptus raveretiana has a wide distribution in Queensland coastal and sub-coastal areas, from south of Townsville to Nebo, around Rockhampton and areas 100 km west of the city (DSEWPaC 2012). This species has been recorded at approximately 23 sites in two main areas: Nebo to Ayr and Apis Creek to Rockhampton (Halford 1997; Queensland Herbarium 2008). The majority of these sites are on roadsides, freehold and leasehold land. It is also present in state forests and national parks (Halford 1997), tributaries of the Fitzroy River, the Suttor River (and its upper tributaries) and the Bowen, Burdekin, Don, Bogie, Broughton, Haughton, O'Connell and Andromache Rivers (BAAM 2011). The extent of occurrence is about 124,000 km^2 (DSEWPaC 2013).

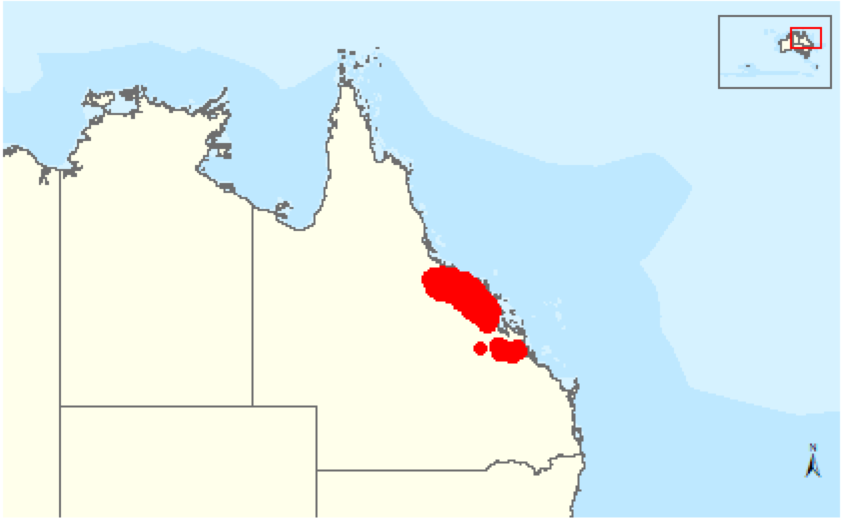


Figure 2 Distribution of *Eucalyptus raveretiana*.

Source (DSEWPaC 2013a)

1.2.4 Habitat

Black Ironbox predominantly grows along watercourses and occasionally on river flats or open woodland (Chippendale 1988; Halford 1997) on soil that varies from sand through to heavy clay (Halford 1997). The species is described as highly salt tolerant (Dunn et al. 1994) and grows in a sub-tropical climate at altitudes from 0 to 300 m with an annual rainfall between 650 and 1100 mm (Boland et al. 2006).

A number of populations occur in areas of remnant vegetation as defined under the *Vegetation Management Act 1999* and are therefore protected from broad-scale vegetation clearing. Black Ironbox rarely occurs in pure stands and is usually co-dominant in RE 11.3.25 (*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines) with species such as (DSEWPaC 2013):

- Narrow Leaved Paperbark (*Melaleuca leucadendra*)
- Weeping Paperbark (*Melaleuca fluviatilis*)
- Blue Gum (*Eucalyptus tereticornis*)
- Carbeen (*Corymbia tessellaris*).

Black Ironbox is also occasionally found in RE 11.3.11 (semi-evergreen vine thicket on alluvial plains) with species such as (DSEWPaC 2013):

- Broad-leaved Bottle Tree (*Brachychiton australis*)
- Narrow-leaved Bottle Tree (*Brachychiton rupestris*)
- Scrub Wilga (*Geijera salicifolia*)

- Native Bauhinia (*Lysiphyllum* spp).

1.2.5 Ecology

Black Ironbox occurs on the banks of rivers, creeks and other watercourses, on clayey or loamy soil (Queensland Herbarium 2008). A number of populations occur in areas of remnant vegetation (Environmental Protection Agency 2008) and are therefore protected from broad-scale vegetation clearing. Black Ironbox produces a millable log and has been harvested for railway sleepers and fencing material in the past (Hall et al. 1970). Black Ironbox matures at five years, flowers from December to March and fruits from March to September (Halford 1997).

1.2.6 Threats

Black Ironbox populations are subject to a number of existing and potential threats, as well as historical impacts.

- Weeds: Invasive weeds can compete for resources, smother trees and increase the frequency and intensity of fires. Significant weeds include:
  - Rubber Vine (*Cryptostegia grandiflora*), which occupies the same habitat and can smother mature eucalypt trees
  - large exotic grasses which inhabit creek-banks such as Guinea Grass (*Megathyrsus maximus*), as these inhibit regeneration and increase the potential for fires
  - other recorded weeds such as Lantana *(Lantana camara*), Bellyache Bush (*Jatropha gossypiifolia*) and Chinee Apple (*Ziziphus mauritiana*) (BAAM 2011).
- Water resource developments: Black Ironbox has in the past been affected by habitat loss or degradation from water resource developments. Environmental flow determinations need to be incorporated into assessments of any further water projects that may impact on habitat where the species occurs (Werren 2002).
- Timber harvesting: Historically, Black Ironbox was used for railway sleepers, light and heavy construction and fence posts (Hall et al. 1970). Presently, the species could be damaged by forest operations through accidental targeting for milling during timber harvesting of other species (Halford 1997).
- Fire: Trees may be damaged or killed by increased fire frequency and intensity from fuel associated with weeds and introduced grasses (Calvert et al. 2005).
- Inappropriate land management activities could increase stream bank erosion (Calvert et al. 2005).

1.2.7 Recovery actions

No recovery plan has been prepared for Black Ironbox. DoE (DSEWPaC 2013) identifies the following priority research, recovery and threat abatement actions for the species.

Research priorities

Research priorities (DSEWPaC 2013) that would inform future regional and local priority actions include:

- design and implement a monitoring program or, if appropriate, support and enhance existing programs
- more precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes, especially weeds
- determine fire regime requirements for Black Ironbox and its habitat.

Regional and local priority actions

The following regional and local priority recovery and threat abatement actions (DSEWPaC 2013) would support the recovery of Black Ironbox.

Habitat Loss, Disturbance and Modification

- identify populations of high conservation priority
- ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on Black Ironbox
- monitor known populations to identify key threats
- minimise adverse impacts from land use at known sites, particularly in relation to forest operations and maintenance of stream bank and riparian vegetation integrity
- investigate formal conservation arrangements, management agreements and covenants on private land
- investigate inclusion in reserve tenure on crown and private land.

Invasive weeds

- identify and remove weeds which could become a threat to Black Ironbox, using appropriate methods
- manage sites to prevent introduction of invasive weeds which could become a threat to the species, using appropriate methods
- implement a management plan for the control of rubber vine in the region (as per rubber vine weed management guide - DEH 2003).

Fire

- develop and implement a suitable fire management strategy for Black Ironbox
- provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigation measures in bush fire risk management plans, risk register and/or operation maps.

Conservation information

- raise awareness of Black Ironbox within the local community.

Enable recovery of additional sites and/or populations

- undertake appropriate seed collection and storage
- investigate options for linking, enhancing or establishing additional populations
- implement national translocation protocols (Vallee et al. 2004) if establishing additional populations is considered necessary and feasible.

Existing plans/management prescriptions relevant to Black Ironbox

- Weeds of National Significance – rubber vine (*Cryptostegia grandiflora*) Strategic Plan (DEH 2003).

1.2.8 Survey effort and methods undertaken for ABP

No methods for flora surveys are documented by DoE. Black Ironbox is similar in appearance to Howitt's Box (*E. howittiana*), but is distinguished by the valves of the fruit, which are prominently projecting (Hall et al. 1970); Black Ironbox also has the smallest fruit of any eucalypt (Brooker & Kleinig 1994). Genetically similar eucalypts are geographically disjunct from Black Ironbox (Brooker & Kleinig 1994) and the species is not known to hybridise (Queensland Herbarium 2008).

Black Ironbox is a large distinctive eucalypt that grows in riparian and alluvial communities and can be effectively surveyed by random meander or systematic transect techniques, targeting semi-permanent or permanent creeks and rivers.

Creek crossings containing suitable habitat for this species were surveyed on foot. Where Black Ironbox individuals were detected, extended sections along the creek bank were surveyed to assess the extent of populations and identify any gaps in populations that could be used as suitable crossing points.

The survey effort undertaken in potential habitat of Black Ironbox is summarised in Table 4.

Table 4 Previous surveys for Black Ironbox

Season	Riparian sites surveyed	Sites with Black Ironbox	Creeks with Black Ironbox	Conclusion
June 2011	70	6	Two Mile Ck Louisa Ck Limestone Ck Deep Ck Lion Ck Neerkol (Scrubby) Ck	Revision D line surveyed. Gaps that could be used for pipeline crossings were identified between Black Ironbox populations on all creeks.
September 2011	40	5	Limestone Ck	Revision D line surveyed. Three gaps were identified between populations on Limestone Creek.
April 2012	22	2	Deep Ck Lion Ck	Revision D1A line surveyed. Gaps were identified between populations

Season	Riparian sites surveyed	Sites with Black Ironbox	Creeks with Black Ironbox	Conclusion
				on both creeks.
August 2012	20	7	Lion Ck Neerkol Ck	Revision SR line surveyed. Gaps were identified between populations on Lion Creek. Neerkol Ck not crossed by Revision H1 line.

1.2.9 ABP survey results

Populations *of Eucalyptus raveretiana* were recorded within and adjacent to the ROW along four watercourse crossings containing RE 11.3.25 on the mainline (KP 352.3 to 387.9). These crossings were:

- Two Mile Creek (KP 352.3)
- Limestone Creek (KP 374.4)
- Deep Creek (KP 376.6)
- Lion Creek (KP 387.9).

Black Ironbox occurred within narrow bands of riparian vegetation, ranging from a single line of trees along the bank to a 20 m wide strip. Most populations were heavily invaded by weeds, including Rubber Vine, Lantana (*Lantana camara*) and Guinea Grass (*Megathyrsus maximus*). Fire scars were common on tree trunks. Some dead trees were observed, probably due to a combination of smothering by weeds and frequent, intense bushfires.

Maps showing locations of Black Ironbox populations and gaps suitable for pipeline construction are provided.

1.2.10 Impacts of ABP on Black Ironbox

1.2.10.1 Potential impacts without mitigation

Potential impacts on Black Ironbox from the pipeline construction could include:

- direct loss of plants within the ROW and associated disturbance areas (e.g. access tracks)
- changes to hydrology
- watercourse erosion
- introduction and spread of weeds
- changes to fire regime.

1.2.10.2 Assessment of potential impacts with mitigation

Surveys were conducted along watercourse crossings between KP 352.3 to 387.9 on the mainline to identify potential routes which do not contain any individuals of *Eucalyptus raveretiana*. Results from these surveys indicate that it is possible to identify watercourse crossings that would avoid any direct impacts on populations.

Only four watercourses contained Black Ironbox in or adjacent to the revision G alignment. Potential crossings were identified within gaps of 20 m or greater between trees at all four watercourses. These gaps are mapped in the figure below. Assuming that construction and associated access tracks can be contained within identified gaps, no trees will be removed during pipeline construction.

If any Black Ironbox trees must be removed for construction, an offset plan would be developed and submitted to DoE before any works commence.

An aquatic values management plan will identify watercourse crossing methods (e.g. trenching with or without pumping / fluming) for each major watercourse within the ABP and measures to minimise impacts on hydrology, water quality and streambank stability. An erosion and sediment control plan will provide further measures to manage erosion and minimise sedimentation of watercourses.

Weed risks will be managed in accordance with a weed management plan, which will incorporate weed hygiene measures to avoid introduction of new weeds and spread of existing weeds, weed control works before, during and after construction, and a monitoring program to evaluate the effectiveness of weed management and trigger contingency measures if performance criteria are not met.

The potential impacts to Black Ironbox from construction of the ABP and the mitigation measures to reduce the risk of impacts are listed in Table 3.

Table 5 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on Black Ironbox

IMPACT	RAW RISK BEFORE MITIGATION*	MITIGATION MEASURES	RESIDUAL RISK AFTER MITIGATION*
DIRECT IMPACTS			
Removal of habitat Removal of potential riparian habitat	L	- minimise clearing of remnant riparian vegetation - use existing cleared corridors where possible - rehabilitate the ROW following construction - clearly mark out areas to be cleared and retained - retain mature trees where practicable	L
Loss of individuals Individuals removed in ROW during clearing and construction	M	- confine clearing and construction to within identified gaps in populations at creeks containing Black Ironbox - clearly mark out areas to be cleared and retained - consult arborist for advice if construction is likely to impact on tree canopies or root systems (i.e. if impacts extend inside the canopy line of trees)	I
INDIRECT IMPACTS			
Changes in water quality Impacts to water leading to changes in habitat downstream	L	- develop a sediment and erosion control plan - install sediment and erosion control fencing in soils that are prone to erosion - reinstate original creek bank profile to ensure no changes in hydrology	I

IMPACT	RAW RISK BEFORE MITIGATION*	MITIGATION MEASURES	RESIDUAL RISK AFTER MITIGATION*
Changes in hydrology Changes in hydrology of waterways caused by damming, changes in morphology or diversions	L	- conduct surveys prior to construction to determine the topography and morphology of the land and creek crossings so that they can be returned to a similar standard during rehabilitation - return creek banks to their pre-construction profile	I
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of populations	L	- minimise areas of remnant vegetation to be cleared - use existing cleared corridors where possible - rehabilitate the ROW following construction	I
Increase in weed abundance -increased competition with native plant species -smothering of native vegetation -increased fuel loads and risk of wildfires	L	- develop and implement a Weed Management Plan - implement site weed hygiene protocols -control weeds in the ROW before, during and after construction - monitor to evaluate the effectiveness of weed management	L
Fire -damage to trees	L	- no fire policy for the construction project - develop an emergency response plan to respond to accidental fires	L

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High, NA- Not applicable

1.2.11 Evaluation under MNES significant impact guidelines

Will the action lead to a long-term decrease in the size of an important population of a species?

Although the action, using field survey data, has revised the route to minimise or avoid clearing any Black Ironbox up to eight trees may need to be removed at selected crossings. All surveyed populations are comprised of hundreds of trees, the loss of one or two at each crossing is unlikely to lead to a substantial long-term decrease in the size of the regional population.

The action will conduct short term works at any particular crossing and this is not expected to cause indirect impacts on the riparian habitat of populations. Impacts will be mitigated in accordance with the erosion and sediment control plan and rehabilitation management plan. These plans are recognised to effectively manage impacts of linear infrastructure to watercourses and are expected to avoid any long term decrease in Black Ironbox habitat and populations.

A weed management plan will be implemented to manage weed risks, including strict weed hygiene procedures, weed control works before, during and after construction, and a monitoring program. A no burning policy will be implemented to prevent fires from onsite activities. An Emergency Response Plan will be developed and implemented to respond to emergency situations (such as fire) should these develop. These plans are widely used to effectively manage impacts of linear infrastructure on weed and fire risks and are expected to avoid any long term decrease in Black Ironbox populations.

Will the action reduce the area of occupancy of an important population of a species?

The majority of the ROW (except for a 7 m wide track) will be allowed to regenerate to a habitat of similar quality to that present before construction. As the average width of riparian habitat on the four watercourses was 20 m, the total loss of habitat is estimated to be 0.1 ha. This area is not considered to be a significant loss of habitat for this species.

Will the action fragment an existing important population into two or more populations?

Black Ironbox populations are naturally fragmented both between and within catchments (i.e. along individual watercourses). Natural gaps of 20 to 40 m were observed within populations at all four watercourses containing Black Ironbox. As none of the proposed crossings will result in the removal of significant numbers of individuals within a population, or lead to a long term gap larger than 7 m, pipeline construction is not expected to lead to increased fragmentation.

Will the action adversely affect habitat critical to the survival of a species?

No critical habitat for Black Ironbox has been identified under the EPBC Act. No recovery plan has been prepared for Black Ironbox. The removal of a maximum of eight trees and 0.1 ha of potential habitat is not likely to adversely affect the survival of the species.

Will the action disrupt the breeding cycle of an important population?

Loss of a maximum of eight trees from the general Fitzroy region metapopulation is unlikely to disrupt breeding (gene exchange) within and between sub-populations. A long term gap of 7 m within the ROW is not expected to impact on the ability of insect pollinators to fly between trees or on the effective dispersal of seeds from trees.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The maintenance of a tree-free strip 7 m wide through suitable Black Ironbox habitat will reduce the area the species can occupy at each watercourse crossing, but this will not cause the species to decline.

Will the action result in establishment of harmful invasive species becoming established in the species' habitat?

Black Ironbox populations adjacent to the proposed ROW are heavily invaded by weeds, including rubber vine, lantana and guinea grass. Disturbance caused by construction activities at watercourse crossings could lead to increased weed densities and affect germination and establishment of Black Ironbox. A weed management plan will incorporate weed hygiene measures to avoid introduction of new weeds; spread of existing weeds; weed control; and a monitoring and management program to manage weeds during the operational phase. Weed management plans are widely used to effectively manage impacts of linear infrastructure on weed risks and, if effectively implemented, is expected to avoid the establishment and spread of harmful weed species.

Will the action result in the introduction of disease(s) that may cause the species to decline?

It is unlikely that the action will result in introduction of a disease that could cause the species to decline. Hygiene measures outlined in the weed management plan are likely to reduce the risk of introducing potential pathogens to Black Ironbox populations.

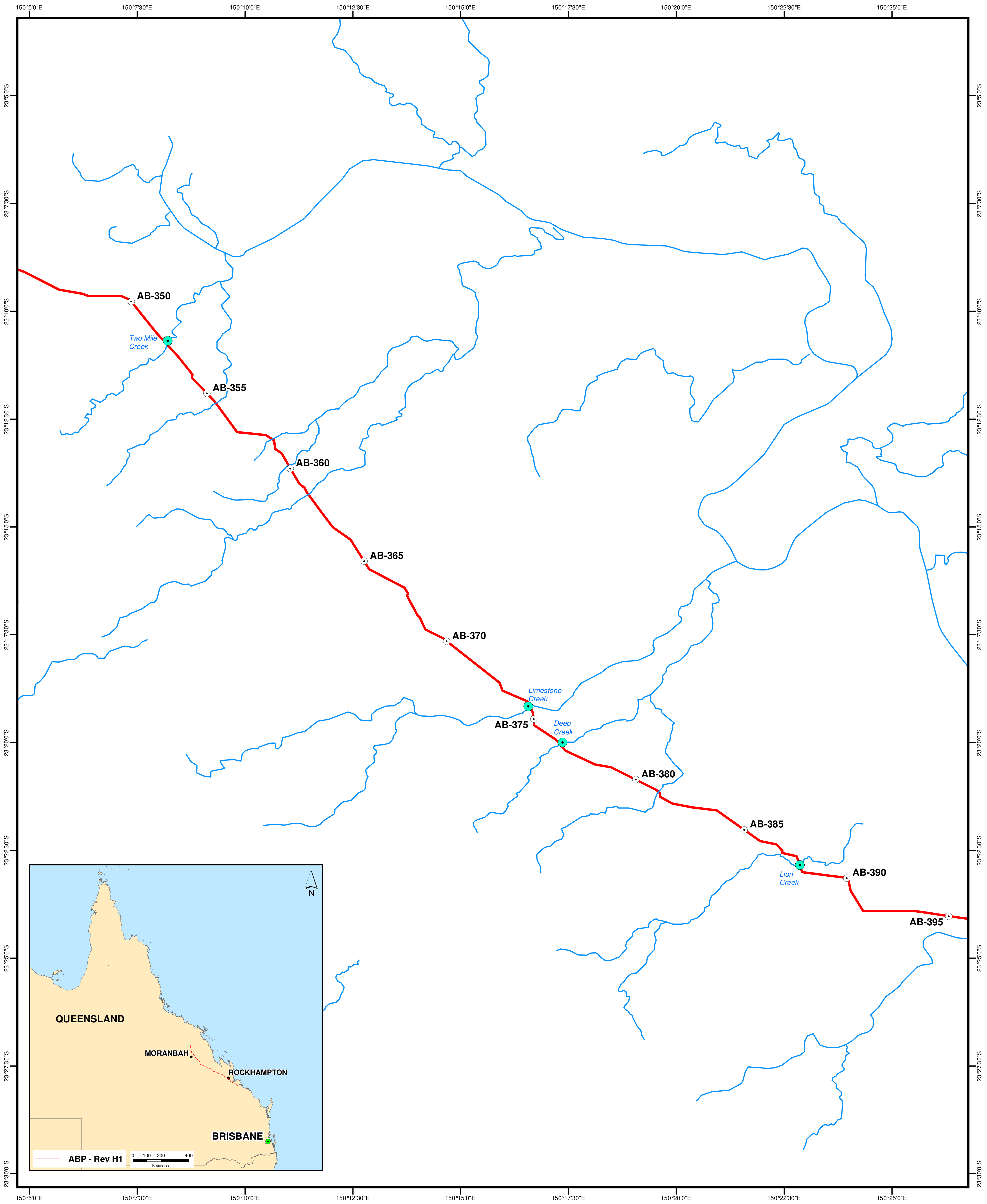
Will the action interfere substantially with the recovery of the species?

Although the action will have local impacts through removal of up to 0.1 ha of potential Black Ironbox habitat and a maximum of eight trees on four watercourses, this will not substantially impede the species' recovery.

1.2.12 Conclusion

The proposed ABP pipeline crosses four watercourses that contain Black Ironbox populations in or adjacent to the ROW. Gaps at least 20 m wide were identified between Black Ironbox trees on all four watercourses. The action will not remove any Black Ironbox, assuming that the pipeline can be constructed within identified gaps between trees. It is possible that one or two trees may need to be removed at selected crossings, which would lead to a maximum loss of eight trees. As all surveyed populations are comprised of hundreds of trees, the loss of one or two at each crossing is unlikely to lead to a substantial long-term decrease in the size of the regional population.

Indirect impacts are expected to be limited as the action will require only short term works at each watercourse crossing and will be limited to a corridor with a maximum width of 40 m. Provided that mitigation measures outlined in management plans are effectively implemented, indirect impacts are expected to be short lived and are not expected to affect Black Ironbox populations.



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Document
BE004_MP_002E_euc_raveretiana_Population_Overview_map

Job Number: BE004

Approved GIS Team Leader		BN		28/08/2013
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- ● ***Eucalyptus raveretiana* Survey Records**
- ⊙ **Kilometre point**
- — **ABP Route - Rev H1**
- ~ **Waterways**

Eucalyptus raveretiana Locations Overview Map

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Arrow Bowen Pipeline Revision H1

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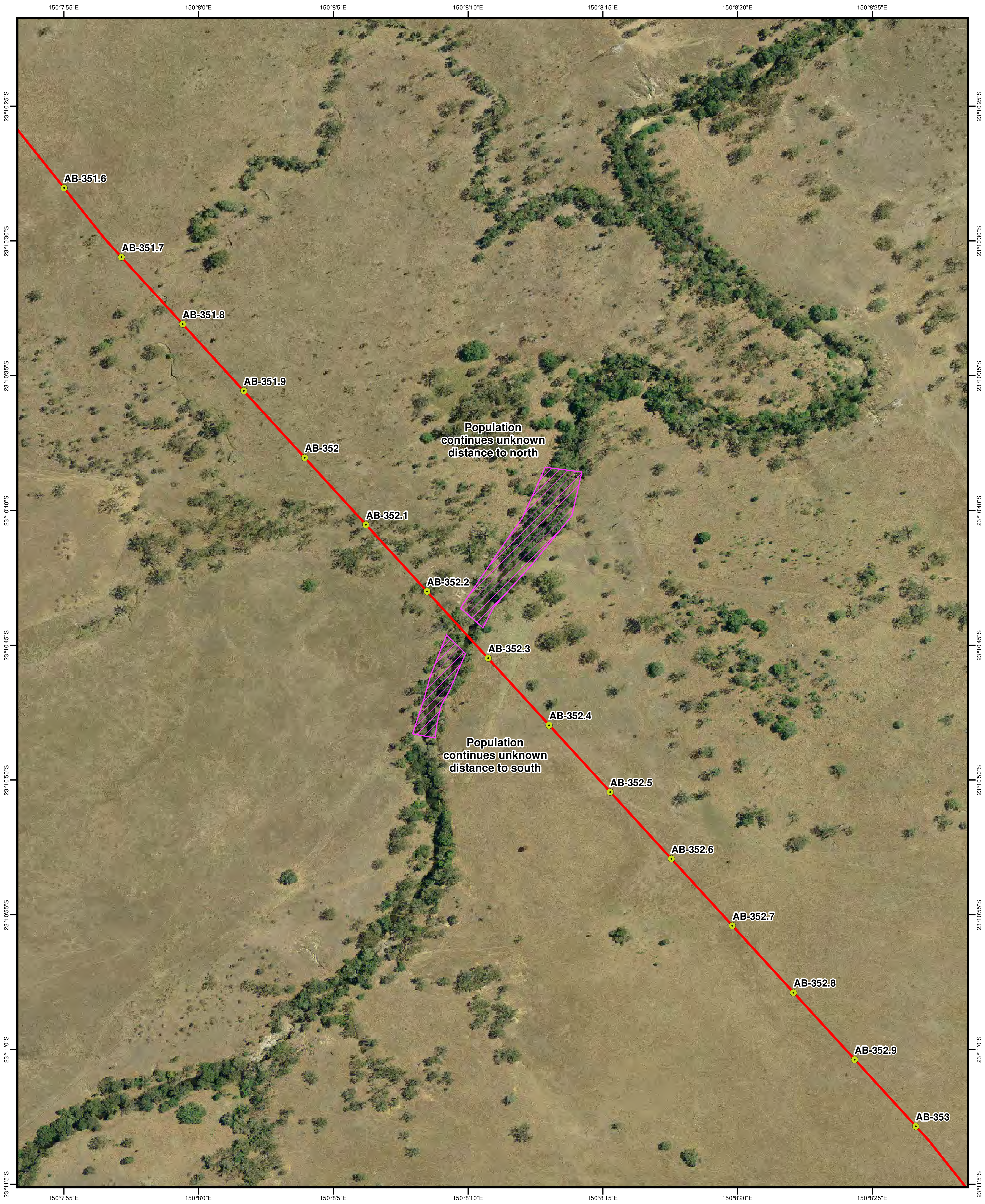

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BE004_MP_002D_euc_raveretiana_Population_Two_Mile_Creek

Job Number: BE004

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- ● **Kilometre point**
- — **ABP Route - Rev H1**
- ▨ **Surveyed *Eucalyptus raveretiana* population**

Eucalyptus raveretiana on Two Mile Creek

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Arrow Bowen Pipeline
Revision H1

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BE004_MP_002C_euc_raveretiana_Population_Lion_Creek

Job Number: BE004

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● Kilometre point
ABP Route - RevH1
▨ **Surveyed *Eucalyptus raveretiana* population**

Eucalyptus raveretiana on Lion Creek

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Arrow Bowen Pipeline
Revision H1

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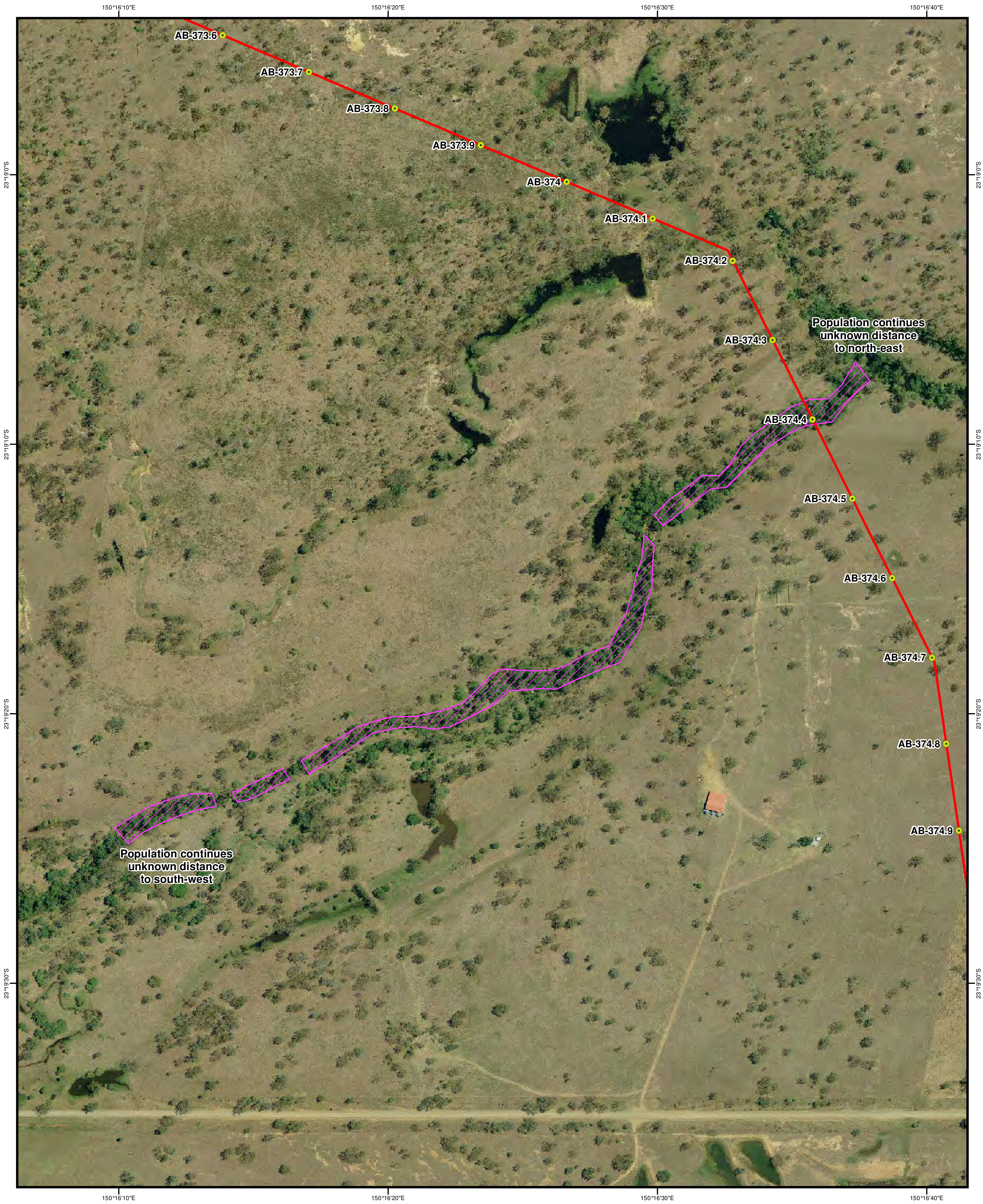

Eucalyptus raveretiana on Limestone Creek

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Job Number: BE004

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▨	**Surveyed *Eucalyptus raveretiana* population**

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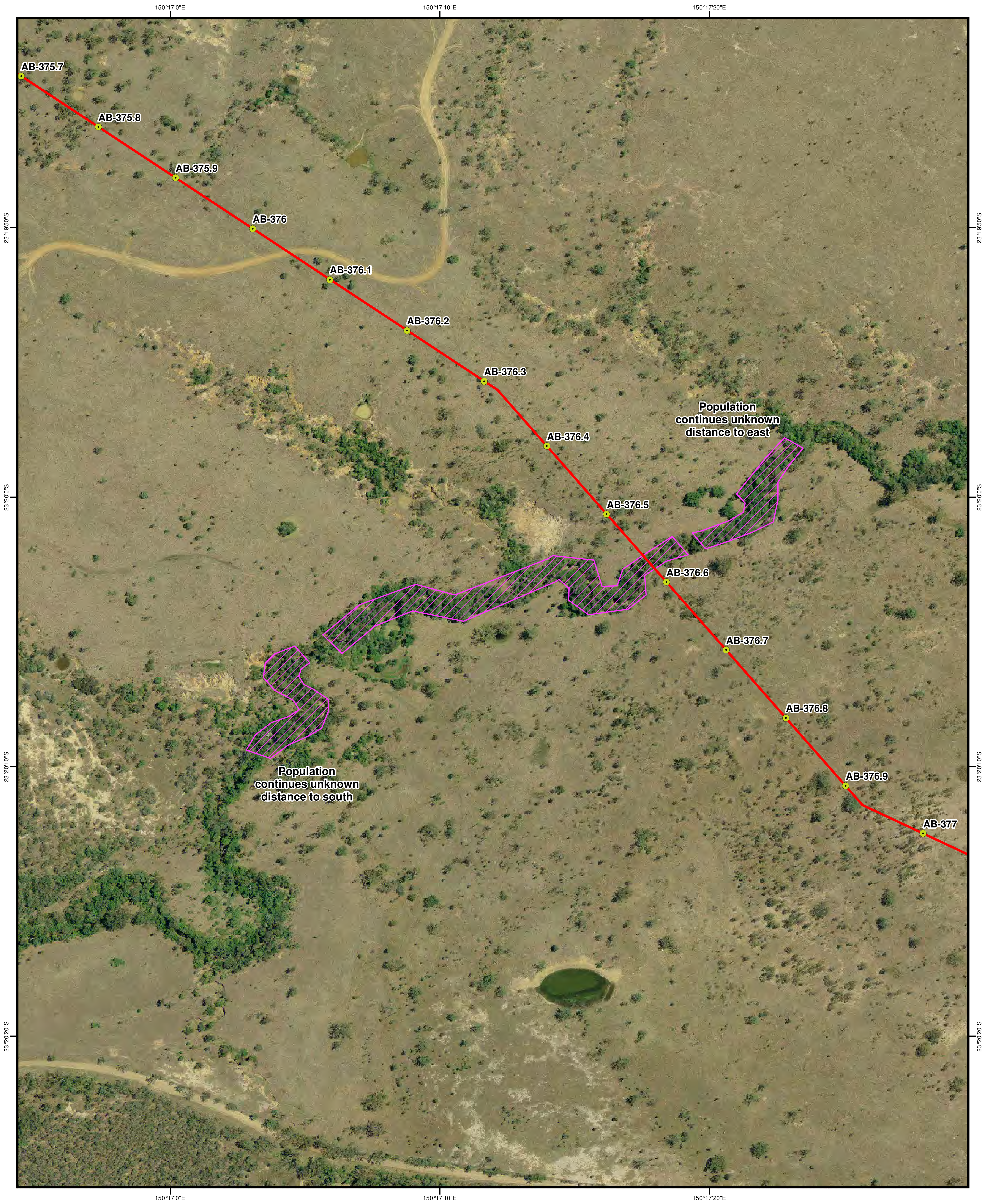

Eucalyptus raveretiana on Deep Creek

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

LEGEND

- ● **Kilometre point**
- — **ABP Route - RevH1**
- ▨ **Surveyed *Eucalyptus raveretiana* population**

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BE004_MP_002A_euc_raveretiana_Population_Deep_Creek

Job Number: BE004

Approved GIS Team Leader	BN			28/08/2013
R1	BN	CF	ISSUED TO CLIENT	28/08/2013
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1.3 Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

1.3.1 Conservation status

National: Endangered Ecological Community (EEC) under EPBC Act.

Queensland: Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin ecological community occur within the following seven Queensland Regional Ecosystems (REs):

- three REs with an Endangered biodiversity status (11.3.21, 11.9.12, 11.11.17)
- three REs with an Of Concern biodiversity status (11.4.4, 11.4.11, 11.8.11)
- one RE with a No Concern biodiversity status (11.9.3).

1.3.2 Description

Native grasslands are dynamic ecological communities that once occurred over a large area of Australia, although few patches of undisturbed native grasslands now remain. The species composition of native grasslands is highly variable and is influenced by factors such as geology, land use, soil, climate and rainfall (Butler 2007). The Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin (hereafter called CQ Native Grasslands) are typically composed of a mixture of forbs and native grasses, a tree canopy that is either absent or sparse and a ground layer that is typically dominated by perennial native grasses (DSEWPaC 2008a; 2008b).

1.3.3 Distribution

The CQ Native Grasslands are endemic to Queensland and occur within the Brigalow Belt North and Brigalow Belt South bioregions, which are largely within the Central Highlands and northern Fitzroy River Basin regions of Queensland (Figure 1). The EEC extends south to the Expedition, Carnarvon, Great Dividing, Drummond and Narrien ranges; and north to the

Clark, Denham, Connors and Broadsound ranges (DSEWPaC 2008a). The CQ Native Grasslands may also coincide with the EPBC-listed Brigalow (*Acacia harpophylla*) dominant and co-dominant ecological community (DSEWPaC 2008a).

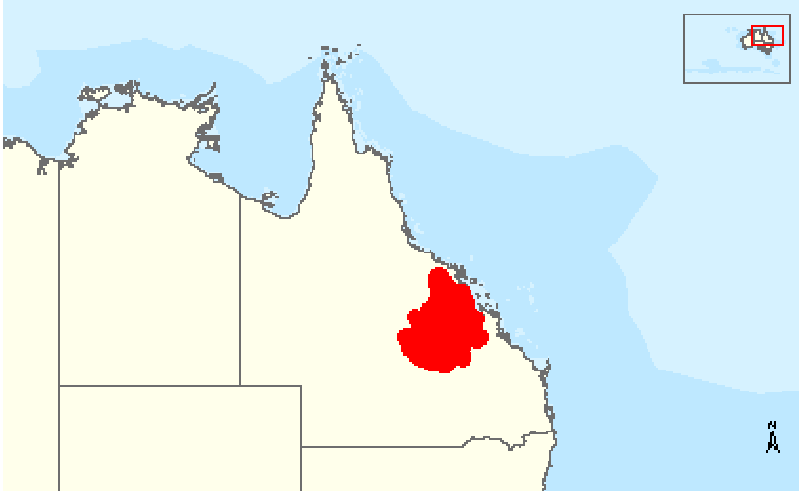


Figure 3 Distribution of Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

Source: (DSEWPaC 2013)

The Interim Biogeographic Regionalisation for Australia (IBRA) identifies eight subregions within the north and south Brigalow Belt bioregions where the CQ Native Grasslands occur (Table 6) (DSEWPaC 2008a).

Table 6 Subregions within the EEC identified by the IBRA.

Brigalow Belt North subregions	**Brigalow Belt South subregions**
BBN 6 Northern Bowen Basin	BBS 1 Claude River Downs
BBN 9 Anakie Inlier	BBS 9 Buckland Basalts
BBN 10 Basalt Downs	
BBN 11 Isaac-Comet Downs	
BBN 12 Nebo-Connors Range	
BBN 13 South Drummond Basin	

1.3.4 Habitat in Queensland

The CQ Native Grasslands usually occur on flat or gently undulating ground. Soils mainly consist of fine textured vertosols (cracking clays) that are often deep, although soils can be shallower on sloping land and ridges (Fensham 1999). The EEC occurs in a subtropical, subhumid climatic zone, with a marked wet summer and moderately dry winter with a mean annual rainfall from 500 to 700 mm (Fensham 1999). The CQ Native Grasslands ecological community corresponds to seven Queensland REs (Table 7).

Table 7 Description, biodiversity status and VM Act status of the equivalent REs in the CQ Native Grasslands EEC.

RE	RE Description	VMA Status*	BD Status*
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains - cracking clay soils	E	E
11.4.4	*Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains	LC	OC
11.4.11	*Dichanthium sericeum*, *Astrebla* spp. and patchy *Acacia harpophylla*, *Eucalyptus coolabah* on Cainozoic clay plains	OC	OC
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	OC	OC
11.9.3	*Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks	LC	NC
11.9.12	*Dichanthium sericeum* grassland with clumps of *Acacia harpophylla* on fine-grained sedimentary rocks	E	E
11.11.17	*Dichanthium sericeum* grassland on old sedimentary rocks with varying degrees of metamorphism and folding.	OC	E

* VM Act and Biodiversity Status recognised by Qld DEHP: E = Endangered; OC = Of Concern; LC = Least Concern; NC = No Concern at Present

1.3.5 Threats

Native grasslands are among the most threatened ecosystems in Australia due to cropping, overgrazing by stock, ploughing, grading, weed invasion, salinity, herbicide and fertiliser spraying and inappropriate management regimes (Kirkpatrick et al. 1995; Benson et al. 2006).

Actual threats to the CQ Native Grasslands are identified as (Butler 2007):

- grazing, cropping and pasture improvement
- weeds and pest animals
- mining activities
- construction of roads and other infrastructure.

Potential threats include:

- climate change
- lack of knowledge.

1.3.6 Recovery actions

No recovery plan has been prepared for the CQ Native Grasslands EEC. DoE (DSEWPaC 2008a) identifies the following priority recovery and threat abatement actions for the listed ecological community:

Habitat Loss, Disturbance and Modification

- Monitor known occurrences to identify key threats or the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
- Identify occurrences of high conservation priority.
- Undertake survey work in potential habitat to locate remnants.
- Avoid mowing and slashing during peak flowering season from spring to summer.
- Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on the ecological community.
- Ensure road widening and maintenance activities (or other infrastructure or development activities) in areas where the ecological community occurs minimise adverse impacts on known sites.
- Investigate and implement formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure.

Invasive Weeds

- Develop and implement management plans for the eradication of weeds such as Parthenium (*Parthenium hysterophorus*), Parkinsonia (*Parkinsonia aculeata*), Prickly Acacia (*Acacia nilotica* subsp. *indica*) and Buffel Grass (*Cenchrus ciliaris*).
- Manage sites to prevent introduction of invasive weeds, which could become a threat to the ecological community, using appropriate methods.
- Observe appropriate State protocols to avoid the spread of weeds. Implement good hygiene measures for mowing and grading equipment and take appropriate steps to avoid dispersing seeds when moving stock.
- Maintaining a good cover of native perennial grasses and spelling the grasslands from grazing are reliable methods of managing the risk of weed invasion.

Trampling, Browsing or Grazing

- Grazing management should focus on maintaining a good cover of perennial grasses and legumes (especially the most palatable species) and maintaining vegetation cover through the driest years.
- Develop and implement a stock management plan for roadside verges and travelling stock routes.
- Manage known sites on private property to ensure appropriate cattle and sheep grazing regimes are conducted outside the growing season (i.e. when plants are not fertile).
- Provide and/or promote incentives for good management.

- Where possible, use an intermittent grazing regime in preference to burning. Avoid burning (or grazing or slashing) during peak flowering season (spring to summer).

Animal Predation or Competition

- Develop and implement management plans for the control of the House Mouse (*Mus musculus*).

Conservation Information

- Raise awareness of the ecological community within the local community. The production of region specific fact sheets or information brochures could benefit land managers.

1.3.7 CQ Native Grasslands condition assessment

Native grasslands are dynamic ecosystems where species composition can change, yearly and seasonally. There are very few patches of undisturbed native grasslands remaining and most patches now have some degree of disturbance and degradation. DoE (DSEWPaC 2008a) provide a range of diagnostic features and condition thresholds to identify CQ Native Grasslands EECs:

- The ecological community occurs within eight Brigalow Belt North and Brigalow Belt South subregions, which are largely within the Central Highlands and northern Fitzroy River Basin regions of Queensland.
- Tree canopy is absent or sparse (less than 10% projective crown cover). If it can be demonstrated, beyond reasonable doubt, that the grassland was derived from cleared woodland then it is not part of the national ecological community.
- The ground layer is typically dominated by perennial native grasses and contains at least three of the indicator native species listed below:
  - *Aristida latifolia* (Feather-top wiregrass)
  - *Aristida leptopoda* (White speargrass)
  - *Astrebla elymoides* (Hoop Mitchell grass)
  - *Astrebla lappacea* (Curly Mitchell grass)
  - *Astrebla squarrosa* (Bull Mitchell grass)
  - *Bothriochloa erianthoides* (Satin-top grass)
  - *Dichanthium queenslandicum* (King bluegrass)
  - *Dichanthium sericeum* (Queensland bluegrass)
  - *Eriochloa crebra* (Cup grass)
  - *Panicum decompositum* (Native millet)
  - *Panicum queenslandicum* (Yabila grass)
  - *Paspalidium globoideum* (Shot grass)
  - *Thellungia advena* (Coolibah grass).

Patches must meet the “best quality” or “good quality” condition thresholds listed in Table 3.

Table 8 Condition thresholds for the CQ Native Grasslands Ecological Community (source: DSEWPC 2008a).

	Best quality	**Good quality**
Patch size	At least 1 ha.	At least 5 ha.
Grasses	At least 4 native perennial grass species from the list of perennial native grass indicator species.	At least 3 native perennial grass species from the list of perennial native grass indicator species.
Tussock cover	At least 200 native grass tussocks.	At least 200 native grass tussocks.
Woody shrub cover*	Total projected canopy cover of shrubs is less than 30%.	Total projected canopy cover of shrubs is less than 50%.
Introduced species	Perennial non-woody introduced species are less than 5% of the total projected perennial plant cover.	Perennial non-woody introduced species are less than 30% of the total projected perennial plant cover.

* The shrub layer is typically absent. However, where shrubs are present, they are defined as woody plants, more than 0.5 m tall that occupy the mid vegetation layer. The upper, or tree canopy layer, is also typically absent but may comprise scattered trees to less than 10% projective crown cover.

1.3.8 Survey effort and methods undertaken for ABP

To assess the presence of the EEC, all areas containing mapped REs that form components of the CQ Native Grasslands were surveyed and assessed according to the diagnostic features, condition thresholds and survey methodology outlined by DoE (DSEWPaC 2008a). If the ground-truthed RE was found to be consistent with the mapped RE during the survey, it was then determined if:

- the community occurred within the eight subregions identified by IBRA in the north and south Brigalow Belt bioregions
- the grassland was not derived from cleared woodland
- the tree canopy was less than 10% projective crown cover
- the ground layer was dominated by perennial native grasses and contained at least three of the indicator native species
- the community met or exceeded the condition thresholds outlined by DoE (DSEWPaC 2008a).

Each community was assessed in accordance to the sampling methodology provided by DoE (DSEWPaC 2008a). The sampling was conducted using the following criteria:

- The quadrat size was based on an area of 0.1 ha (e.g. 50 m x 20 m).
- The selected survey area contained the most apparent native perennial grass species.
- Surveys were conducted during a good season and within two months of effective rain in order to maximise the assessment of condition.
- Where possible, surveys were conducted two months after cessation of disturbance (fire/grazing/mowing/slashing). While this was not possible in all cases, all sites had good ground cover, allowing surveys to effectively assess diagnostic features and condition.

1.3.9 ABP survey results

DEHP mapping identified six occurrences of REs that form components of the CQ Native Grasslands EEC within the ROW. Surveys at these sites confirmed two occurrences of RE 11.8.11 on the ABP mainline between KP 35.25 to 36.70 and KP 37.05 to 37.43 (1.83 km of the ROW - Table 4). The remaining areas mapped within the ROW were either non-remnant or contained REs that were not components of the CQ Native Grasslands EEC. Maps showing locations of the field-verified CQ Natural Grassland EEC are provided.

Table 9 Survey results, total length and area of all mapped REs that correspond to the CQ Natural Grassland EECs

KP Start (km)	KP End (km)	Mapped RE	Surveyed RE	EPBC Status	Length (km)	Area (ha) within the ROW
35.25	36.70	11.8.11/11.8.5	11.8.11	E	1.45	5.79
37.05	37.43	11.8.11/11.8.5	11.8.11	E	0.38	1.52
37.43	37.58	11.8.11/11.8.5	Non-remnant	-		
39.39	39.59	11.8.11/11.8.5	11.5.3	-		
74.51	74.82	11.8.11/11.8.5	Non-remnant	-		
165.83	166.11	11.3.21	11.3.2/11.3.7	-		
				EEC total	**1.83**	**1.837.31**

1.3.9.1 Potential impacts without mitigation

Without mitigation, the project will result in a direct loss of 7.31 ha of CQ Natural Grassland EEC. Potential indirect impacts on adjacent communities could include:

- spread of weeds
- changes in fire regimes.

1.3.9.2 Assessment of potential impacts with mitigation

The revision H1 alignment transects 1.83 km of the CQ Native Grasslands EEC from KP 32.25 to 37.43. It is not feasible to avoid the EEC in this section of the ROW, as the pipeline is highly constrained by existing coal mines (Burton Colliery to the east and Goonyella Colliery to the west) and the EEC extends a large distance either side of the ROW (at least 8 km to the east and 16 km to the west). At the time of writing, it is uncertain whether this northern section of the pipeline will be constructed. If this section is constructed, an offset plan would be developed and submitted to DoE for approval before any works commence.

Weed risks will be managed in accordance with a Weed Management Plan, which will incorporate weed hygiene measures to avoid introduction of new weeds and spread of existing weeds, weed control works before, during and after construction, and a monitoring program to evaluate the effectiveness of weed management and trigger contingency measures if performance criteria are not met.

The Project will implement a no-burning policy to manage activities that could cause fires and develop an Emergency Response Plan that will identify resources and emergency responses to any fire incident.

The potential impacts to the CQ Native Grasslands EEC from construction of the ABP and the mitigation measures to reduce the risk of impacts are listed in Table 3.

Table 10 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on CQ Natural Grasslands.

Impact	Impact before mitigation*	Mitigation measures	Impact after mitigation*
DIRECT IMPACTS			
Removal of community Removal of CQ Natural Grasslands	M	- where CQ Natural Grasslands are found, investigate possible route revisions to reduce clearing of EEC - minimise clearing of RE 11.8.11, which contain EEC - use existing cleared corridors where possible - rehabilitate the ROW following construction - clearly mark out areas to be cleared and retained	M
INDIRECT IMPACTS			
Changes in water quality Impacts to water leading to changes in habitat downstream	NA	- no mitigation measures for water quality recommended for this EEC as it is not dependent on riparian /wetland habitats	NA
Changes in hydrology Changes in hydrology of waterways caused by damming, changes in morphology or diversions	NA	- no mitigation measures for hydrology recommended for this EEC as it is not dependent on riparian / wetland habitats	NA
Soil degradation Erosion and sediment loss	L	- scarify or rip ROW after construction and before respreading topsoil to reduce soil compaction, improve water infiltration and promote vegetation regrowth - develop and implement an Erosion and Sediment Control Plan	I
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of populations	L	- minimise areas of remnant vegetation to be cleared - use existing cleared corridors where possible - rehabilitate the ROW following construction	I
Increase in weed abundance -increased competition with native plant species -smothering of native vegetation -increased fuel loads and risk of wildfires	L	- develop and implement a Weed Management Plan - implement site weed hygiene protocols - control weeds in the ROW before, during and after construction - monitor to evaluate the effectiveness of weed management	I
Fire -damage to CQ Natural Grasslands	L	- Implement a no-burning policy for the Project - develop and implement an Emergency Response Plan, which will manage activities that could cause fires and identify resources and emergency responses for any fire incident	I

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High, NA- Not applicable

1.3.10 Evaluation under MNES significant impact guidelines

The following assessments are based on existing information.

***Significant impact criteria*:**

Will the action reduce the extent of an ecological community?

Construction of the revision H1 ABP will require clearing of up to 7.31 ha of CQ Natural Grassland EEC. The area of clearing may be reduced by ongoing route revisions and minimising the width of the ROW where feasible. Clearing may be avoided altogether if the northern 50 km of the ABP is not constructed.

Will the action fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines?

The action would result in the temporary creation of a 40 m corridor through 1.83 km of EEC. A corridor of this width is unlikely to affect the ability of wind-pollinated grass species to disperse and maintain viable populations. Edge effects such as weed invasion and fire will be managed by implementation of a Weed Management Plan and Emergency Response Plan. The majority of the ROW (except for a 7 m wide track) will be rehabilitated after construction using native grasses and shrubs, further reducing fragmentation effects.

Will the action adversely affect habitat critical to the survival of an ecological community?

The action will require clearing of up to 7.31 ha of CQ Natural Grassland EEC. However, the majority of the ROW (except for a 7 m wide track which will be rehabilitated using native grass) will be rehabilitated after construction using native grasses and shrubs, reducing the area of impact. Any remaining impacts would be offset according to an offset plan approved by DoE.

Will the action modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns?

Construction of the gas pipeline is unlikely to impact on abiotic factors necessary for the survival of this EEC, as it grows on flat to gently undulating vertosols. Post-construction rehabilitation of the ROW will re-establish original land profiles and drainage patterns according to a Sediment and Erosion Management Plan.

Will the action cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting?

The temporary creation of a 40 m corridor through the EEC is unlikely to affect the ability of wind-pollinated grass species to disperse and maintain viable populations. Weed impacts will be minimised by the development and implementation of a Weed Management Plan. An Emergency Response Plan will detail appropriate fire management strategies during construction and operation of the pipeline.

Will the action cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

- assisting invasive species, that are harmful to the listed ecological community, to become established, or
- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community?

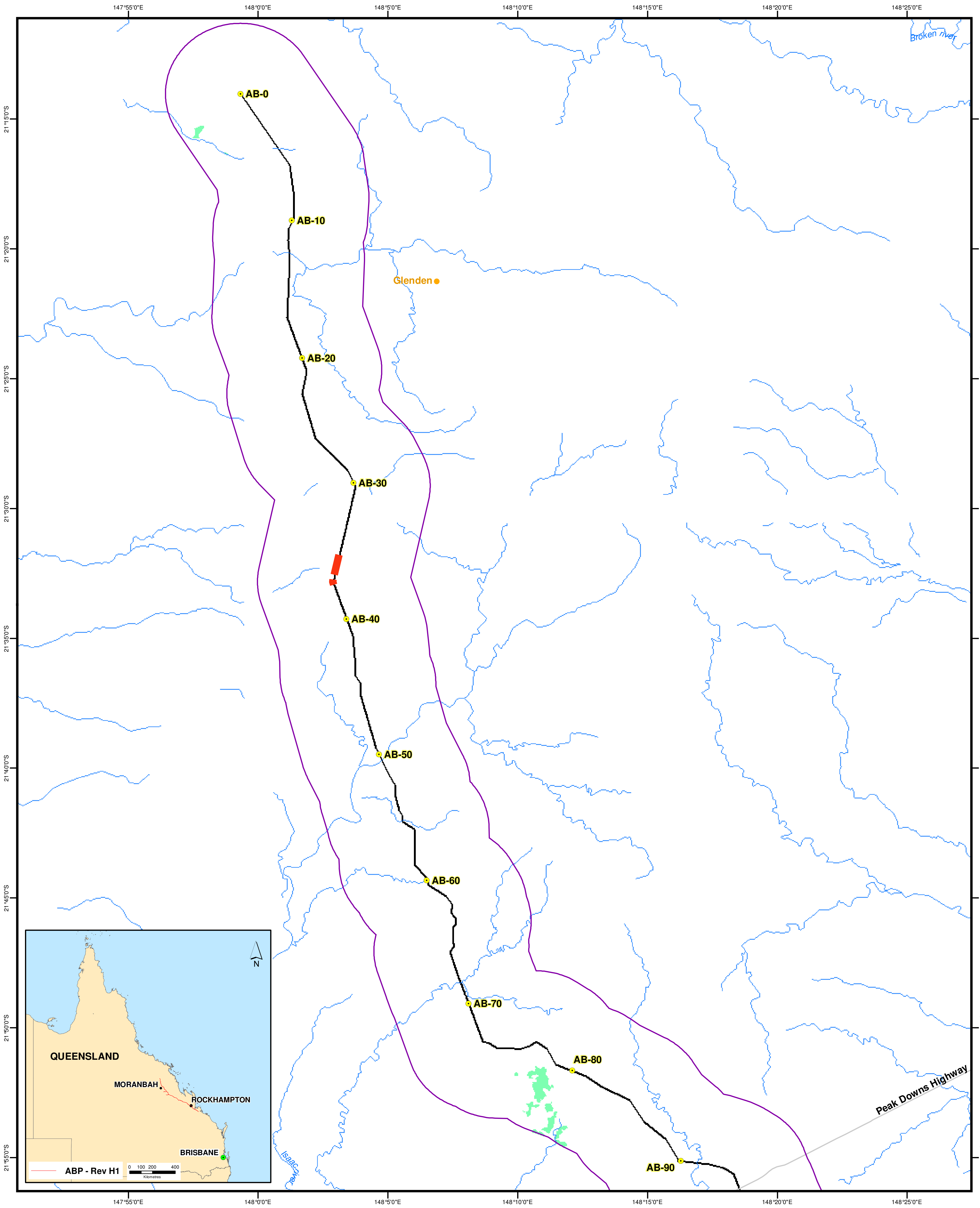
Provided that the proposed mitigation measures are effectively implemented, impacts are expected to be limited to the direct loss of a small area of EEC. A Weed Management Plan will be prepared and implemented before, during and after construction to manage the risk of weeds. Construction of the pipeline is not expected to change the distribution of weeds or pest species. Post-construction rehabilitation of the ROW will re-establish original land profiles and drainage patterns according to a Sediment and Erosion Management Plan and revegetate the majority of the ROW with native grass and shrub species.

Will the action interfere with the recovery of an ecological community?

The action will require clearing of up to 7.31 ha of CQ Natural Grassland EEC. However, the majority of the ROW (except for a 7 m wide track) will be rehabilitated after construction using native grasses and shrubs and trees, reducing the area of impact. Indirect impacts will be mitigated by development and implementation of a Weed Management Plan, Sediment and Erosion Management Plan and Emergency Response Plan. Any remaining impacts will be offset according to an offset plan approved by DoE.

1.3.11 Conclusion

The revision H1 alignment transects 1.83 km of the CQ Native Grasslands EEC from KP 32.25 to 37.43. It is not feasible to avoid the EEC in this section of the ROW, as the community extends large distances to the east and west of the alignment and large coal mines constrain the location of the pipeline. Direct impacts will be reduced by rehabilitation of the majority of the ROW (except for a 7 m wide track) after construction using native grasses and shrubs. Any remaining impacts will be offset according to an offset plan approved by DoE. It is possible that the northern 50 km of pipeline will not be constructed, which will avoid any impacts on this EEC.



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Job Number: BE004

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REV	By	CHK	Description	Date

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Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

- ● City or town
- ⊙ Kilometre Point
- ～ Waterway or Coast Line
- ─ Main roads
- ━ ABP - Rev H1
- 🟥 Potential Habitat in ROW (Field Verified)
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ☐ Buffer (5 km)

Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

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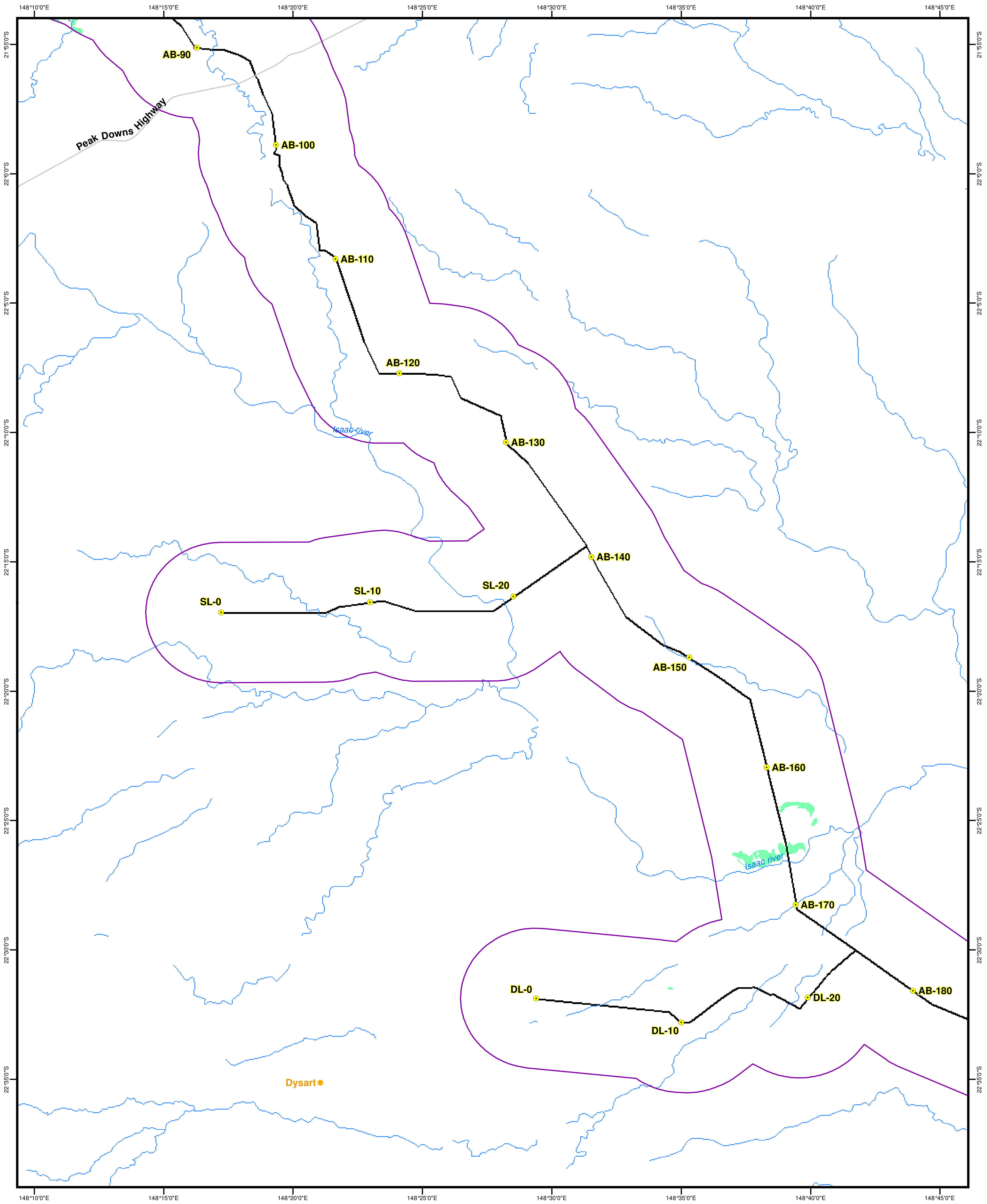
Arrow Bowen Pipeline
Revision H1

Page 1 of 7

A3



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—	ABP - Rev H1
🟩	Potential Habitat in Buffer (from State RE Mapping)
☐	Buffer (5 km)

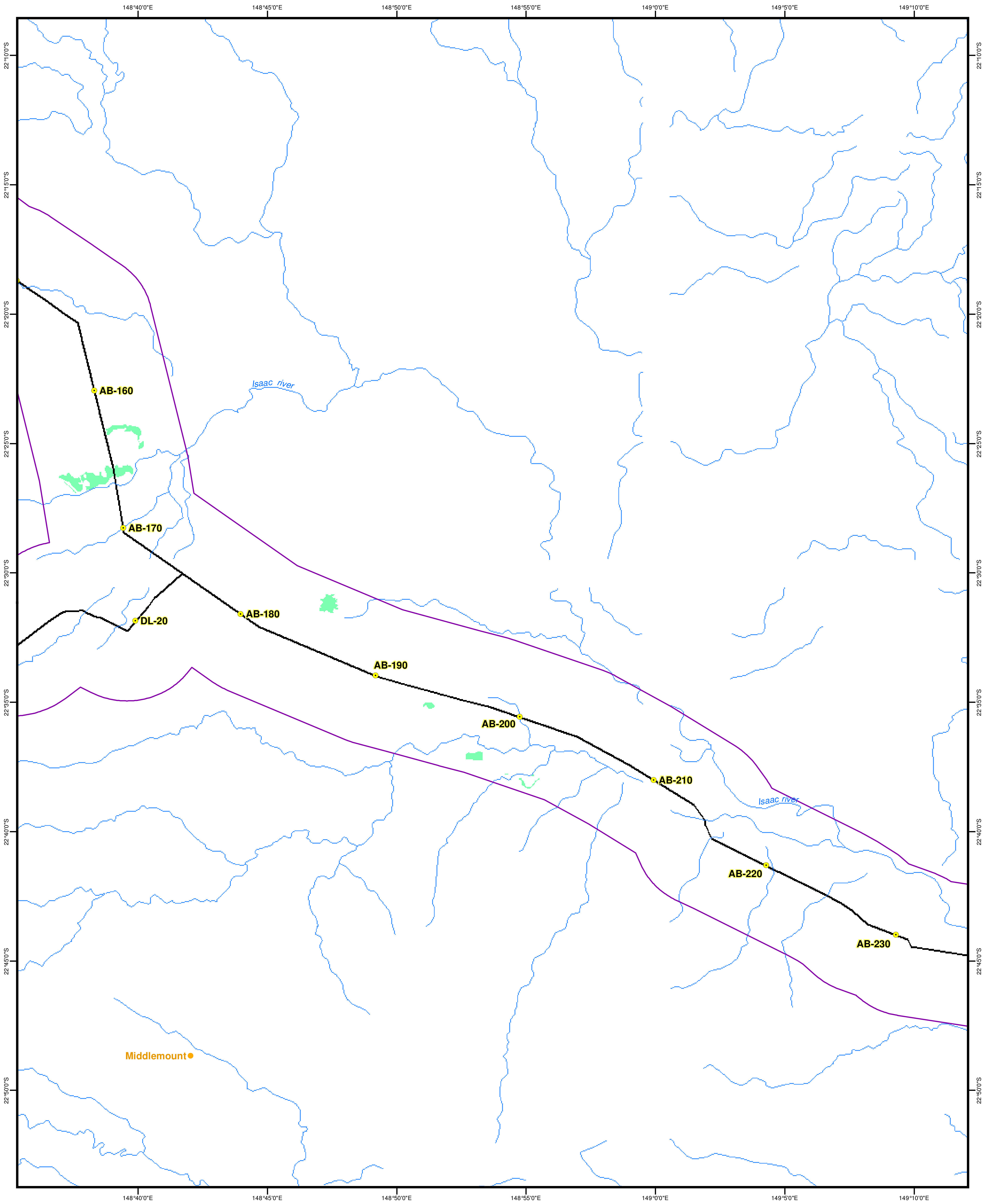
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 2 of 7

A3



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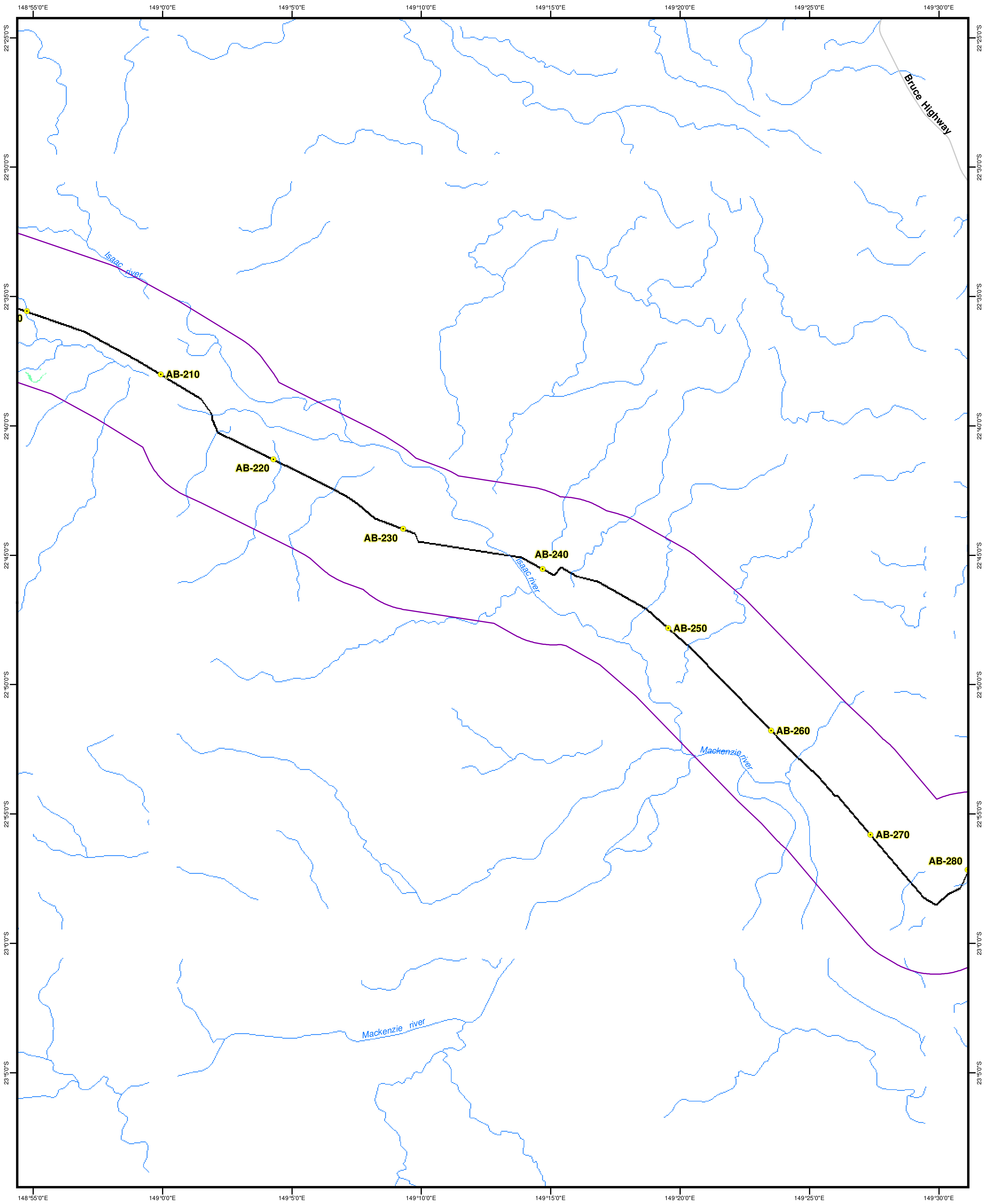
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

Arrow Energy Pty Ltd

Arrow Bowen Pipeline Revision H1

Page 3 of 7

A3



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—	**Main roads**
—	**ABP - Rev H1**
🟩	**Potential Habitat in Buffer (from State RE Mapping)**
☐	**Buffer (5 km)**

Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

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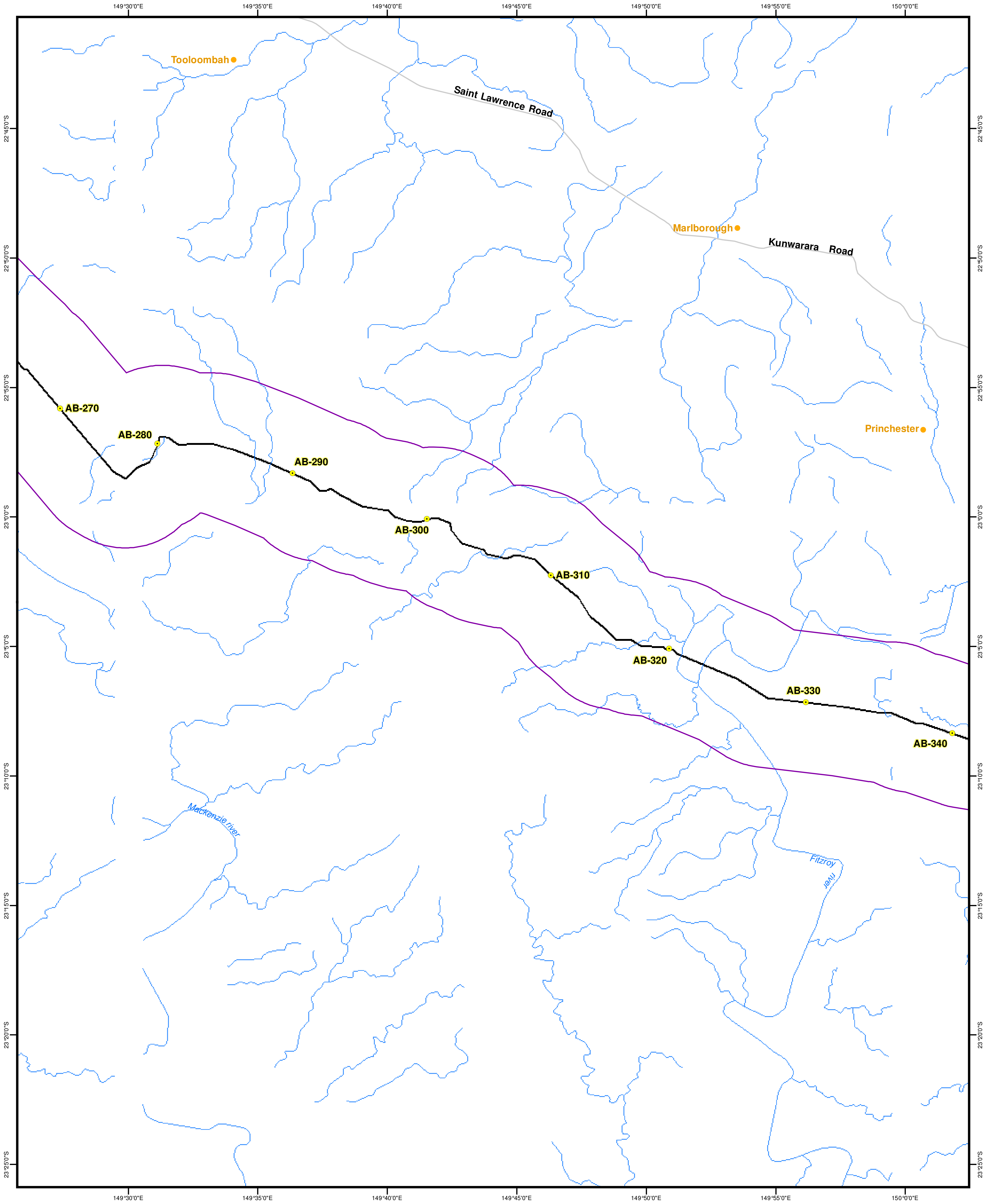
Arrow Bowen Pipeline
Revision H1



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—	**ABP - Rev H1**
☐	**Buffer (5 km)**

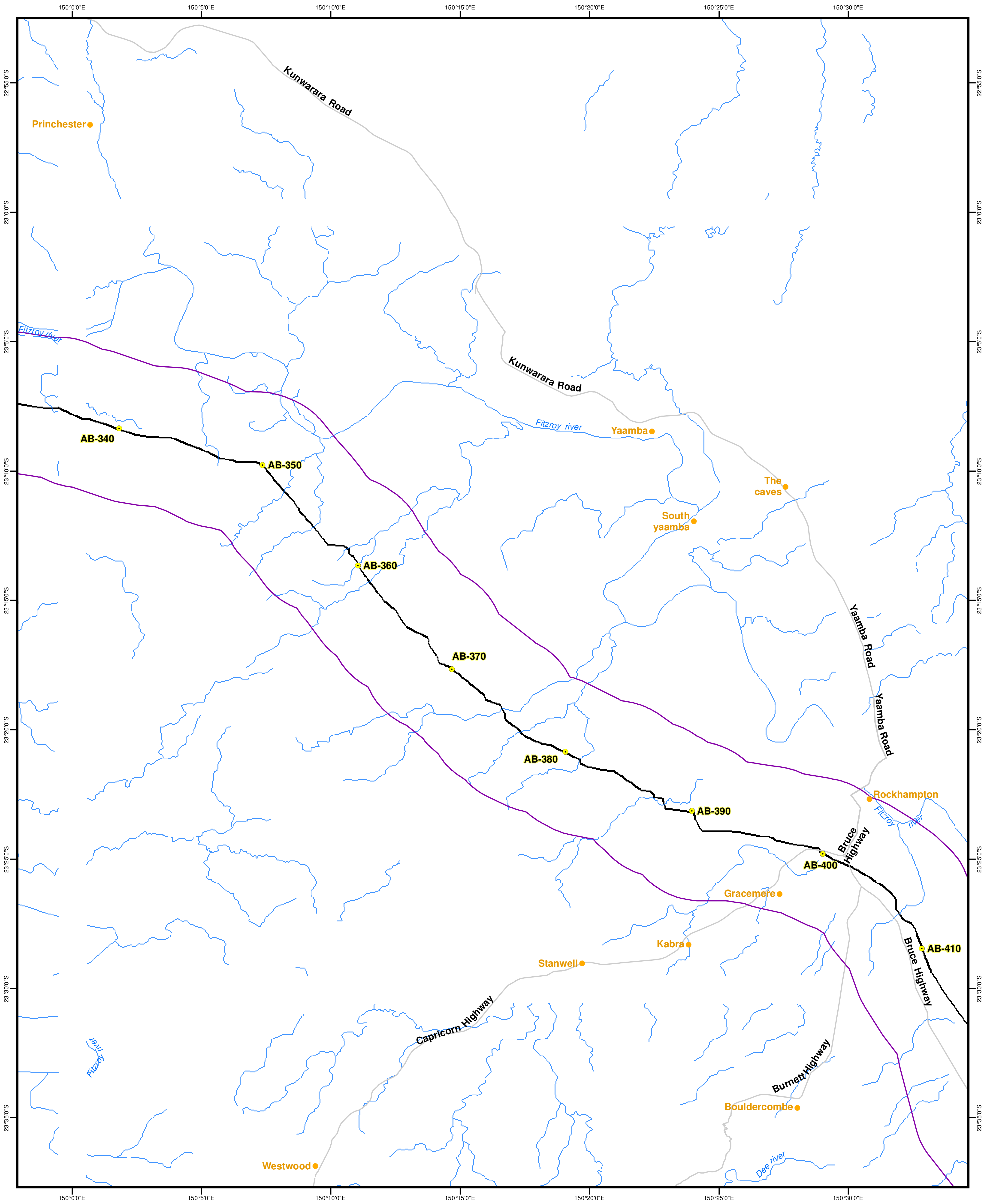
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

Arrow Energy Pty Ltd

Arrow Bowen Pipeline Revision H1

Page 5 of 7

A3



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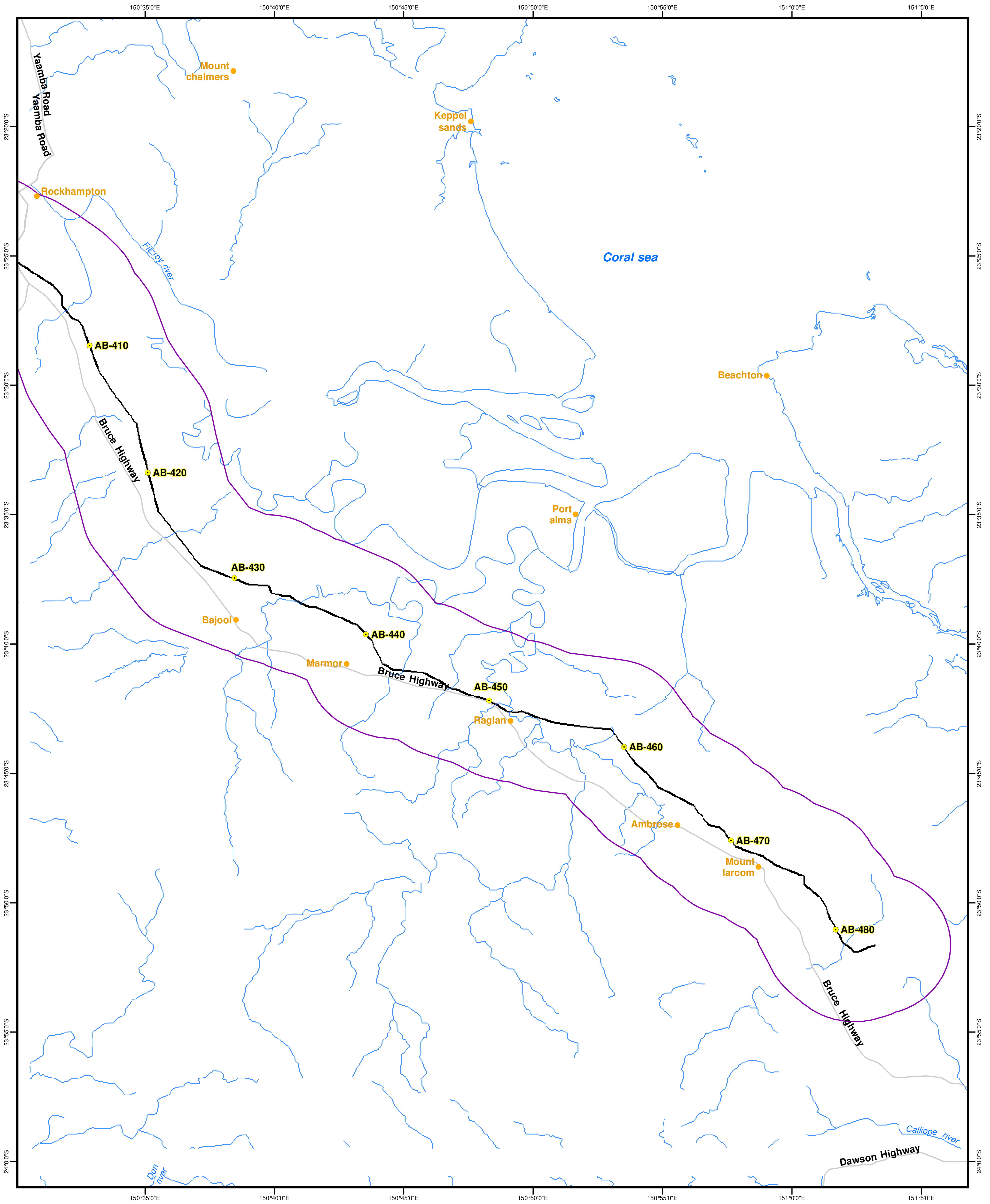
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

Arrow Energy Pty Ltd

Arrow Bowen Pipeline Revision H1

Page 6 of 7

A3



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Page 7 of 7

A3

1.4 Weeping Myall Woodlands

Source: 3D Environmental 2013

1.4.1 Conservation status

Queensland: Weeping Myall Woodlands Ecological Community occurs in Regional Ecosystem (RE) 11.3.2, which has an Of Concern biodiversity status

National: Endangered Ecological Community (EEC) under EPBC Act

1.4.2 Description

Weeping Myall Woodlands naturally occur as grassy or shrubby open woodlands (<10% foliage cover) to woodlands (10-30% foliage cover), and may include more than 80 species of plants. Weeping Myall Woodlands are generally 4 to 12 m high with Weeping Myall (*Acacia pendula*) the sole or dominant overstorey tree species. Other woodland species that may also form part of the overstorey include:

- Western Rosewood (*Alectryon oleifolius* subsp. *elongatus*)
- Poplar Box (*Eucalyptus populnea*)
- Black Box (*Eucalyptus largiflorens*)
- Grey Mistletoe (*Amyema quandang*) commonly occurs on the branches of weeping myall trees throughout the ecological community's range (DSEWPaC 2008).

Weeping Myall goes through regular cycles of senescence and regeneration, is susceptible to defoliation by Bag-shelter Moth (*Ochrogaster lunifer*) caterpillars and is often lopped for domestic stock fodder. Therefore, the ecological community can contain Weeping Myall trees that are living, defoliated or dead.

The understorey of Weeping Myall Woodlands often includes an open layer of shrubs above an open ground layer of grasses and herbs. In many areas, however, the shrub layer has disappeared through overgrazing and dieback events, resulting in a primarily grassy understorey (Beadle 1948). In the northern parts of the ecological community, summer-growing grasses such as Mitchell Grass (*Astrebla* spp.) and Queensland Blue Grass (*Dichanthium sericeum*) may be more abundant than in the south. The ground layer includes a diversity of grasses and forbs (Benson 2006, White et al. 2002).

1.4.3 Distribution

The Weeping Myall Woodlands Ecological Community occurs on the inland alluvial plains west of the Great Dividing Range in NSW and Queensland. It occurs in the Riverina, NSW South Western Slopes, Darling Riverine Plains, Brigalow Belt South, Brigalow Belt North, Murray-Darling Depression, Nandewar and Cobar Peneplain Bioregions (DSEWPaC 2008).

In Queensland, Weeping Myall woodlands are found in the following Natural Resource Management / Catchment Management Authority Regions (DSEWPaC 2009):

- Queensland Murray Darling (Border Rivers & Maranoa-Balonne)
- Condamine
- Fitzroy Basin
- South West Queensland
- Burnett-Mary.

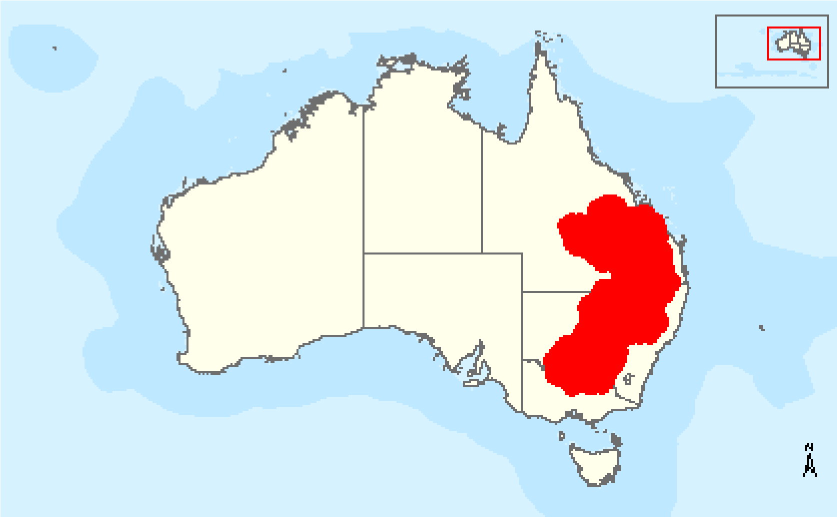


Figure 4 Distribution of Weeping Myall woodlands.

Source: (DSEWPaC 2008)

1.4.4 Habitat in Queensland

Although *Acacia pendula* occurs widely in Queensland, Weeping Myall Woodlands are restricted to small patches that occur within two Queensland REs, including (DSEWPaC 2009):

- 11.3.2 - *Eucalyptus populnea* woodland on alluvial plains
- 11.3.28 - *Casuarina cristata* ± *Eucalyptus coolabah* open woodland on alluvial plains.

The Queensland Herbarium assigns an Of Concern biodiversity status to both of these REs. It is not possible to estimate the exact proportion of each RE that comprises Weeping Myall Woodlands but it is likely to be small, at most 5% of the RE extent. Most patches of Weeping

Myall Woodlands are less than 1 to 2 ha in area (DSEWPaC 2013a).

Small patches of Weeping Myall trees may also occur in REs 11.9.3a and 4.9.6. However, these occurrences are on different landscape and soil types (undulating country on fine grained sedimentary rocks) to the landzone 3 regional ecosystems which occur on alluvial plains. Subsequently, they are not considered to be part of the listed ecological community (DSEWPaC 2008).

Weeping Myall Woodlands generally occur on flat areas, shallow depressions or gilgais on raised alluvial plains. They occur on black, brown, red-brown, grey clay or clay loam soils. The areas associated with this ecological community rarely flood and are not associated with active drainage channels (DSEWPaC 2009).

1.4.5 Threats

The main threats to the ecological community are clearing and ongoing degradation (DSEWPaC 2008, 2009). Weeping Myall occurs on highly fertile and arable soils where there is significant pressure to clear for cropping. Other threats include:

- overgrazing
- lopping for drought fodder
- weed invasion
- fertiliser and herbicide application
- loss of fauna from the ecological community
- increased levels of herbivory by caterpillars of the bag-shelter moth.

1.4.6 Recovery actions

No recovery plan has been prepared for the Weeping Myall Woodlands Endangered Ecological Community (EEC). DoE (DSEWPaC 2008) identifies the following priority recovery and threat abatement actions for the listed ecological community:

- protecting remnants of the listed ecological community through the development of conservation agreements and covenants
- the use of strategic grazing that allows regeneration
- replanting of understorey species where they have been depleted
- use of lopping methods that do not result in the death of the dominant tree species
- avoiding the application of fertilisers and herbicides in or near remnants
- protecting remnants from weeds including the speedy eradication of any new invasions
- raising awareness of Weeping Myall Woodlands within the community.

1.4.7 ABP survey results

A total of 18 occurrences of RE 11.3.2 were found on the ABP mainline, Saraji and Dysart laterals:

- 17 occur as pure 11.3.2
- two occur as a mixed community of 11.3.2 (75%) and 11.3.7 (25%)
- one occurs as a mixed community of 11.3.2 (50%) and 11.3.25 (50%).

Surveys were conducted in 12 sites containing RE 11.3.2 within the ROW and 18 sites adjacent to the ROW (up to 500 m from the centre line). No evidence of communities dominated by Weeping Myall was found in any of these surveys.

Based on existing survey results, it is unlikely that any Weeping Myall Woodlands occur within the ROW. However, all remaining areas of RE 11.3.2 within and adjacent to the ROW will be surveyed to confirm this finding before construction commences.

1.4.8 Impacts of ABP on Weeping Myall Woodland EEC

1.4.8.1 Potential impacts without mitigation

The project will have no direct or indirect impacts on this EEC, based on existing survey results.

Indirect impacts on adjacent communities could include an increase in weed densities.

1.4.8.2 Assessment of potential impacts with mitigation

If found within the ROW, stands of Weeping Myall are likely to be small and therefore can be avoided by minor route changes.

If surveys identify that removal of trees is unavoidable, offset provisions would apply under Commonwealth offset policies for Weeping Myall Woodlands, and under state offset policies for the Of Concern RE 11.3.2.

Weed risks will be managed in accordance with a weed management plan, which will incorporate weed hygiene measures to avoid introduction of new weeds and spread of existing weeds, weed control works before, during and after construction. A monitoring program will be implemented to evaluate the effectiveness of weed management and trigger contingency measures if performance criteria are not met.

The Project will implement a no-burning policy to manage activities that could cause fires and identify resources and emergency responses to any fire incident.

The potential impacts to Weeping Myall Woodlands from construction of the ABP (based on existing knowledge of occurrence within the ROW) and proposed mitigation measures to reduce the risk of impacts are listed in Table 3.

Table 11 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on Weeping Myall Woodlands

Impact	Raw Riskt before mitigation*	Mitigation measures	Residual Risk after mitigation*
DIRECT IMPACTS			
Removal of community Removal of Weeping Myall Woodlands	L	- survey all areas of RE 11.3.2 not yet ground-truthed within ROW to assess presence of EEC - if any Weeping Myall Woodlands found, investigate minor route revisions to avoid EEC - minimise clearing of RE 11.3.2, which can contain EEC - use existing cleared corridors where possible - rehabilitate the ROW following construction - clearly mark out areas to be cleared and retained	I
INDIRECT IMPACTS			
Changes in water quality Impacts to water leading to changes in habitat downstream	NA	- no mitigation measures for water quality recommended for this species as it is not dependent on riparian /wetland habitats	NA
Changes in hydrology Changes in hydrology of waterways caused by damming, changes in morphology or diversions	NA	- no mitigation measures for hydrology recommended for this species as it is not dependent on riparian / wetland habitats	NA
Soil degradation Erosion and sediment loss	L	- scarify or rip ROW after construction and before respreading topsoil to reduce soil compaction, improve water infiltration and promote vegetation regrowth - develop and implement an erosion and sediment control plan	I
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of populations	L	- EEC typically occurs in small (<2 ha) isolated patches, so appears tolerant to fragmentation effects - minimise areas of remnant vegetation to be cleared - use existing cleared corridors where possible - rehabilitate the ROW following construction	I
Increase in weed abundance -increased competition with native plant species -smothering of native vegetation -increased fuel loads and risk of wildfires	L	- develop and implement a Weed Management Plan - implement site weed hygiene protocols - control weeds in the ROW before, during and after construction - monitor to evaluate the effectiveness of weed management	I
Fire -damage to plants	L	- Implement a no-burning policy for the Project develop and implement an emergency response plan, which will manage activities that could cause fires and identify resources and emergency responses for any fire incident	I

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High, NA- Not applicable

1.4.9 Evaluation under MNES significant impact guidelines

Weeping Myall Woodlands generally occur as small areas (less than 1-2 ha) within RE 11.3.2. No Weeping Myall Woodland was detected during surveys of the majority of RE 11.3.2 within the ROW, but small areas could occur within unsurveyed areas of RE 11.3.2. Further surveys will be conducted to confirm that this EEC is not present in or adjacent to the ROW. If any patches are found, they are likely to be small enough to be easily avoided by minor route realignments.

The following assessments are based on existing information.

***Significant impact criteria*:**

Will the action reduce the extent of an ecological community?

Based on existing information the action will not result in reduction of the Weeping Myall Woodland ecological community. If any patches are found, they are likely to be less than 2 ha and therefore small enough to be easily avoided by minor route realignments.

Will the action fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines?

The Weeping Myall Woodland EEC typically occurs in small (<2 ha) isolated patches, so is likely to be tolerant to fragmentation effects. Based on existing information the action will not fragment or increase fragmentation of the ecological community.

Will the action adversely affect habitat critical to the survival of an ecological community?

Based on existing information the action will not adversely affect habitat critical for the survival of the ecological community. If patches are found within the ROW they could be avoided by minor route realignment.

Will the action modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community’s survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns?

Based on existing information the action will not modify or destroy abiotic or factors necessary for the survival of the ecological community. Post-construction rehabilitation of the ROW will re-establish original land profiles and drainage patterns according to a sediment and erosion management plan.

Will the action cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting?

Based on existing information the action will not cause a substantial change in species composition of the ecological community, or a decline or loss of functionally important species. An emergency response plan will detail appropriate fire management strategies during construction and operation of the pipeline.

Will the action cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

- assisting invasive species, that are harmful to the listed ecological community, to become established, or

- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community?

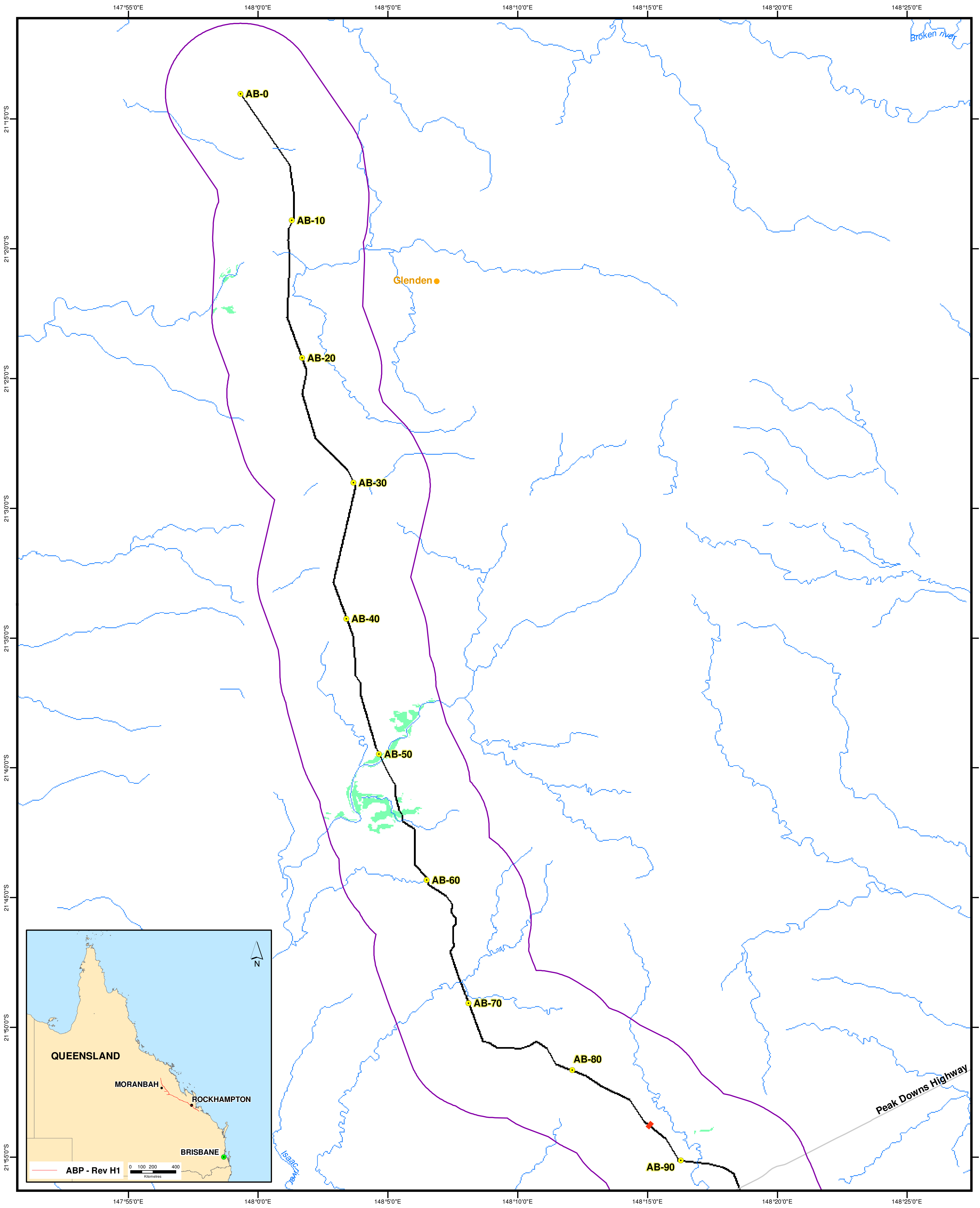
Based on existing information the action will not result in substantial reduction in the quality or integrity of the ecological community. A weed management plan will address potential invasive plant threats and reduce likelihood of adverse ecological outcomes (e.g. reduced regeneration potential, changed fire behaviour).

Will the action interfere with the recovery of an ecological community?

Based on existing information the action will not interfere with the recovery of the ecological community. If any patches are found, they are likely to be less than 2 ha and therefore small enough to be easily avoided by minor route realignments. The action is also unlikely to have any indirect impacts on Weeping Myall Woodlands.

1.4.10 Conclusion

No Weeping Myall was detected in or adjacent to the ROW during field surveys. Further targeted surveys may detect small patches of the community that meet the criteria for inclusion in the EEC. If Weeping Myall is found it is likely that it can be avoided by minor route changes. Provided that mitigation measures outlined in management plans are effectively implemented, indirect impacts are expected to be of a short duration and are not expected to affect Weeping Myall communities.



Document
BE004_MP_006J_Weeping_Myall_RevH1

Job Number: BE004

Approved GIS Team Leader	BN	30/08/2013

R0	BN	CF	ISSUED TO CLIENT	29/08/2013
REV	By	CHK	Description	Date

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Kilometres

Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

●	**City or town**
⊙	**Kilometre Point**
~	**Waterway or Coast Line**
—	**Main roads**
—	**ABP - Rev H1**
🟥	**Potential Habitat in ROW (Field Verified)**
🟩	**Potential Habitat in Buffer (from State RE Mapping)**
☐	**Buffer (5 km)**

Weeping Myall

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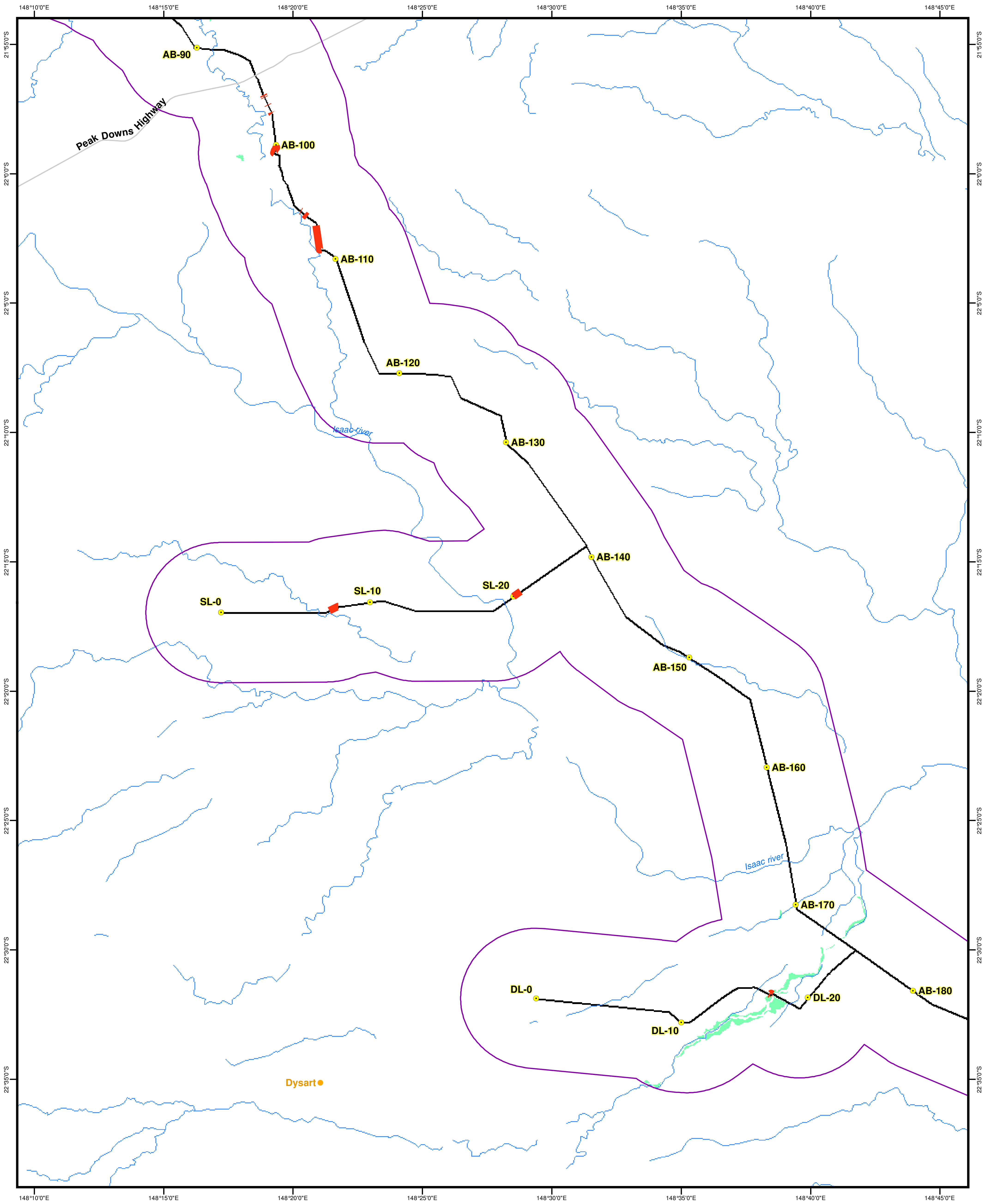
Arrow Bowen Pipeline Revision H1

Page 1 of 7

A3



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- ▭ Buffer (5 km)

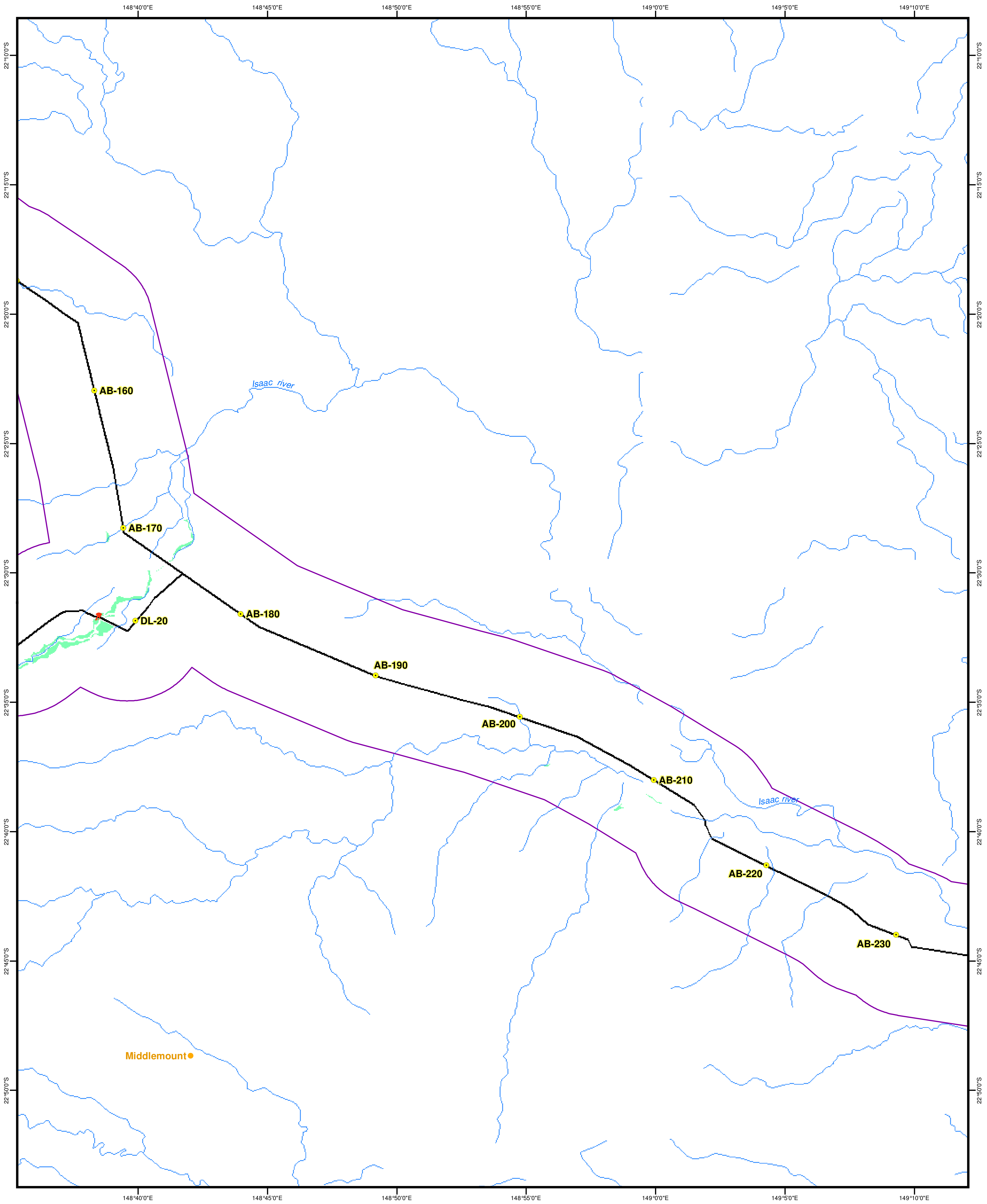
Weeping Myall

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 2 of 7

A3



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Weeping Myall

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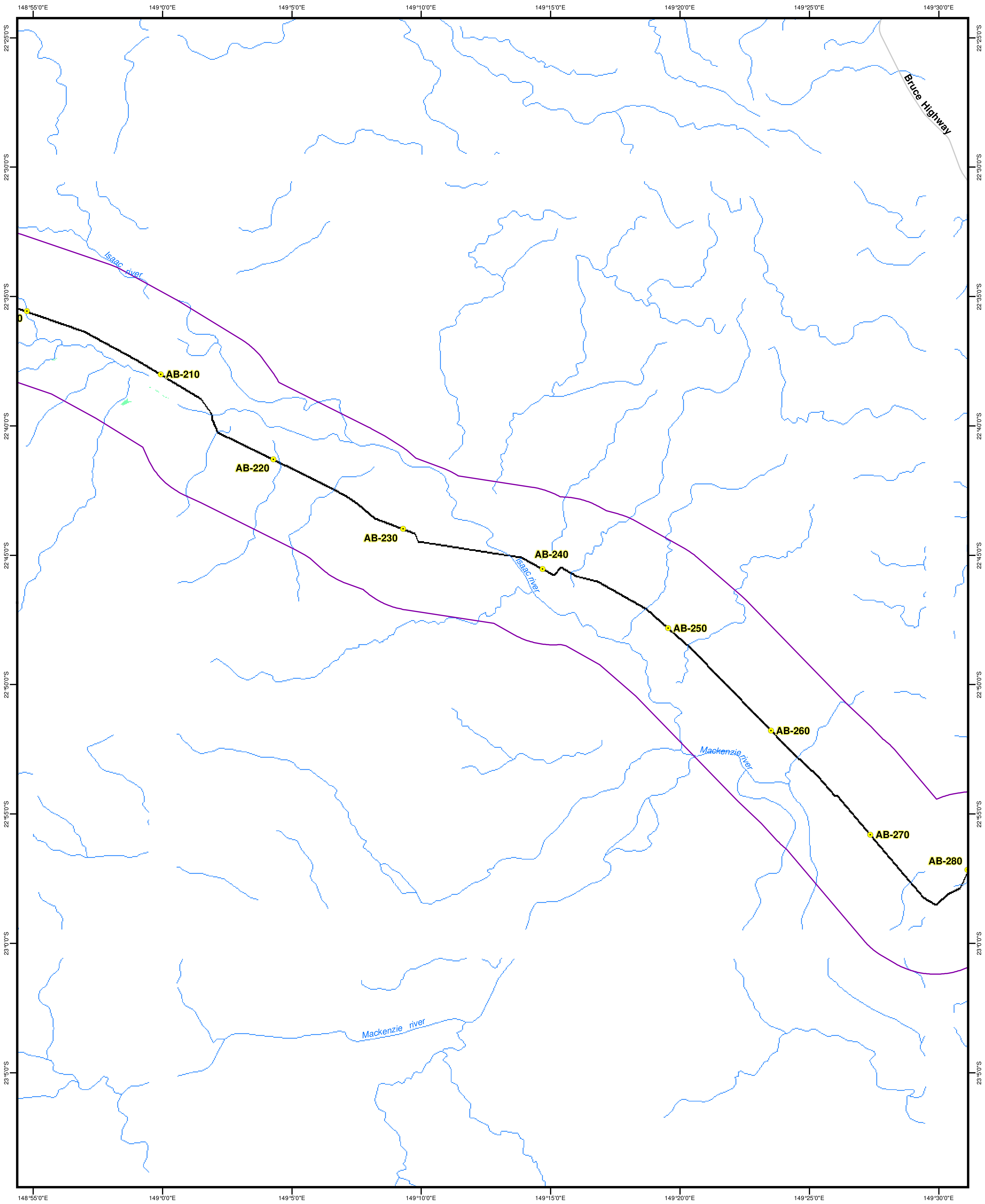
Arrow Bowen Pipeline
Revision H1

Page 3 of 7

A3



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Weeping Myall

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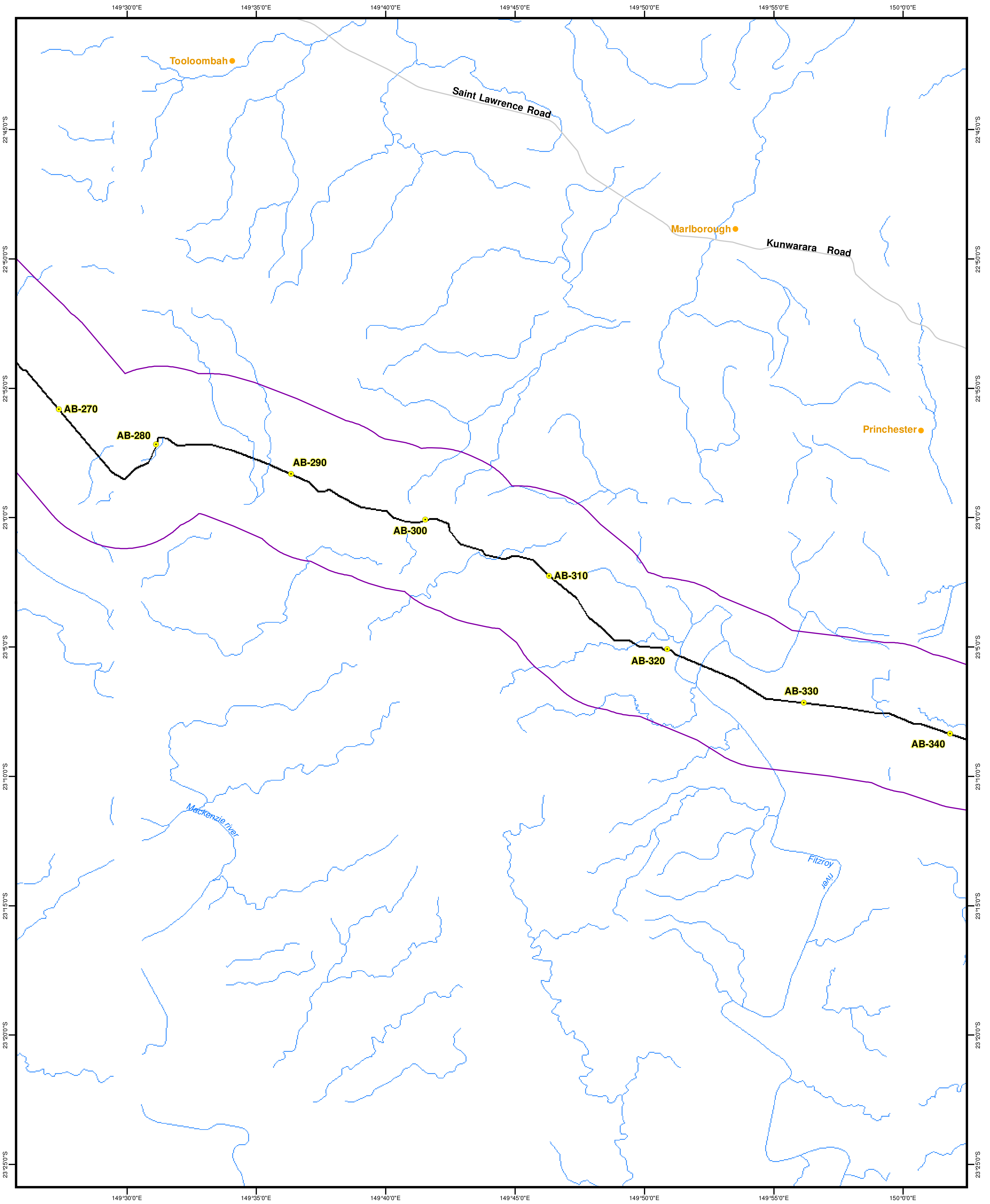
Arrow Bowen Pipeline
Revision H1

Page 4 of 7

A3



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—	**Main roads**
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▭	**Buffer (5 km)**

Weeping Myall

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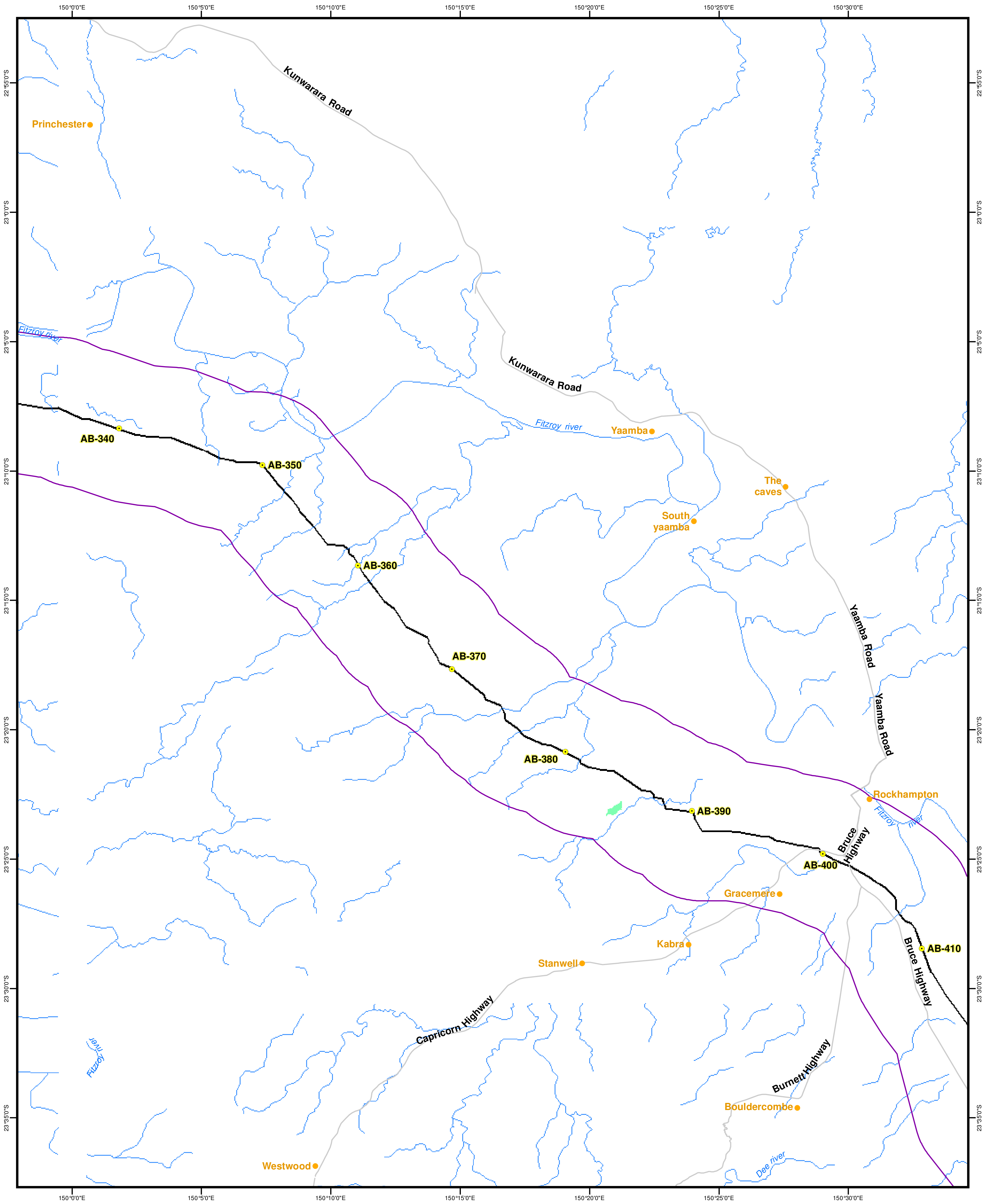
Arrow Bowen Pipeline
Revision H1

Page 5 of 7

A3



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Weeping Myall

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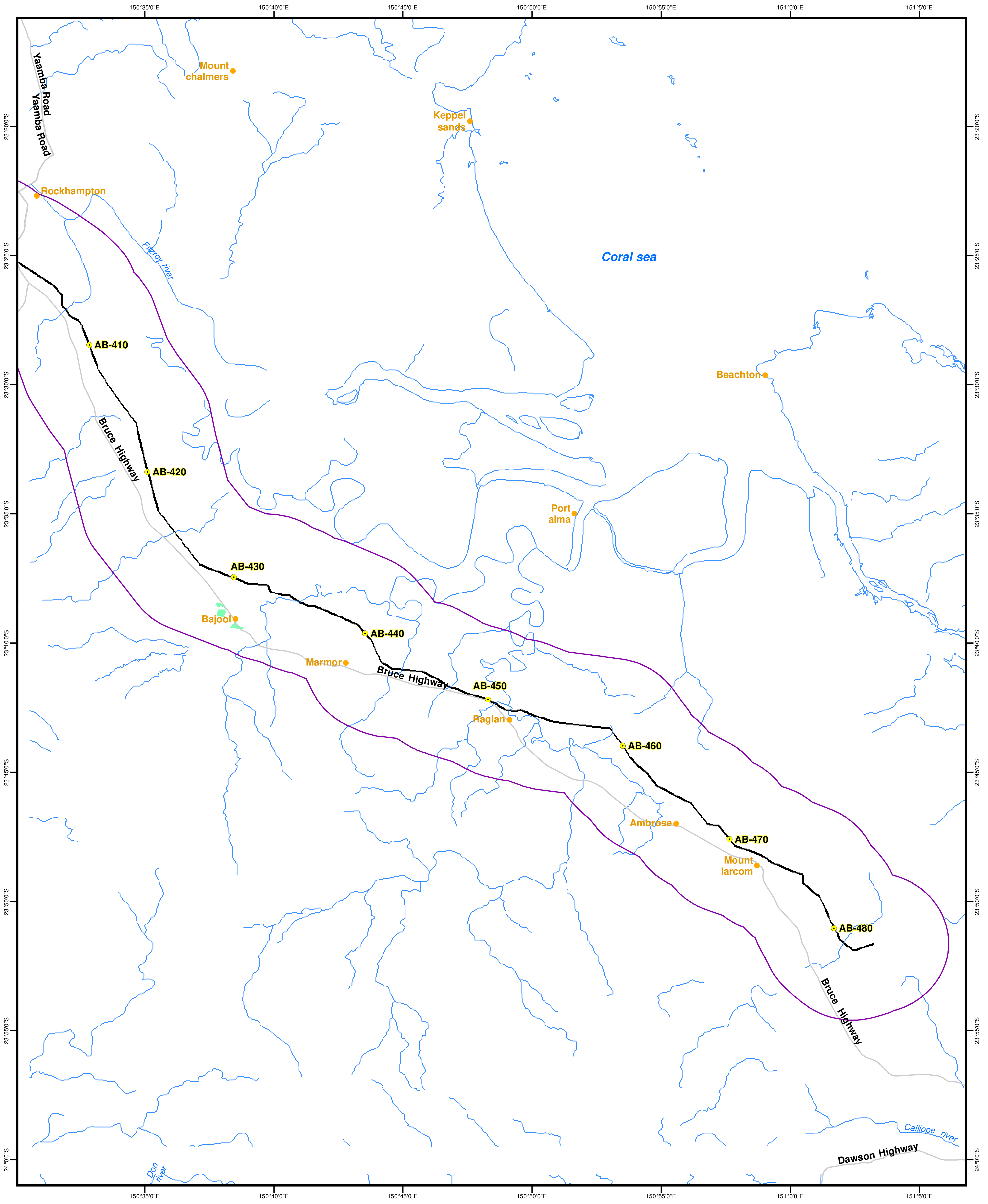
Arrow Bowen Pipeline Revision H1

Page 6 of 7

A3



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Revision H1

Page 7 of 7

A3

2 Fauna

A summary of the impacts to EPBC fauna is presented in Table 12. An overview of critical habitat for EPBC listed fauna species is presented in Appendix 1.

Table 12 Summary of Impacts to EPBC Fauna

	Potential Habitat				**Essential Habitat**	**Critical Habitat**	
Species	**REs containing potential habitat in ROW**	**Area in ROW (ha)**	**Area in 5 km buffer (including REs not in the ROW) (ha)**	**% of potential habitat in 5 km buffer that occurs within ROW**	**Area in ROW (ha)**	**Criteria for defining Critical Habitat as defined in EPBC Significant Impact Guidelines.**	**Area in ROW (ha)**
Yakka Skink (*Egernia rugosa*)	11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.7, 11.3.25, 11.3.26, 11.3.36, 11.5.3, 11.5.9, 11.5.12, 11.7.2, 11.8.5, 11.9.2, 11.9.9.	254.65	107601.2	0.23	0	None identified	0
Ornamental Snake (*Denisonia maculata*)	11.3.3	5.3	2459.59	0.08	0	None identified	0
Dunmall's Snake (*Furina dunmalli*)	11.3.2, , 11.3.3, 11.3.4, 11.3.7, 11.3.26, 11.3.36, 11.5.3, 11.5.8, 11.5.9, 11.7.2, 11.9.7, 11.9.9, 11.11.1, 11.11.4, 11.11.15, 11.11.16, 11.12.2	218.12	128313.05	0.17	0	None identified	0
Water Mouse	11.1.1, 11.1.2, 11.1.4	1.66	5448.77	0.30	0	Mangrove communities	1.66[1]

---

[1] This habitat fits the critical habitat definition under the guidelines abut has been surveyed as marginal in comparison to better habitat downstream. This critical habitat will be completely avoided by using HDD to cross Inkerman and Raglan Creeks.

	Potential Habitat				Essential Habitat	Critical Habitat	
Species	**REs containing potential habitat in ROW**	**Area in ROW (ha)**	**Area in 5 km buffer (including REs not in the ROW) (ha)**	**% of potential habitat in 5 km buffer that occurs within ROW**	**Area in ROW (ha)**	**Criteria for defining Critical Habitat as defined in EPBC Significant Impact Guidelines.**	**Area in ROW (ha)**
(*Xeromys myoides*)						and other intertidal communities or coastal freshwater wetlands with intact hydrology, prey resources, nest mounds	
Koala (*Phascolarctos cinereus*)	11.3.2, 11.3.3, 11.3.4, 11.3.7, 11.3.25, 11.3.26, 11.3.36, 11.5.3, 11.5.9, 11.9.2, 11.9.9, 11.11.1, 11.11.4, 11.11.15, 11.11.16, 11.12.2	203.55	109606.07	0.18	0	REs dominated by primary food tree species	17.97
Grey-headed Flying-fox (*Pteropus poliocephalus*)	11.1.4, , 11.3.4, 11.3.25, 11.3.26, 11.11.4, 11.11.16	14 (1.18 ha of roosting and 14 ha of foraging habitat) (from Rockhampton to Gladstone)	5636.9	0.266	0	None identified	0
Yellow Chat	11.33.27a, 11.3.27b,	7.17	8359.78	0.08	0	Wetlands and associated	0

	Potential Habitat				Essential Habitat	Critical Habitat	
Species	**REs containing potential habitat in ROW**	**Area in ROW (ha)**	**Area in 5 km buffer (including REs not in the ROW) (ha)**	**% of potential habitat in 5 km buffer that occurs within ROW**	**Area in ROW (ha)**	**Criteria for defining Critical Habitat as defined in EPBC Significant Impact Guidelines.**	**Area in ROW (ha)**
(*Epthianura crocea macgregori)*	11.3.27c, 11.3.27x1a, 11.3.27x1b, 11.3.3c, non-remnant, 11.1.4d, 11.1.4, 11.3.27x1b					grasslands on seasonally inundated marine plains	Marginal[2]
Squatter Pigeon (*Geophaps scripta scripta*)	11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.7, 11.3.25, 11.3.26, 11.3.36, 11.5.3, 11.5.9, 11.5.12, 11.8.5, 11.8.11, 11.9.9, 11.11.1, 11.11.4, 11.11.15, 11.11.16, 11.12.2	267.49	130078.99	0.2	0	None identified	0

---

[2] Surveys of the areas identified as critical habitat during the desktop surveys, found that the habitat on Raglan, Twelve Mile and Inkerman Creeks is marginal habitat and is unlikely to be used by significant numbers of Yellow Chat or used for breeding.

2.1 *Denisonia maculata* (Ornamental Snake)

Photo taken by Ben Nottidge, Green Leaf Ecology

2.1.1 Conservation Status

Queensland: Vulnerable under the NC Act

National: Vulnerable under the EPBC Act

2.1.2 Description

The Ornamental Snake is a brown, grey-brown or black snake with distinctly barred lips and a white/cream belly. They grow to approximately 50 cm and when sexually mature, have a minimum snout-vent length of 24.7 cm for females and 23.0 cm for males (Shine 1983). The mid-body scales are smooth and in rows of 17 (EHP 2012).

2.1.3 Distribution

The Ornamental Snake is known to inhabit the north and south sub-regions of the Brigalow Belt bioregion. The species' core distribution occurs within the drainage system of the Fitzroy and Dawson Rivers (McDonald et al. 1991; Cogger et al. 1993).

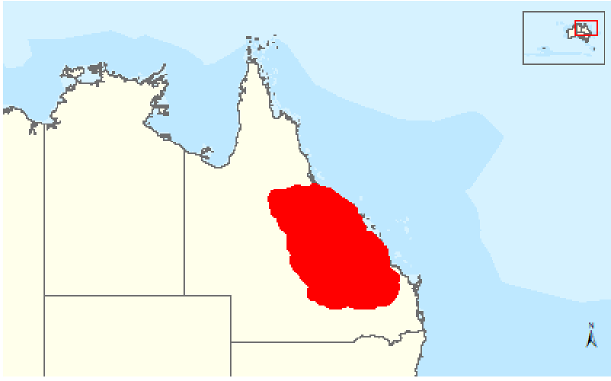


Figure 5 Distribution of *Denisonia maculata*

Source: DSEWPaC 2013a

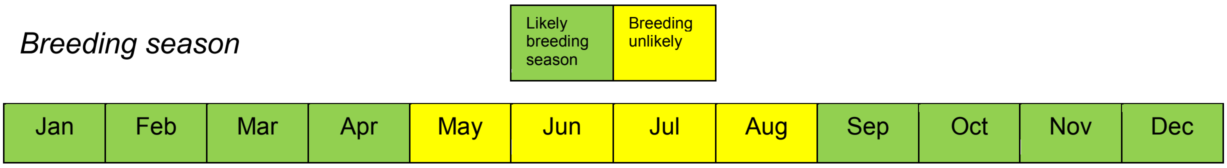
2.1.4 Habitat

The Ornamental Snake prefers habitat that is close to its prey (frogs). It is found in vegetation communities dominated by Brigalow (*Acacia harpophylla*), Gidgee (*Acacia cambagei*), Blackwood (*Acacia argyrodendron*) or Coolibah (*Eucalyptus coolabah*). It prefers moist woodlands and open forests, particularly gilgai (melon-hole) mounds, as well as lake margins and wetlands (Brigalow Belt Reptiles Workshop 2010; Wilson & Knowles 1988). The species typically seeks refuge during dry periods within soil cracks on gilgai mounds (Brigalow Belt Reptiles Workshop 2010). DoE (DSEWPaC 2013a) states that Ornamental Snake is known to occur in REs 11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.3.3 and 11.5.16. Recent surveys for Arrow Energy near Moranbah have recorded large numbers of Ornamental Snakes in cleared and disturbed paddocks that contain cracking soils and gilgais (C. Free, pers. obs.).

2.1.5 Ecology

The Ornamental Snake feeds predominantly on a range of frog species. It is a viviparous (live-bearing) species with a mean litter size of 6.8 (Shine 1983). The breeding season for this species is unknown but is likely to coincide with abundance of frogs in the wet season.

Breeding season



🟩	🟨
Likely breeding season	Breeding unlikely

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩

2.1.6 Activity period

Ornamental Snakes are nocturnally active. They shelter during the day in deep soil cracks, or under fallen timber, rocks and bark. The species is thought to be active throughout the warmer months, with peak activity likely to be in early summer. The snake can remain inactive for months throughout dry times in suitable shelter sites (DSEWPaC 2013a; Shine 1983). A high abundance of snakes was observed to coincide with an abundance of young frogs emerging from an ephemeral pool (DSEWPaC 2013a).

2.1.7 Threats

Identified threats to this species include (DSEWPaC 2013a):

- inadequate knowledge of the species
- habitat loss through clearing for activities such as roads, ploughing (including levelling of gilgaied microtopography), railways, mining-related activities, pipeline constructions
- habitat fragmentation
- habitat degradation by overgrazing by stock, especially cattle
- grazing of gilgais during the wet season leading to soil compaction and compromising of soil structure
- alteration of landscape hydrology in and around gilgai environments
- alteration of water quality through chemical and sediment pollution of wet areas
- ingestion of cane toads
- predation by feral species
- invasive weeds.

2.1.8 DoE recommended survey methods

No survey methods are known to reliably detect the Ornamental Snake during the dry season. The species is most likely to be encountered by:

- searching around suitable gilgai habitat while frogs are active, approximately 1–3 days following heavy rainfall (greater than 5 mm), especially thunderstorms
- driving on roads at night, after wet weather when frogs are active, may be necessary if wet weather precludes access to suitable (gilgai) habitat
- diurnal searches under sheltering sites (rocks, logs or other large objects on the ground)
- pitfall and funnel trap arrays could be trialled (DSEWPaC 2011a; DSEWPaC 2013a).

The species has also been found in abundance 3 to 4 weeks after heavy rainfall when young frogs are emerging in and around gilgais/wetlands. The optimal climatic conditions for the Ornamental Snake occur with the combination of high temperatures, humidity and electrical storms which typically occur from January to mid-March.

2.1.9 Survey effort and methods undertaken for ABP

Targeted surveys for Ornamental Snake were conducted at four sites during the summer survey period in December 2011. Surveys in winter 2011 and spring 2011 also sampled sites containing preferred habitat of this species.

Survey techniques included pitfall trapping, active searching, and spotlighting on foot and from a car travelling at slow speed.

Targeted surveys conducted during the summer survey period in December 2011, involved thirty minutes of nocturnal spotlighting on foot along roads and ground habitat within each site. Spotlighting was also completed along roads and tracks whilst travelling between sites.

Sampling undertaken during the spring survey period in September 2011 included pitfall trapping with drift fences. The standard pitfall trapping effort for each site was 3 buckets along a 30 m drift fence for a minimum of 4 nights, used in conjunction with funnel traps. Pitfall traps were not able to be installed at every site due to difficult substrates.

Sampling for reptiles during the winter survey period in June/July 2011 focussed on active searching under potential shelter sites. Each site was actively searched for thirty minutes. Searches were undertaken before mid-morning (i.e. before reptiles had reached their optimal body temperature).

2.1.10 Comparison with DoE guidelines

The effort conducted during the field surveys for this species is shown in Table 13 along with the effort recommended under the DoE guidelines. It must be noted that the guidelines are recommendations only and surveys are ongoing.

Table 13 Actual and DoE recommended survey effort for ornamental snake in suitable habitat

Method	Actual effort	SEWPC
Spotlighting and active search (hours)	5 (5 sites) x 2 hours = 10	7.26
Trap effort (trap nights)	3 traps for 4 nights = 12	12

2.1.11 ABP survey results

This species was not recorded within the ROW but was detected in the surrounding study area. ABP surveys recorded Ornamental Snake in alluvial woodland 6 km south west of KP 166, 6.3 km south west of KP 166 and 3 km south west of KP 206.1 on the revision SR mainline.

Potential habitat for Ornamental Snake in the ROW is summarised in Table 2. Only 5.3 ha of remnant vegetation (RE 11.3.3) suitable for Ornamental Snake occur within the ROW. Additional REs found on cracking clay soils within the buffer may provide good habitat for Ornamental Snake prey species. Recent surveys completed for Arrow Energy near Moranbah suggest that the species can also occur in highly modified and disturbed habitats (e.g. buffel grass paddocks) that contain clay soils with gilgais. The *Referral guidelines for nationally threatened Brigalow Belt reptiles* does not identify critical habitat for this species and given that this species also occurs in non-remnant habitat it is unlikely that any critical habitat occurs in the ROW. An assessment of the impacts on this potential habitat is discussed in Section 1.1.12.

Table 14 Remnant REs that contain potential habitat for Ornamental Snake within the ROW (based on field verified REs).

RE	RE description	Potential habitat area in the ROW (ha)	Potential habitat in the 5 km buffer (ha)	% of buffer*	Critical habitat in the ROW (ha)
11.3.3	Eucalyptus coolabah woodland on alluvial plains	5.3	3941.48	0.13	0
	Other REs containing suitable habitat in the 5 km buffer	0	2459.59	0	
	Totals	5.3	6401.07	0.08	0

***** percent of the potential habitat within the ROW which is contained within the 5 km buffer .

2.1.12 Impacts of ABP on Ornamental Snake

2.1.12.1 Potential impacts without mitigation

Ornamental Snakes inhabit woodlands and disturbed cleared habitat on clay soils. They remain in soil cracks during the day and emerge at night to feed on frogs. Impacts associated with the proposed project could include:

- temporary loss of remnant woodland vegetation that could provide habitat for Ornamental Snake
- trenchfall
- increased pest animal abundance associated with improper disposal of food waste
- damage to soil structure including soil compaction, destruction of gilgais and destruction of soil cracks
- direct mortality through excavation and collisions with vehicles during construction, operation and maintenance.

2.1.12.2 Assessment of potential impacts with mitigation

Table 2 summarises potential direct and indirect impacts of the project on Ornamental Snake populations and proposed measures to mitigate potential impacts. The table provides a risk assessment for each impact with and without mitigation measures.

Table 15 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on Ornamental Snake.

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
DIRECT IMPACTS			
Removal of habitat Removal of vegetation which could provide potential foraging, breeding and sheltering habitat	L	- minimise areas of remnant vegetation to be cleared on deep cracking clay soils -use existing cleared corridors where possible -clearly mark out areas to be cleared and retained	I

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
		- -rehabilitate the ROW following construction	
Trenchfall Death of individuals trapped in the trench	M	-monitoring of open trenches by fauna spotter catchers during the construction period -minimise the length of time the trench is open - if possible, install drift fencing to prevent animals from falling in the trench - install ramps in the trenches to allow animals to escape	I
Fatalities Death of individuals via vehicles and equipment during clearing, construction and operation	M	-maintain an appropriate speed limit in the ROW especially in areas where the ROW goes through remnant vegetation -employ a spotter catcher to check microhabitat prior to clearing to remove individuals before clearing commences -if possible use pre-clearance trapping or spotlighting in areas with cracking clay soils to capture individuals prior to clearing -employ a spotter catcher to be on hand during clearing to move displaced animals -avoid working at night when Ornamental Snakes are active and potentially present on the ROW or access tracks	I
INDIRECT IMPACTS			
Changes in water quality Impacts to water quality upstream leading to changes in vegetation/habitat downstream	I	Temporary disturbance during construction is not likely to affect the downstream vegetation or habitat.	I
Changes in hydrology Changes in wet/dry cycling of waterways caused by damming, changes in morphology or diversions	I	Temporary disturbance during construction is not likely to affect the downstream vegetation or habitat.	I
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of population	L	-minimise areas of remnant vegetation on deep cracking claysoils to be cleared -use existing cleared corridors where possible -rehabilitate the ROW following construction	I
Increase in weed abundance -increased competition with native plant species used for foraging and shelter. -smothering of native vegetation	L	-develop and implement a Weed Management Plan -control weeds in the ROW before and after construction -implement site weed hygiene protocols	I
Increase in introduced predator abundance Increase in introduced predator abundance caused by increased food availability in the ROW	L	-develop and implement a Waste Management Plan -develop and implement a Pest Management Plan -educate staff about the importance of removing any food waste from the ROW -keep the work site clean of debris which could be used as -shelter for introduced predators	I
Removal of micro-habitat Removal of logs, leaf litter and debris, cracking clays, gilgais	L	-rehabilitate the ROW following construction -reinstate microhabitat such as logs, rocks and leaf litter after construction	I
Noise and disturbance Disturbance caused by noise or human disturbance leading to stress, disease and abandonment of habitat.	N/A	-no mitigation measures for noise are recommended for this species as it is not likely to be impacted by noise created during the day -ensure staff stay within the ROW and do not disturb neighbouring habitats	N/A
Spread of disease	N/A	-no mitigation measures for reducing the spread of disease are recommended for this species as there are no known diseases for this species which could be spread by human activities	N/A

I-Insignificant, L- Low, M – Moderate, H – High, E- Extremely High; N/A – impact not applicable to this species.

The project will result in the temporary loss of some remnant vegetation on deep cracking clay soils that could provide habitat for Ornamental Snake. However, Ornamental Snakes also inhabit highly modified grazing areas dominated by introduced pasture grasses with cracking clay soils (DSEWPaC 2013a). The temporary loss of remnant vegetation is unlikely to impact Ornamental Snake populations given that they also occur in highly modified and disturbed habitats. Impacts will be further reduced by progressive construction of the pipeline within the ROW (which will limit the extent of disturbance at any one time) and progressive rehabilitation immediately following construction (which will restore suitable habitat and microhabitat features). Gilgais and soil cracks will reform naturally with alternating swelling and shrinking of clay soils during the wet/dry cycle. The impact on this species from clearing of habitat is therefore considered to be **Insignificant**.

There is a small chance that Ornamental Snake could fall into open trenches. Before clearing and construction commence, pre-clearance surveys will be undertaken to relocate as many individuals as possible to adjacent suitable habitat. During construction, trench inspection, by trained fauna handling personnel, will occur every morning to check for animals (including Ornamental Snakes) that may have fallen into the trench overnight. Works will be undertaken progressively to minimise the length of trench open during construction at any one time. Refuges (such a moistened sacks) will also be placed within the trench for shelter to reduce mortalities. If any snakes are detected in the trenches, they will be safely captured and released into suitable habitat a safe distance from where the works are occurring. With the implementation of proposed mitigation measures, the impact of trenchfall on Ornamental Snake is considered to be **Insignificant.**

There is a moderate chance that an Ornamental Snake could be killed or injured during clearing or construction activities as a result of vehicle strike or excavating in cracking clay soils. Pre-clearance surveys will be conducted along the ROW prior to construction to remove any snakes found within the ROW. A spotter catcher will be on hand during clearing to remove any animals found during excavation. Therefore the impact of direct fatalities on Ornamental Snake populations is considered to be **Low**.

With mitigation measures, construction of the pipeline is not expected to change the risks to Ornamental Snakes from the introduction of pests. Introduced predators (such as foxes and cats) are present and active in the area. Reasonable management measures, such as the removal of food waste from the ROW or induction programs which stress non-feeding of animals will ensure a Low level of risk from pests.

Ornamental Snakes rely on soil cracks and debris (logs, etc.) for shelter. The temporary removal of this micro-habitat in the ROW could impact Ornamental Snake populations in the local area. However, logs and debris removed from the ROW will be placed back in the ROW after construction so the loss of these features will only be temporary. Topsoil will be reinstated following construction and soil compaction will be relieved by scarification and / or ripping. Soil cracks and gilgais will reform naturally with alternating swelling and shrinking of clay soils over time. Therefore, the impact of removal of micro-habitat on Ornamental Snake is likely to be **Low**.

Overall the impact of the ABP project on Ornamental Snake is considered to be **Low** provided that all the mitigation measures listed in Table 2 are implemented.

2.1.13 Evaluation under MNES significant impact guidelines

The *Draft referral guidelines for nationally threatened Brigalow Belt reptiles* states that important habitat should be used as a surrogate for important population during assessments involving Brigalow Belt reptiles. If the habitat is considered important under any of the “important habitat” criteria, then the habitat is deemed to be important habitat. Important micro-habitats for Ornamental Snake include gilgai depressions and mounds. Habitat connectivity between gilgais and other suitable habitats is also important. The presence of important habitat is assessed under the four criteria specified in the guidelines.

Suitable habitat for this species is considered important habitat if it is any of the following:

Habitat where the species has been identified during a survey

This species was not recorded within the ROW but was detected in the surrounding study area.

ABP surveys recorded Ornamental Snake in alluvial woodland 6 km south west of KP 166, 6.3 km south west of KP 166 and 3 km south west of KP 206.1 on the revision SR mainline.

Near the limits of the species known range

The pipeline runs through the known and likely range of the species. The action will not impact habitat at the limits of the species known range. The habitat in the ROW is not important habitat based on this criterion.

Large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations)

The pipeline will disturb large patches of remnant vegetation within corridors that could be used for dispersal. Recent surveys have found that the species can also occur in non-remnant land with suitable cracking soils, gilgais and frogs. The temporary disturbance and the occurrence of this species in non-remnant land indicates that the pipeline will not disturb important habitat.

A habitat type where the species is identified during a survey, but which was previously thought not to support the species

Surveys of the ABP recorded this species only in habitat already known to support the species. The habitat in the ROW is not important habitat based on this criterion.

Is there an important population of this species in the study site?

The ABP pipeline contains habitat where the species has been identified during a survey and areas of suitable habitat that could be used for breeding and dispersal.

Surveys undertaken for this species on the ROW have not recorded any of this species present within the ROW. Consequently, the possibility that important populations may be present is regarded as unlikely.

Will the action lead to a long-term decrease in the size of an important population of a species?

The proposal will temporarily clear potential habitat for Ornamental Snake. However, construction of the pipeline will be progressive with clearing and rehabilitation occurring continuously within the designated ROW so that only a small amount of potential habitat will be impacted at any one time. Additionally, rehabilitation will be ongoing and clearing effects will be short-term. Ornamental Snakes inhabit modified and disturbed habitats including pasture. Consequently, provided mitigation measures listed in Table 2, particularly those related to soil compaction, trenchfall and direct mortality are implemented, the action is unlikely to result in a significant decline in an important population of Ornamental Snakes.

Will the action reduce the area of occupancy of an important population of a species?

The proposal is unlikely to lead to a permanent decrease in the area of occupancy for this species as the species will inhabit heavily modified habitats that contain important microhabitat features such as soil cracks, gilgais and suitable prey habitat. Provided that soil structure is maintained through the stockpiling and replacement of soil in the original profile, landscape topography is restored and logs are returned to the ROW following construction, the action in unlikely to lead to a reduction in occupancy of an important population.

Will the action fragment an existing important population into two or more populations?

Clearing will result in the short-term partial fragmentation of remnant vegetation by the construction of a 40 m ROW. However, the majority of the ROW (except for a 7 m wide track) will be allowed to regenerate to a habitat of similar quality to that present before construction. Further, this species occurs in heavily modified open habitats (e.g. buffel grass grazing paddocks) so is unlikely to be impacted by clearing of remnant vegetation within the ROW. The action is therefore unlikely to lead to fragmentation of an important population of Ornamental Snake.

Will the action adversely affect habitat critical to the survival of a species?

No critical habitat for brigalow reptiles has been identified on the Register of Critical Habitat under the EPBC Act. No habitat critical for the species survival is listed in the *Draft referral guidelines for nationally threatened Brigalow Belt reptiles*.

Will the action disrupt the breeding cycle of an important population?

There is very little information about the breeding cycle of Ornamental Snake, but breeding is likely to occur during the period of maximum activity in summer. Construction in areas of cracking clay soils will be conducted in the dry season, when Ornamental Snakes are less active, reducing the likely impact on Ornamental Snake breeding activities. Given the short period of time required for construction it is unlikely the proposed action will impact the breeding cycle of the species.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The ABP pipeline will modify potential habitat for this species through clearing. However, the species also inhabits heavily modified habitats that contain important microhabitat features such as soil cracks, gilgais and habitat for frogs.

Gilgais are known to reform after levelling of the ground if the ground is left undisturbed for a number of wetting and drying cycles (Victorian Department of Primary Industry, 2011). It is likely that any gilgais in the ROW which are levelled during the construction, will reform again following rehabilitation of the ROW. Furthermore, provided that soil structure is maintained through the stockpiling and replacement of soil in the original profile, landscape topography is restored and logs are returned to the ROW following construction, the action in unlikely to lead to impacts to habitats to the extent that an important population will decline.

Will the action result in harmful invasive species becoming established in the species' habitat?

Field surveys have identified a number of invasive flora species and feral animals are currently present throughout the project site. Pest and weed management plans will ensure these species are adequately managed during both the construction and operational phases of the project so it unlikely that the action will result in the establishment of invasive species.

Will the action result in the introduction of disease(s) that may cause the species to decline?

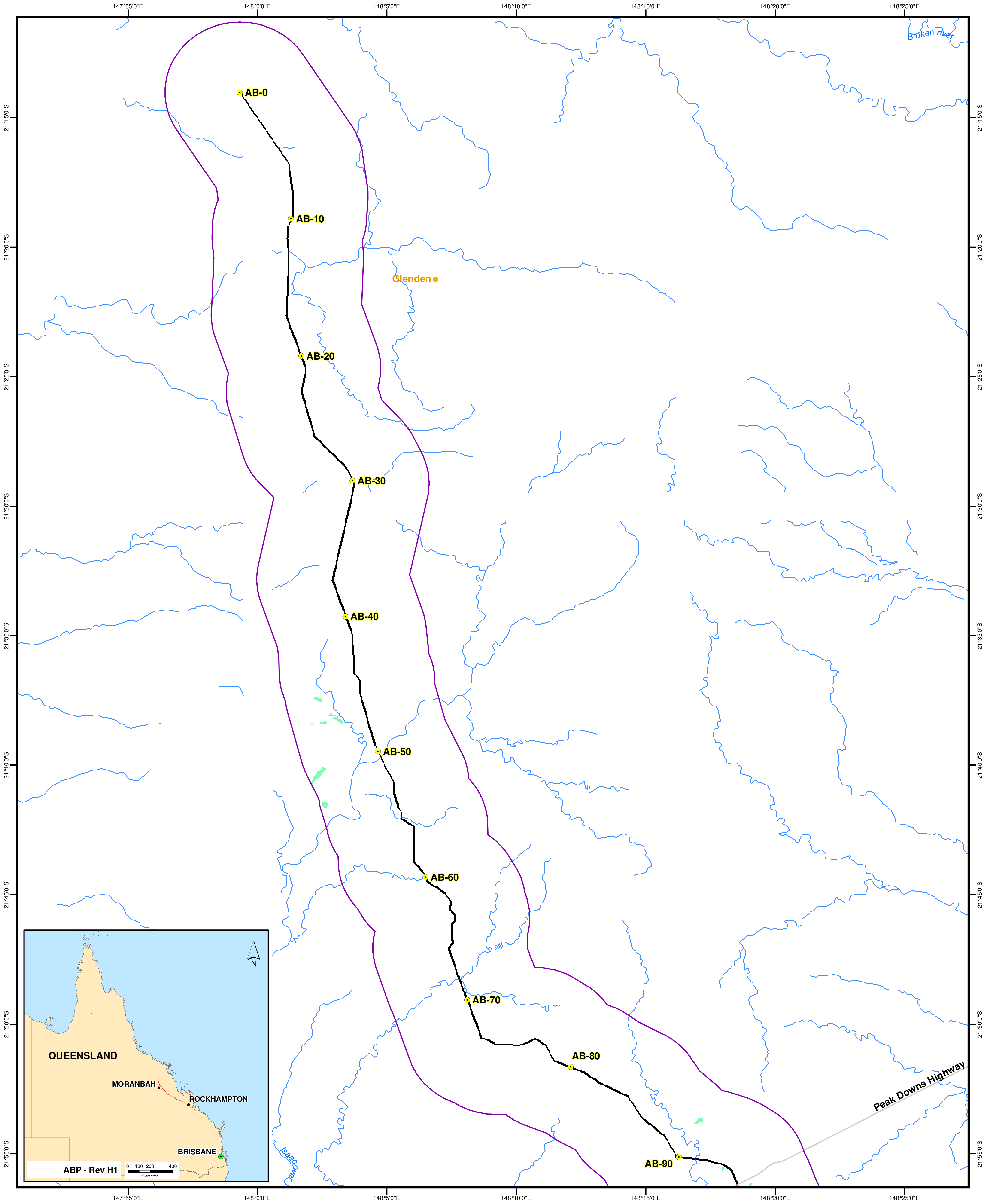
There are no known diseases likely to be introduced to the project site that would significantly affect the Ornamental Snake.

Will the action interfere substantially with the recovery of the species?

Clearing of habitat on the site is likely to have minor local impacts on the species. Provided that mitigation measures listed in Table 2 are implemented, the action is unlikely to interfere with the recovery of the species as a whole.

2.1.14 Conclusion

With the successful implementation of the recommended mitigation measures, it is considered that the impact of the project on the Ornamental Snake will be of low overall significance. This species will be included in a significant species management plan for the ABP.



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BE004_MP_006B_Ornamental_Snake_RevH1

Job Number: BE004

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REV	By	CHK	Description	Date

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⊙	**Kilometre Point**
～	**Waterway or Coast Line**
—	**Main roads**
—	**ABP - Rev H1**
🟩	**Potential Habitat in Buffer (from State RE Mapping)**
☐	**Buffer (5 km)**

Ornamental Snake

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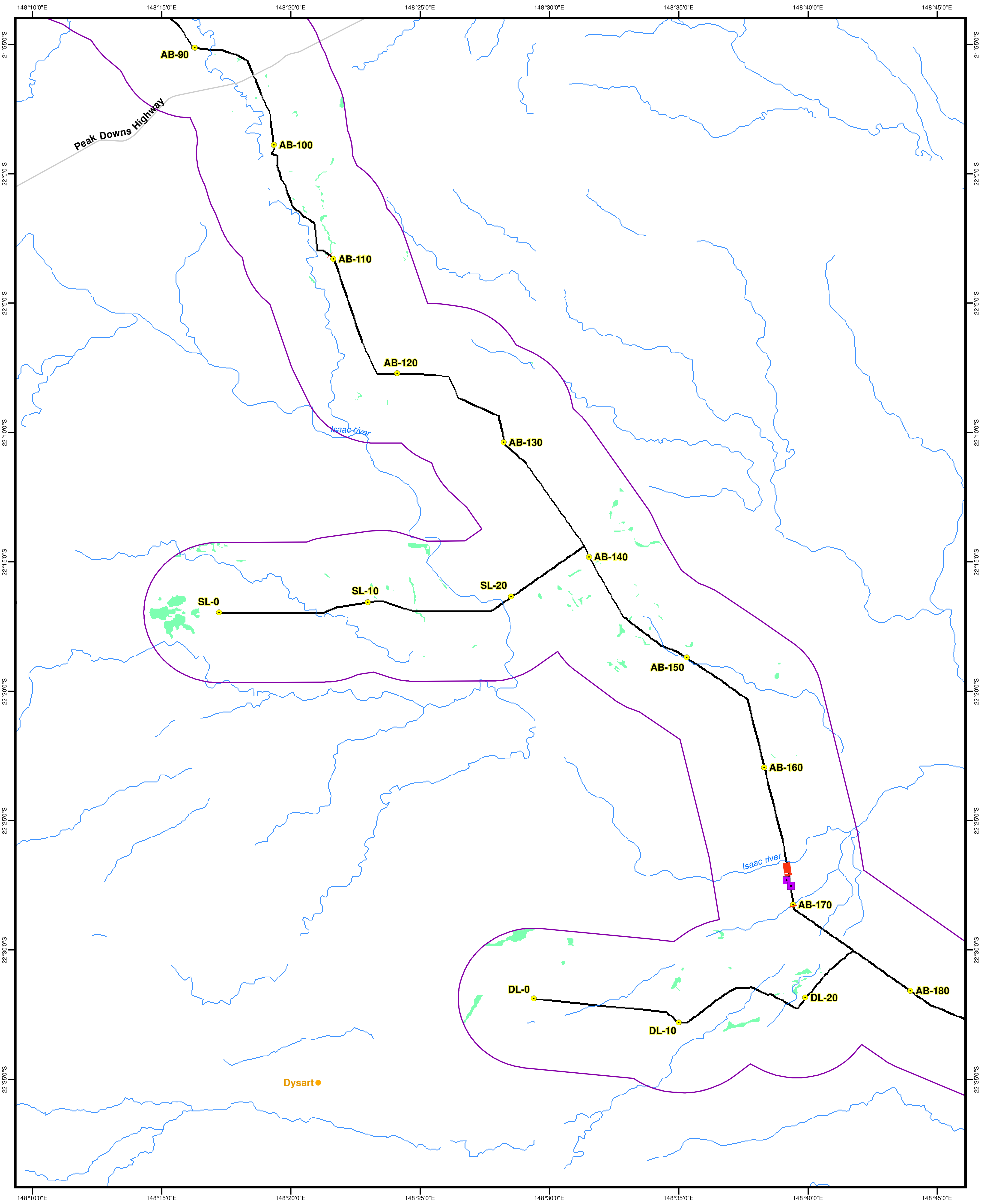
Revision H1

Page 1 of 7

A3



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Ornamental Snake

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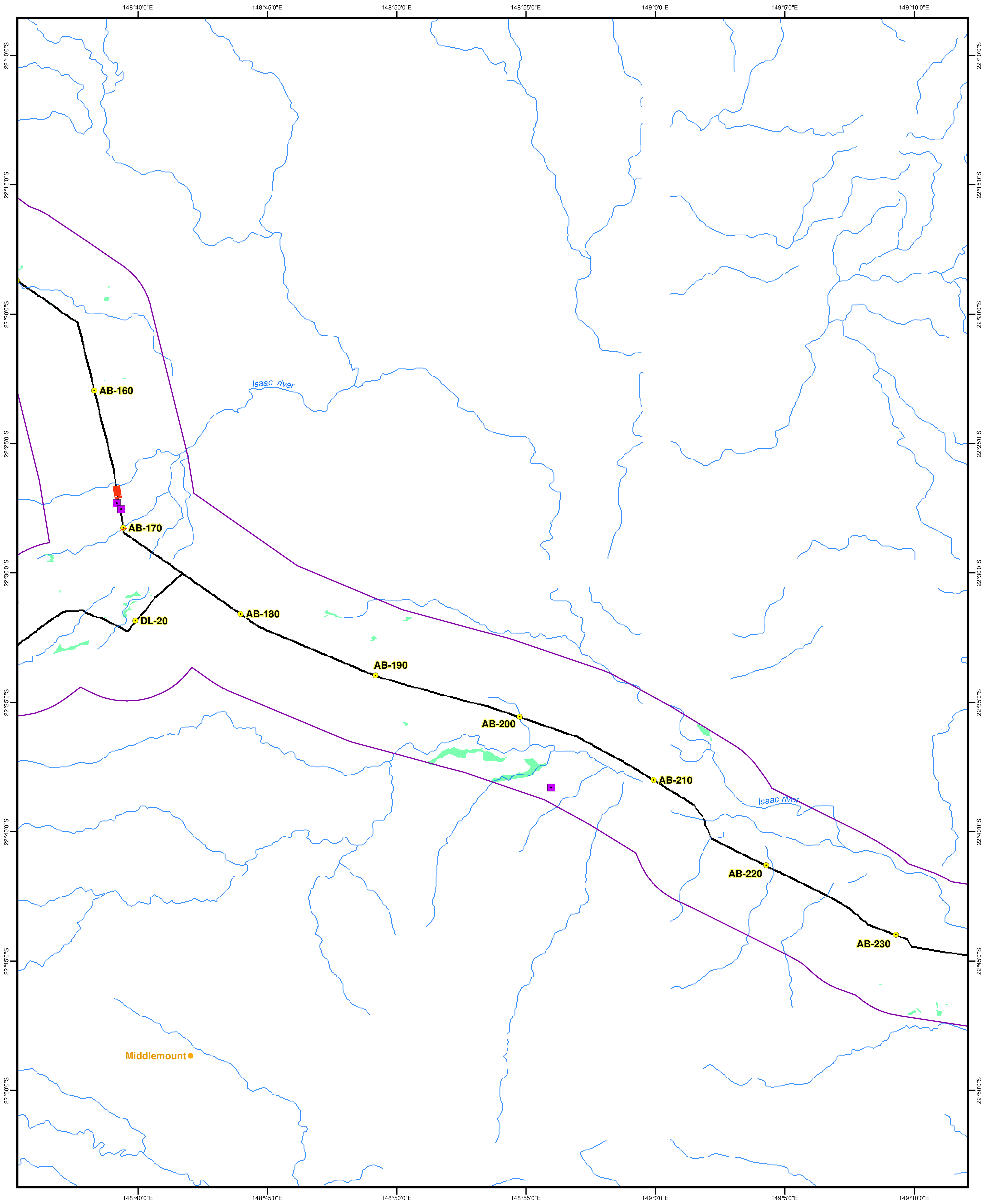
Revision H1

Page 2 of 7

A3



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Ornamental Snake

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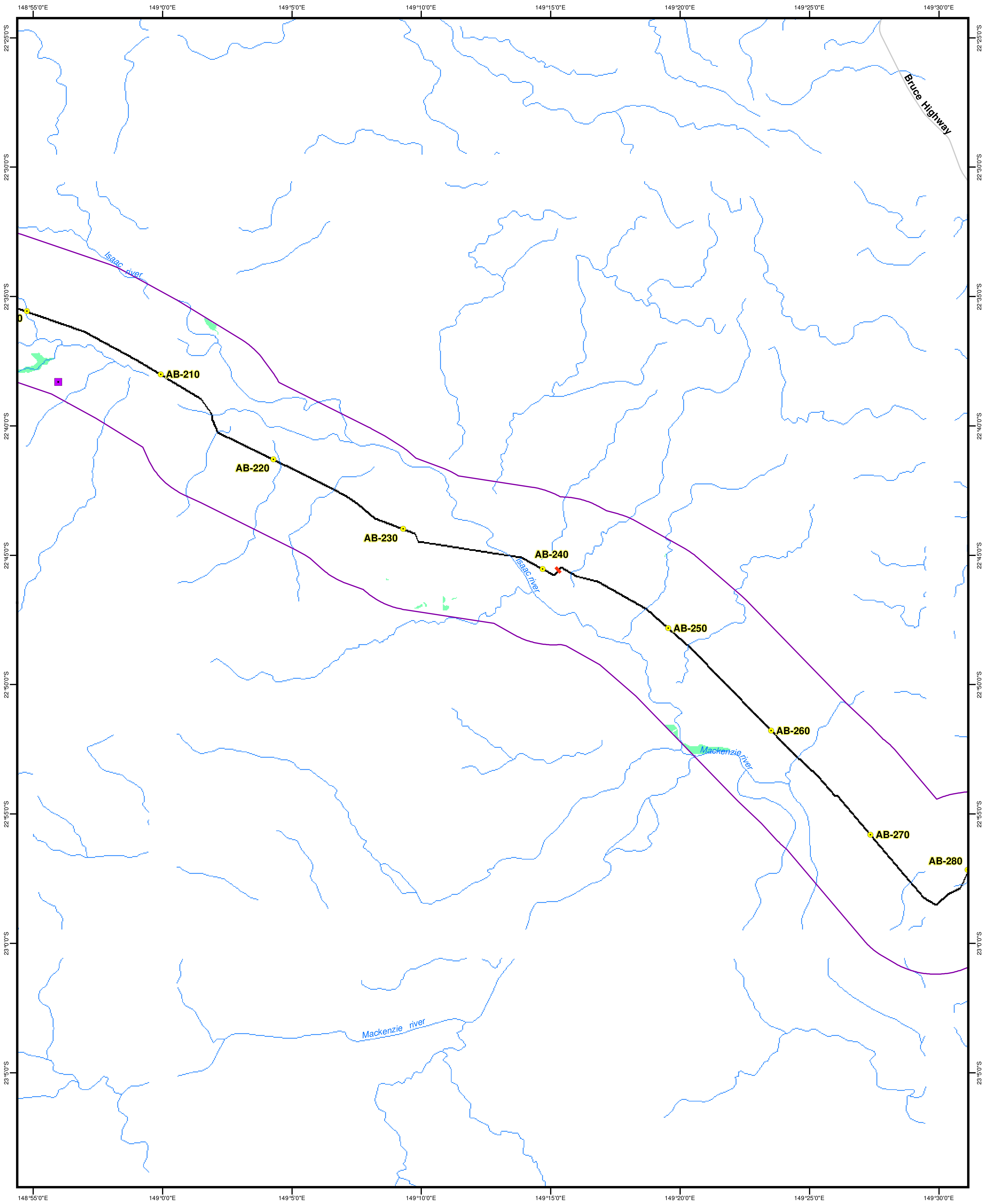
Arrow Bowen Pipeline
Revision H1

Page 3 of 7

A3



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- ☐ **Buffer (5 km)**

Ornamental Snake

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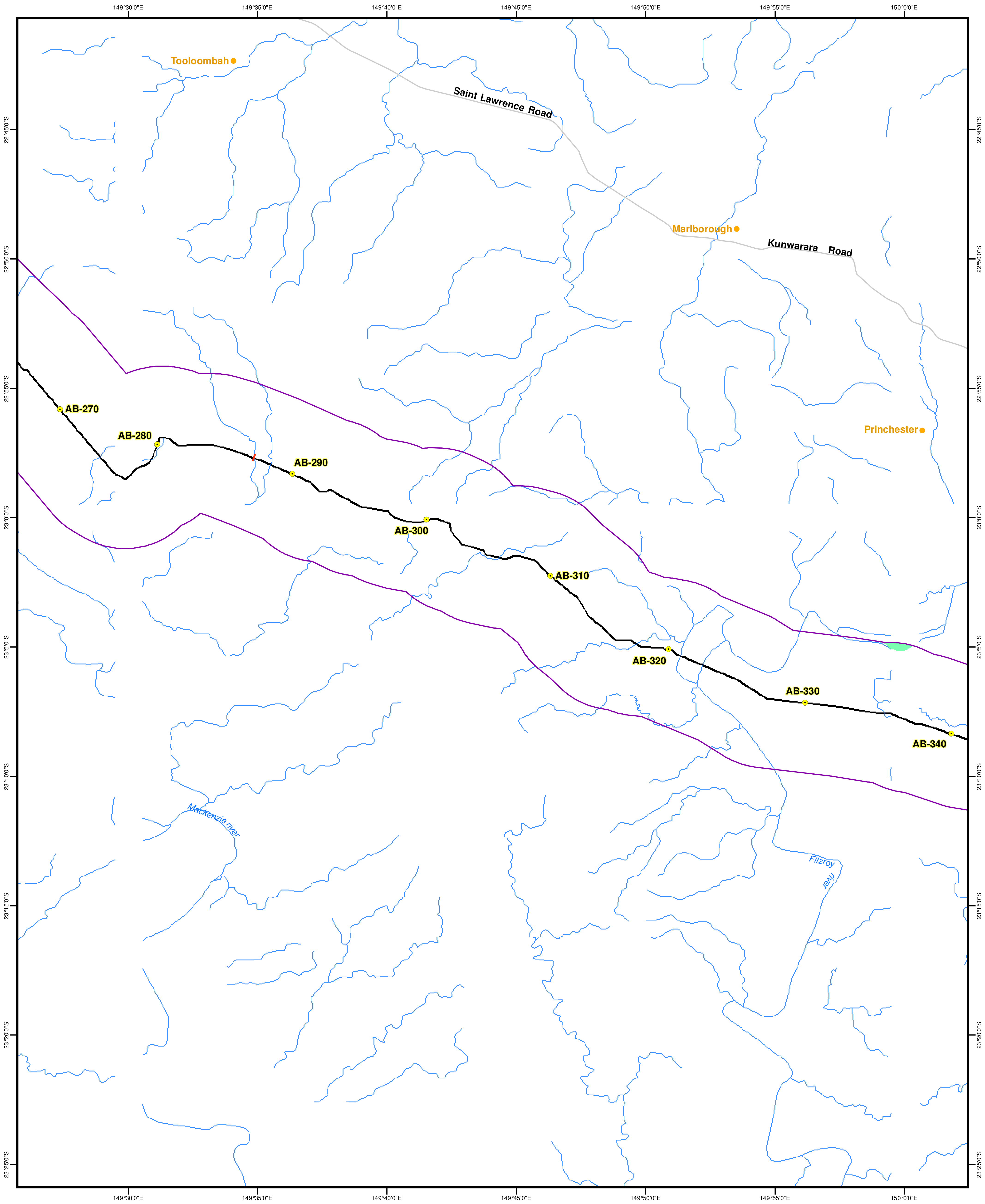
Arrow Bowen Pipeline
Revision H1

Page 4 of 7

A3



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Ornamental Snake

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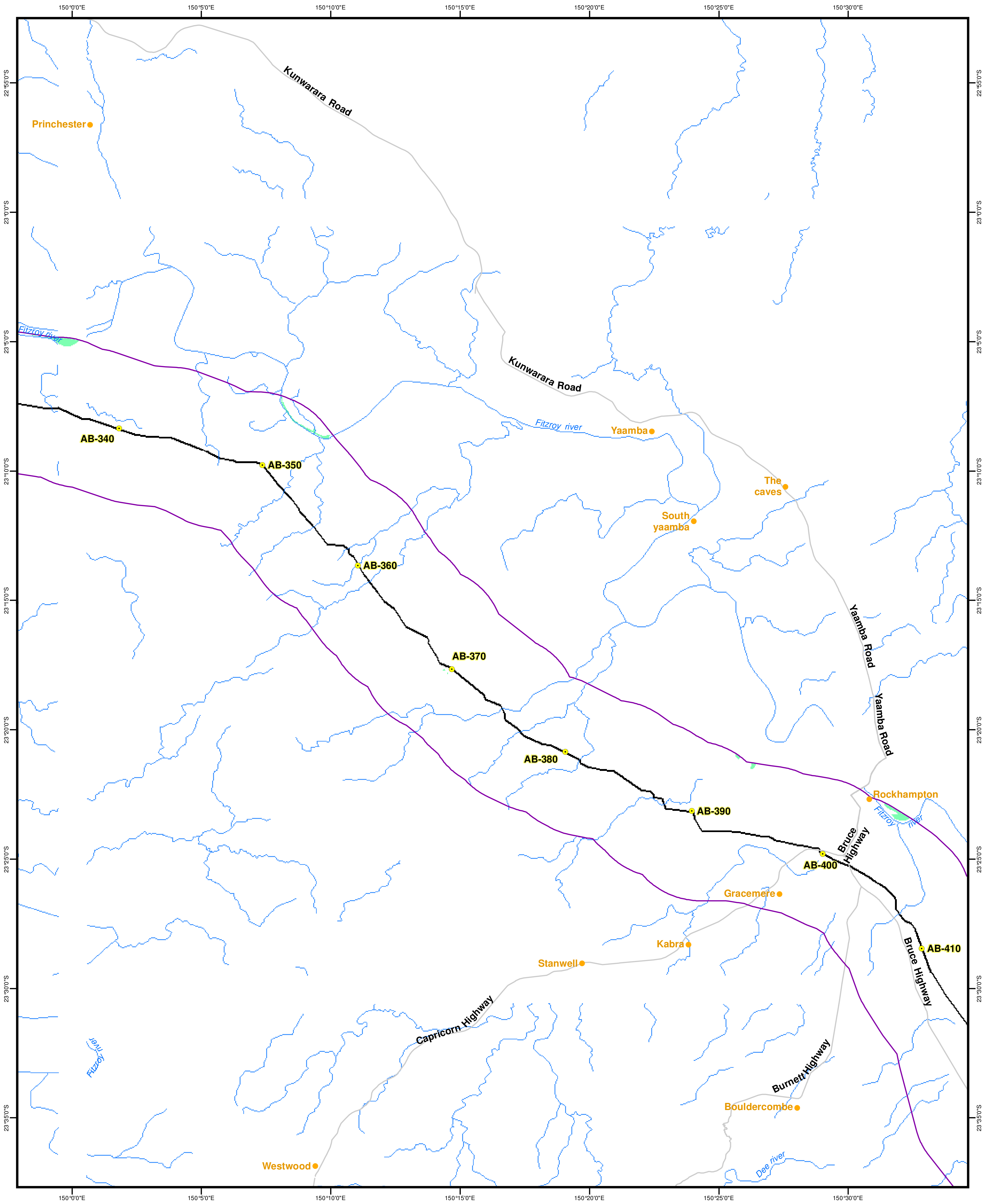
Arrow Bowen Pipeline
Revision H1

Page 5 of 7

A3



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Ornamental Snake

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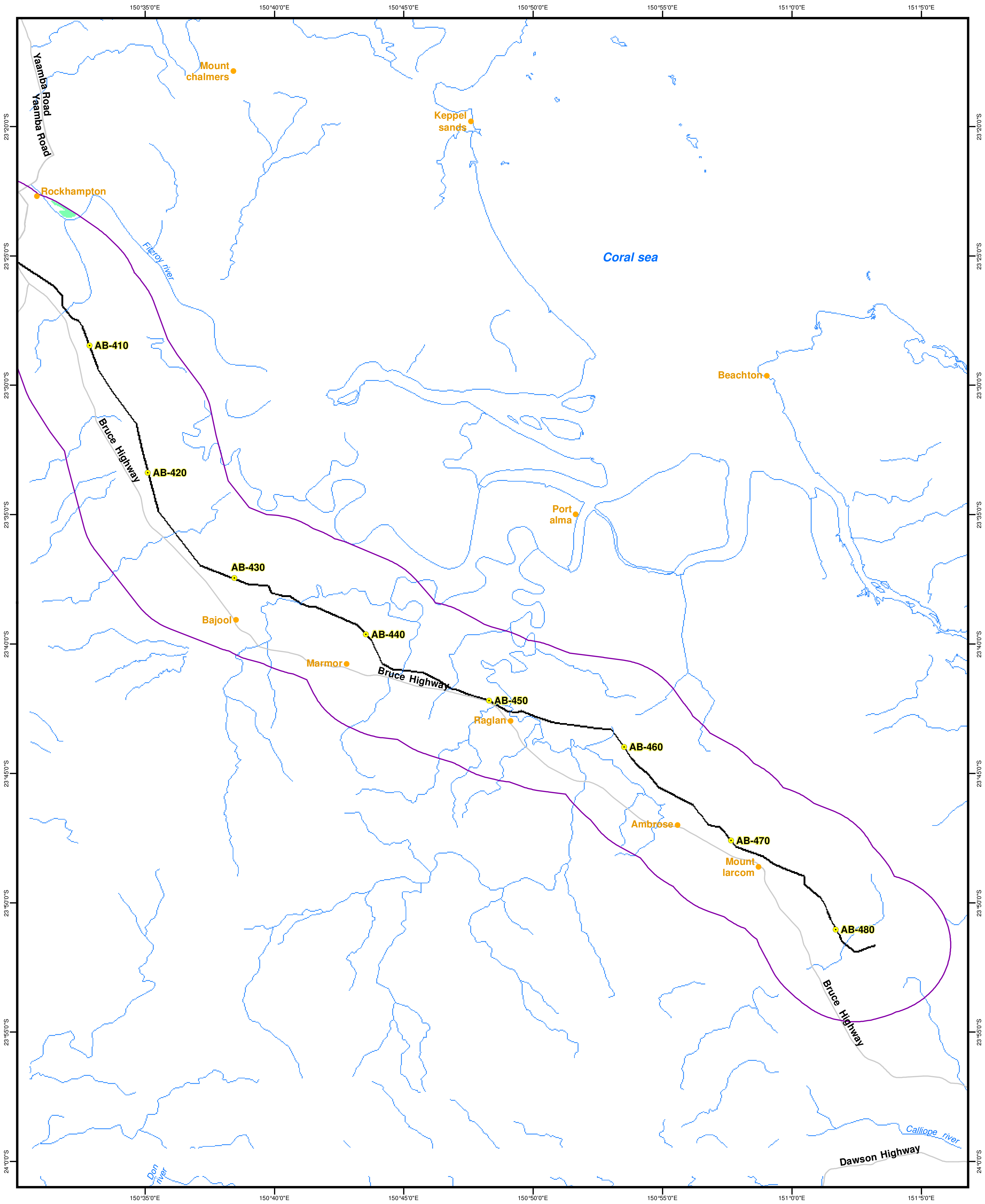
Arrow Bowen Pipeline
Revision H1

Page 6 of 7

A3



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Revision H1

Page 7 of 7

A3

2.2 *Egernia rugosa* (Yakka Skink)

2.2.1 Conservation Status

Queensland: Vulnerable under the NC Act

National: Vulnerable under the EPBC Act

2.2.2 Description

The Yakka Skink is a large lizard with a snout vent length of 200 mm, and has a robust build and thick tail. Generally brown, this species has a distinctive dark stripe down the back and pale brown stripes on its sides (Wilson 2009).

2.2.3 Distribution

The Yakka Skink is restricted to Queensland, although a small amount of potential habitat occurs in northern NSW (Cogger 2000). The Yakka Skink's known distribution extends from the east Queensland coast to the hinterland. This area covers the northern and southern parts of the Brigalow Belt, South-east Queensland, Mulga Lands, Einasleigh Uplands, Cape York Peninsula and the Wet Tropics bioregions (Brigalow Belt Reptiles Workshop 2010; Cogger 2000).

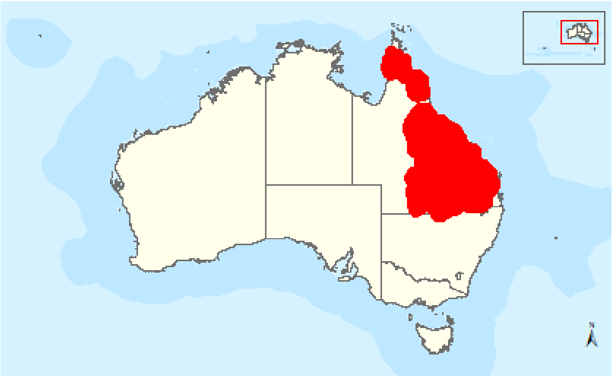


Figure 6 Distribution of *Egernia rugosa*

Source: DSEWPaC 2013a

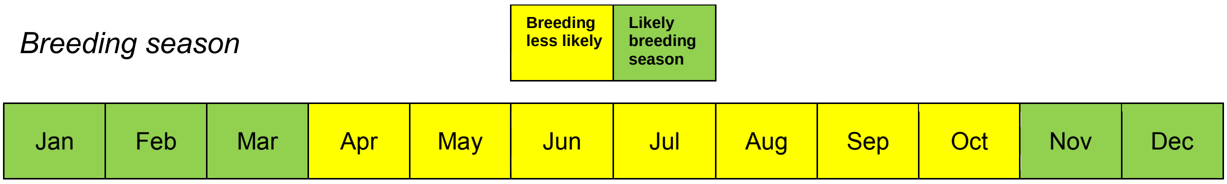
2.2.4 Habitat

The Yakka Skink's core habitat is within the Mulga Lands and Brigalow Belt bioregions (TSN 2008). This species inhabits woodland, scrub and open dry sclerophyll forest (Brigalow Belt Reptiles Workshop 2010; Cogger 2000; Wilson & Knowles 1988), typically dominated by ironbark (e.g. *E. crebra*), poplar box (*E. populnea*), Bull Oak (*Allocasuarina luehmannii*) or *Acacia* species such as brigalow (*A. harpophylla*). They shelter in logs, abandoned rabbit warrens, log piles, rock crevices, tree roots and sink holes (Curtis et. al. 2012). Burrows are excavated in a variety of substrates which includes loam, sand and clay (Curtis et. al. 2012).

2.2.5 Ecology

The Yakka Skink is highly sociable, with populations occurring mainly in colonies. These groups consist of adults and juveniles of various sizes (Chapple 2003). Even though a colony of skinks may use a number of shelter sites during the year, an occupied burrow will be indicated by the piles of recent scats near its entrance. The Yakka Skink is omnivorous; it ambushes small creatures such as beetles, grasshoppers and spiders that venture near the burrow entrance, and also forages for soft plant material and fruits. The Yakka Skink bears live young and rarely produces more than six per litter. The breeding season for this species has not been recorded (Chapple 2003) but it is likely that this species breeds when it is most active in late spring and summer.

Breeding season



🟨	🟩
Breeding less likely	**Likely breeding season**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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2.2.6 Activity period

Schmida (1985) states that the species is most active during the early morning and late afternoon, while Ehmann (1992) reports personal observations of both diurnal and (on warm nights) nocturnal activity. The species is very wary and will quickly retreat into its burrow or shelter site in response to nearby movement or disturbance. Nothing is reported on seasonal activity patterns, but Queensland Museum specimens have been collected in November (two), December (one), February (three) and March (two), suggesting a peak in activity in late spring and summer, like other large *Egernia* species (DSEWPaC 2013a).

2.2.7 Threats

The threats to this species include (DSEWPaC 2013a):

- habitat loss and degradation
- removal of microhabitat, such as rocks, logs and fallen bark
- predation by feral animals
- the Yakka Skink exhibits high site-fidelity/low fecundity and is long-lived, therefore this species is susceptible to potential population crashes.

2.2.8 Recovery actions

No recovery plan has been prepared for Yakka Skink. DoE (DSEWPaC 2013a) identifies the following actions designed to assist in the recovery of this species:

- identify suitable habitat for conservation of Yakka Skink
- identify key threats and develop management guidelines to protect key habitat
- monitor and evaluate recovery actions and apply an adaptive management approach

- ensure Yakka Skink conservation is incorporated into appropriate land management decisions.

2.2.9 DoE recommended survey methods

Targeted surveys should be undertaken during optimal conditions. As a general rule, surveys should only be undertaken from late September through to late March when weather conditions are warm, not too dry and maximum temperatures are greater than 25°C on most survey days. All of the listed Brigalow Belt reptiles are difficult to detect and are therefore likely to require more than one applicable survey technique to ascertain whether they are present or absent.

One-off diurnal searches

Searching for burrow systems and communal defecation sites is the most reliable method of detection. Optimal survey time is during the coolest parts of the day. Surveys should be conducted over a minimum of three days, and should include a minimum of 1.5 person hours per hectare for habitats of average complexity. Potential Yakka Skink colony sites can be watched using a telescope or binoculars at 30 m distance.

Transects

Transects can be used to survey for Yakka Skink in large habitat patches (>10 ha) and should be strategically positioned to adequately sample representative microhabitats in each habitat type.

Spotlighting

Spotlighting should target large logs between dusk and early morning hours. It is most effective on warm, humid evenings. Surveys should be conducted over a minimum of three days, and should include a minimum of 1.5 person hours per hectare for habitats of average complexity.

Elliott and cage trapping

Trapping should target colony sites through diurnal surveys of suitable habitat. One large Elliott-style trap (15.5 cm x 15 cm x 46 cm) and one cage trap should be placed as close as possible to burrow entrances. Traps should be checked every morning and early evening (after the optimal foraging periods) over four days (DSEWPaC 2011a).

2.2.10 Survey effort and methods undertaken for ABP

Emphasis was placed on selecting sites that had a high level of microhabitat diversity (presence of understorey, logs, leaf litter and other debris) as these sites were considered most likely to support Yakka Skink.

Survey techniques used included active searching, and spotlighting.

Sampling for reptiles focussed on active searching under potential shelter sites. Each site was actively searched for thirty minutes. Searches were undertaken before mid-morning (i.e. before reptiles had reached their optimal body temperature). Thirty minutes of nocturnal spotlighting was conducted on foot along roads and ground habitat within each site. Spotlighting was also completed along roads and tracks whilst travelling to sites.

2.2.10.1 Comparison with DoE guidelines

The effort conducted during the field surveys for this species is shown in Table 16 along with the effort recommended under the DoE guidelines. It must be noted that the guidelines are recommendations only and surveys are ongoing.

Table 16 Actual and DoE recommended survey effort for Yakka Skink

Methods	Actual effort	DSEWPC
Spotlighting effort (hours)	47	381
Active search effort (hours)	80.40	381
Trap effort (trap nights)	3 traps (6 locations) x 4 nights = 72	768

2.2.11 ABP survey results

This species was not recorded during the field surveys.

Yakka Skink could potentially occur within the ROW in 15 REs (Table 17) with a total area of 254.65 ha. The majority of the remaining REs lie within small remnants or narrow parts of larger remnants. The majority of the ROW is mapped by DoE (DSEWPaC 2013a) as habitat in which Yakka Skink ‘may occur’. The area in the vicinity of KP 436 and 456 is mapped as habitat in which the Yakka Skink is ‘known or likely’ to occur. However the pipeline route avoids remnant vegetation in this area and intersects areas identified as potential habitat. No habitat has been identified as habitat critical for the survival of Yakka Skink in the *Draft referral guidelines for nationally threatened Brigalow Belt reptiles.* An assessment of the impacts on this potential habitat is discussed in Section1.1.13.

Table 17 Remnant REs that contain potential habitat for Yakka Skink within the ROW

RE	Habitat Type	Potential habitat in ROW (ha)	Potential habitat in the 5 km buffer (ha)	% of buffer*	Critical habitat in ROW (ha)
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	1.29	3666.53	0.03	0
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	29.14	11397.97	0.25	0
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	5.30	3941.48	0.13	0
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	0.63	3235.83	0.01	0
11.3.7	*Corymbia* spp. woodland on alluvial plains. Sandy soils	4.24	1112.84	0.38	0
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	17.34	9112.56	0.19	0
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains	5.64	3088.83	0.18	0
11.3.36	*Eucalyptus crebra* and/or *E. populnea* and/or	3.23	332.98	0.97	0

RE	Habitat Type	Potential habitat in ROW (ha)	Potential habitat in the 5 km buffer (ha)	% of buffer*	Critical habitat in ROW (ha)
	E. melanophloia on alluvial plains. Higher terraces				
11.5.3	*Eucalyptus populnea* and/or *E. melanophloia* and/or *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces	79.57	18509.98	0.42	0
11.5.9	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains/remnant surfaces. Plateaus and broad crests	26.72	6600.89	0.40	0
11.5.12	*Corymbia clarksoniana* woodland and other *Corymbia* spp. and *Eucalyptus* spp. on Cainozoic sand plains/remnant surfaces	12.87	1361.91	0.94	0
11.7.2	*Acacia* spp. woodland on lateritic duricrust. Scarp retreat zone	19.04	7791.01	0.24	0
11.8.5	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks	42.47	9636.93	0.44	0
11.9.2	*Eucalyptus melanophloia +/- E. orgadophila* woodland on fine-grained sedimentary rocks	0.70	1357.38	0.05	0
11.9.9	*Eucalyptus crebra* woodland on fine-grained sedimentary rocks	6.47	2837.52	0.22	0
	Other REs containing suitable habitat in the 5 km buffer	0	23616.56	0	
	Totals	254.65	107601.2	0.23	

* percent of the potential habitat within the ROW which is contained within the 5 km buffer .

2.2.11.1 Other survey results

There were two records for Yakka Skink from the Wildnet search area within the 5 km buffer. No Queensland Museum records were found in close proximity to the project site.

2.2.12 Impacts of ABP on Yakka Skink

2.2.12.1 Potential impacts without mitigation

Yakka Skinks inhabit woodland, scrub and open dry sclerophyll forest, typically dominated by Narrow-leaved Red Ironbark (e.g. *E. crebra*), Poplar Box (*E. populnea*), Bull Oak (*Allocasuarina luehmannii*) or *Acacia* species such as Brigalow (*A. harpophylla*). They shelter in logs, abandoned rabbit warrens, rock crevices, tree roots and sink holes. Impacts associated with the proposed project could include:

- temporary loss of remnant woodland vegetation that could provide habitat for Yakka Skink
- trenchfall
- increased pest animal abundance associated with improper disposal of food waste
- destruction of colony shelters (log piles, rock piles, warrens, etc.)
- direct mortality through excavation works and collisions with vehicles during construction, operation and maintenance.

2.2.12.2 Assessment of potential impacts with mitigation

Table 18 summarises potential direct and indirect impacts of the project on Yakka Skink populations and proposed measures to mitigate potential impacts. The table provides a risk assessment for each impact with and without mitigation measures.

Table 18 Raw risk (before mitigation) and residual risk (after mitigation) associated with construction of the ABP on Yakka Skink

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
DIRECT IMPACTS			
Removal of habitat Removal of remnant vegetation representing potential foraging, breeding and sheltering habitat	M	-minimise areas of remnant vegetation to be cleared -use existing cleared corridors where possible -clearly mark out areas to be cleared and retained -rehabilitate the ROW following construction -reinstate microhabitat (logs, etc) after construction	L
Trenchfall Death of individuals trapped in the trench	M	-employ a spotter catcher to check microhabitat prior to clearing and to remove individuals before clearing commences -monitoring of open trenches by fauna spotter catchers during the construction period -minimise the length of time the trench is open -implement measures to protect colonies identified/relocated adjacent to ROW	I
Fatalities Death of individuals via vehicles and equipment during clearing, construction and operation	L	-maintain an appropriate speed limit in the ROW especially in areas where the ROW goes through remnant vegetation -employ a spotter catcher to check microhabitat prior to clearing and to remove individuals before clearing commences -consider pre-clearance trapping or spotlighting to capture individuals prior to clearing if a population is found in the ROW -employ a spotter catcher during construction to be on hand during clearing to move displaced animals	I
INDIRECT IMPACTS			
Changes in water quality Impacts to water quality upstream leading to changes in vegetation/habitat downstream	NA	-no mitigation measures for water quality recommended for this species as it is not dependent on aquatic habitats or riparian vegetation	NA
Changes in hydrology Changes in wet/dry cycling of waterways caused by damming, changes in morphology or diversions	NA	-no mitigation measures for hydrology are recommended for this species as it is not dependent on aquatic habitats or riparian vegetation	NA
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of population	L	-minimise areas of remnant vegetation to be cleared -use existing cleared corridors where possible -rehabilitate the ROW following construction -reinstate microhabitat (logs, etc) after construction	L
Increase in weed abundance Increased competition with native plant species used for foraging and shelter Smothering of native vegetation	L	-develop and implement a weed management plan -control weeds in the ROW before, during and after construction -implement site weed hygiene protocols	I
Increase in introduced predator abundance	L	-develop and implement a Waste Management Plan -develop and implement a Pest Management Plan	L

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
Increase in introduced predator abundance caused by increased food availability in the ROW		-educate staff about the importance of removing any food waste from the ROW -keep the work site clean of debris which could be used as shelter for introduced predators	
Removal of micro-habitat Removal of logs, leaf litter and debris	M	-rehabilitate the ROW following construction -reinstate microhabitat such as logs, rocks and leaf litter after construction -Pre-clearance surveys will be conducted along the ROW prior to construction to identify important microhabitat -all log piles found to have Yakka Skink colonies should be relocated to adjacent habitat using a qualified spotter catcher	L
Noise and disturbance Disturbance caused by noise or human disturbance leading to stress, disease and abandonment of habitat.	NA	-no mitigation measures for noise are recommended for this species as it is not likely to be impacted by noise	NA
Spread of disease	NA	-no mitigation measures for reducing the spread of disease are recommended for this species as there are no known diseases for this species which could be spread by human activities	NA

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High, NA - impact not likely to occur.

The project will result in the temporary loss of some remnant vegetation that could provide habitat for Yakka Skink. This species was not recorded during the surveys and no known records of this species occur within the ROW. Progressive construction of the pipeline within the ROW (which will limit the extent of disturbance at any one time) and progressive rehabilitation immediately following construction (which will restore many of the microhabitat features) will limit the impacts to potential habitats.

This species can occur in cleared and disturbed habitats (including around human habitation) as long as the microhabitat features needed for the colony are present (e.g. log piles, rabbit warrens or cement slabs). Provided that the ROW is rehabilitated and logs and other microhabitat features are returned to the ROW following construction, the impact of habitat clearing on this species is likely to be **Low**.

There is a small chance that Yakka Skink could fall in open trenches. Trenches will be regularly checked by experienced personnel every morning to check for animals that may have fallen into the trench overnight. To reduce the number of animals falling into the trench, pre-clearance surveys will be undertaken to facilitate relocation where appropriate and the amount of trench open during construction at any one time will be minimised as much as possible.

Refuges (such a moistened sacks) will also be placed within the trench to shelter animals and reduce mortalities. If any skinks are detected in the trenches, they will be captured and released into suitable habitat a safe distance from where the works are occurring. With these mitigation measures, the impact of trenchfall on Yakka Skink is considered to be **Low**.

There is a small chance that a Yakka Skink could be killed or injured during clearing or construction activities as a result of vehicle strike or excavation works. Pre-clearance surveys will be conducted along the ROW prior to construction to identify potential colony sites (e.g. log piles with evidence of Yakka Skink occupation). If an active colony is found in the ROW, the preferred option is to avoid it by a minor realignment of the pipeline. If the colony cannot be avoided, the colony will be relocated to a suitable area adjacent to the ROW by a qualified spotter catcher, in accordance with an approved translocation management plan. Colonies adjacent to the ROW will be monitored during construction works to ensure that impacts are minimised. Provided that proposed mitigation measures are implemented, the risk of Yakka Skink fatalities is considered to be **Low**.

Construction of the pipeline is not expected to change the risks to Yakka Skink resulting from the introduction of pests. Introduced predators (such as foxes and cats) that are present and active in the area are able to transit the area using existing tracks and fencelines. Reasonable management measures, such as the removal of food waste from the ROW and induction programs which stress the importance of not feeding animals will ensure a **Low** level of risk from pests.

Yakka Skink colonies rely on log piles, rock piles, old rabbit warrens and burrows for shelter. Logs will be temporarily placed on the edge of the ROW during vegetation clearing. Logs removed from the ROW will be placed back in the ROW after construction so the loss of these features will only be temporary. Therefore, the impact of removal of micro-habitat on Yakka Skink is likely to be **Low**.

Overall the impact of the ABP project on Yakka Skink is considered to be **Low** provided that all the mitigation measures listed in Table 28 are implemented.

2.2.13 Evaluation under MNES significant impact guidelines

The *Draft referral guidelines for nationally threatened Brigalow Belt reptiles* states that important habitat should be used as a surrogate for important population during assessments involving Brigalow Belt reptiles. Important habitats for Yakka Skink include any contiguous patch of suitable habitat, particularly remnant vegetation, where a colony is known or identified, and any microhabitat where colonies are likely to be found. Given the Yakka Skink’s longevity (up to 20 years), low fecundity (2-5 years to sexual maturity), high site-fidelity, and highly fragmented populations, this species may be prone to localised extinctions. The presence of important habitat is assessed under the four criteria specified in the guidelines.

Suitable habitat for this species is considered important habitat if it is:

Habitat where the species has been identified during a survey

This species was not recorded during surveys in the study site, therefore the ABP ROW is not considered to contain important habitat under this criterion.

Near the limits of the species known range

The ABP is not located near the limit of the species' known range. Therefore the habitat along ABP is not considered important habitat under this criterion.

Large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations)

The pipeline passes through large patches of remnant vegetation that contain suitable habitat and that could be used for dispersal. Therefore some of the habitat within the ABP ROW could be considered suitable habitat under this criterion.

A habitat type where the species is identified during a survey, but which was previously thought not to support the species

This species was not recorded during surveys and was not recorded in habitat not previously thought to support the species. Therefore the habitat along ABP is not considered important habitat under this criterion.

Is there an important population of this species in the study site?

No Yakka Skinks were recorded during surveys. The ABP transects potential habitat for this species however, there is no evidence that the pipeline will transect an important population. Furthermore, the ROW contains no potential habitat within the area mapped as 'known or likely to occur' by DEWSPaC.

Will the action lead to a long-term decrease in the size of an important population of a species?

No Yakka Skinks were recorded during surveys. Pre-clearance surveys will be conducted along the entire alignment to identify any Yakka Skink colonies present in the ROW. Provided that any colonies discovered in the ROW are avoided or relocated to adjacent habitat and measures are implemented to protect colonies adjacent to the ROW, it is unlikely that any significant number of Yakka Skinks will be impacted during the project. Therefore it is unlikely that the project will result in a long-term decrease of an important population of Yakka Skink.

Will the action reduce the area of occupancy of an important population of a species?

The ROW contains no potential habitat within the area mapped as 'known or likely to occur' by DoE and 254.65 ha of potential habitat within the area mapped as 'may occur'. Although no colonies were detected during surveys, the removal of this habitat may temporarily reduce the occupancy of this species. Progressive construction of the pipeline within the ROW (which will limit the extent of disturbance at any one time) and progressive rehabilitation immediately following construction (which will restore potential habitat and microhabitat features) will allow the majority of the disturbed area to be reoccupied in a relatively short timeframe. Therefore it is unlikely that the project will reduce the area of occupancy of an important population of Yakka Skink in the long term.

Will the action fragment an existing important population into two or more populations?

Construction will clear potential habitat which is not mapped as “known or likely to occur” by DoE. Surveys of the ROW have not identified any Yakka Skinks within the area to be cleared. Due to the narrow clearing footprint and short duration of the disturbance, clearing of the ROW is unlikely to fragment an existing important population of this species in the long term.

Will the action adversely affect habitat critical to the survival of a species?

No critical habitat for brigalow belt reptiles has been identified on the Register of Critical Habitat under the EPBC Act within the proposed ABP project area. No habitat has been identified as habitat critical for the survival of Yakka Skink in the *Draft referral guidelines for nationally threatened Brigalow Belt reptiles.* The action is not likely to affect habitat critical to the survival of this species.

Will the action disrupt the breeding cycle of an important population?

Provided that pre-clearance surveys are conducted along the ROW prior to construction and any colonies found are avoided or moved to adjacent habitat, it is unlikely that the breeding cycle of this species will be significantly impacted by the proposed development.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The ABP project will result in the modification and removal of some potential habitat for Yakka Skink, but the proposed clearing within the project site is a relatively small area in comparison to the extent of similar habitat available in the local area. Some temporary reduction in the occupancy of this species is possible but this species can occur in open habitats so it is likely that animals would reoccupy the ROW after rehabilitation and reinstatement of microhabitat features such as logs, rocks and leaf litter. Therefore it is unlikely that the action will modify or remove habitat to the extent that the species is likely to decline.

Will the action result in harmful invasive species becoming established in the species’ habitat?

Field surveys have identified a number of invasive flora species and feral animals in the project site. Pest and weed management plans will ensure these species are adequately managed during both the construction and operational phases of the project so it unlikely that the action will result in the establishment of invasive species.

Will the action result in the introduction of disease(s) that may cause the species to decline?

There are no known diseases likely to be introduced to the project site that would significantly affect the Yakka Skink.

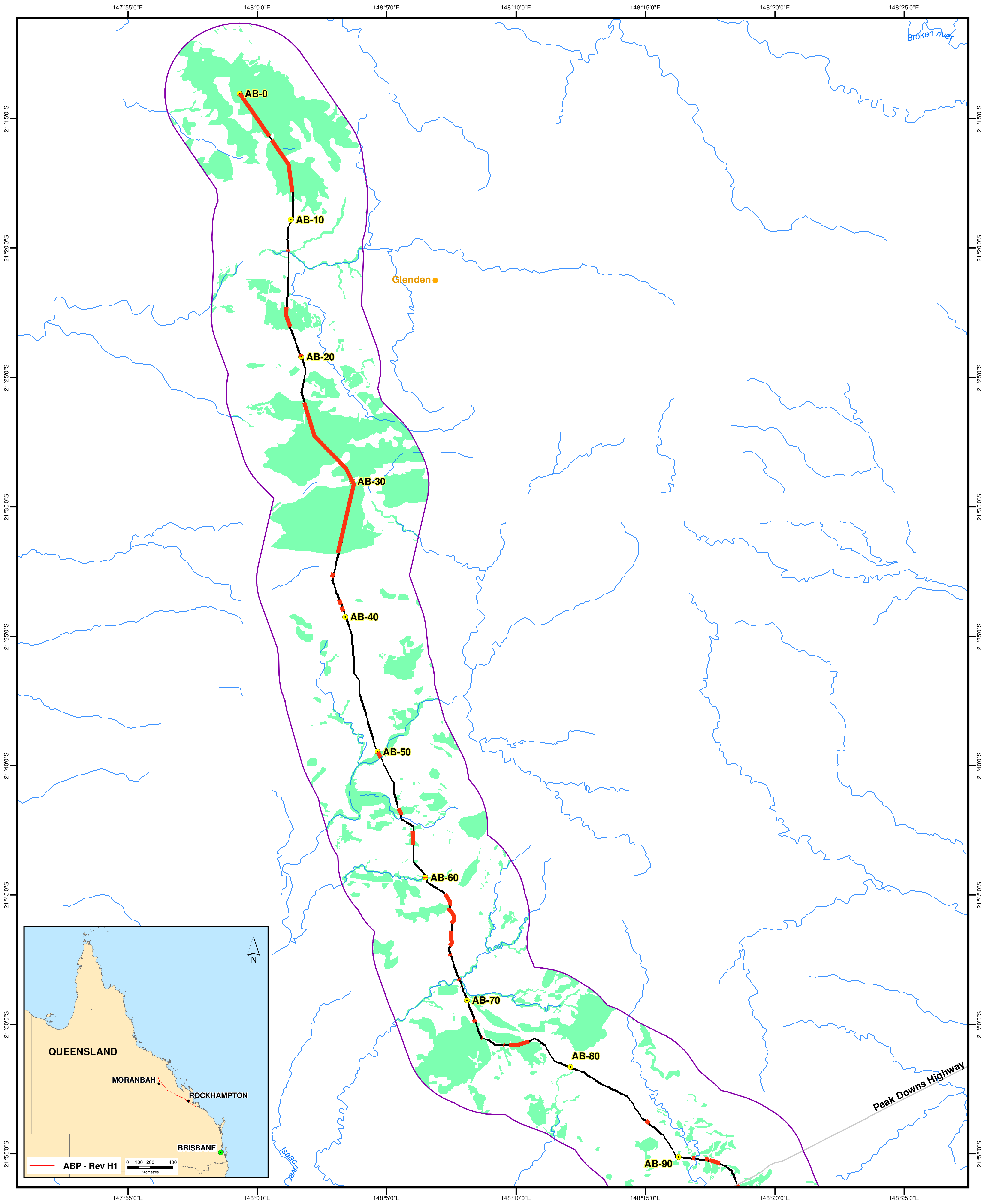
Will the action interfere substantially with the recovery of the species?

The action is unlikely to significantly impact on the recovery of the species at a national level. Construction will temporarily clear potential habitat which is not mapped as “known or likely to occur” by DoE. Surveys of the ROW have not identified any Yakka Skinks within the area to be cleared. Due to the narrow clearing footprint and short duration of the disturbance, clearing of the ROW is unlikely to fragment an existing important population of this species in the long term.

Construction will temporarily clear potential habitat which is not mapped as “known or likely to occur” by DoE. Surveys of the ROW have not identified any Yakka Skinks within the area to be cleared. Due to the narrow clearing footprint and short duration of the disturbance, clearing of the ROW is unlikely to fragment an existing important population of this species in the long term.

2.2.14 Conclusion

Given this species’ secretive habit, the clumped nature of its distribution and the area of potential habitat, it is possible that Yakka Skink is present within the ROW. However, disturbance effects are contained within non-critical habitat and no identified individuals were located during targeted searches. The impact of the project on this species will be of low overall significance.



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Document
BE004_MP_006C_Yakka_Skink_RevH1

Job Number: BE004

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REV	By	CHK	Description	Date
R0	BN	CF	ISSUED TO CLIENT	29/08/2013

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Datum: GDA 1994
Units: Degree

LEGEND

- ● City or town
- ⊙ Kilometre Point
- 〰 Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- 🟥 Potential Habitat in ROW (Field Verified)
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ☐ Buffer (5 km)

Yakka Skink

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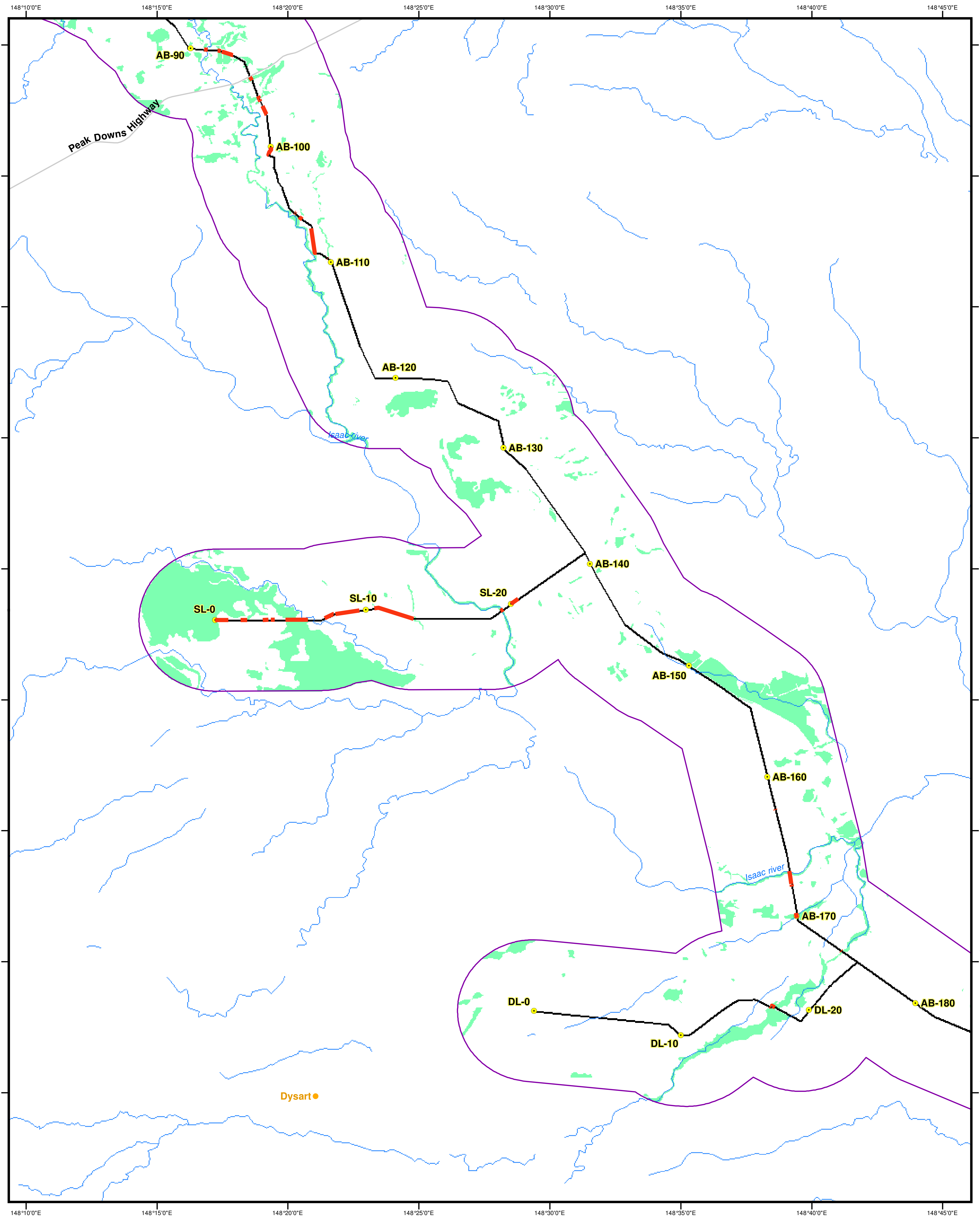
Revision H1

Page 1 of 7

A3



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Yakka Skink

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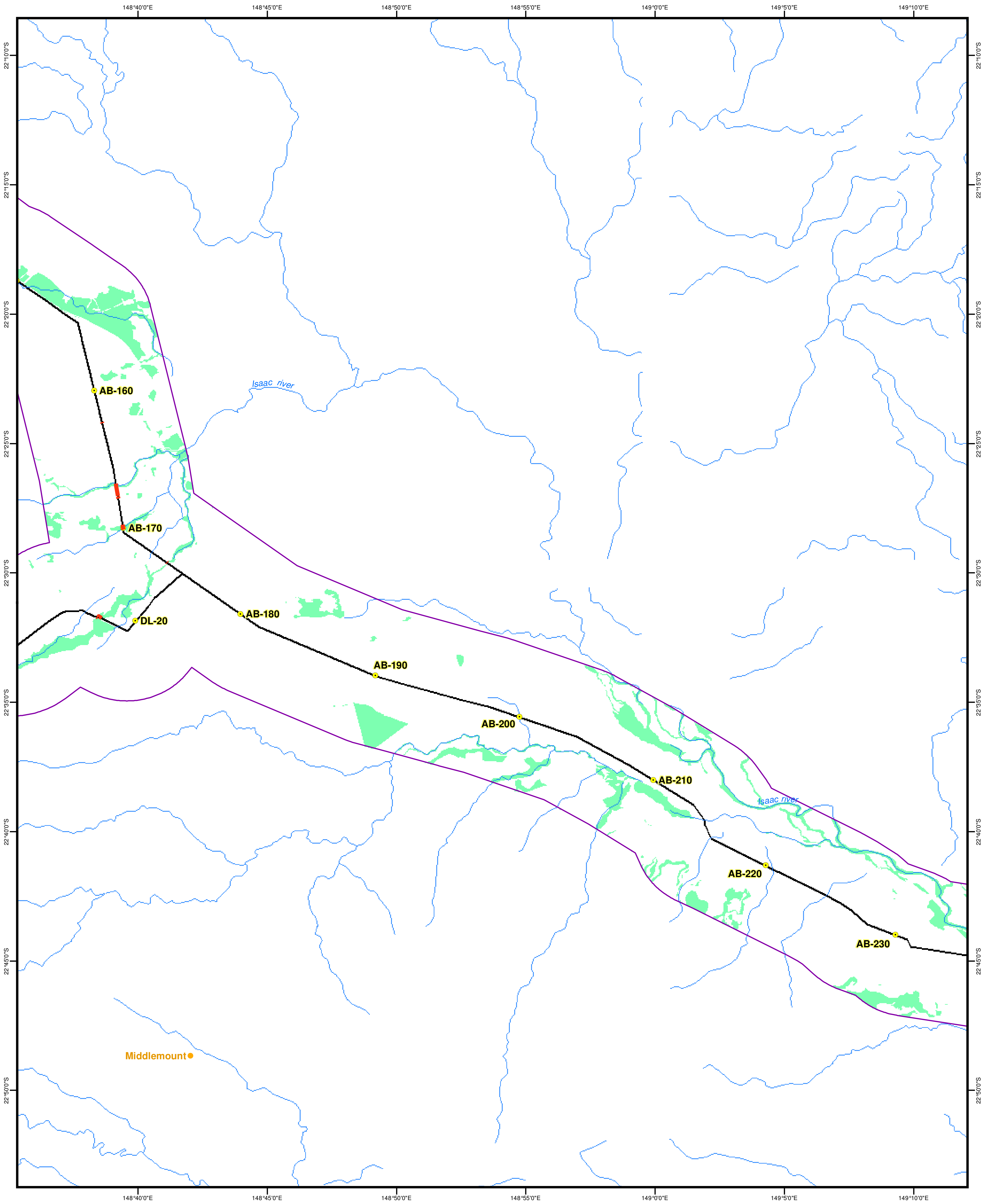
Revision H1

Page 2 of 7

A3



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Yakka Skink

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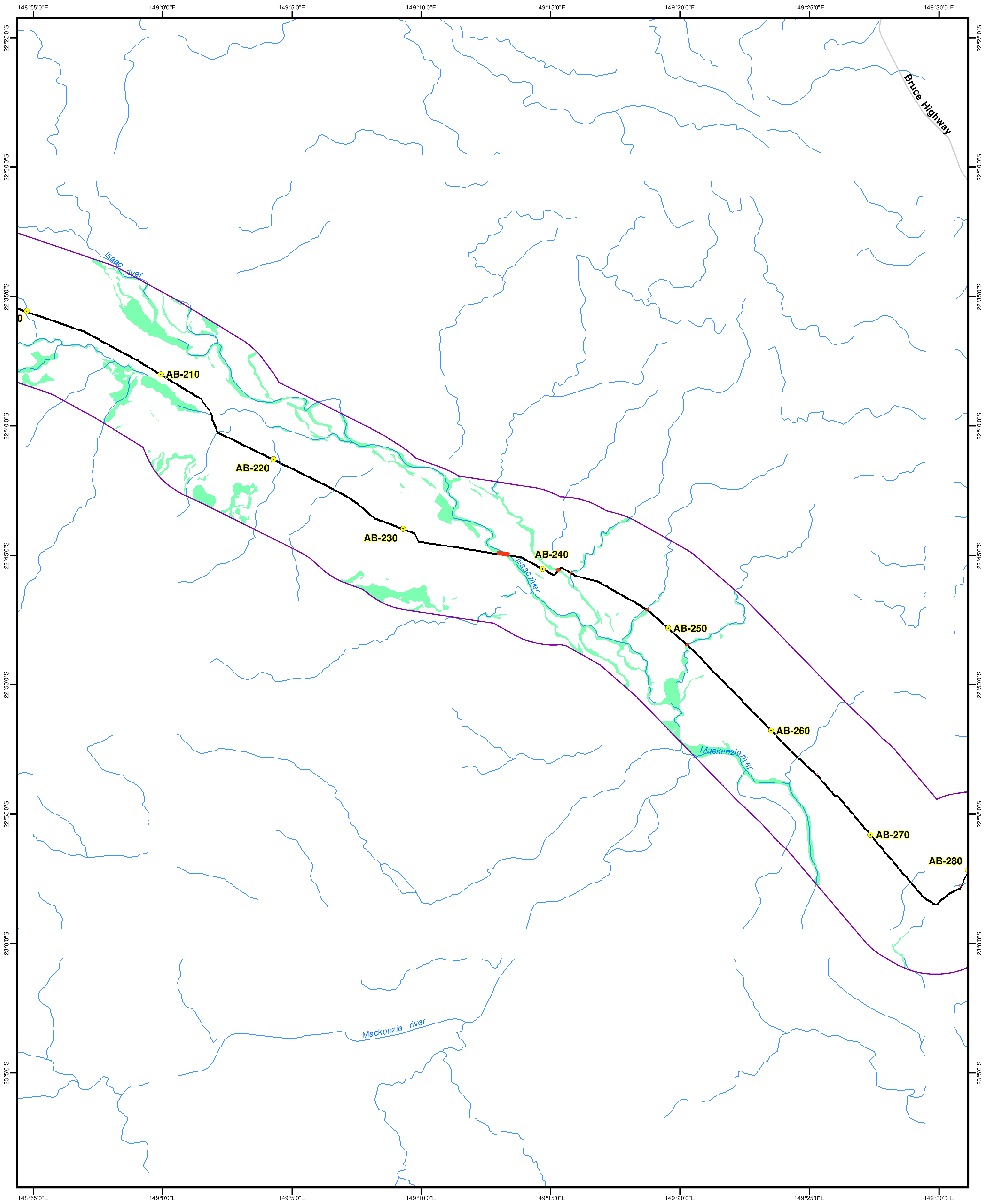
Revision H1**

Page 3 of 7

A3



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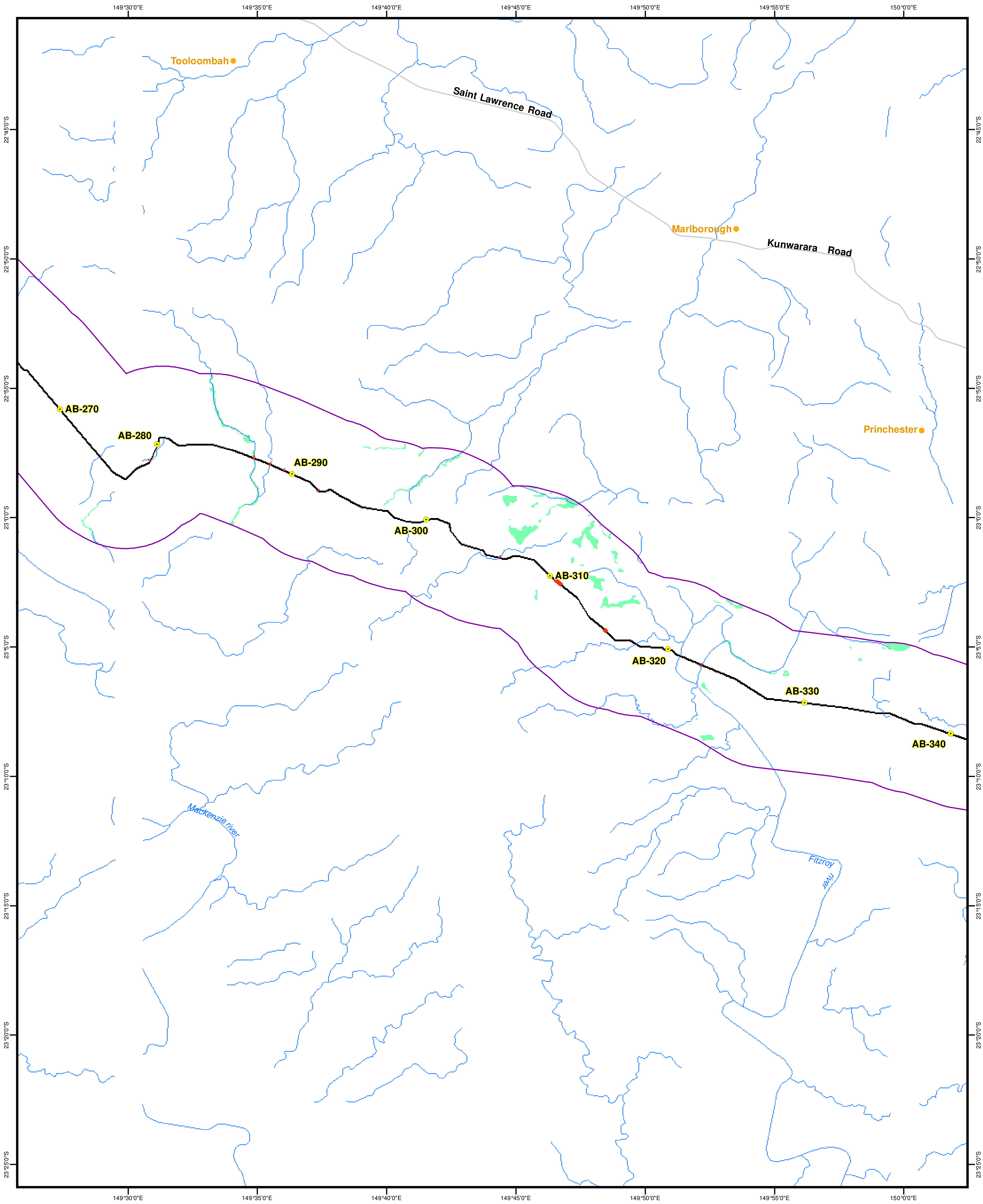
Revision H1

Page 4 of 7

A3



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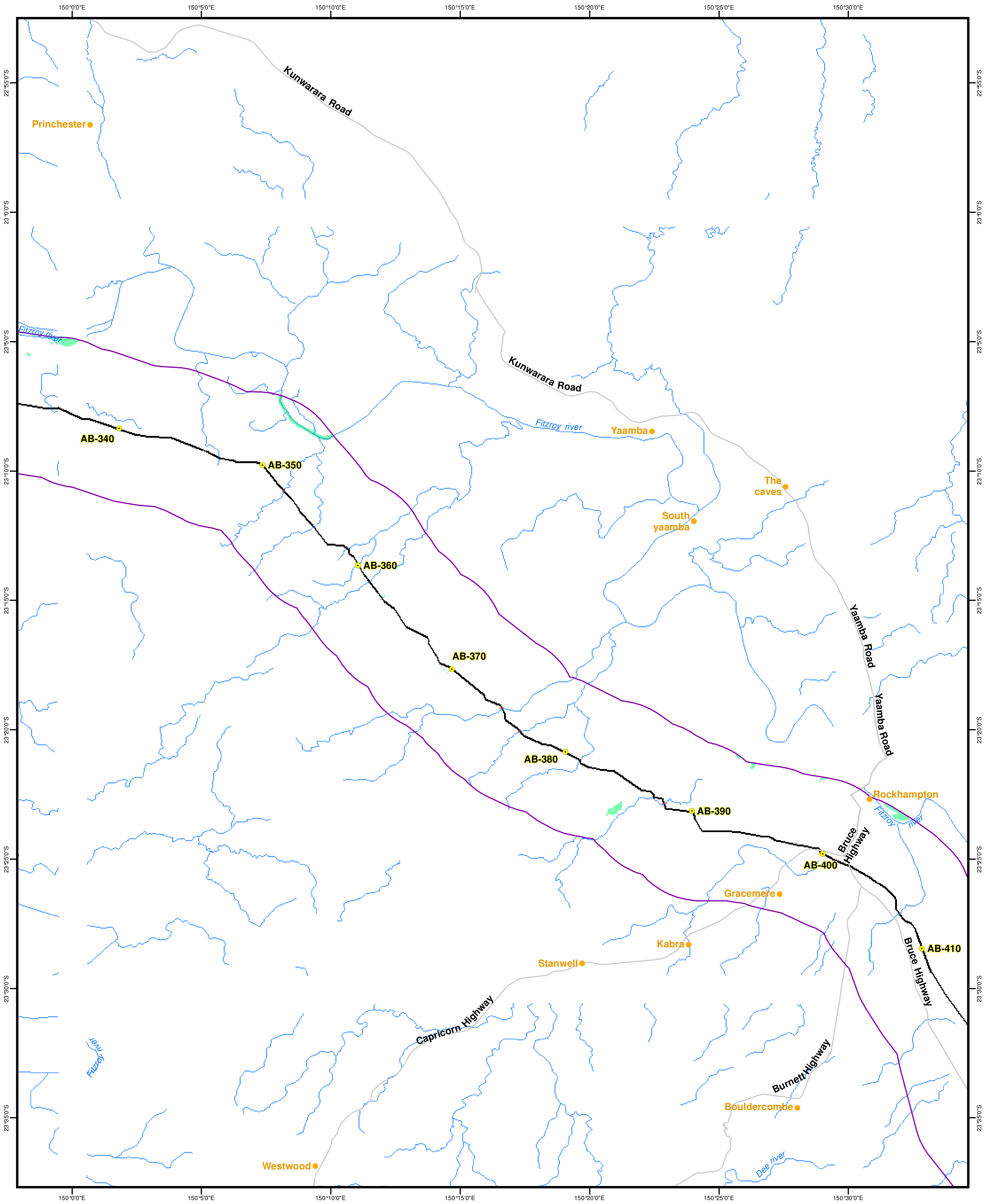
Page 5 of 7

A3



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Yakka Skink

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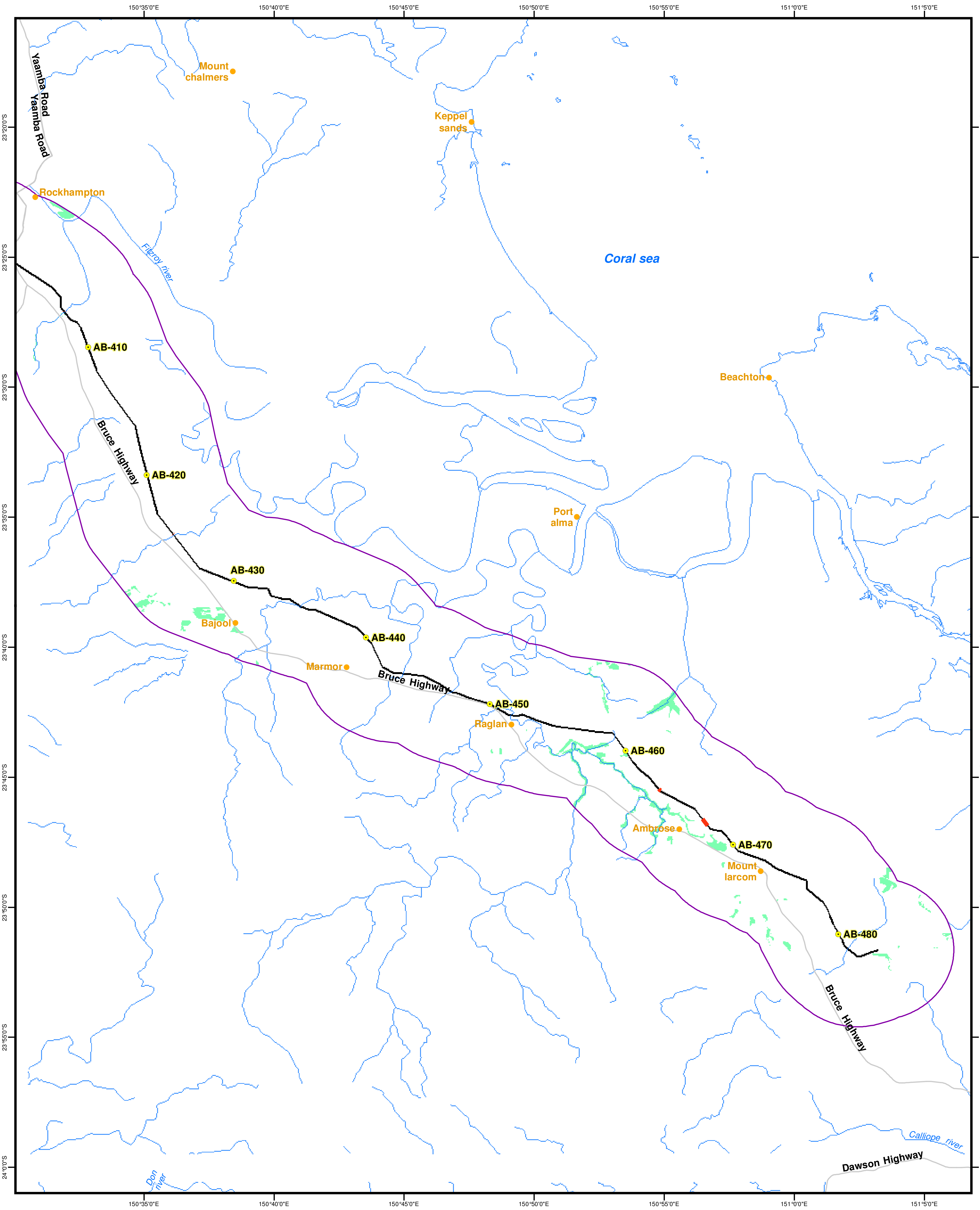
Arrow Bowen Pipeline
Revision H1

Page 6 of 7

A3



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Revision H1

Page 7 of 7

A3

2.3 *Epthianura crocea macgregori (Dawson Yellow Chat)*

Photo by Brendan Cook, Avisure

2.3.1 Acknowledgement

Arrow Energy would like to acknowledge the contribution made by Wayne Houston from Central Queensland University in the development of this species dossier.

2.3.2 Conservation Status

Queensland: Endangered under the NC Act

National: Critically Endangered under the EPBC Act

2.3.3 Description

The Dawson Yellow Chat, also known as the Capricorn Yellow Chat, is around 11 cm in length and weighs about 9 g (DSEWPaC, 2013a). Adult males are mainly yellow-olive above with a rich golden-yellow head and rump and black crescent on the breast. Adult females are bright yellow on the breast and rump, have a yellow eyebrow and lack the distinct black mark on the breast (Houston et al. 2004a). Juveniles have a more even brown colour on the upperparts, light brown throat and breast, and otherwise paler yellow underparts (Houston et al. 2004a).

2.3.4 Distribution

The Dawson Yellow Chat is restricted to coastal areas of central Queensland (Schodde & Mason 1999) (Figure 7). Breeding populations are known to occur on the Torilla Plain and Fitzroy River Delta (Houston et al. 2004b, 2006). An extensive survey conducted in 2007 failed to detect a population of Dawson Yellow Chat that was previously recorded on Curtis Island in 2002 (Houston et al. 2004a). The current total extent of occurrence is estimated to be between 130 and 145 km² (W. Houston 2007, pers. comm.).

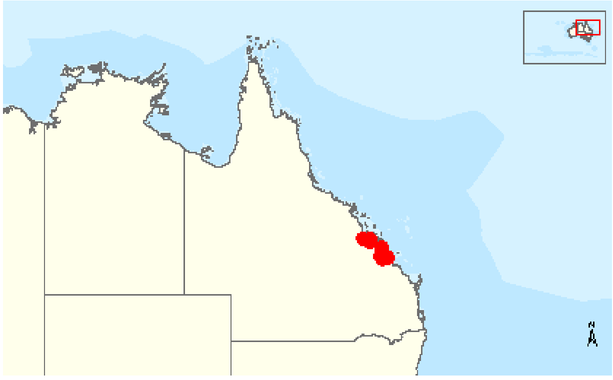


Figure 7 Distribution of *Epthianura crocea macgregori*

Source: DSEWPaC 2013

2.3.5 Habitat

Dawson Yellow Chats occur on marine plains (i.e. shallow coastal bays that slowly filled with sediments from tidal deposition, or a combination of tidal and fluvial processes about 10,000 years ago). Habitat comprises grass-sedge wetlands (especially those dominated by *Schoenoplectus litoralis* or *Cyperus alopecuroides*) or supratidal saltmarshes (a mixture of the samphire *Tecticornia pergranulata* and the grass *Sporobolus virginicus*) that are temporarily flooded, with pools becoming brackish to hypersaline as they dry (Houston 2010; Houston et al. in press). They also occur in shallow grass-sedge swamps on alluvial plains but only where these immediately abut known marine plain habitats. In some parts of their range they move between breeding habitat and dry season habitat (including the vegetated banks of saltfields) (Houston 2010). Four sites (including two saltfields) have been confirmed as being currently used by Dawson Yellow Chats during the drier months.

Dawson Yellow Chats are known to inhabit several Regional Ecosystems (REs) including 11.1.2b and 11.1.1 (supratidal saltmarshes) and 11.1.3, 11.3.27x1c and 11.3.27x1a (grass-sedge wetlands). However, Dawson Yellow Chats have also been observed in grass-sedge wetlands mapped as non-remnant under RE mapping (mainly due to issues of the coarse scale of mapping or modification by sea walls).

Nesting has only been observed in relatively tall sedge, grass or samphire vegetation (typically > 0.25 m) located on channel and pool edges of supratidal saltmarshes and grass-sedge wetlands of marine plains (Houston 2010; Houston et al. in press). Such habitat is not located within or adjacent to the ABP ROW.

During the breeding season chats typically forage on the muddy surfaces around pool margins and on the foliage of sedges, grasses, samphire and associated shrubs (e.g. *Sesbania, Avicennia* and *Myoporum*) (Houston 2010). In the dry season, chats forage around the edges of dried swamps in tall grasses, samphire, low shrubs, on bare substrates and the margins of saltfield evaporation ponds. Dawson Yellow Chats typically forage close to vegetation, presumably for protection from predators.

Their dispersal requirements are not known but Dawson Yellow Chats move between breeding habitat and dry season grounds over distances of 10 km or less (Houston 2010). These sites are separated by mostly unvegetated saltflats, although these flats have small patches of mangrove and saltmarsh embedded in them that could be used in a “stepping-stone” fashion. Also, the margins of these saltflats are bordered on the terrestrial side by the alluvial plain and the transition zone between the two, and on the marine side by mangroves. The grassy margins of the marine – alluvial plain transition zone also support grass-sedge swamps that may provide temporary habitat for dispersing birds.

Suboptimal habitat may be used in drought or flood years. Habitats of interest include those linked to known chat sites such as nearby alluvial plain wetlands or creek pools immediately upstream of marine plain habitats.

It is also likely that, with continuing search effort, chats will be reported in some areas currently regarded as unoccupied. This may be a consequence of climatic phase (e.g. a sequence of wetter years will enhance some wetland vegetation) or climatic change leading to loss of some existing habitat and creation of new habitat.

2.3.6 Ecology

Dawson Yellow Chats are thought to be primarily insectivorous, although they do have a brush tongue and may be capable of feeding on nectar as well. Analysis of stomach contents of Yellow Chats from inland Australia showed that flies (Diptera) comprised the greatest proportion, but with beetles (Coleoptera), homopteran bugs (Hemiptera), lacewing larvae (Neuroptera), caterpillars (Lepidoptera), ants (Formicidae: Hymenoptera) and spiders (Araneae) also present. Dawson Yellow Chats have been observed feeding on caterpillars, spiders, damsel flies (Odonata), moths and winged ants (Houston et al. 2004a; Houston et al. 2004b; Houston 2010).

Dawson Yellow Chats breed mainly in the wetter months corresponding to late spring, summer and early autumn but can breed in any season or month following substantial rainfall (Houston 2010; Houston 2013). Breeding commencement is correlated with rainfall and follows substantial inundation of their breeding habitat which may be a breeding cue (Houston 2010; Houston 2013). Dawson Yellow Chats return to the same areas to breed each year.

Pairs build concealed nests in low vegetation close to the ground, often in clumps of vegetation over shallow water. Two to four eggs are usually laid with both parents incubating and feeding the young (Houston 2010). The incubation period is estimated at 13-14 days and nestling duration at 12-14 days. Fledgling stage (time to independence following leaving the nest) is thought to be at least 13-14 days but may be longer. Nesting pairs defend a ‘territory’ around the nest site but, following fledging, family groups range more widely across the breeding grounds.

Post-breeding aggregations of up to 80 birds have been observed, typically in the late autumn-early winter period (Houston 2010).

Breeding season

🟩	🟨
Likely breeding season	Breeding unlikely

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩

2.3.7 Activity period

The Dawson Yellow Chat has been observed to be most active during the wet season and is capable of dispersing over long distances in response to changes in weather patterns. They appear to be territorial during the breeding season with pairs and family groups of up to six being recorded.

2.3.8 Threats

Dawson Yellow Chats are threatened by habitat loss or degradation due to industrial development (e.g. port facilities, rail corridors, pipelines), saltfield expansion and shale oil mining (Houston and Melzer 2008). Developments that reduce the amount of freshwater surface runoff reaching the marine plain breeding habitats, impacting on wetland productivity and vegetation structure, are of great concern (Houston 2010, Houston et al. in press).

Other threats include weed invasion by exotic pasture grasses leading to loss of sedge nesting habitat, over-grazing leading to loss of tall cover and reduction in sensitive plants such as samphire and sedges, changes in water quality, damage to groundwater aquifers and wildfires. Pigs can damage grass-sedge swamps by digging up and consuming food species such as *Schoenoplectus* and *Eleocharis*. Increases in predator numbers (e.g. cats and pigs) are also a threat to ground nesting species such as Dawson Yellow Chats.

Sea level rise was recently identified as a major threat to the subspecies with most Dawson Yellow Chat sightings averaging less than 2 m above current highest astronomical tidal influence. These sites will become tidal or be subject to regular storm surge influence under future modest predicted sea level rise scenarios of 0.5 m by 2100 (Houston et al. in press).

2.3.9 Recovery actions

The overall objective of the National Recovery Plan for Yellow Chat (Houston and Melzer, 2008) is to improve the conservation status of the Dawson Yellow Chat and manage its habitat. The plan has three main objectives:

- protect, enhance and manage Dawson Yellow Chat habitat
- address known threats, and identify and quantify potential threats
- increase knowledge and awareness of the Dawson Yellow Chat through the development of an extension program targeting the community, industry and landholders.

2.3.10 DoE recommended survey methods

The *Survey Guidelines for Australia's Threatened Birds* (Commonwealth of Australia, 2010) contains recommended guidelines for surveys of Dawson Yellow Chat. This species can be difficult to survey due to difficulty in accessing its preferred swampy grassland habitat. During the breeding season the males are often conspicuous while they are calling and engaging in display flights (Commonwealth of Australia, 2010). The species is much less conspicuous in the non-breeding season. Unfledged juveniles hide in reed beds and can be difficult to detect.

DoE recommends area searches and transect point surveys of all suitable habitat. The surveys should be conducted in the early morning or late afternoon particularly in the breeding season (Commonwealth of Australia, 2010).

The maximum area impacted by the ABP would be approximately 6.89 ha (assuming no avoidance by trenchless crossing, refer below - mitigation measures). For areas less than 50 ha, DoE recommends the following area searches and transect surveys for Dawson Yellow Chat.

2.3.10.1 Area searches

Area searches entail searching a defined area for a defined period of time. Each selected area is searched systematically, while investigating possible sightings, calls or signs of presence (Commonwealth of Australia 2010). This method is likely to be the most suitable for surveying Dawson Yellow Chat as the habitat preferences of this species are specific and a meandering technique will allow these areas to be investigated fully. The recommended effort for Dawson Yellow Chat using this method is 12 hrs of searching in suitable habitat over 4 days.

2.3.10.2 Transect surveys

Transect surveys involve travelling along a pre-defined path between two points for a known distance and recording any birds heard or seen. These surveys can be done on foot or from a vehicle. The length of each transect generally depends on the width of habitat being surveyed. The recommended effort for Dawson Yellow Chat using this method is 10 hrs of survey in suitable habitat over 3 days.

2.3.11 Survey effort and methods undertaken for ABP

2.3.11.1 Desktop methods

A desktop assessment was conducted to identify potential habitat in and adjacent to the ROW. Potential habitats are defined as coastal wetlands which are mapped either in Queensland government wetland mapping or RE mapping (W. Houston, pers. comm.). Wetland Management Areas (WMAs), Wetland Protection Areas (WPAs) and REs (including 11.1.1, 11.1.2b, 11.1.3, 11.3.27x1c and 11.3.27x1a) were used to estimate potential habitat of Dawson Yellow Chat. This mapping includes areas of palustrine, lacustrine, estuarine and riverine wetlands which contain both remnant and non-remnant vegetation.

2.3.11.2 Field survey methods

Field surveys were used to search for populations and classify potential habitat as either marginal or critical habitat for Dawson Yellow Chat.

Critical habitats are defined in the National Recovery Plan (Houston and Melzer 2008) as wetlands and associated grasslands on seasonally inundated marine plains that contain shallow braided channels, and depressions with a mosaic of dense sedge-beds, grasslands, tall samphire and areas of mud and/or shallow water.

Marginal habitats are defined as other areas of coastal wetlands which do not contain critical habitat features. Based on this definition, areas that are dominated by mangroves and saltwater couch (*Sporobulus virginicus*) and do not contain significant areas of samphire and sedge beds are considered to be marginal habitat. It is unlikely that breeding occurs in marginal habitats but they may be used for foraging.

Targeted surveys for Dawson Yellow Chat were undertaken in December 2011 and March 2012. A total of 18 locations between Rockhampton and Gladstone were surveyed for Dawson Yellow Chats (and other species) over approximately 9 hours. Surveys at these sites consisted of call playback and area searches.

In October 2013, field surveys were conducted to ground-truth potential habitat and undertake targeted searches for Dawson Yellow Chat. Habitat assessments to classify habitat as marginal or critical were undertaken in areas identified as potential habitat, including the three major creeks crossings (Twelve Mile, Raglan and Inkerman Creeks).

Due to land access restraints during the October 2013 surveys, not all potential habitat areas were assessed so further surveys are required to complete ground-truthing of habitats and continue targeted searches for populations.

2.3.12 Survey results

2.3.12.1 ABP survey results

Queensland government wetland mapping identifies approximately 5.41 ha of WPAs and 1.48 ha of WMAs in the ROW between KP 380 and KP 480 (Rockhampton to the end of the alignment) (Table 19). Based on this mapping, there is 6.89 ha of potential habitat for Dawson Yellow Chat in the ROW. This equates to 0.07% of mapped potential habitat in the 5 km buffer.

An extra 0.28 ha of riparian vegetation within the ROW at Twelve Mile Creek is also considered to be potential habitat as it is coastal wetland adjacent to known Dawson Yellow Chat populations. However, none of this habitat is mapped as a WMA or WPA and therefore is not included in the mapped wetland table (Table 19). The total area of potential habitat including Twelve Mile Creek is therefore 7.17 ha.

Table 19 Areas of mapped wetlands in ROW and in 5 km buffer between Rockhampton and the end of the ROW which could be potential habitat for Yellow Chat.

Wetland type	**REs in the ROW**	**Area in 40 m ROW (ha)**	**Area in 5 km buffer (ha)**	**% cleared in 5 km buffer**
Wetland protection areas (WPAs)	11.3.27a, 11.3.27b, 11.3.27c, 11.3.27x1a, 11.3.27x1b, 11.3.3c, non-remnant	5.41	2499.38	0.21
Wetland management areas (WMAs)	11.1.4d, 11.1.4, 11.1.4b, 11.3.27x1b, non-remnant	1.481.48	6655.66	0.02
Totals		7.371*	9155.04	0.07

* this area does not include approximately 0.28 ha of habitat on Twelve Mile Creek which is not mapped as wetland but is known to be used by Yellow Chat

Yellow chats were recorded during two surveys conducted by EcoSM. Two birds were detected at Twelve Mile Creek in December 2011 and another two birds were recorded at a nearby location in March 2012. These sites are approximately 1 km north (downstream) of the proposed ABP pipeline at KP 443.7. During these surveys, the presence of Dawson Yellow Chats was confirmed by both call identification and visual observation. Surveys in October 2013 did not detect Dawson Yellow Chats in or adjacent to the ROW.

Habitat at the Raglan Creek crossing point consists of saltwater couch grassland and mangroves lining a tidal watercourse (RE 11.1.4 and 11.1.1). This habitat is considered to be marginal habitat as it does not contain significant areas of samphire or sedgelands and no previous surveys have recorded birds in this location.

The habitat on Inkerman Creek consisted of saltwater couch grasslands with small mangroves and scattered samphires (RE 11.1.4 and 11.1.1). Based on this assessment, the habitat is considered to be marginal.

Yellow Chat have been recorded both upstream and downstream of the Twelve Mile Creek crossing. Habitat at this crossing consists of a freshwater creek lined with a narrow band of *Typha* sp. and saltwater couch with cleared paddock on either side. This habitat is considered to be marginal as it does not contain areas of samphire or significant amounts of sedges. Although birds have been recorded near this crossing previously, it is unlikely that the habitat is suitable for breeding but may be used for foraging.

Based on this information, a total of 1.25 ha of marginal habitat could be impacted on Inkerman, Raglan and Twelve Mile Creeks (Table 20). All of this habitat would be avoided if trenchless techniques are used to cross these creeks.

Table 20 Area of marginal and critical habitat potentially impacted by ABP

Creek	Area of marginal habitat to be impacted (ha)	Critical habitat (ha)
Inkerman	0.24	0
Twelve Mile	0.28	0
Raglan Creek	0.73	0
Totals	1.25	0

Further surveys will to be conducted along the ROW to classify potential habitat outside of Raglan, Twelve Mile and Inkerman Creeks. Based on aerial imagery, it is likely that all potential habitat within the ROW is marginal habitat and is not likely to contain significant numbers of Dawson Yellow Chat. An assessment of the impacts on potential habitat is discussed in Section 2.3.13.

2.3.12.2 Other survey results

Birdlife Australia has 35 records for Dawson Yellow Chat in the vicinity of ABP. Most of these records lie approximately 1 km east of KP 443.8 in an area known to contain a significant population of Dawson Yellow Chats. One record lies approximately 250 m upstream of the pipeline on KP 443.8 on Twelve Mile Creek. This bird is likely to belong to the population downstream of the line and would have travelled along Twelve Mile Creek while foraging. There are also records of Dawson Yellow Chat on Inkerman and Raglan Creeks, downstream of the creek crossings. Wayne Houston (pers. comm.) recorded birds 2 km downstream of Inkerman Creek and 1.6 km downstream of Raglan Creek.

2.3.13 Impacts of ABP on Dawson Yellow Chat

2.3.13.1 Potential impacts without mitigation

If no mitigation measures are implemented, the ABP pipeline could potentially impact Yellow Chat populations through direct impacts to individual birds and habitat and indirectly through disturbance to downstream habitat and introduction of weeds and pest animals. Direct impacts associated with proposed project could include:

- loss of habitat
- mortality of adults.

Indirect impacts associated with the proposed project could include:

- downstream impacts on habitat caused by changes in water quality and hydrology
- increase in weed abundance
- increase in pest animal abundance
- noise and disturbance

2.3.13.2 Assessment of potential impacts with mitigation

Table 21 summarises potential direct and indirect impacts of the project on Dawson Yellow Chat populations and proposed measures to mitigate potential impacts. It is likely that trenchless crossing techniques will be used to cross habitat on Raglan, Twelve Mile and Inkerman Creeks. Traditional trenching techniques will be used for the remainder of Yellow Chat habitat. The table below provides a risk assessment for each impact, assuming trenchless crossing techniques will be used across creek crossings and trenching will be used in other habitat. In the unlikely event that crossings could not be safely achieved using trenchless techniques, Arrow has produced a significant species management plan which assesses the potential impacts of alternative crossing methods to this species and details mitigation measures to reduce these impacts (Appendix 2).

Table 21 Impacts and mitigation measures associated with construction of the ABP on Yellow Chat.

Potential Impact	Raw risk (before mitigation)	Mitigation measures	Residual risk (after mitigation)
DIRECT IMPACTS			
Removal of habitat* · Temporary removal of wetland habitat which could provide potential foraging, breeding and sheltering habitat	M	· use trenchless techniques to cross Inkerman, Raglan and Twelve Mile Creeks · use existing cleared corridors where possible · clearly mark out areas to be cleared and retained · rehabilitate the ROW following construction · develop a Significant Species Management Plan which includes Yellow Chat · all activities are to remain in the construction area or designated lay-down area · all ancillary areas (e.g., lay down areas, stockpiles etc.) are situated outside of suitable habitat and a buffer of at least 200 m is maintained · if possible, existing access roads will be used to cross creeks thus avoiding constructing new access points · the majority of the ROW (except for a 7 m wide track) will be rehabilitated after construction using native grasses, shrubs and trees	L*
Mortality of adults · Direct loss of breeding individuals through vehicle strike	L	· use trenchless techniques to cross Inkerman, Raglan and Twelve Mile Creeks · reduce the speed limit for machinery and vehicles in the ROW in areas identified as Dawson Yellow Chat habitat · a spotter catcher will be present during clearing in case a Dawson Yellow Chat is injured.	L
INDIRECT IMPACTS			

Potential Impact	Raw risk (before mitigation)	Mitigation measures	Residual risk (after mitigation)
Long term changes in hydrology · Changes in wet/ dry season cycle leading to changes in vegetation in Dawson Yellow Chat habitat	L	· use trenchless techniques to cross Inkerman, Raglan and Twelve Mile Creeks	I
Long term changes in water quality · Sedimentation of the waterway caused by erosion in the ROW leading to changes in Dawson Yellow Chat habitat · Pollution of waterways by hydrocarbons	L	· use trenchless techniques to cross Inkerman, Raglan and Twelve Mile Creeks · construction will be conducted outside the wet season · rainfall forecasts will be carefully monitored to enable management measures to be put in place before large rainfall events · acid sulfate soils will be managed in accordance with the acid sulfate soils management plan · chemical spills will be managed in accordance with the emergency response plan · conduct surveys prior to construction to determine the topography and morphology of the land and creek crossings so that they can be returned to a similar standard during rehabilitation	L
Noise and disturbance* · Displacement of individuals into more marginal habitat leading to decreased survival and overall decline in population	L	· use trenchless techniques to cross Inkerman, Raglan and Twelve Mile Creeks · noise will be managed in accordance with the noise and vibration management plan · to avoid disturbance exclude access by construction personnel, vehicles or plant to buffers established around nests	L*
Dust · Smothering of plants used for shelter and foraging	I	· dust will be managed in accordance with the air quality management plan	I
· Increase in weed abundance · Smothering of habitat vegetation by weeds potentially leading to loss of plant diversity and displacement of native plants	M	· develop and implement a Weed Management Plan · control weeds in the ROW before, during and after construction · implement site weed hygiene protocols	L
Increase in pest animal abundance · Introduction of exotic predators to habitat i.e. foxes, cats, dogs leading to increased predation on Dawson Yellow Chats	L	· develop and implement a Waste Management Plan · develop and implement a Pest Management Plan · educate staff about the importance of removing any food waste from the ROW · keep the work site clean of debris which could be used as shelter for introduced predators	L
Increase in fire	L	· implement a no –burning policy	I

Potential Impact	Raw risk (before mitigation)	Mitigation measures	Residual risk (after mitigation)
frequency · Increased chances of wildfire during construction, e.g. sparks from welding, personnel smoking			

* This risk rating will be reassessed following more field surveys.

The construction of the ABP may result in a temporary loss of potential habitat for Dawson Yellow Chat. Desktop mapping and imagery identified 7.17 ha of potential habitat within the ROW. Raglan, Twelve Mile and Inkerman Creeks contain approximately 1.25 ha of potential habitat, all of which has been assessed as marginal habitat during surveys. Further surveys will be conducted to determine the area and quality of habitat to be impacted outside of Raglan, Twelve Mile and Inkerman Creeks. Based on aerial imagery, it is likely that other habitat within the ROW is marginal habitat that would not be suitable for breeding although it may provide foraging habitat.

Arrow is committed to using trenchless techniques (such as HDD) to cross under Raglan, Twelve Mile and Inkerman Creeks, which will significantly reduce the impacts on habitat at these locations. In the unlikely event that crossing using these techniques is not possible, Arrow will produce a revised significant species management plan which will assess the potential impacts of alternative crossing methods to this species and detail mitigation measures to reduce these impacts.

Existing access ways will be used for movement of vehicles and equipment across these waterways, wherever possible, to further reduce disturbance on habitats. Other wetland habitats within the ROW that are disturbed by the project will be rehabilitated following construction to restore habitat features that are suitable for Dawson Yellow Chat. Arrow is committed to the rehabilitation of the ROW and consequently any impacts to Dawson Yellow Chat habitat will be temporary.

There is a low risk that adult Dawson Yellow Chats could be directly killed by vehicles and machinery during clearing or construction activities. However, this bird is mobile and is likely to avoid the construction area. A reduced speed limit to 40 km/h within the ROW will reduce the risk of collisions with animals. With these mitigation measures the impacts associated with direct mortality of Dawson Yellow Chat is likely to be **Low**.

Dawson Yellow Chats are most active during the breeding season which is dependent on substantial wet season rainfall and inundation of marine plain wetland habitats (Houston 2010, Houston 2013). This period also corresponds to peaks in the abundance of invertebrates which provide food for adults and their dependent young (Houston 2010, Houston 2013). Thus, any changes in the wetting and drying cycle of wetlands has the potential to impact on Dawson Yellow Chats indirectly through changes in vegetation and associated productivity of invertebrate food. Arrow is committed to use trenchless techniques, if geology permits, to cross Raglan, Twelve Mile and Inkerman Creeks. The use of trenchless techniques will avoid impacts on downstream Yellow Chat habitats Impacts will be further mitigated by undertaking crossings in the dry season (when freshwater flows in these ephemeral watercourses are minimal or absent) and during periods of neap tides (when tidal flows are minimised).

Changes in water quality could potentially lead to changes in vegetation composition or cover in downstream habitats for Dawson Yellow Chats.

Arrow has committed to the implementation of management plans to manage potential impacts from erosion and sediment, acid sulphate soils and storage and use of chemicals, which will manage the risks associated with water quality. Therefore, the impact of changes in water quality on Dawson Yellow Chat is likely to be **Insignificant**.

The construction of the pipeline could potentially lead to disturbance of Dawson Yellow Chats through:

- noise of machinery including excavators, reversing alarms and cranes
- noise of vehicles including running vehicles and closing doors
- people approaching birds and their habitat
- people speaking and yelling
- lights at night.

Disturbance of Yellow Chats is most likely in areas of marginal habitat associated with Raglan, Twelve Mile and Inkerman Creeks. Construction activities in wetland areas between KP 380 to 483, also have the potential to disturb Dawson Yellow Chats. The risk mitigation measures identified in Table 2 above will be applied to manage risks associated with construction in these areas. Utilisation of these measures will reduce construction level impacts to Low.

Construction may result in a short term disturbance of Dawson Yellow Chat behaviour but no significant long term impacts are expected as all habitat within the ROW is likely to be marginal. The use of trenchless techniques to cross Raglan, Twelve Mile and Inkerman Creeks will provide additional buffer between construction disturbance and habitat. The risk associated with construction disturbance on Dawson Yellow Chat is expected to be Low.

Construction of the pipeline is not expected to change the risks to Dawson Yellow Chat from introduced pests. Introduced predators (such as foxes and cats) are present and active in the area. Reasonable management measures, such as the removal of food waste from the ROW or induction programs which stress non-feeding of animals will ensure a Low level of risk from pests

2.3.14 Evaluation under MNES significant impact guidelines

Will the action lead to a long-term decrease in the size of a population?

Adoption of the management measures within Table 2 above would result in a low level of risk to the population. When combined with rehabilitation measures a long term decrease to the population would not be expected.

No long term effects are expected from operational activities as these activities will be low level impacts associated with periodic inspections along the pipeline.

Will the action reduce the area of occupancy of the species?

The majority of coastal wetlands that could be potential habitat for Dawson Yellow Chat are mapped as non-remnant and are heavily degraded by invasive species such as para grass. The most significant habitat for Dawson Yellow Chat in the ROW occurs on Raglan, Twelve Mile and Inkerman Creeks. These creeks have been classified as marginal habitat following field surveys and are therefore unlikely to contain significant populations of Dawson Yellow Chats. Provided that habitat and wetland areas within the ROW are rehabilitated after construction and other proposed measures to mitigate indirect impacts are implemented, the project is unlikely to significantly reduce the occupancy of Dawson Yellow Chats in the Fitzroy River Delta.

Will the action fragment an existing population into two or more populations?

Dawson Yellow Chats will be able to move freely across the ROW. Rehabilitation of disturbed wetland and habitat areas will restore connectivity to current levels and no fragmentation the existing population is considered likely.

Will the action adversely affect habitat critical to the survival of a species?

The National Recovery Plan for Dawson Yellow Chat suggests that wetlands and associated grasslands on seasonally inundated marine plains are critical habitat for Dawson Yellow Chats. The Torilla Plain area (over 60 km north-east of the ABP) is likely to be especially critical for the species survival given that 75% of the population occurs there. No impact will occur in this critical habitat. Based on surveys and aerial imagery it is unlikely that any habitat critical for the survival of Yellow Chat will be impacted by the proposed development. Trenchless techniques are proposed to cross Raglan, Inkerman and Twelve Mile Creeks. It is unlikely that the construction of the pipeline will have any impact on critical habitat for Yellow Chat.

Will the action disrupt the breeding cycle of a population?

The habitat on Raglan, Twelve Mile and Inkerman Creeks is considered to be marginal and is unlikely to be used for breeding. Therefore the proposed pipeline is unlikely to disrupt the breeding cycle of Yellow Chat.

Will the action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

No long term impact to habitat is expected from the construction or operation of this pipeline. The ROW is expected to contain marginal habitat degraded by invasive species (such as paragrass) and clearing to support construction will not remove significant amounts of habitat (conservative estimate of clearing is expected to be less than 0.2% of potential habitat within 5 km of the ROW).

Inkerman Creek, Raglan Creek and Twelve Mile Creek contain marginal habitat for Dawson Yellow Chats. Provided that proposed mitigation measures are implemented for these creeks, including HDD of crossings, sediment and erosion control, and rehabilitation after construction, impacts to these areas of habitat are likely to be negligible.

Habitat impacts from construction or operation of the pipeline are not likely to result in the decline of this species.

Will the action result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

The Action will not increase predator access to Yellow Chat habitat. Provided that food waste is removed from the ROW and a pest management plan is put in place, it is unlikely that the action will result in an introduced species becoming more abundant in the area.

Will the action introduce disease that may cause the species to decline?

There are no known diseases of Dawson Yellow Chats which could be introduced to the area through construction.

Will the action interfere with the recovery of the species?

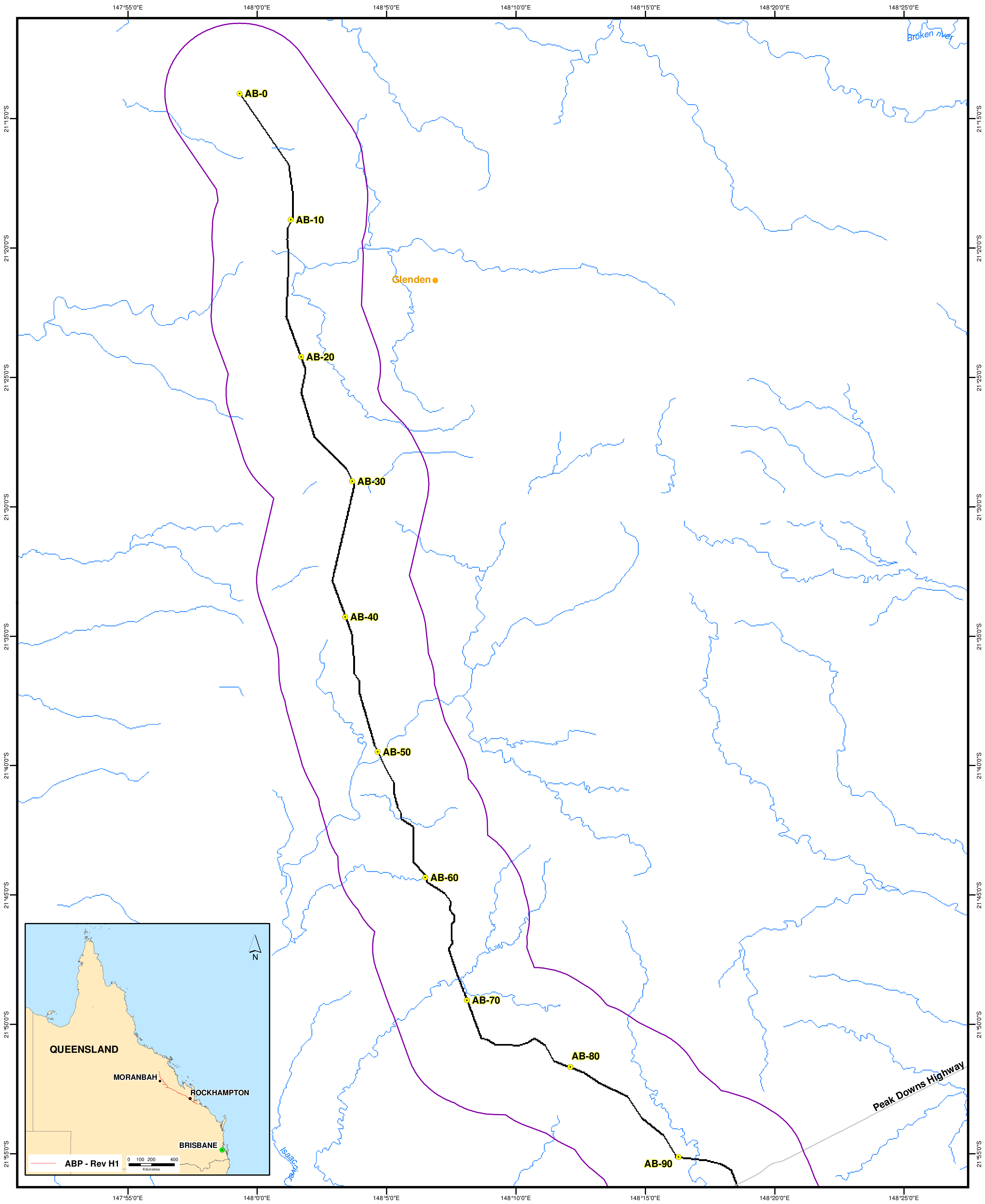
The overall objective of the National Recovery Plan for Dawson Yellow Chat (Houston and Melzer, 2008) is to improve the conservation status of the Dawson Yellow Chat and manage its habitat. The plan has three main objectives:

- protect, enhance and manage Dawson Yellow Chat habitat
- address known threats, and identify and quantify potential threats
- increase knowledge and awareness of the Dawson Yellow Chat throughout the community, industry and landholders.

The proposed pipeline may result in a small amount of potential Dawson Yellow Chat habitat being temporarily removed. Provided that mitigation measures proposed are implemented, the temporary removal of a small amount of habitat in an area of already highly modified wetlands is unlikely to impact the species recovery.

2.3.15 Conclusion

The ABP pipeline is unlikely to reduce the amount of potential habitat available for Dawson Yellow Chat in the Fitzroy River Delta. Based on existing knowledge and proposed mitigation measures, impacts are expected to be low and short-lived, with no adverse effects on Yellow Chat populations. This species will be included in a significant species management plan for the ABP.



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BE004_MP_006L_YellowChat_RevH1

Job Number: BE004

Approved GIS Team Leader		BN		19/11/2013
R0	BN	CF	ISSUED TO CLIENT	30/08/2013
REV	By	CHK	Description	Date

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Kilometres

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Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

●	**City or town**
⊙	**Kilometre Point**
〰	**Waterway or Coast Line**
—	**Main roads**
—	**ABP - Rev H1**
▭	**Buffer (5 km)**

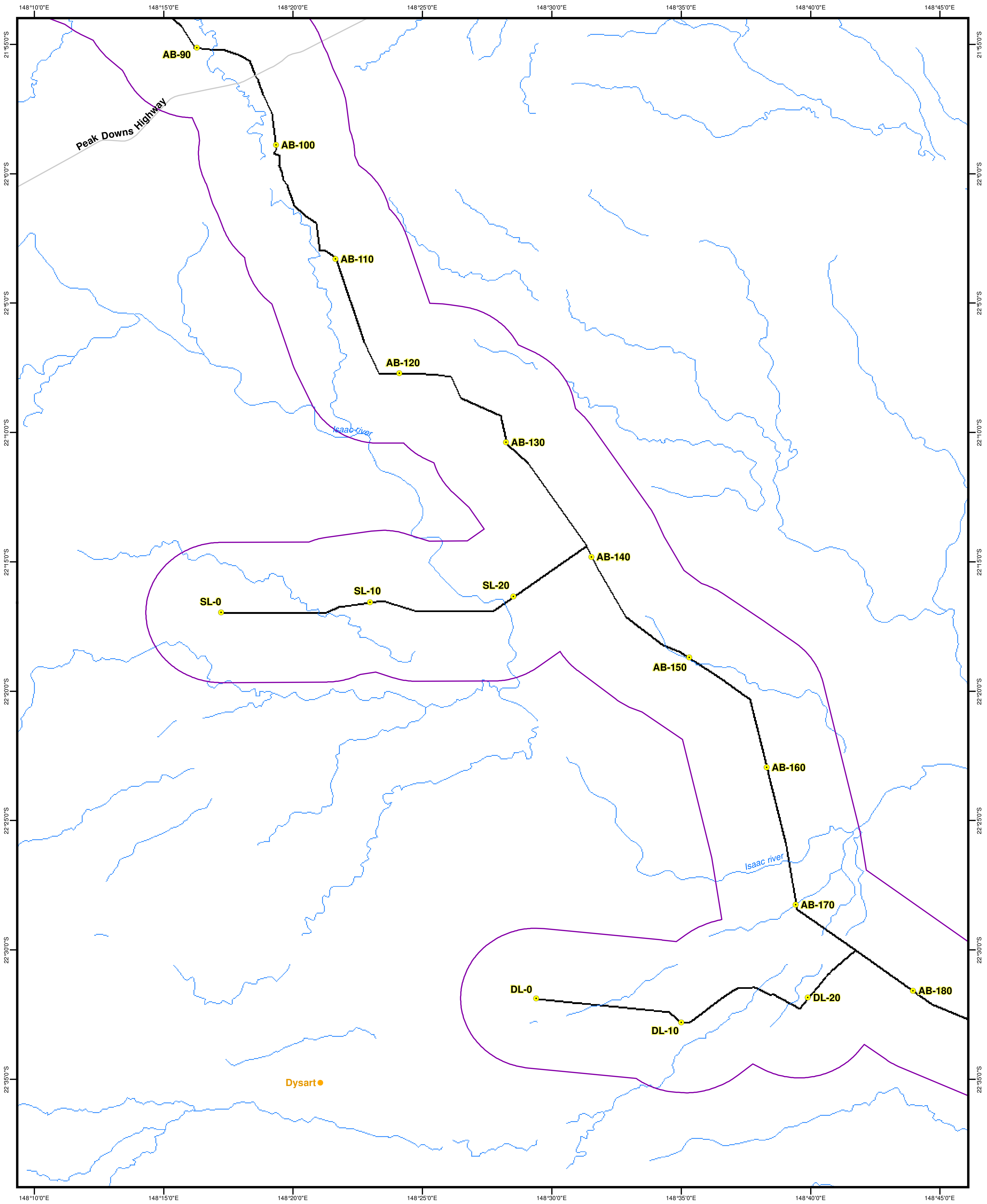
Habitat for Yellow Chat

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 1 of 7

A3



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REV	By	CHK	Description	Date

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Scale: 1:250,000 when printed at A3

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

●	**City or town**
⊙	**Kilometre Point**
~	**Waterway or Coast Line**
—	**Main roads**
—	**ABP - Rev H1**
☐	**Buffer (5 km)**

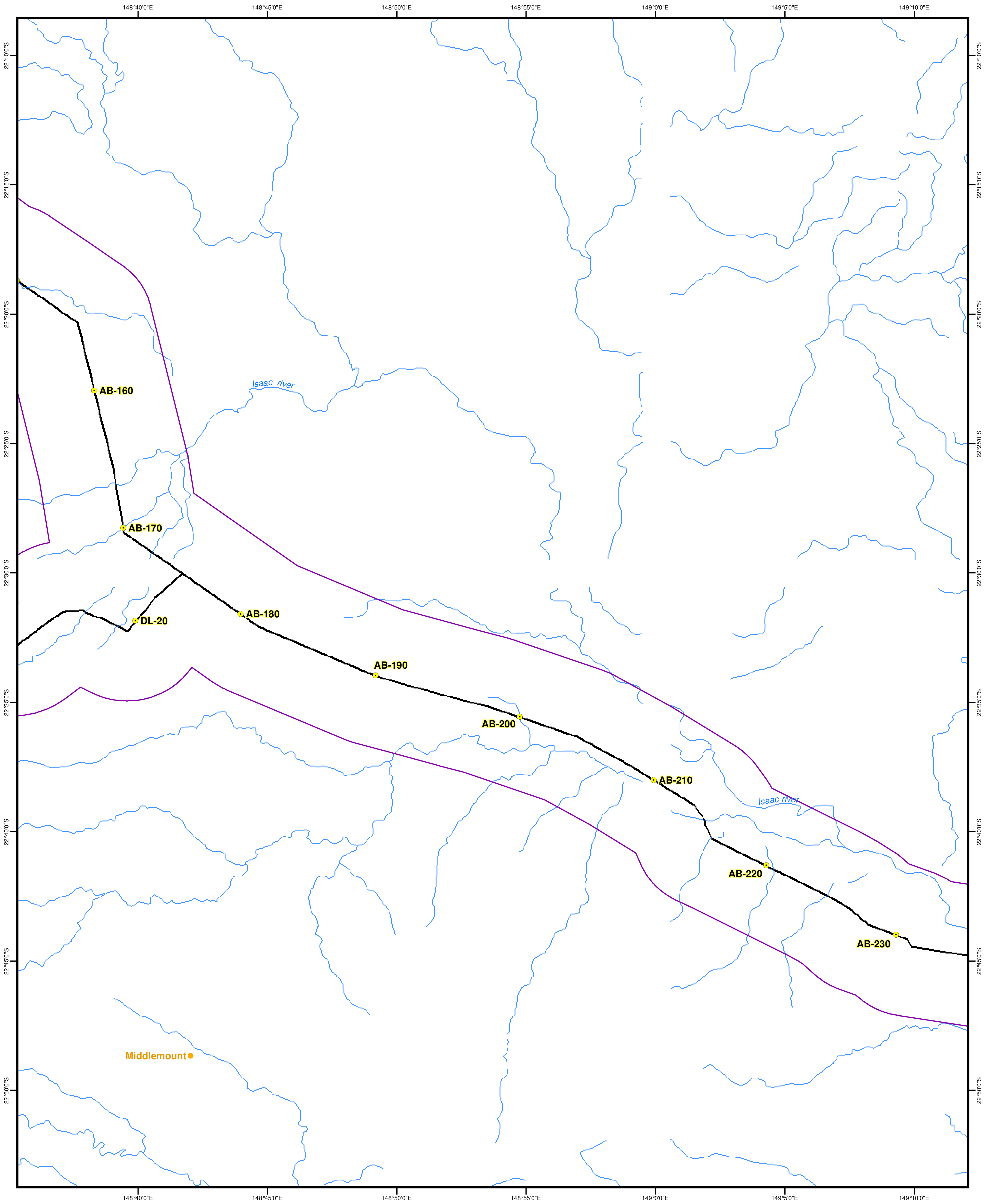
Habitat for Yellow Chat

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 2 of 7

A3



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Document
BE004_MP_006L_YellowChat_RevH1

Job Number: BE004

Approved GIS Team Leader		BN		19/11/2013
R0	BN	CF	ISSUED TO CLIENT	30/08/2013
REV	By	CHK	Description	Date

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Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

- ● City or town
- ⊙ Kilometre Point
- ~ Waterway or Coast Line
- — ABP - Rev H1
- ▭ Buffer (5 km)

Habitat for Yellow Chat

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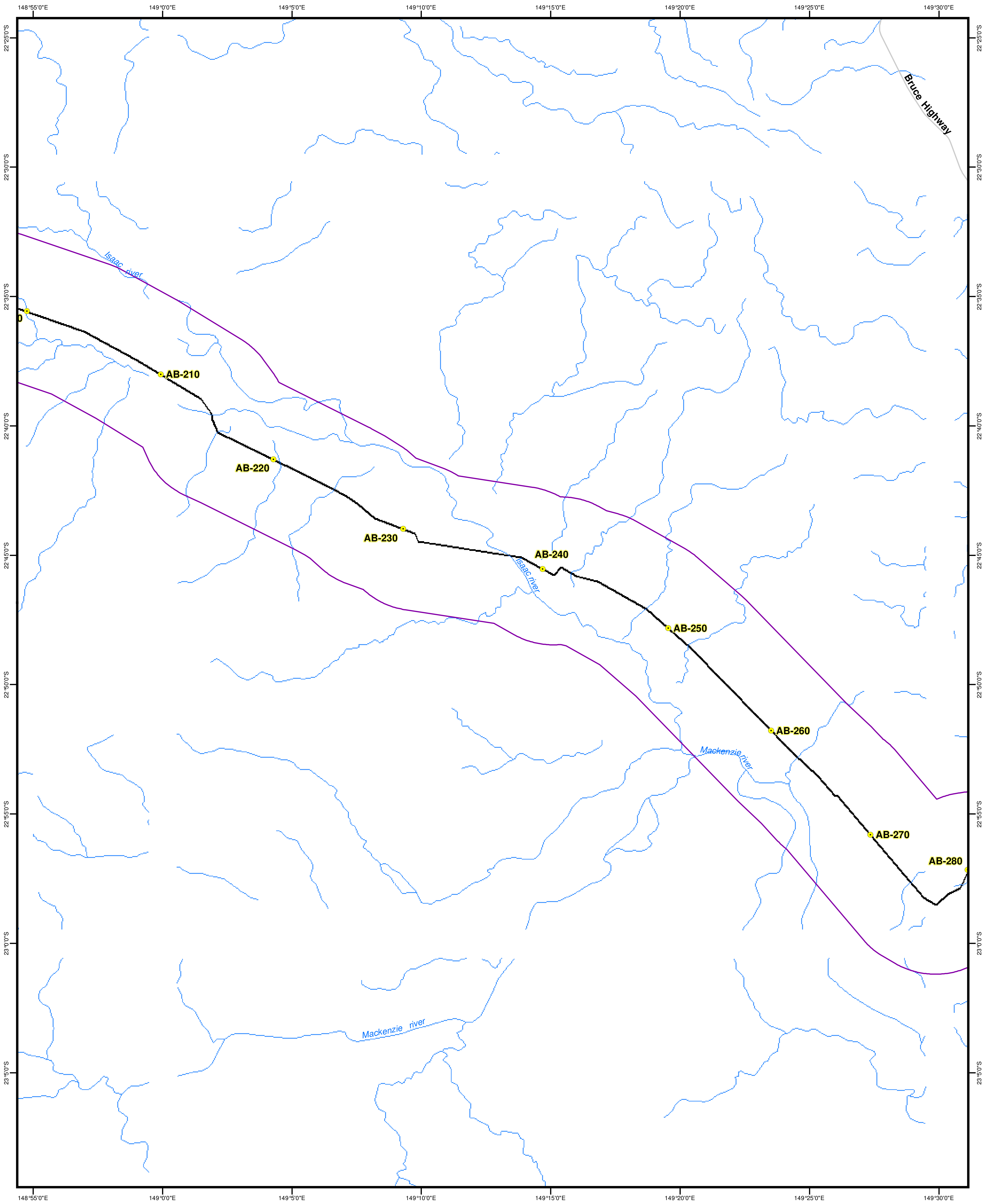
Arrow Bowen Pipeline
Revision H1

Page 3 of 7

A3



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Job Number: BE004

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Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

- ● Kilometre Point
- Waterway or Coast Line
- Main roads
- ABP - Rev H1
- ▭ Buffer (5 km)

Habitat for Yellow Chat

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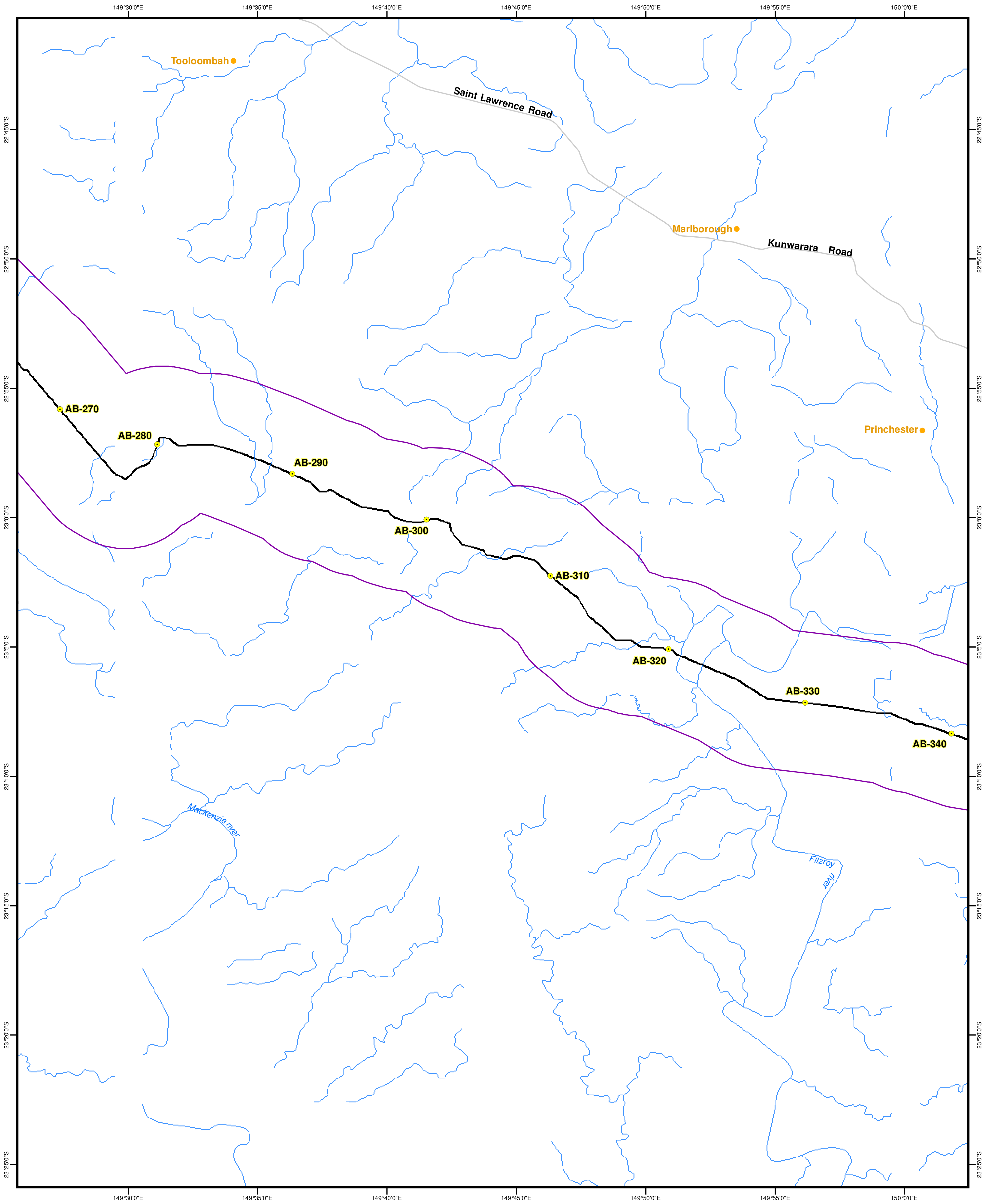
Arrow Bowen Pipeline Revision H1

Page 4 of 7

A3



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Job Number: BE004

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R0	BN	CF	ISSUED TO CLIENT	30/08/2013
REV	By	CHK	Description	Date

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Kilometres

Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

- ● City or town
- ⊙ Kilometre Point
- ～ Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- ▭ Buffer (5 km)

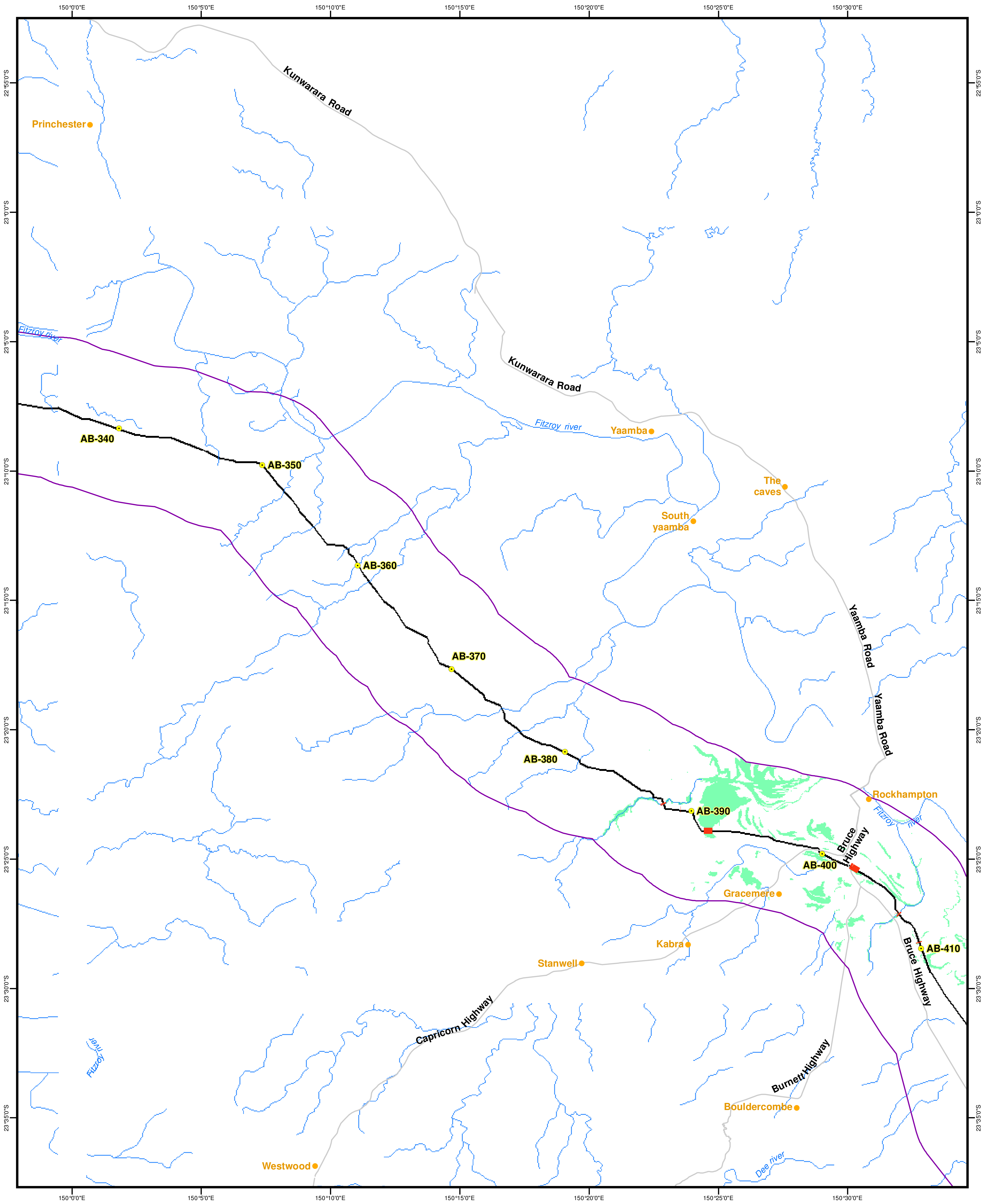
Habitat for Yellow Chat

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 5 of 7

A3



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Job Number: BE004

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REV	By	CHK	Description	Date

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Kilometres

Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

●	City or town
⊙	Kilometre Point
〜	Waterway or Coast Line
—	Main roads
—	ABP - Rev H1
🟥	Potential Habitat in ROW (Field Verified)
🟩	Potential Habitat in Buffer (from State RE Mapping)
☐	Buffer (5 km)

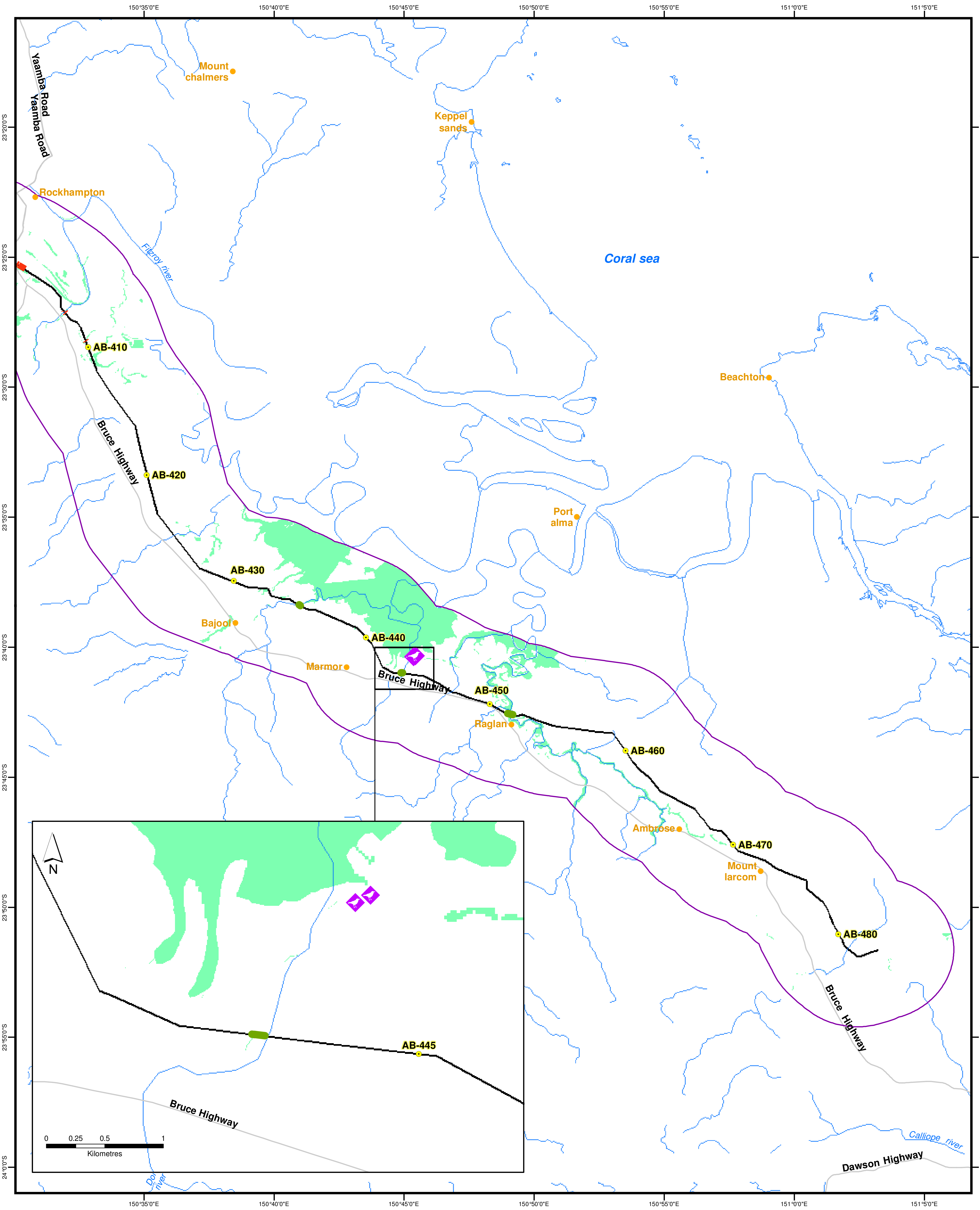
Habitat for Yellow Chat

Arrow Energy Pty Ltd

Arrow Bowen Pipeline Revision H1

Page 6 of 7

A3



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Job Number: BE004

Approved GIS Team Leader		BN		19/11/2013
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REV	**By**	**CHK**	**Description**	**Date**

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Kilometres

Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

- ● **City or town**
- ⊙ **Kilometre Point**
- ◆ **Yellow Chat Survey Records**
- ~ **Waterway or Coast Line**
- — **Main roads**
- — **ABP - Rev H1**
- ▬ **Marginal habitat**
- 🟥 **Potential Habitat in ROW (Field Verified)**
- 🟩 **Potential Habitat in Buffer (from State RE Mapping)**
- ☐ **Buffer (5 km)**

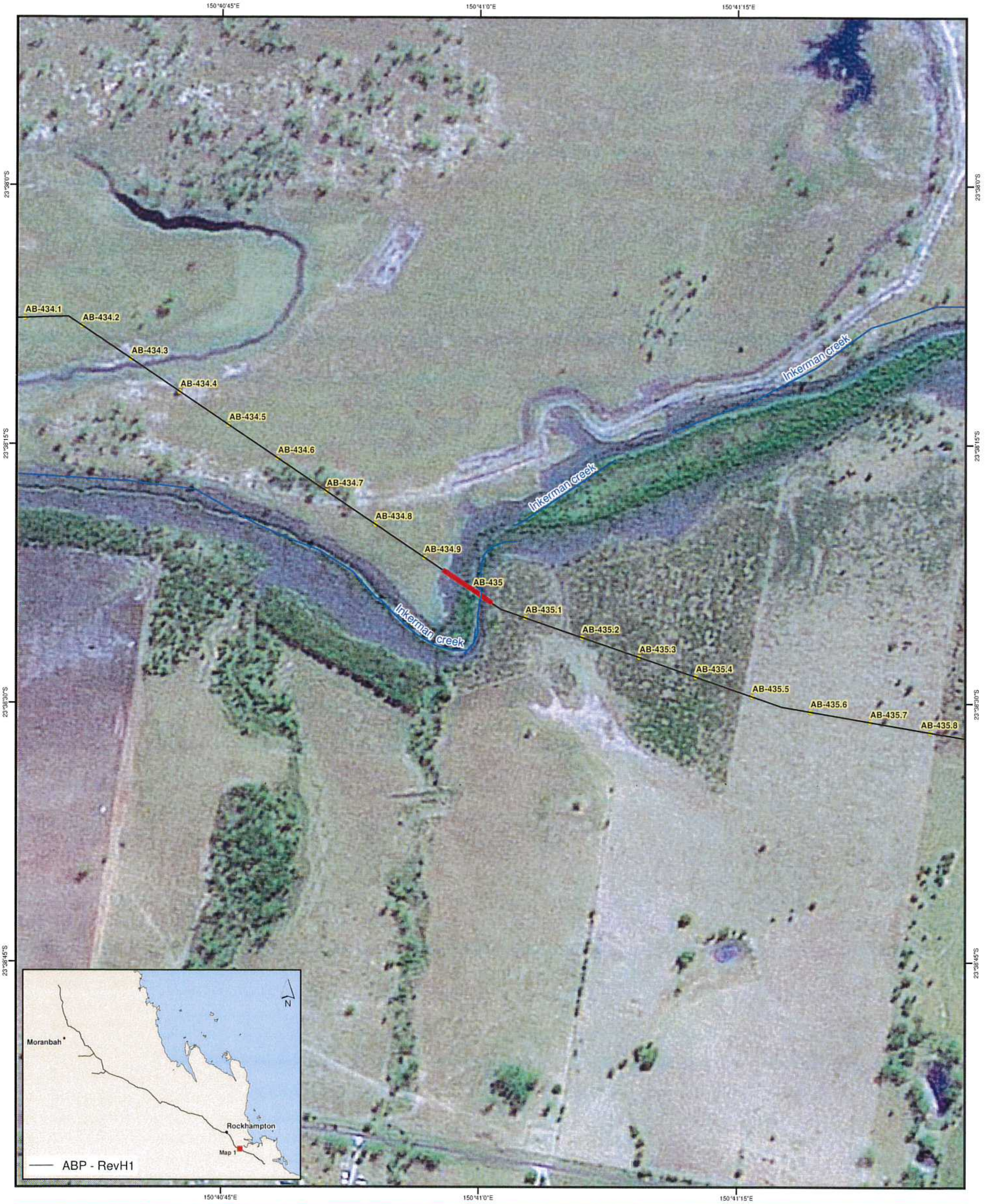
Habitat for Yellow Chat

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 7 of 7

A3



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BE004_MP_003_Critical_habitat_for_YellowChat_F

Job Number: BE004

Approved GIS Team Leader		BN		12/11/2013
R0	BN	CF	ISSUED TO CLIENT	22/08/2013
REV	By	CHK	Description	Date

0 50 100 200
Metres

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Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

🟥	Marginal habitat
—	ABP Route - Rev H1
〰	Waterway

Habitat for Yellow Chat

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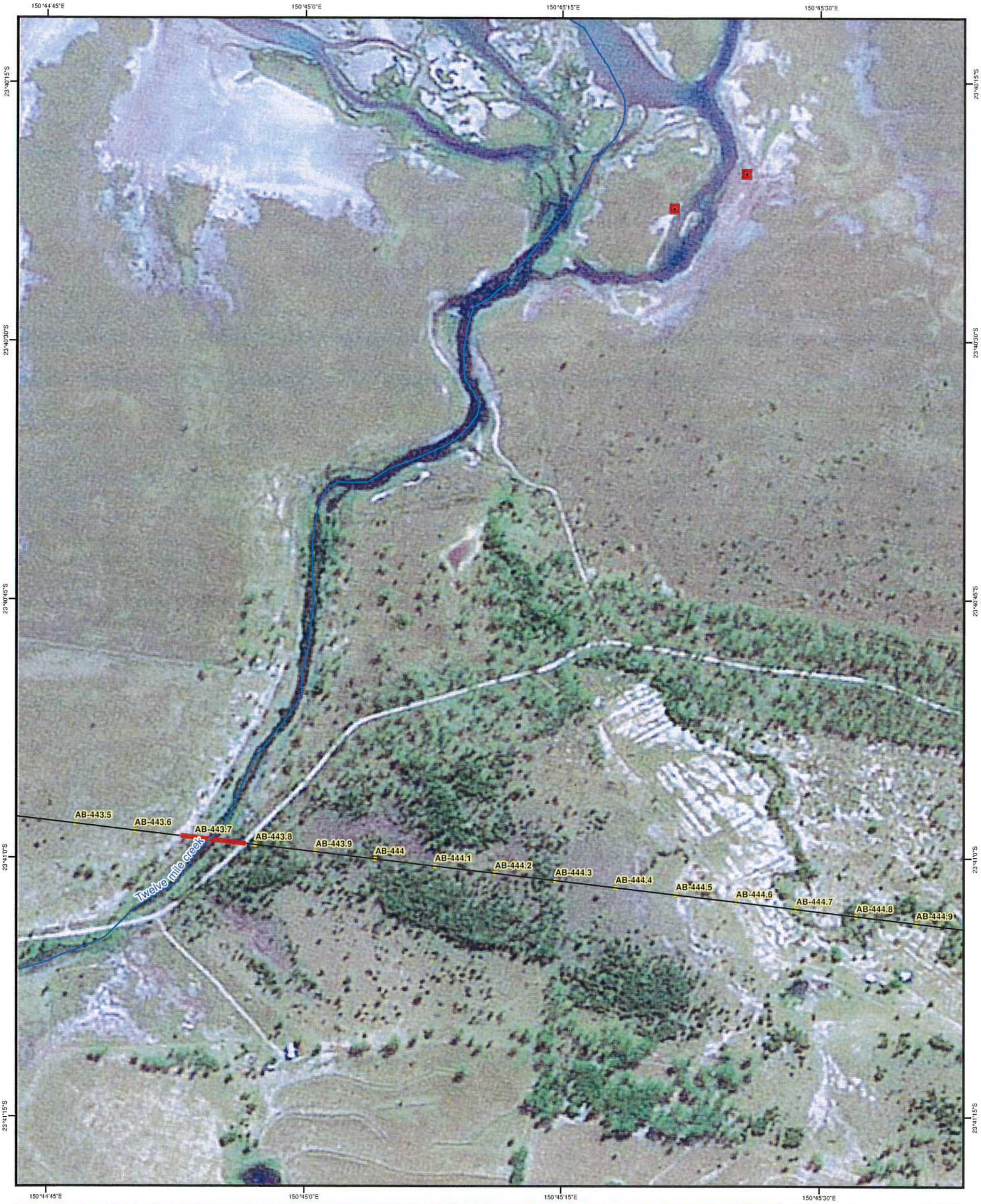
Revision H1

Map 1 of 3 - Inkerman creek - AB-434.3 to AB-435.6

A3



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BE004_MP_003_Critical_habitat_for_YellowChat_F

Job Number: BE004

Approved GIS Team Leader			BN	12/11/2013
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REV	By	CHK	Description	Date

N W E S

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Metres

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Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

- 🟥 Yellow Chat Records
- ▬ Marginal habitat
- — ABP Route - Rev H1
- 〰 Waterway

Habitat for Yellow Chat

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Revision H1

Map 2 of 3 - Twelve mile creek - AB-443.6 to AB-44

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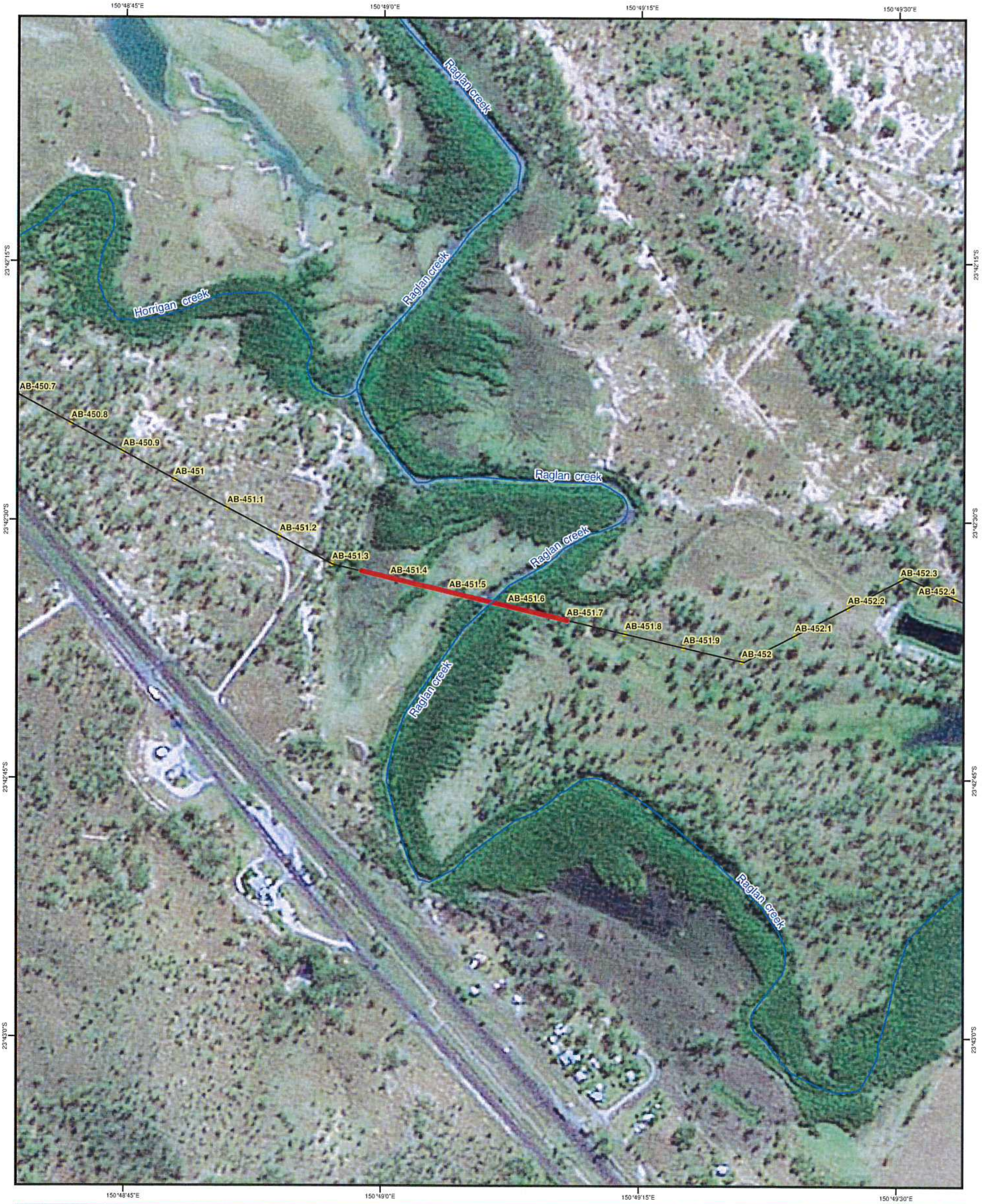

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BE004_MP_003_Critical_habitat_for_YellowChat_F

Job Number: BE004

Approved GIS Team Leader			BN	12/11/2013
R0	BN	CF	ISSUED TO CLIENT	22/08/2013
REV	By	CHK	Description	Date

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0 50 100 200
Metres

Scale: 1:6,250 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

🟥 Marginal habitat

— ABP Route - Rev H1

〰 Waterway

Habitat for Yellow Chat

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Map 3 of 3 - Raglan creek - AB-450.9 to AB-452.2

A3

2.4 *Furina dunmalli* (Dunmall's Snake)

2.4.1 Conservation Status

Queensland: Vulnerable under the NC Act

National: Vulnerable under the EPBC Act

2.4.2 Description

Dunmall's Snake is brown to olive with some pale blotches on the upper lips. Otherwise, the body has little or no markings. This species has a robust build and can reach a total length of 700 mm (Wilson 2009).

2.4.3 Distribution

Dunmall's Snake is found primarily in the south-eastern interior of Queensland in the Brigalow Belt bioregion at elevations between 200 – 500 m above sea level. The snake is rare and secretive with few existing records (Cogger et al. 1993; DSEWPaC 2013a).

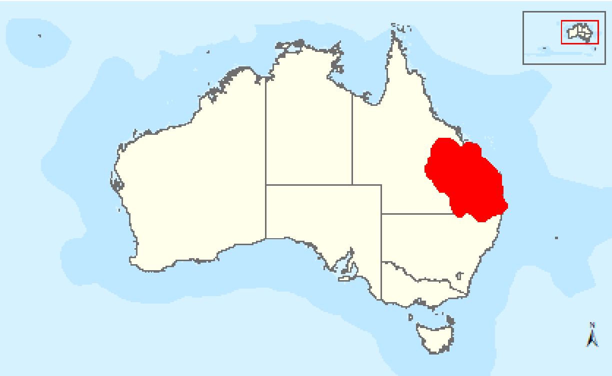


Figure 8 Distribution of *Furina dunmalli*

Source: (DSEWPaC 2013)

2.4.4 Habitat

Dunmall's Snake inhabit a wide variety of habitats including woodlands on clays and clay loams and woodland dominated by eucalypts (including *Corymbia citriodora*, *Eucalyptus melanophloia*, *Eucalyptus crebra*), *Callitris* spp. or *Allocasuarina luehmannii* on (DSEWPaC 2013a).

2.4.5 Ecology

Little is known of the behavioural ecology of this species. However, observations of captive specimens suggest it is docile, terrestrial and nocturnal. It is active on the surface at night and seems to rest in hidden or dark places, sheltering under fallen timber and possibly in leaf litter and earth cracks. It is assumed that the diet of Dunmall's Snake consists of small skinks and geckos. There is almost no information about the reproduction of Dunmall's Snake and the clutch size of this species has not been recorded but it is known that they lay eggs rather than produce live young (Queensland CRA/RFA Steering Committee 1997). Although the breeding season for Dunmall's Snake is also unknown it is likely that breeding occurs when it is most active from spring to late summer.

Breeding season

🟩 Likely breeding season	🟨 Breeding unlikely

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟩	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩

2.4.6 Activity period

There is limited information about activity cycles of the Dunmall's Snake. They are not active on the ground surface by day and have been observed moving between sheltering sites at night. They are thought to be active from late spring through summer to early autumn. Peak activity is likely to be early summer through to the wet season (DSEWPaC 2011a).

2.4.7 Threats

The threats to this species include (DSEWPaC 2013a):

- extensive clearing of habitat for development
- loss of fallen timber and ground litter
- predatory animals and introduced weeds
- possible drainage of swamps.

2.4.8 DoE recommended survey methods

Targeted surveys should be undertaken during optimal conditions. As a general rule surveys should only be undertaken from late September through to late March when weather conditions are warm, not too dry and maximum temperatures are greater than 25°C on most survey days. All of the listed Brigalow Belt reptiles are difficult to detect and are therefore likely to require more than one applicable survey technique to ascertain whether they are present. Recommended methods include:

- transects
- spotlighting (1.5 person hours per ha)
- opportunistic surveys of roads
- pitfall and funnel trapping (12 trap nights per habitat type over 4 nights).

2.4.9 Survey effort and methodology undertaken for ABP

The survey effort conducted in potential habitat of Dunmall's Snake is shown in Table 22.

Techniques used included pitfall trapping, active searching, and spotlighting on foot and from a car travelling at low speed.

Table 22 Survey effort for Dunmall's Snake undertaken during field surveys

Season	Number of sites in REs suitable for Dunmall's Snake	Spotlighting effort	Active search effort	Trap effort
Winter	20	9 person hours (at 9 sites)	14 person hours (at 14 sites)	
Spring	15	9 person hours (at 9 sites)	9 person hours (at 9 sites)	84 trap nights (at 7 sites over 4 nights)
Summer	4	3 person hours (at 3 sites)	3 person hours (at 3 sites)	

Emphasis was placed on selecting survey sites that had a high level of microhabitat diversity (presence of understorey, logs, leaf litter and other debris) as these sites were considered most likely to support the species.

Sampling undertaken during September 2011 in the warmer spring survey period, when reptiles were more active, included pitfall trapping with drift fences. The standard pitfall trapping effort for each site was 3 buckets along a 30 m drift fence for a minimum of 4 nights, used in conjunction with funnel traps. Pitfall traps were not able to be installed at every site due to difficult substrates.

Sampling for reptiles during the winter survey period in June 2011 focussed on active searching under potential shelter sites. Each site was actively searched for thirty minutes. Searches were undertaken before mid-morning (i.e. before reptiles had reached their optimal body temperature). Thirty minutes of nocturnal spotlighting was conducted on foot along roads and ground habitat within each site. Spotlighting was also completed along roads and tracks whilst travelling to sites.

2.4.10 Comparison with DoE guidelines

During field surveys, 39 sites with suitable habitat for Dunmall's Snake were visited and a total of 47 hours was spent searching for the species. Although this number is less than that recommended by DoE (327.18 hrs based on 218 ha impacted), surveys focused on vegetation that contained the micro-habitat features likely to support Dunmall's Snake. Further, due to the nature of linear infrastructure surveys (e.g. long distances between sites, large number of landholders and properties, access constraints imposed by some landholders) it can be difficult to access all remnant vegetation along the line and not all vegetation can be surveyed. Assessment of this species is based on a precautionary approach since surveys will not necessarily detect its presence at a site as it is highly cryptic and can be difficult to find.

2.4.11 ABP Survey Results

This species was not recorded during fauna surveys.

A maximum of 218.12 ha of potential Dunmall's Snake habitat occurs within the ABP ROW, based on field verified RE mapping (Table 23). This estimate assumes that Dunmall's Snake could occur in any woodland or open forest along the entire route. However, the potential distribution of Dunmall's Snake is patchy and only a small amount of the line lies in the known distribution. Therefore, this figure is likely to be a large over-estimation of actual habitat within the ROW. The *Referral guidelines for nationally threatened Brigalow Belt reptiles* does not identify critical habitat for this species and given that this species also occurs in non-remnant habitat it is unlikely that any critical habitat occurs in the ROW. An assessment of the impacts on this potential habitat is discussed in Section 2.4.13.

Table 23 Approximate maximum potential habitat for Dunmall's Snake in the ROW

RE	**Habitat Type**	**Potential habitat in ROW (ha)**	**Potential habitat in the 5 km buffer (ha)**	**% of buffer***	**Critical habitat in ROW (ha)**
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	29.14	11397.97	0.06	0
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	5.30	3941.48	0.33	0
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	0.63	3235.83	0.93	0
11.3.7	*Corymbia* spp. woodland on alluvial plains. Sandy soils	4.24	1112.84	0.61	0
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains	5.64	3088.83	0.13	0
11.3.36	*Eucalyptus crebra* and/or *E. populnea* and/or *E. melanophloia* on alluvial plains. Higher terraces	3.23	332.98	0.26	0
11.5.3	*Eucalyptus populnea* and/or *E. melanophloia* and/or *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces	79.57	18509.98	0.18	0
11.5.8	*Melaleuca* spp., *Eucalyptus crebra*, *Corymbia intermedia* woodland on Cainozoic sand plains/remnant surfaces	0	0	0.13	0
11.5.9	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains/remnant surfaces. Plateaus and broad crests	26.72	1224.31	0.97	0
11.5.12	*Corymbia clarksoniana* woodland and other *Corymbia* spp. and *Eucalyptus* spp. on Cainozoic sand plains/remnant surfaces	12.87	1361.91	0.02	0
11.7.2	*Acacia* spp. woodland on lateritic duricrust. Scarp retreat zone	19.04	7791.01	0.38	0
11.9.2	*Eucalyptus melanophloia +/- E. orgadophila woodland on fine-grained sedimentary rocks*	0.70	1357.38	0.94	0
11.9.7	*Eucalyptus populnea*, *Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	0	0	0.43	0
11.9.9	*Eucalyptus crebra* woodland on fine-grained sedimentary rocks	6.47	2837.52	2.18	0
11.11.1	*Eucalyptus crebra* +/- *Acacia rhodoxylon* woodland on old sedimentary rocks with varying degrees of metamorphism and folding	2.63	4684.21	0.24	0
11.11.4	*Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of	4.58	746.07	0.05	0

RE	Habitat Type	Potential habitat in ROW (ha)	Potential habitat in the 5 km buffer (ha)	% of buffer*	Critical habitat in ROW (ha)
	metamorphism and folding. Coastal ranges				
11.11.15	*Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains	12.71	3839.01	0.23	0
11.11.16	*Eucalyptus cambageana*, *Acacia harpophylla* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands	1.96	211.52	0.06	0
11.12.2	*Eucalyptus melanophloia* woodland on igneous rocks	2.69	2016.34	0.33	0
	Other REs containing suitable habitat in the 5 km buffer	0	60623.86		
	Total	218.12	128313.05	0.17	

* percent of the potential habitat within the the ROW which is contained within 5 km buffer .

2.4.12 Other Survey Data

There is one record of this species from the 5 km buffer on EHP Wildnet, while the nearest Queensland Museum record is 20 km west of the project site.

DoE maps one 20 km section of the ABP near Raglan (between Rockhampton and Gladstone) as habitat where Dunmall’s Snake is known to occur. Based on field-verified RE mapping, only 1.6 ha of potential habitat occurs within this section of the ABP ROW. Most of the remainder of the ABP is mapped in the “may occur” category, except for a 100 km section south of Middlemount which is outside the known distribution. The northern section of the ABP runs relatively close to the mapped limit of the species’ range, but no records of Dunmall’s Snake are known from this section.

2.4.13 Impacts of ABP on Dunmall’s Snake

2.4.13.1 Potential impacts without mitigation

Very little is known about the ecology of Dunmall’s Snake but they are thought to inhabit a wide variety of habitats, including woodlands on clays and clay loams and woodland dominated by eucalypts (including *Corymbia citriodora*, *Eucalyptus melanophloia*, *Eucalyptus crebra*), *Callitris* spp. or *Allocasuarina luehmannii* on sandstone derived soils. Impacts associated with the proposed project could include:

- temporary loss of remnant woodland vegetation that could provide habitat for Dunmall’s Snake
- increase in edge effects including weed incursion and increased pest animal abundance associated with clearing through remnant vegetation
- direct mortality through excavation works and collisions with vehicles during construction, operation and maintenance
- removal of micro-habitat features including logs and debris

- trenchfall.

2.4.13.2 Assessment of potential impacts with mitigation

Table 24 summarises potential direct and indirect impacts of the project on Dunmall's Snake populations and proposed measures to mitigate potential impacts. The table provides a risk assessment for each impact with and without mitigation measures.

Table 24 Raw Risk (before mitigation) and Residual Risk (after mitigation) measures associated with construction of the ABP on Dunmall's Snake

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
DIRECT IMPACTS			
Removal of habitat Removal of remnant vegetation which could provide potential foraging, breeding and sheltering habitat	M	- conduct further surveys to determine the presence of Dunmall's Snake in areas of potential habitat within the ROW - minimise areas of remnant vegetation (woodlands on clay soils) to be cleared - use existing cleared corridors in woodlands on clay soils where possible - clearly mark out areas to be cleared and retained - rehabilitate the ROW following construction - reinstate microhabitat (logs, etc) after construction	L
Trenchfall Death of individuals trapped in the trench	L	- monitoring of open trenches by fauna spotter catchers during the construction period - minimise the length of time the trench is open	I
Fatalities Death of individuals via vehicles and equipment during clearing, construction and operation	L	- maintain an appropriate speed limit in the ROW especially in areas where the ROW goes through remnant vegetation - employ a spotter catcher to check microhabitat prior to clearing and to remove individuals before clearing commences - employ a spotter catcher to be on hand during clearing to move displaced animals.	I
INDIRECT IMPACTS			
Changes in water quality	N/A	- no mitigation measures for water quality recommended for this species as it is not dependent on aquatic habitats or riparian vegetation	N/A
Changes in hydrology	N/A	- no mitigation measures for hydrology are recommended for this species as it is not dependent on aquatic habitats or riparian vegetation	N/A
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of population	M	- minimise areas of remnant vegetation (woodlands on clay soils) to be cleared - use existing cleared corridors (woodlands on clay soils) where practicable - rehabilitate the ROW following construction	L
Increase in weed abundance Increased competition with native plant species used for foraging and shelter. Smothering of native vegetation	L	- develop and implement a Weed Management Plan - control weeds in the ROW before, during and after construction - implement site weed hygiene protocols	I
Increase in introduced predator abundance	L	-develop and implement a Waste Management Plan -develop and implement a Pest Management Plan	L

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
Increase in introduced predator abundance caused by increased food availability in the ROW		-educate staff about the importance of removing any food waste from the ROW - keep the work site clean of debris which could be used as shelter for introduced predators.	
Removal of micro-habitat Removal of logs, leaf litter and debris	L	- rehabilitate the ROW following construction - reinstate microhabitat such as logs, rocks and leaf litter after construction	L
Noise and disturbance	N/A	- no mitigation measures for noise are recommended for this species as it is not likely to be impacted by noise	N/A
Spread of disease	N/A	- no mitigation measures for reducing the spread of disease are recommended for this species as there are no known diseases for this species which could be spread by human activities	N/A

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High; N/A – impact not applicable to this species

The project will result in the temporary loss of some remnant vegetation that could provide habitat for Dunmall’s Snake. However, because very little is known about the habitat requirements of Dunmall’s Snake it is difficult to determine the exact extent of impacts to Dunmall’s Snake. Records of this species are sparse, so the likelihood of a significant population occurring in the ROW is **low**.

Further, progressive construction of the pipeline within the ROW (which will limit the extent of disturbance at any one time) and progressive rehabilitation immediately following construction (which will restore suitable grassy habitat and microhabitat features) will limit the impacts to potential habitats. Further surveys will be conducted in 2014 to determine if Dunmall’s Snake occurs in the mapped ‘known habitat’ near Raglan at the southern end of the ABP. The impact on this species from clearing of habitat cannot be fully determined at this time, but is likely to be **Low** with appropriate mitigation.

There is a low risk that a Dunmall’s Snake could be directly killed by vehicles and machinery during clearing or construction activities. To reduce the risk to Dunmall’s Snake, pre-clearance surveys in the ROW will be conducted prior to construction. Pre-clearance surveys will be undertaken in all non-remnant areas (including roadsides, paddocks, etc) as well as remnant vegetation. Any Dunmall’s Snake found during surveys will be relocated to adjacent vegetation. With these mitigation measures the impacts associated with direct mortality of Dunmall’s Snake is likely to be **Insignificant**.

Construction of the pipeline is not expected to change the risks to Dunmall’s snake from the introduction of pests. Introduced predators (such as foxes and cats) are present and active in the area. Reasonable management measures, such as the removal of food waste from the ROW or induction programs which stress the importance of not feeding animals will ensure a Low level of risk from pests.

It is expected that the overall the impact of the ABP project on Dunmall’s Snake is likely to be **Insignificant**. However further surveys will be undertaken to determine the presence of the Dunmall's Snake in 'known habitat' on the proposed route, assess likely impacts to this species and refine mitigation measures.

2.4.14 Evaluation under MNES significant impact guidelines

The Draft referral guidelines for nationally threatened Brigalow Belt reptiles states that important habitat should be used as a surrogate for an important population during assessments involving Brigalow Belt reptiles. If the habitat is considered important under any of the "important habitat" criteria, then the habitat is deemed to be important habitat. Important habitats for Dunmall's Snake include suitable habitat within the known / likely-to-occur distribution of the species and any habitat corridors in between. Identifying and maintaining areas of connective habitat is essential for this species.

Suitable habitat for this species is considered important habitat if it is:

Habitat where the species has been identified during a survey

This species was not recorded during surveys in the study site despite spending 21 person hours spotlighting and 26 person hours of diurnal searching in 39 sites with suitable habitat. The Queensland Museum has no records of Dunmall's Snake within the ROW or the 5 km buffer. One 20 km section of the ABP near Raglan (between Rockhampton and Gladstone) is mapped as habitat where Dunmall's Snake is known or likely to occur. Further surveys will be conducted in this section.

Near the limits of the species known range

Most of the ABP is mapped is mapped as "may occur" habitat, except for a 100 km section south of Middlemount. The northern section of the ABP runs relatively close to the mapped limit of the species' range. Although mapped in the "may occur" category, no records of Dunmall's Snake are known from this region. The habitat in the ROW is not considered 'important habitat' under this criterion.

Large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations)

The pipeline passes through some large patches of remnant vegetation within corridors that could be used for maintenance of genetic diversity and dispersal. However, the majority of the remnant vegetation within the ROW occurs in small patches with little connectivity. A limited amount of habitat within the ROW may be classified as important habitat.

A habitat type where the species is identified during a survey, but which was previously thought not to support the species

This species was not recorded during surveys and was not recorded in habitat not previously thought to support the species. The habitat in the ROW is not considered 'important habitat' under this criterion.

Is there an important population of this species in the study site?

This species was not recorded in or adjacent to the ROW during surveys or in published databases. One 20 km section of the ABP near Raglan (between Rockhampton and Gladstone) is mapped as habitat where Dunmall's Snake is known or likely to occur. Further surveys will be conducted in 2014 to determine if this species occurs in the mapped 'known or likely to occur habitat' near Raglan at the southern end of the ABP.

Will the action lead to a long-term decrease in the size of an important population of a species?

No populations have been recorded in or adjacent to the ROW during surveys or in published databases, so the action is unlikely to decrease the size of any population. Further surveys will be conducted in 2014 to determine if this species occurs in the mapped 'known or likely to occur habitat' near Raglan at the southern end of the ABP.

Will the action reduce the area of occupancy of an important population of a species?

This species has not been recorded in or adjacent to the ROW during surveys or in published databases, so the action is unlikely to reduce the area of occupancy. Further surveys will be conducted in 2014 to determine if an important population of this species occurs in the mapped 'known or likely to occur habitat' near Raglan at the southern end of the ABP.

Will the action fragment an existing important population into two or more populations?

No populations have been recorded in or adjacent to the ROW during surveys or in published databases, so the action is unlikely to fragment populations. Further surveys will be conducted in 2014 to determine if an important population of this species occurs in the mapped 'known or likely to occur habitat' near Raglan at the southern end of the ABP Temporary clearing for construction may result in short-term fragmentation of remnant vegetation The pipeline is therefore unlikely to have a long term impact on habitat connectivity.

Will the action adversely affect habitat critical to the survival of a species?

No populations have been recorded in or adjacent to the ROW during surveys or in published databases, so the action is unlikely to adversely affect critical habitat. Further surveys will be conducted in 2014 to determine if an important population of this species occurs in the mapped 'known or likely to occur habitat' near Raglan at the southern end of the ABP.

Will the action disrupt the breeding cycle of an important population?

The ROW is not likely to contain an important population of this species. Arrow proposes to use spotter catchers before clearing and during clearing, to mitigate the risk to any individuals of this species.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

This species has not been recorded in or adjacent to the ROW during surveys or in published databases, so the action is unlikely to lead to species decline. Further surveys will be conducted in 2014 to determine if an important population of this species occurs in the mapped ‘known or likely to occur habitat’ near Raglan at the southern end of the ABP.

Will the action result in harmful invasive species becoming established in the species’ habitat?

Pest species are currently active in the Project footprint area and the Action is not likely to encourage further establishment of pests. Reasonable management measures, such as the removal of food waste from the ROW or induction programs which stress the importance of not feeding animals will ensure the level of risk from pests will remain unchanged as a result of the action.

Will the action result in the introduction of disease(s) that may cause the species to decline?

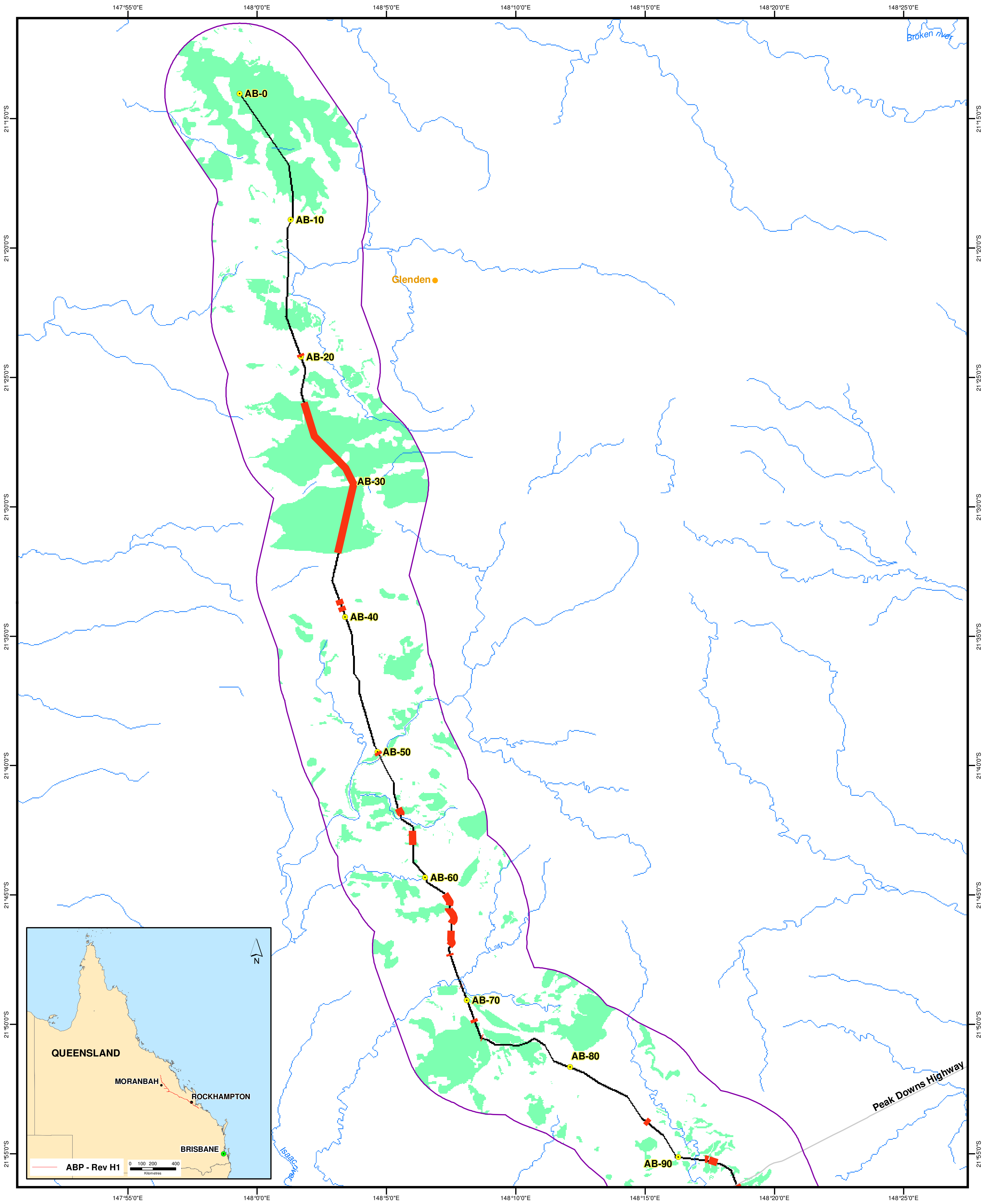
There are no known diseases likely to be introduced to the study site that would significantly affect Dunmall’s Snake.

Will the action interfere substantially with the recovery of the species?

This species has not been recorded in or adjacent to the ROW during surveys or in published databases, so the action is unlikely to interfere substantially with the recovery of the species. Further surveys will be conducted in 2014 to determine if an important population of this species occurs in the mapped ‘known or likely to occur habitat’ near Raglan at the southern end of the ABP.

2.4.15 Conclusion

Dunmall’s Snake was not recorded in or adjacent to the ROW during surveys or in published databases. One 20 km section of the ABP near Raglan (between Rockhampton and Gladstone) is mapped by DoE as habitat where Dunmall’s Snake is known or likely to occur. This section will be surveyed in 2014 to determine if this species or its habitat is present in the ROW and to allow more effective assessment of potential impacts. Nevertheless, mitigation actions have been proposed in areas of potential habitat for Dunmall’s Snake as a precautionary measure.



Document
BE004_MP_006D_Dunmalls_Snake_RevH1

Job Number: BE004

Approved GIS Team Leader		BN		30/08/2013
R0	BN	CF	ISSUED TO CLIENT	29/08/2013
REV	By	CHK	Description	Date

0 2.5 5 10
Kilometres

Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

●	City or town
⊙	Kilometre Point
~	Waterway or Coast Line
—	Main roads
—	ABP - Rev H1
🟥	Potential Habitat in ROW (Field Verified)
🟩	Potential Habitat in Buffer (from State RE Mapping)
☐	Buffer (5 km)

Dunmalls Snake

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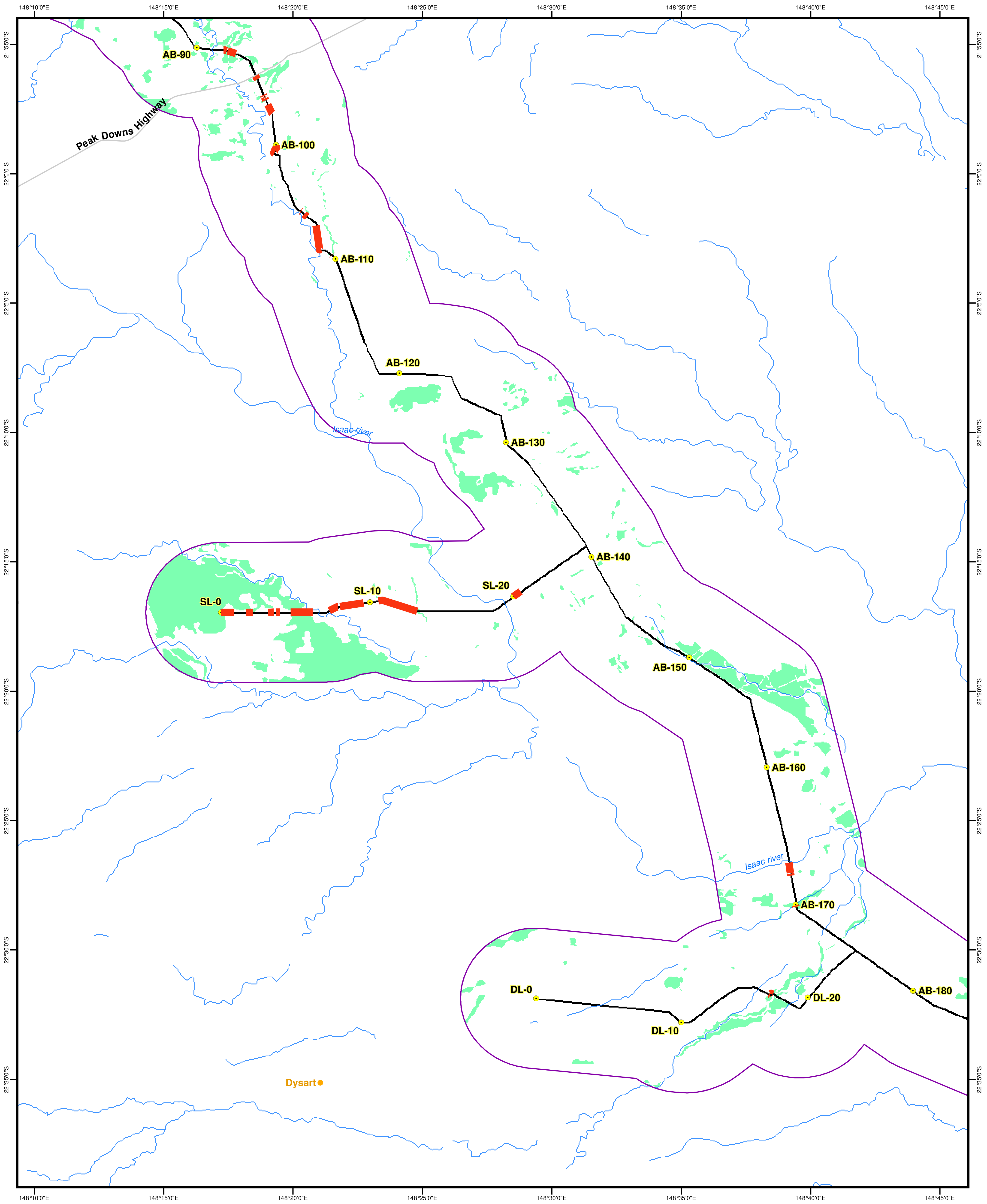
Revision H1

Page 1 of 7

A3



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BE004_MP_006D_Dunmalls_Snake_RevH1

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REV	By	CHK	Description	Date

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Coordinate System:
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Datum: GDA 1994
Units: Degree

LEGEND

- ● City or town
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- ~ Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- 🟥 Potential Habitat in ROW (Field Verified)
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ▢ Buffer (5 km)

Dunmalls Snake

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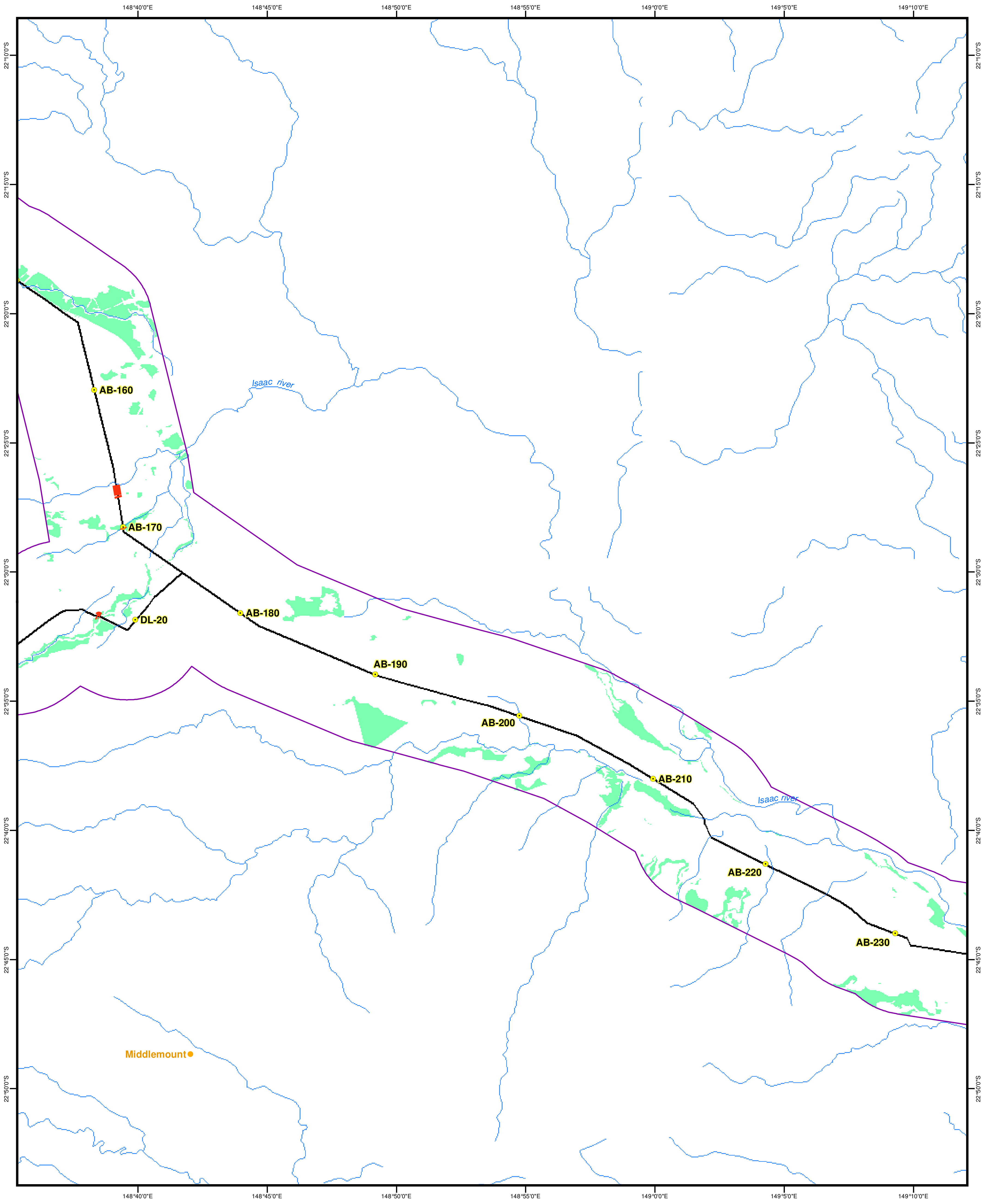
Arrow Bowen Pipeline
Revision H1

Page 2 of 7

A3



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🟩	Potential Habitat in Buffer (from State RE Mapping)
☐	Buffer (5 km)

Dunmalls Snake

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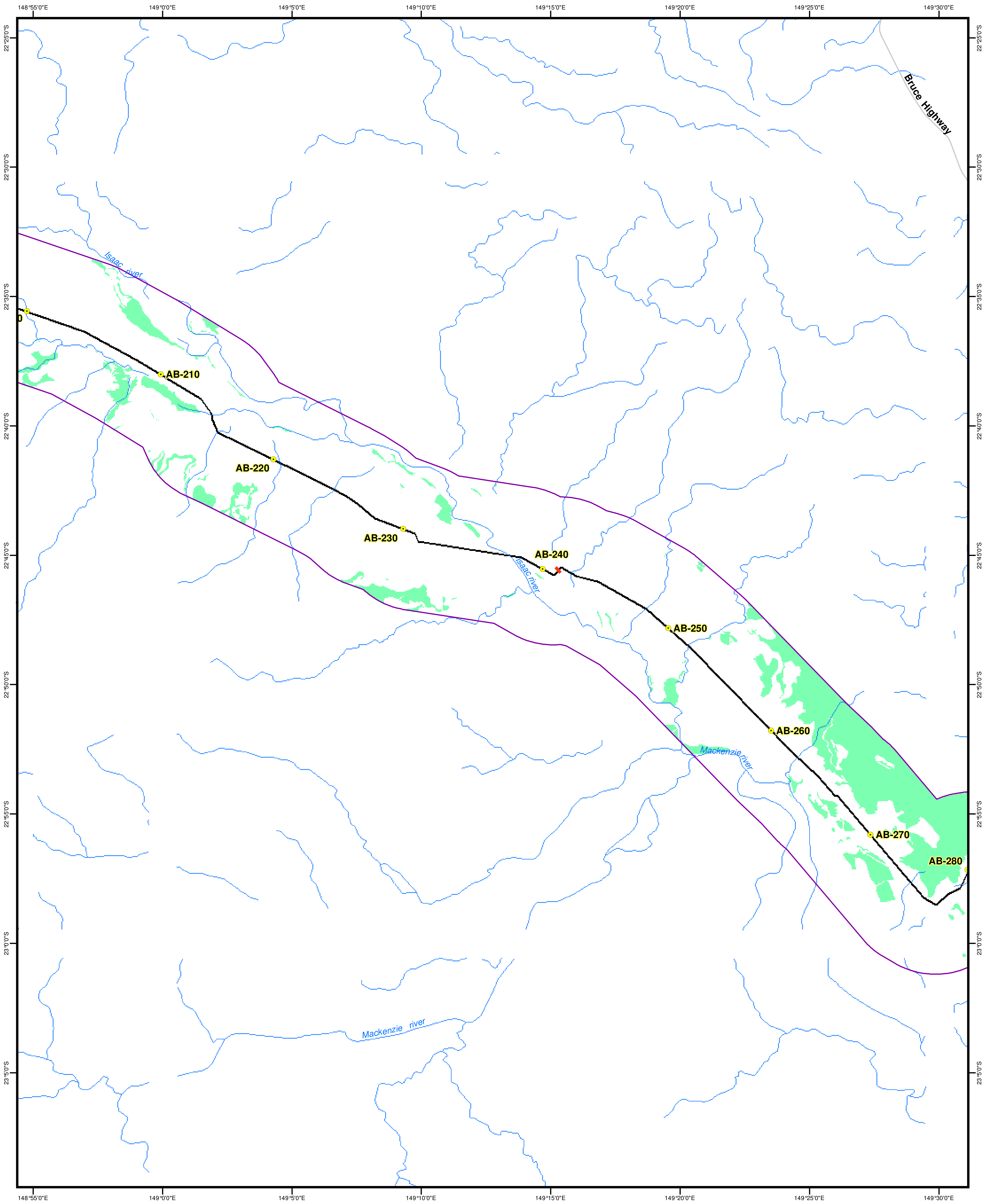
Arrow Bowen Pipeline
Revision H1

Page 3 of 7

A3



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Coordinate System:
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Datum: GDA 1994
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LEGEND

- ● **Kilometre Point**
- 〰 **Waterway or Coast Line**
- — **Main roads**
- — **ABP - Rev H1**
- 🟥 **Potential Habitat in ROW (Field Verified)**
- 🟩 **Potential Habitat in Buffer (from State RE Mapping)**
- ▭ **Buffer (5 km)**

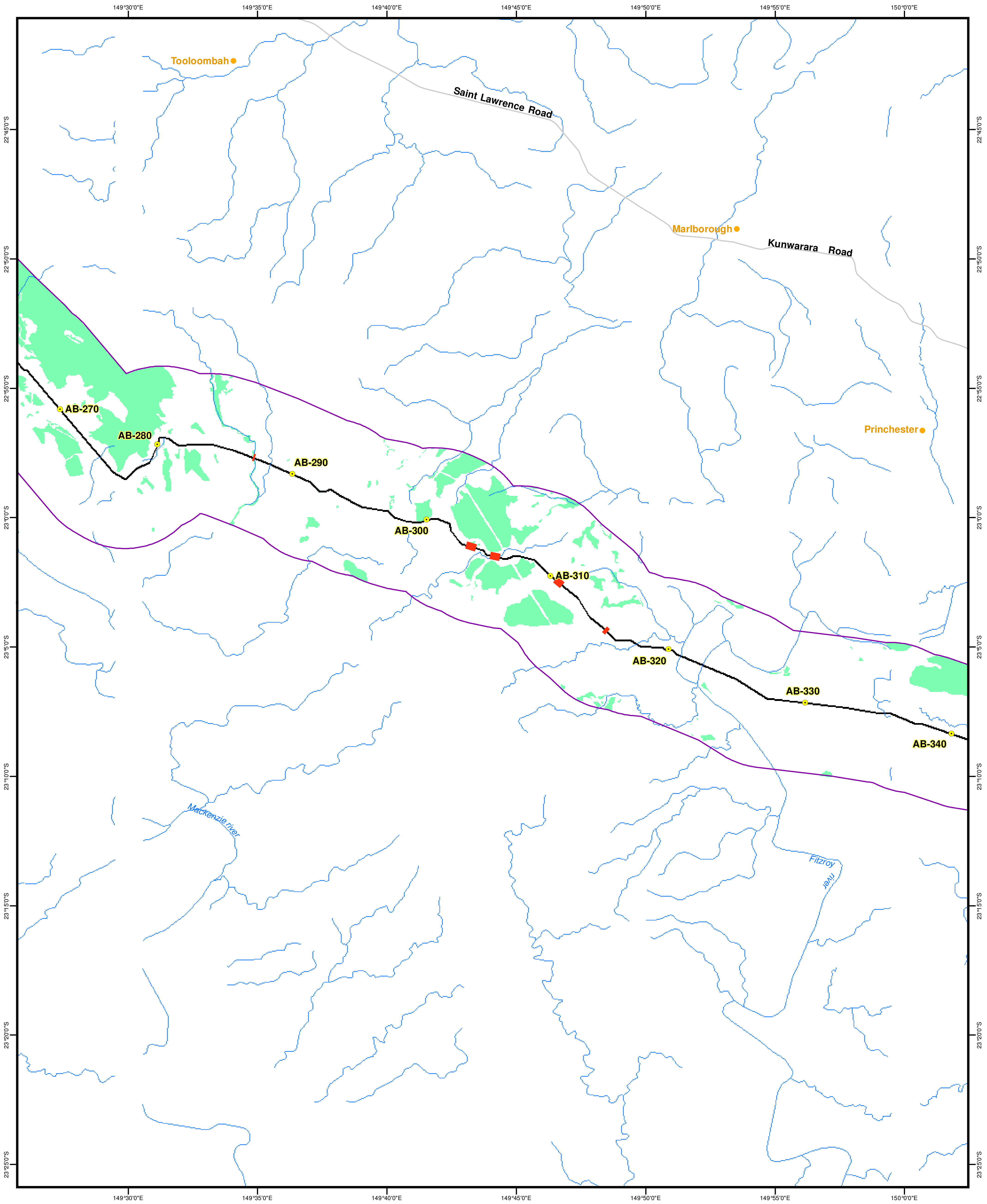
Dunmalls Snake

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 4 of 7

A3



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- ☐ Buffer (5 km)

Dunmalls Snake

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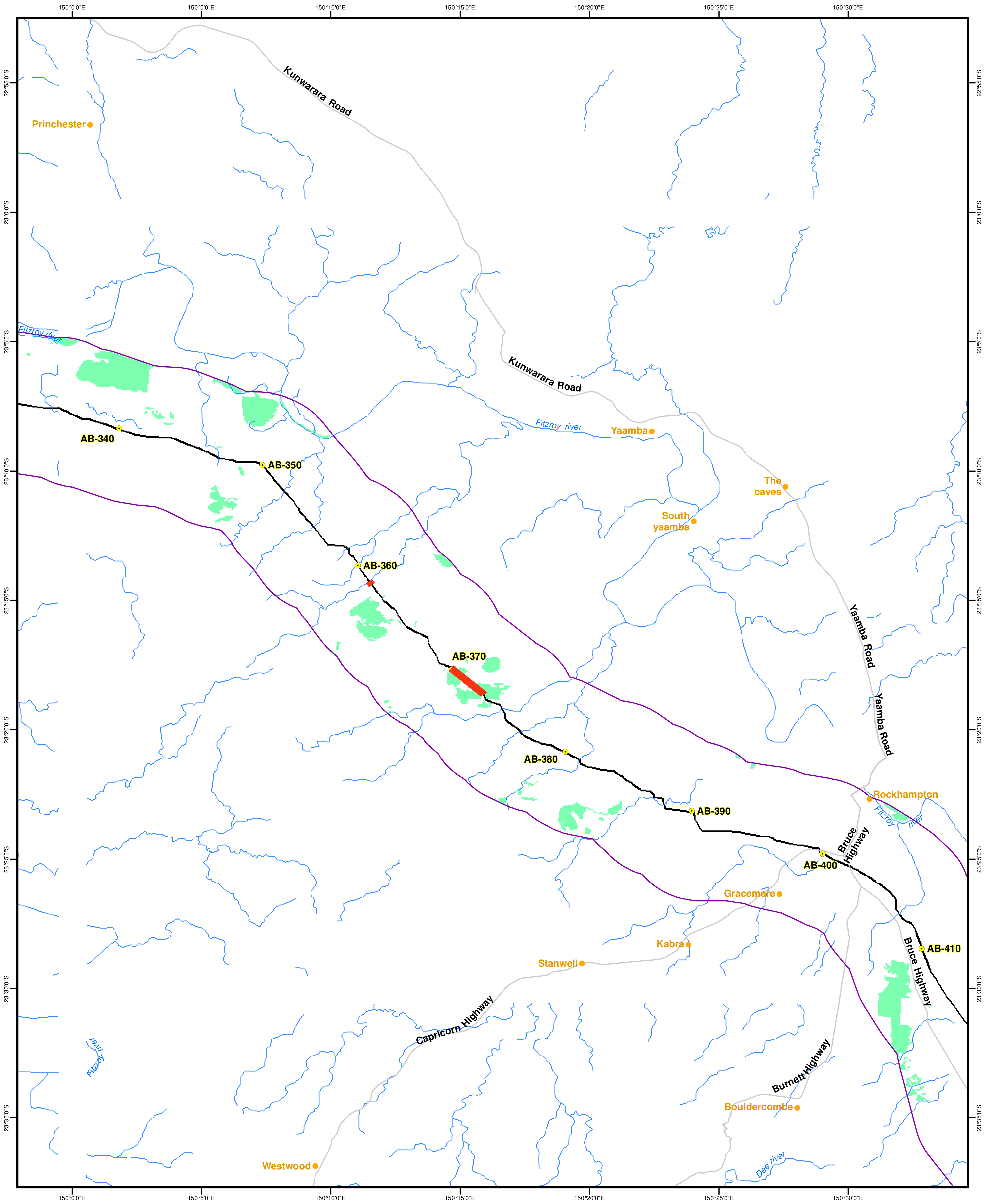
Arrow Bowen Pipeline
Revision H1

Page 5 of 7

A3



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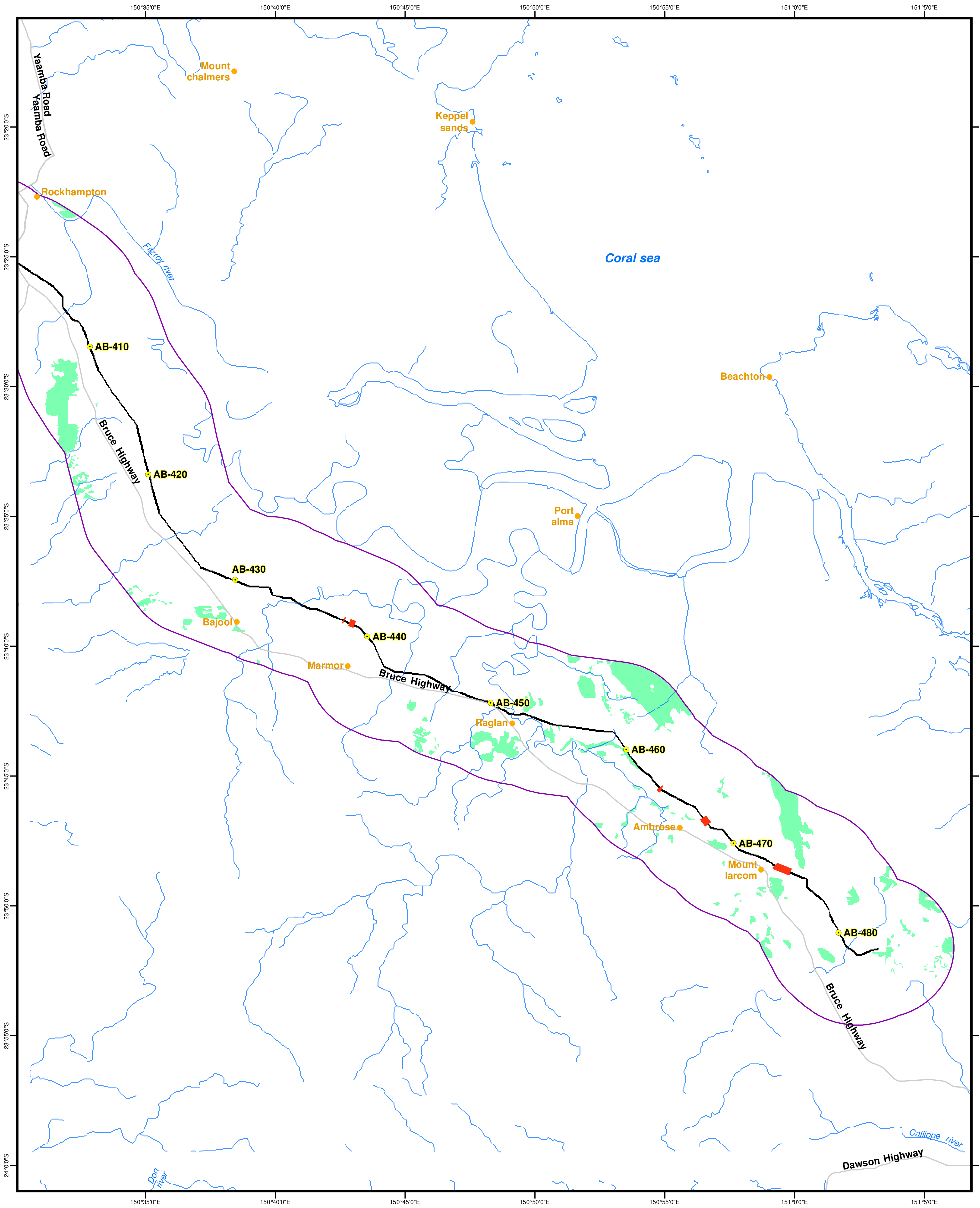
Dunmalls Snake

Arrow Energy Pty Ltd

Arrow Bowen Pipeline Revision H1

Page 6 of 7

A3



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- ☐ Buffer (5 km)

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Page 7 of 7

A3

2.5 *Geophaps scripta scripta (Squatter Pigeon - southern)*

Photo taken by Carissa Free, Ecosure

2.5.1 Conservation Status

Queensland: Vulnerable under the NC Act

National: Vulnerable under the EPBC Act

2.5.2 Description

The Squatter Pigeon (southern) is a ground-dwelling pigeon that measures approximately 30 cm in length (head to tail). The adults are predominantly grey-brown in colour and have distinctive black and white stripes on the face and throat. A blue-grey skin around the eyes and the black and white stripe pattern distinguishes this species from similar species.

2.5.3 Distribution

The distribution of the Squatter Pigeon (southern) is mainly on the slopes of the Great Dividing Range, extending from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coastline between Proserpine and Port Curtis and south to scattered sites in south-eastern Queensland (DSEWPaC 2013a).

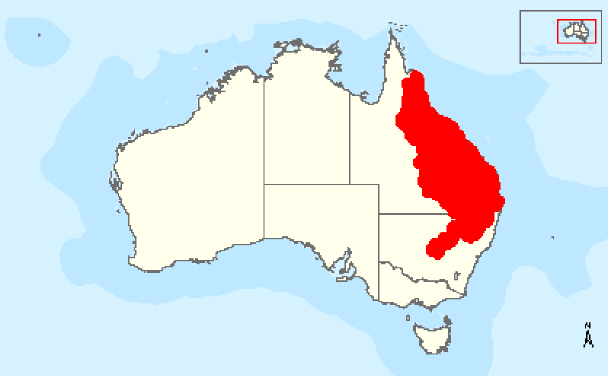


Figure 9 Distribution of *Geophaps scripta scripta*

Source: DSEWPaC 2013a

2.5.4 Habitat

The Squatter Pigeon generally inhabits the grassy understorey of eucalypt woodland and is nearly always found near permanent water (Higgins & Davies 1996). It is also regularly observed in a variety of disturbed habitats including along roads and railway lines, around cattle yards and settlements and in farming and grazing areas (DSEWPaC 2013a).

2.5.5 Ecology

The Squatter Pigeon's breeding season usually extends from late winter to summer; however, if conditions are favourable, they are capable of breeding throughout most of the year (DSEWPaC 2013a). The nest is a sparsely grass-lined depression scraped into the ground beneath a tussock of grass (Lord 1956; DSEWPaC 2013a). The female lays one or two eggs that are incubated for around 17 days. Chicks remain in the nest for around 9 days and following fledging remain dependent on their parents for about four weeks after leaving the nest (EPA 2006; DSEWPaC 2013a). The Squatter Pigeon feeds on grass seeds, legumes, herbs and forbs, insects, ticks, and readily takes grit (DSEWPaC 2013a).

Breeding season

🟩 Normal breeding season	🟨 Potential breeding season

🟩 Jan	🟩 Feb	🟨 Mar	🟨 Apr	🟨 May	🟨 Jun	🟨 Jul	🟩 Aug	🟩 Sep	🟩 Oct	🟩 Nov	🟩 Dec

2.5.6 Activity period

Squatter Pigeons are active throughout the year with a peak in daily activity occurring in the early morning (Ben Blewitt, pers. obs.).

2.5.7 Threats

Documented threats to this species include (DSEWPaC 2008a; DSEWPaC 2013a):

- loss of habitat due to land clearing
- degradation of habitat from grazing
- predation from feral animals (especially cats and foxes).

2.5.8 DoE recommended methods

The Squatter Pigeon is likely to be detected by its distinctive call. It is readily approachable in some locations and will often attempt to flee on foot in the non-breeding season. In the breeding season, pairs will often take flight and seek shelter in trees if approached (DSEWPaC 2013a). For areas of suitable habitat up to 50 ha, DoE recommends the following survey methods and effort (DSEWPaC 2010b):

- area searches or transect surveys for 15 hours over three days
- flushing surveys conducted for 10 hours over three days

2.5.9 Survey effort and methods undertaken for ABP

Survey effort for Squatter Pigeon included 79.5 hrs of diurnal bird surveys at 76 sites in REs identified as habitat for this species.

Birds were recorded by both sight and vocalisations. Birds were surveyed during peak calling times (within two hours of dawn and dusk). Weather conditions over the survey period were generally favourable for bird calls (i.e. still or slightly breezy and clear mornings). Species were recorded as present within the site or flying overhead. The species forages over large areas each day and therefore two surveys of 30 minutes each were conducted in the morning and afternoon for each site.

2.5.10 Comparison with DoE guidelines

The effort conducted during the field surveys for this species is shown in Table 25along with the effort recommended under the DoE guidelines. It must be noted that the guidelines are recommendations only and surveys are ongoing.

Table 25 Actual and DoE recommended survey effort for Squatter Pigeon in suitable habitat

	Actual effort (person hours)	SEWPC recommended effort (person hours)
Timed bird surveys	79.5	80.2 (based on 15 hrs for every 50 ha of habitat)

2.5.11 ABP survey results

Squatter Pigeons were recorded at multiple locations on the mainline and laterals during field surveys (Table 26). The closest record was 135 m from the mainline. The majority of the records were sightings of small numbers of birds (1 – 2) foraging on the ground. The birds were mostly recorded in grassy woodlands, pastures and roadsides.

Table 26 Locations of Squatter Pigeon recorded near ABP

Nearest KP	Coordinates (GDA94 datum)		Distance to nearest KP (m)	Number of birds
KP - 96	148.3087	-21.958	1024	7
KP - 168	148.7091	-22.4379	1504	9
KP - 311	149.803	-23.0691	303	2
KP - 320	149.8566	-23.1505	6173	11
KP - 323	149.8731	-23.1608	6269	3
KP - 329	149.9554	-23.1612	4340	7
KP - 335	150.0074	-23.1587	2848	1
KP - 335	150.0149	-23.1586	2603	2
KP - 348	150.114	-23.1879	2373	15
KP - 355	150.1866	-23.2128	1846	2
KP - 461	150.9385	-23.7746	309	1
KP - 20	148.0824	-21.3837	6022	1
KP - 51	148.063	-21.671	2012	1
KP - 51	148.0639	-21.6703	1906	1
KP - 65	148.1195	-21.7785	249	1
KP - 274	149.5055	-22.9664	135	1
KP - 311	149.8011	-23.0665	342	2
KP - 366	150.24	-23.3033	1027	7

KP – kilometre point on mainline

Flora and fauna surveys of the ABP identified 20 REs that contain grassy woodland habitat suitable for Squatter Pigeon. These REs comprise approximately 267.5 ha within the ROW. The actual area of remnant vegetation that contains potential habitat for Squatter Pigeons is likely to be substantially less than this figure as they generally only occur close to permanent water. Squatter Pigeons also commonly occur in non-remnant vegetation including grazed paddocks, roadside verges and cattle yards. No critical habitat has been identified for Squatter Pigeon and given the broad habitat requirements of the species, it is unlikely that the habitat in the ROW is critical for the species survival. An assessment of the impacts on this potential habitat is discussed in Section 2.2.12.2.

Table 27 Remnant REs that contain potential habitat for Squatter Pigeon within the ROW

RE	Habitat Type	Potential habitat in the ROW (ha)	Potential habitat in the 5 km buffer (ha)	% of buffer*	Critical habitat in the ROW (ha)
11.3.1	Acacia harpophylla and/or Casuarina cristata open forest on alluvial plains	1.29	3666.53	0.04	0
11.3.2	Eucalyptus populnea woodland on alluvial plains	29.14	11397.97	0.26	0
11.3.3	Eucalyptus coolabah woodland on alluvial plains	5.30	3941.48	0.13	0
11.3.4	Eucalyptus tereticornis and/or Eucalyptus spp. tall woodland on alluvial plains	0.63	3235.83	0.02	0
11.3.7	Corymbia spp. woodland on alluvial plains. Sandy soils	4.24	1112.84	0.38	0

RE	Habitat Type	Potential habitat in the ROW (ha)	Potential habitat in the 5 km buffer (ha)	% of buffer*	Critical habitat in the ROW (ha)
11.3.25	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	17.34	9010.19	0.19	0
11.3.26	Eucalyptus moluccana or E. microcarpa woodland to open forest on margins of alluvial plains	5.64	3088.83	0.18	0
11.3.36	Eucalyptus crebra and/or E. populnea and/or E. melanophloia on alluvial plains. Higher terraces	3.23	332.98	0.97	0
11.5.3	Eucalyptus populnea and/or E. melanophloia and/or Corymbia clarksoniana on Cainozoic sand plains/remnant surfaces	79.57	18509.98	0.43	0
11.5.9	Eucalyptus crebra and other Eucalyptus spp. and Corymbia spp. woodland on Cainozoic sand plains/remnant surfaces. Plateaus and broad crests	26.72	1224.31	2.18	0
11.5.12	Corymbia clarksoniana woodland and other Corymbia spp. and Eucalyptus spp. on Cainozoic sand plains/remnant surfaces	12.87	1361.91	0.94	0
11.8.5	Eucalyptus orgadophila open woodland on Cainozoic igneous rocks	42.47	9636.93	0.44	0
11.8.11	Dichanthium sericeum grassland on Cainozoic igneous rocks	7.31	4765.30	0.15	0
11.9.2	Eucalyptus melanophloia +/- E. orgadophila woodland on fine-grained sedimentary rocks	0.70	1357.38	0.05	0
11.9.9	Eucalyptus crebra woodland on fine-grained sedimentary rocks	6.47	2837.52	0.23	0
11.11.1	Eucalyptus crebra +/- Acacia rhodoxylon woodland on old sedimentary rocks with varying degrees of metamorphism and folding	2.63	4684.21	0.06	0
11.11.4	Eucalyptus crebra woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	4.58	746.07	0.61	0
11.11.15	Eucalyptus crebra woodland on deformed and metamorphosed sediments and inter-bedded volcanics. Undulating plains	12.71	3839.01	0.33	0
11.11.16	Eucalyptus cambageana, Acacia harpophylla woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands	1.96	211.52	0.93	0
11.12.2	Eucalyptus melanophloia woodland on igneous rocks	2.69	2016.34	0.13	0
	Other REs containing suitable habitat in the 5 km buffer	0	43101.86	0.00	0
	Total	267.49	130078.99	0.20	0

***** percent of the potential habitat within the ROW which is contained within the 5 km buffer.

2.5.12 Impacts of ABP on Squatter Pigeon

2.5.12.1 Potential impacts without mitigation

Squatter Pigeons inhabit remnant woodlands but are also commonly found in highly disturbed and modified open grasslands and roadsides. They are also highly mobile and are generally tolerant of human disturbance. Impacts associated with the proposed project could include:

- temporary loss of remnant woodland vegetation that could provide habitat for Squatter Pigeon
- increase in edge effects including weed incursion and increased pest animal abundance associated with clearing through remnant vegetation
- direct mortality through collisions with vehicles during operation and maintenance.

2.5.12.2 Assessment of potential impacts with mitigation

Table 28 summarises potential direct and indirect impacts of the project on Squatter Pigeon populations and proposed measures to mitigate potential impacts. The table provides a risk assessment for each impact with and without mitigation measures.

Table 28 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on Squatter Pigeon

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
DIRECT IMPACTS			
Removal of habitat Removal of vegetation representing potential foraging, breeding and sheltering habitat	L	- minimise areas of remnant vegetation to be cleared - clearly mark out areas to be cleared and retained -use existing cleared corridors where practicable - rehabilitate the ROW following construction	I
Trenchfall Death of individuals trapped in the trench	N/a	-no mitigation measures for trench fall are recommended for this species as it is unlikely to fall in the trench	N/a
Fatalities Death of individuals via vehicles and equipment during clearing, construction and operation	L	-maintain an appropriate speed limit in the ROW especially in areas where the ROW goes through remnant vegetation -conduct surveys for nests prior to commencement of clearing operations. -create a 50 m buffer zone around any active nests located in the ROW during the pre-clearance survey. -exclude all clearing operations from the nesting buffer zone until natural dispersal of nesting birds occurs -employ fauna spotter catcher during construction to minimise harm to this species and recover any injured birds	I
INDIRECT IMPACTS			
Changes in water quality Impacts to water quality upstream leading to changes in vegetation / habitat downstream	N/a	-no mitigation measures for water quality recommended for this species as it is not dependent on riparian vegetation	N/a
Changes in hydrology Changes in wet/dry cycling of waterways caused by damming, changes in morphology or diversions	N/a	-no mitigation measures for hydrology are recommended for this species as it is not dependent on riparian vegetation. -hydrology is unlikely to be permanently impacted by the construction of the pipeline	N/a
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of population	L	-minimise areas of remnant vegetation to be cleared -use existing cleared corridors where practicable -rehabilitate the ROW following construction	I
Increase in weed abundance -increase competition with native	L	-develop and implement a Weed Management Plan -control weeds in the ROW before and after construction	I

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
plant species used for foraging and shelter. -smothering of native vegetation		-implement site weed hygiene protocols	
Increase in introduced predator abundance Increase in introduced predator abundance caused by increased food availability in the ROW	M	-develop and implement a Waste Management Plan -develop and implement a Pest Management Plan -educate staff about the importance of removing any food waste from the ROW -keep the work site clean of debris which could be used as -shelter for introduced predators.	I
Removal of micro-habitat Removal of logs, leaf litter and debris	L	-no mitigation measures for removal of microhabitat are recommended for this species as it is not likely to be significantly impacted by loss of logs etc.	I
Noise and disturbance Disturbance caused by noise or human disturbance leading to stress, disease and abandonment of habitat.	I	-no mitigation measures for noise are recommended for this species as it is not likely to be significantly impacted by noise	I
Spread of disease	I	-no mitigation measures for reducing the spread of disease are recommended for this species as there are no known diseases for this species which could be spread by human activities	I

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High

The project will result in the temporary loss of some remnant vegetation that could provide habitat for Squatter Pigeon. However, Squatter Pigeons occupy a wide variety of habitats, including natural grasslands, remnant and regrowth open woodland, highly modified grazing areas dominated by introduced pasture grasses and open ground with little or no cover (DSEWPaC 2013a). These habitats are widespread throughout central Queensland, so the temporary loss of a small area of remnant habitat is unlikely to impact on this highly mobile species. Impacts will be further reduced by progressive construction of the pipeline within the ROW (which will limit the extent of disturbance at any one time) and progressive rehabilitation immediately following construction (which will restore suitable grassy habitat). The impact on this species from clearing of habitat is therefore considered to be **Insignificant**.

The risk associated with a Squatter Pigeon being directly killed by vehicles or equipment travelling along the ROW can be effectively managed through the implementation of appropriate speed limits for vehicles travelling along the ROW (to 40km/h). This mitigation measure will reduce the residual risk to **insignificant**.

Pre-clearance surveys for Squatter Pigeon nests in the ROW will be used in both non-remnant areas (including roadsides, paddocks etc) as well as remnant vegetation. Any nest found in the ROW or within 50 m either side of the ROW should be protected using a 50 m buffer area. Construction should not be conducted in the buffer zone until after young have fledged (up to a maximum of 4 weeks). The nest should be monitored by a spotter catcher to ensure the parents remain with the nest during construction. With these mitigation measures the impacts associated with direct mortality of Squatter Pigeons is likely to be **Insignificant**.

There is a small chance that the construction of the pipeline ROW will increase accessibility for introduced predators which use roads for travel (particularly foxes and cats). Because Squatter Pigeons nest on the ground they are susceptible to high predation rates by introduced predators (DSEWPaC, 2013a). Introduced predators are currently active throughout the region and the action is not expected to change their abundance or distribution. Therefore, the impact of introduced predators on Squatter Pigeons from the action is expected to be unchanged. Notwithstanding this, a waste management plan will be developed to ensure food wastes and other materials that may attract pests will be removed from the ROW.

Overall the impact of the ABP project on Squatter Pigeon is considered to be **Insignificant** provided that all the mitigation measures listed in Table 28 are implemented.

2.5.13 Evaluation under MNES significant impact guidelines

Is there an important population of this species in the study site?

The *EPBC significant impact guidelines* states that an ‘important population’ is a population that is necessary for a species’ long-term survival and recovery. This may include populations identified in recovery plans, and / or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity
- populations that are near the limit of the species range.

The Squatter Pigeon populations that occur within the study site are not considered important populations because:

- the Squatter Pigeon (southern) is thought to occur as a single, contiguous (i.e. inter-breeding) population, and therefore local populations in the study area are unlikely to be key source populations or populations necessary for maintaining genetic diversity
- the species is not at the limits of its range within the study site
- no populations have been identified as being especially important to the long-term survival or recovery of the Squatter Pigeon (DSEWPaC 2013a).

Will the action lead to a long-term decrease in the size of an important population of a species?

The project will result in the temporary loss of some remnant and non-remnant vegetation that could provide habitat for Squatter Pigeon. However, due to the broad range of habitats this species inhabits, the narrow width of the ROW, the short term nature of the construction and the mobility of the species, it is unlikely that the action is will result in a long term decrease in an important population of Squatter Pigeon.

Will the action reduce the area of occupancy of an important population of a species?

Clearing within the project site is unlikely to reduce the area of occupancy of Squatter Pigeon, due to the mobility of this species and the relatively short-term construction impacts for the pipeline. The Squatter Pigeon populations that occur within the study site are not considered important populations.

Will the action fragment an existing important population into two or more populations?

The Squatter Pigeon populations that occur within the study site are not considered important populations. This species is highly mobile; is not restricted to habitat within the project site; and occurs in highly fragmented, modified and disturbed landscapes. The proposed clearing of a 40 m ROW (which will be rehabilitated after construction) will not fragment an important population of the Squatter Pigeon.

Will the action adversely affect habitat critical to the survival of a species?

Habitat within the project site is not considered critical to the survival of the Squatter Pigeon.

Will the action disrupt the breeding cycle of an important population?

The Squatter Pigeon can breed throughout most of the year. Provided the proposed mitigation measures are implemented, particularly those relating to a 50 m buffer zone around active nests found within the ROW, the project is unlikely to disrupt the breeding cycle of this species.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Clearing within the project site may result in a temporary loss of potential foraging, nesting and roosting habitat for the Squatter Pigeon. However, this species is highly mobile and is often found in disturbed habitats. Consequently, it is unlikely that the project will lead to a significant decline in the population.

Will the action result in harmful invasive species becoming established in the species' habitat?

Field surveys have identified a number of invasive flora species and feral animals in the project site. Pest management plans will ensure these species are adequately managed during construction of the project so it is unlikely that the action will result in the establishment of invasive species.

Will the action result in the introduction of disease(s) that may cause the species to decline?

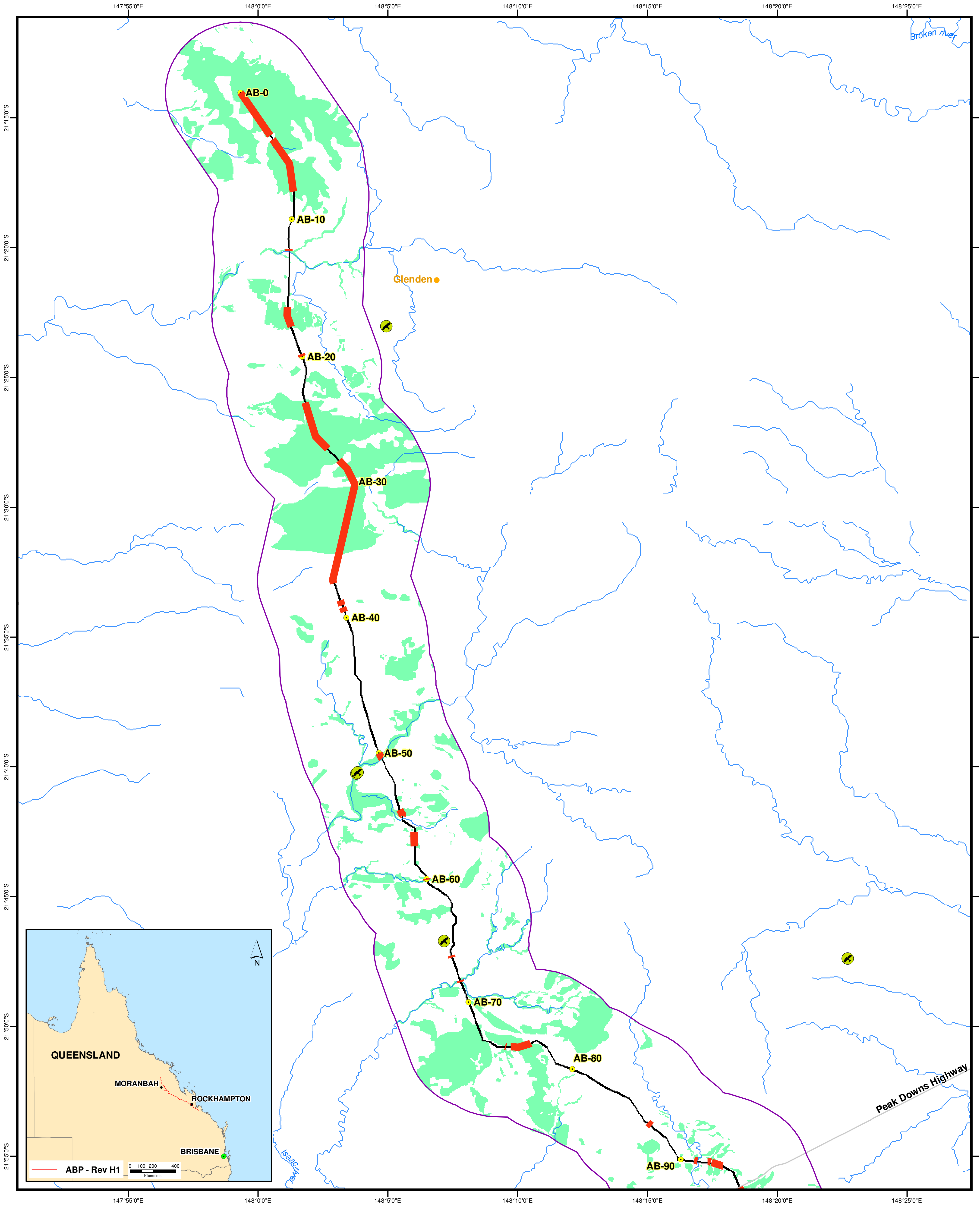
There are no known diseases likely to be introduced to the project site that would significantly affect the Squatter Pigeon.

Will the action interfere substantially with the recovery of the species?

Although potential habitat for this species will be cleared under the current alignment, Squatter Pigeons are often found in disturbed and significantly modified habitat so it is unlikely the clearing of the ROW will impact significantly on the recovery of the species.

2.5.14 Conclusion

Although potential habitat for this species will be cleared under the current alignment, no critical habitat has been identified in the ROW and it will be allowed to regenerate with grass and shrubs. Given the mobility of this species, the ability of Squatter Pigeons to utilise disturbed and modified habitat and the relatively short-term construction impacts for the pipeline, it is considered that the impact of the action on the Squatter Pigeon will be insignificant.



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Document
BE004_MP_006A_Squatter_Pigeon_RevH1

Job Number: BE004

Approved GIS Team Leader	BN			29/08/2013
R0	BN	CF	ISSUED TO CLIENT	29/08/2013
REV	By	CHK	Description	Date

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Kilometres

Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

- ● **City or town**
- ● **Kilometre Point**
- ● **Squatter Pigeon Survey Records**
- 〰 **Waterway or Coast Line**
- — **Main roads**
- — **ABP - Rev H1**
- 🟥 **Potential Habitat in ROW (Field Verified)**
- 🟩 **Potential Habitat in Buffer (from State RE Mapping)**
- ☐ **Buffer (5 km)**

Squatter Pigeon

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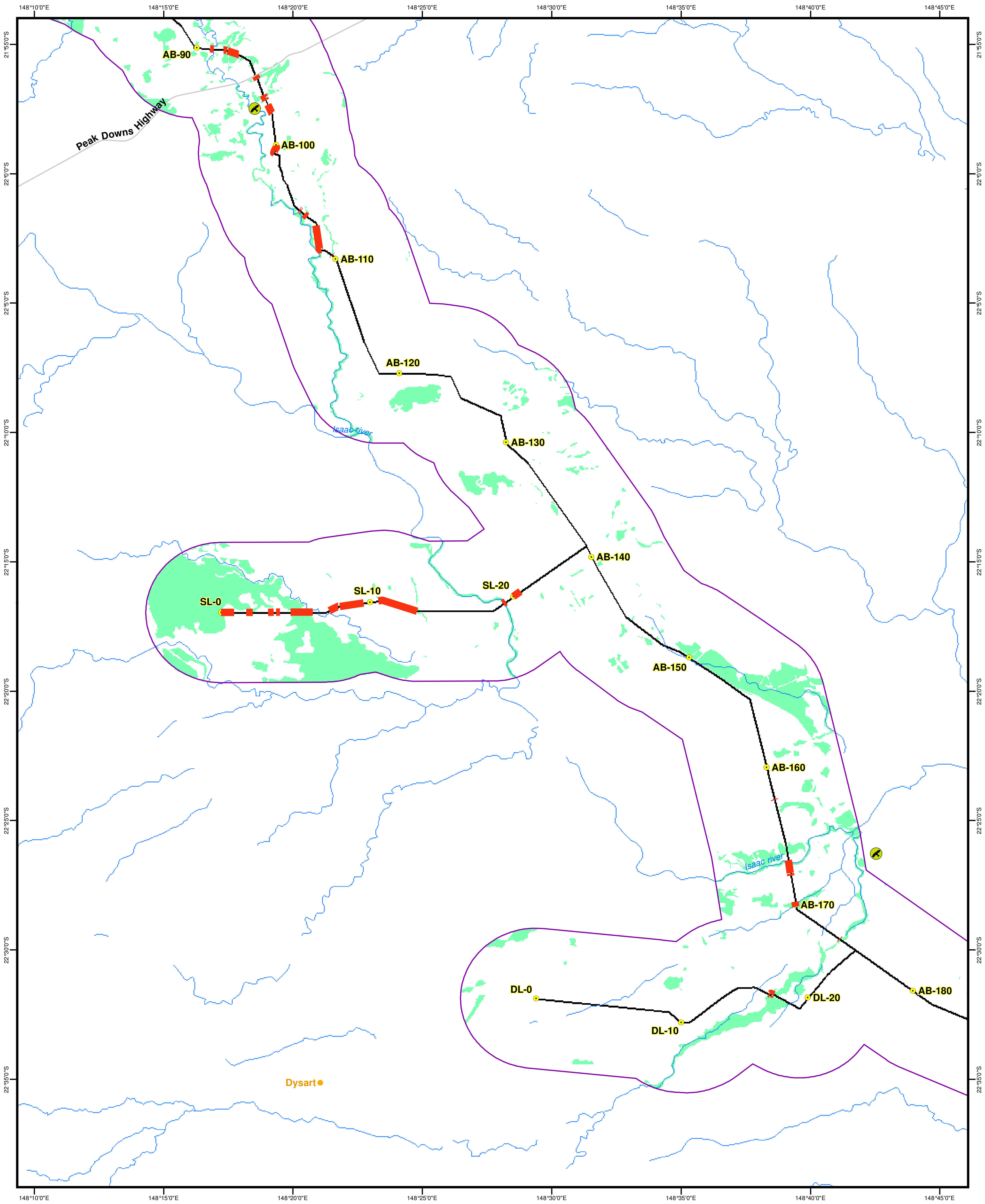
Revision H1

Page 1 of 7

A3



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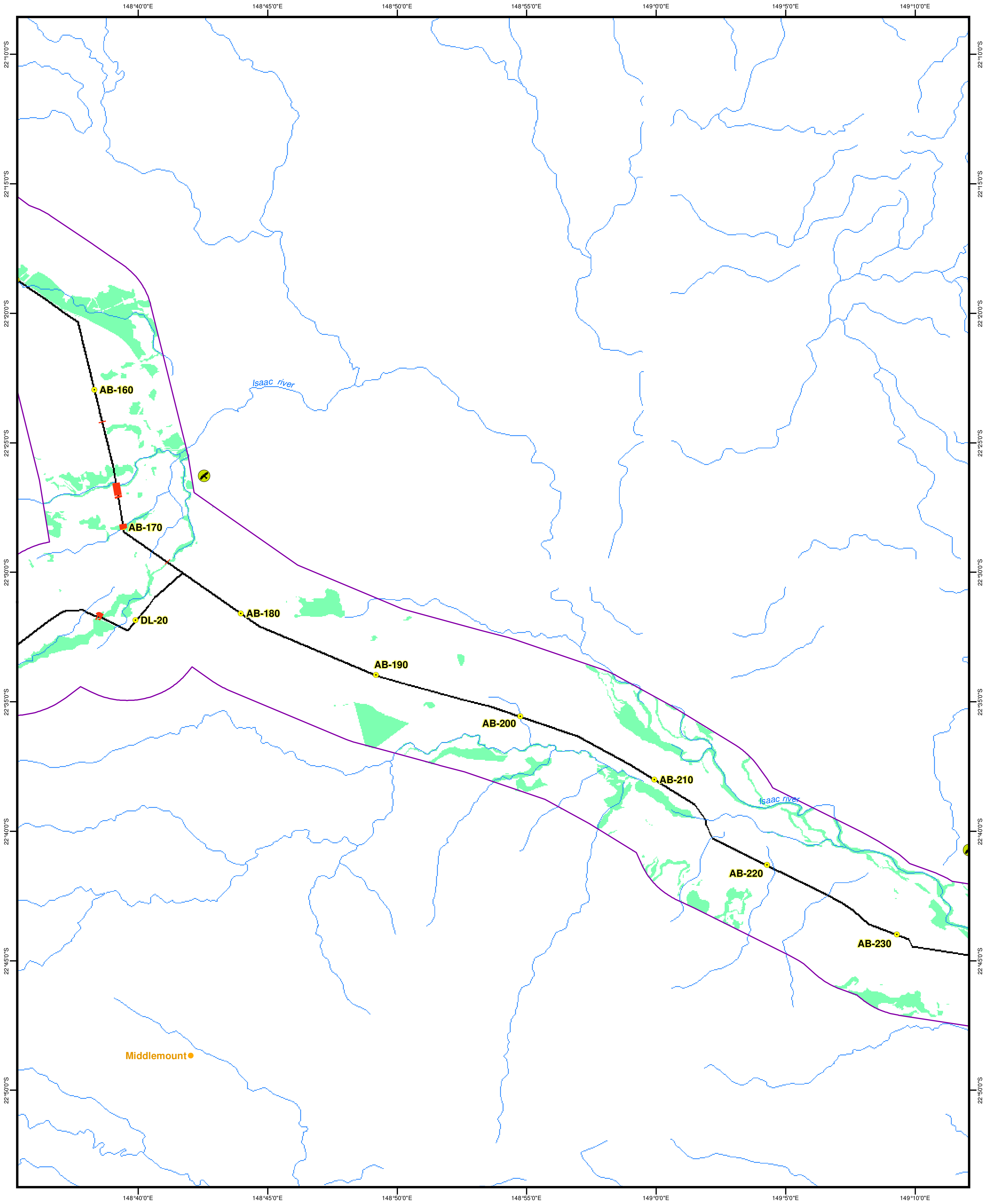
Squatter Pigeon

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 2 of 7

A3



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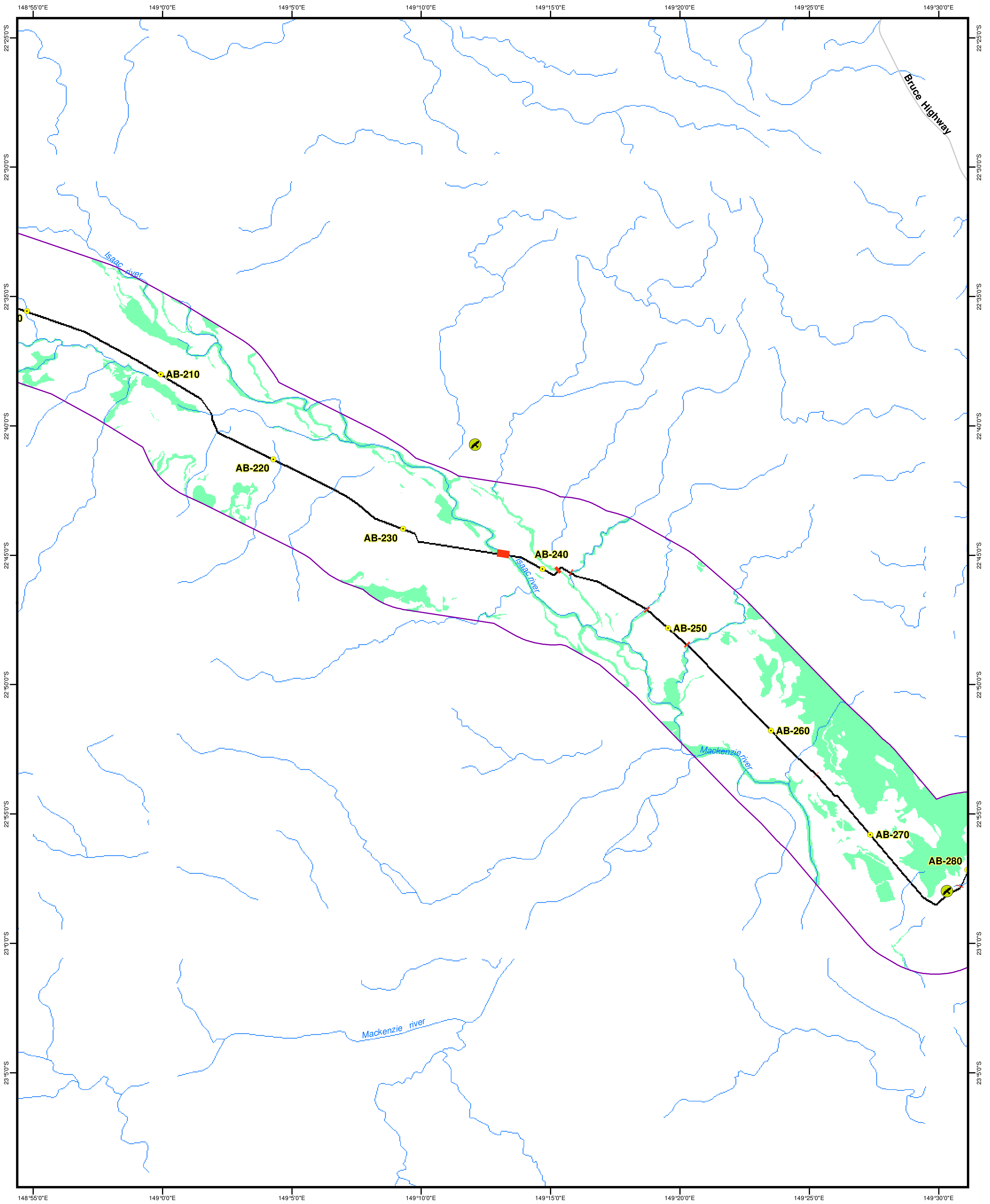
Squatter Pigeon

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 3 of 7

A3



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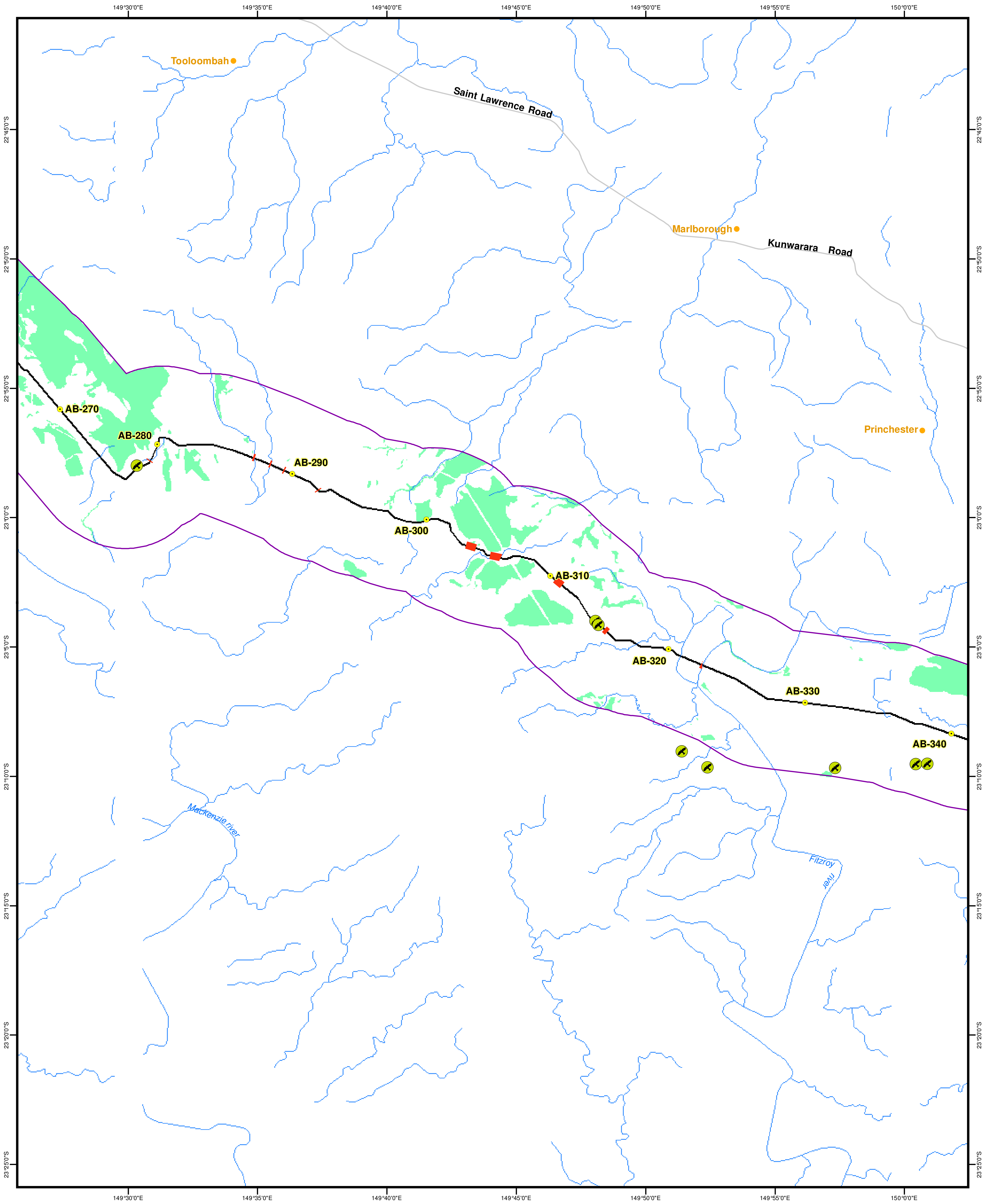
Arrow Bowen Pipeline
Revision H1

Page 4 of 7

A3



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Squatter Pigeon

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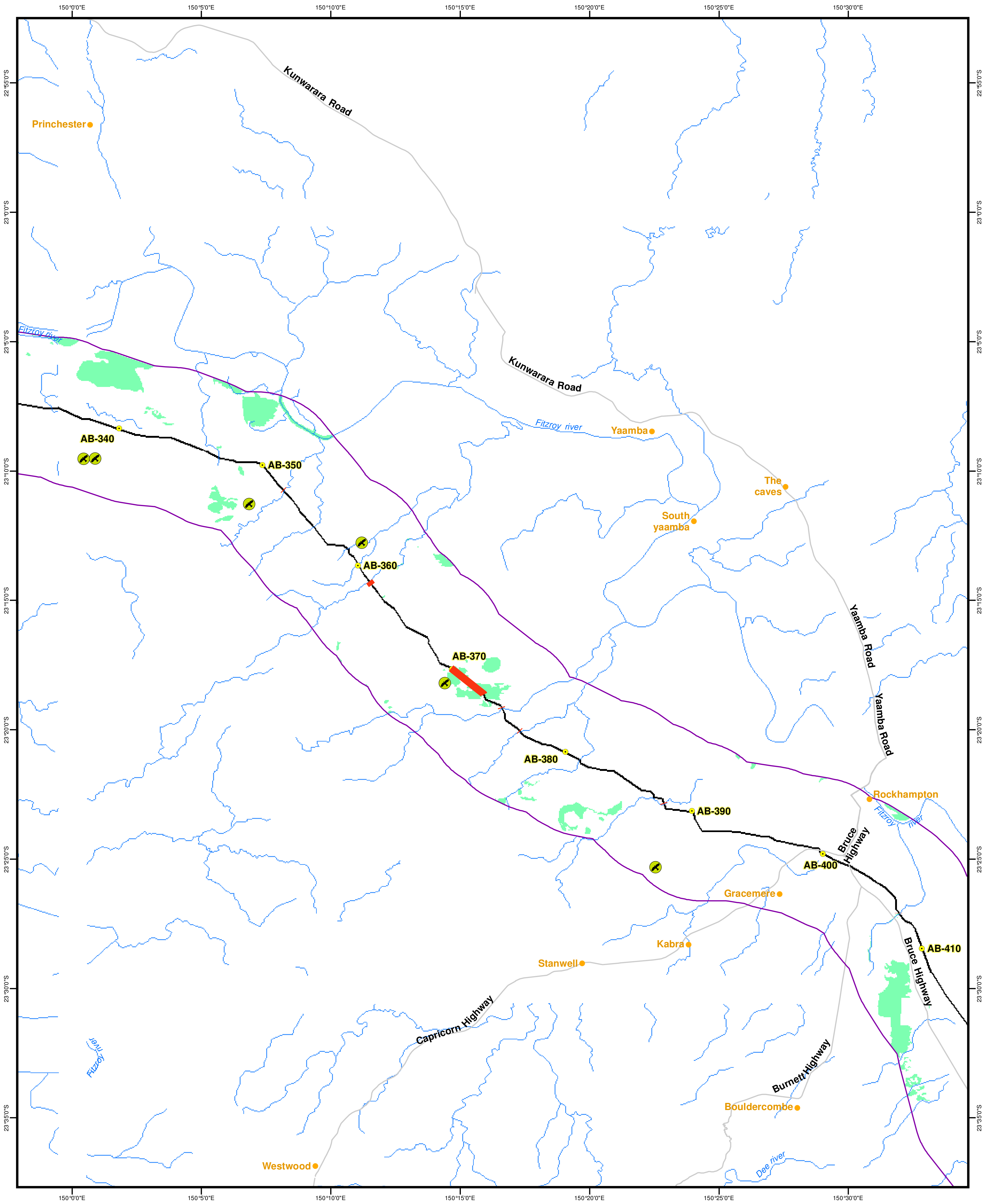
Arrow Bowen Pipeline
Revision H1

Page 5 of 7

A3



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Squatter Pigeon

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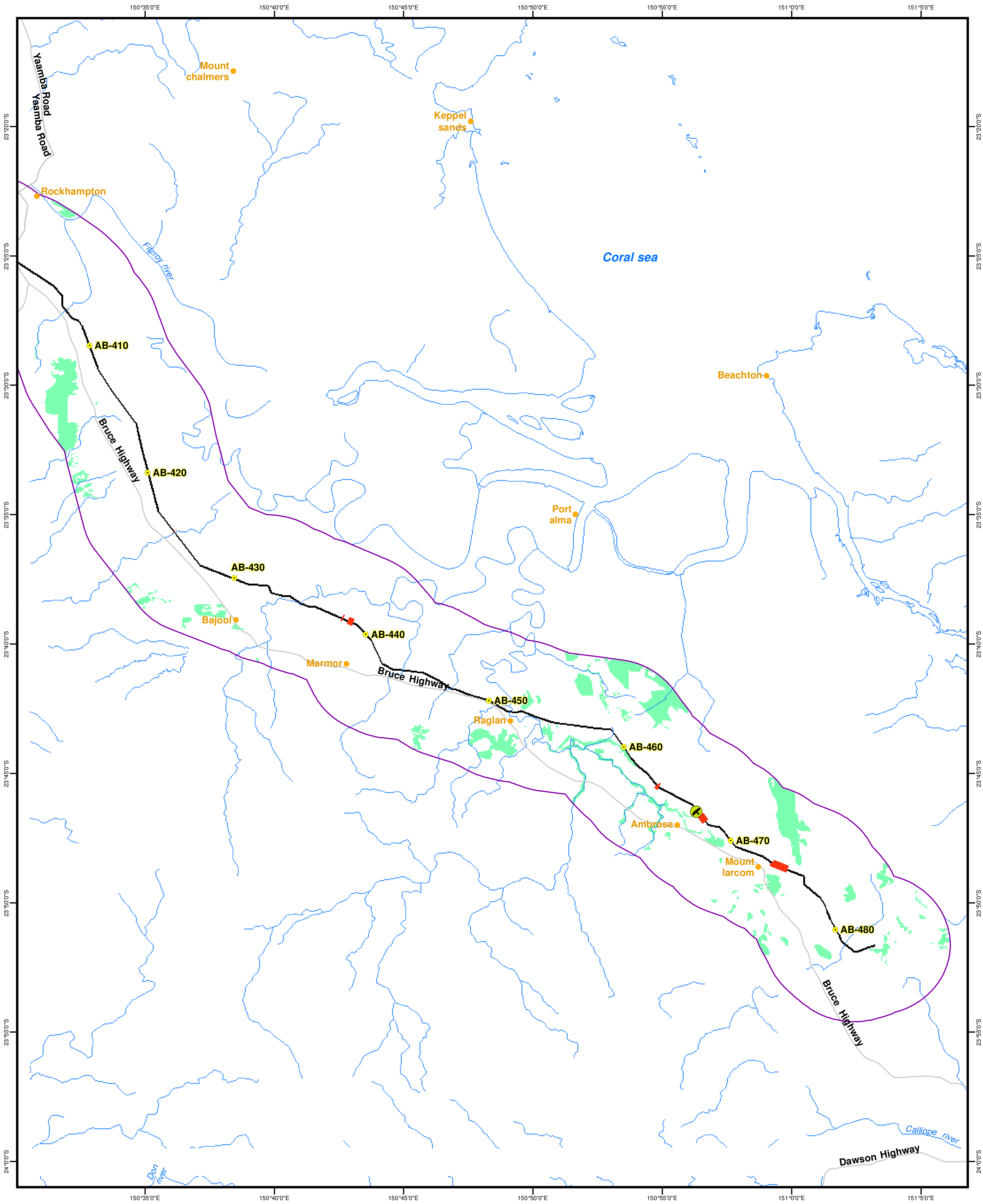
Arrow Bowen Pipeline
Revision H1

Page 6 of 7

A3



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Revision H1

Page 7 of 7

A3

2.6 *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT) — Koala

2.6.1 Conservation Status

Queensland: Vulnerable under the NC Act in the south -east Queensland (QLD) bioregion, and as Least Concern for other bioregions in Queensland.

National: Vulnerable in QLD, New South Wales (NSW) and the Australian Capital Territory (ACT) under the EPBC Act

2.6.2 Description

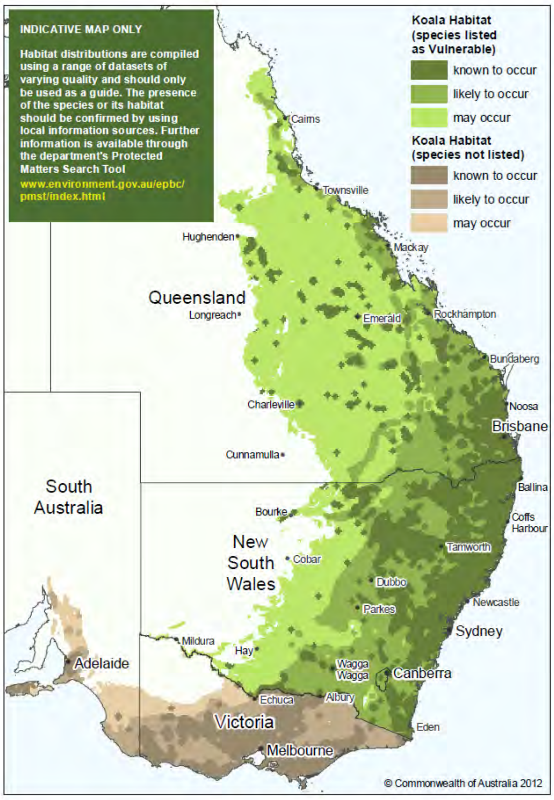
The koala is an arboreal marsupial with predominately grey fur, large rounded ears and a stocky body. In Queensland the average weight of a male koala is 6.5 kg (DSEWPaC, 2013a).

2.6.3 Distribution

The koala has an extensive, but fragmented, distribution from north-eastern Queensland to the Eyre Peninsula in South Australia, and inland into the eastern margins of the arid zone of New South Wales and Queensland. Distribution is not continuous across this range and is influenced by altitude (generally occurs < 800 m above sea level), temperature and, at the western and northern ends of the range, leaf moisture (Munks et al. 1996). In drier regions koala distribution is correlated with higher moisture content in eucalypt leaves, which is a factor of water availability in soils.

In Queensland, the greatest density of koalas occurs in the South East Queensland bioregion, however the species occurs in several other coastal and inland bioregions including Einasleigh Uplands, Wet Tropics, Desert Uplands, Central Mackay Coast, Mitchell Grass Downs, Mulga Lands, Brigalow Belt and Channel Country (Patterson 1996). Within these bioregions, koalas occur in moist coastal forests, subhumid woodlands in southern and central Queensland, and in some eucalypt woodlands along watercourses in the semi-arid environments of the western part of the State (Melzer et al. 2000).

The estimated total population count for koala in QLD is 167,000 with 75,000 estimated to occur in the Brigalow Belt bioregion, where the project is located.



INDICATIVE MAP ONLY

Habitat distributions are compiled using a range of datasets of varying quality and should only be used as a guide. The presence of the species or its habitat should be confirmed by using local information sources. Further information is available through the department's Protected Matters Search Tool www.environment.gov.au/epbc/pmst/index.html

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Figure 10 Phascolarctos cinereus habitat in Queensland, NSW and ACT

(Source: DSEWPaC 2013)

2.6.4 Habitat

Koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus Eucalyptus (Martin & Handasyde 1999). Suitable habitat contains Koala food trees or shelter trees and is contiguous or connected with other suitable habitat to allow dispersal and access to sufficient foraging resources. Koalas have also been found to inhabit *Acacia harpophylla* (Brigalow) dominated vegetation within the Brigalow Belt bioregion.

2.6.5 Ecology

Diet is restricted mainly to foliage of *Eucalyptus* spp. (Phillips et al. 2000) but Koalas may also eat leaves from the genera *Corymbia, Angophora, Lophostemon, Leptospermum* and *Melaleuca*. Preferences for particular food tree species vary between individual Koalas and also between regions and seasons (Moore and Foley 2000).

Female Koalas can produce up to one offspring each year, with births occurring between October and May (McLean 2003). Young stay in the pouch for six to eight months and then ride on the mother's back, remaining dependant until around 12 months old. Juvenile Koala disperse from their natal home range prior to or early in the breeding season, moving up to 10 kilometres (Dique et al. 2003b) away. Koalas live for approximately 15 years (females) or 12 years (males) in the wild and have a generation length of around 6 to 8 years (Phillips 2000).

Home range size is highly variable depending on the quality of habitat, with those in poorer quality habitats being larger than in higher quality habitats. This can range from around 10 to 100 ha depending on the habitat. Koalas are not territorial and the home ranges of individuals extensively overlap (Ellis et al. 2009).

Breeding season

🟩 Normal breeding season	🟨 Outside breeding season

🟩 Jan	🟩 Feb	🟩 Mar	🟩 Apr	🟩 May	🟨 Jun	🟨 Jul	🟨 Aug	🟨 Sep	🟩 Oct	🟩 Nov	🟩 Dec

Koalas are inactive for most of the day with the most active period occurring at night. Moving between trees occurs infrequently during a 24 hour period, unless an individual is dispersing from its natal home range.

Populations of koala may undergo large fluctuations due to natural occurrences (e.g. drought or over-browsing leading to defoliation of food trees), as well as anthropogenic factors such as habitat clearing and fragmentation.

2.6.6 Threats

The main identified threats to the Koala include:

- loss and fragmentation of habitat
- vehicle strike
- disease
- predation by introduced pests (particularly dogs).

Vehicle strike and dog attacks are more frequent in urban areas, however these threats are also relevant for non-urban areas.

Drought and wild fire are also known to cause significant mortality. The impact of natural disasters such as fire and drought is higher where fragmentation of habitat has also occurred (NRMMC 2009).

2.6.7 Recovery actions

The National Koala Conservation and Management Strategy (NRMMC 2009) provides a framework for incorporating state and local activities into broader national actions. Objectives of the strategy include identification and protection of koala habitat, development of national guidelines for koala sensitive road design and continuing research.

Priority management actions identified in the approved Conservation Advice statement (TSSC 2012) are aimed at addressing:

- habitat loss and degradation
- predation by dogs
- implementation of koala conservation actions by engaging with land managers.

The Queensland *Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016* contains a set of policies to provide direction and management approaches to address key threatening processes to koalas. The policies include guidance for:

- Koala sensitive development
- offsets for net benefit to Koalas and Koala habitat
- drafting and amending planning schemes
- SEQ Regional Plan investigation areas
- determining overriding need in the public interest
- Koala survey methodology for site assessment
- Koala habitat assessment and mapping
- rehabilitation of land to provide Koala habitat
- requirements for the translocation and release of Koalas
- vegetation clearing practices
- requirements for private Koala hospitals
- local road placement, design and upgrade.

2.6.8 DoE recommended survey methods

The survey approach recommended by DoE (DSEWPaC 2012) includes:

The Spot Assessment Technique (SAT) (Philips and Callaghan 2011) is recommended to determine if a resident population is present within the area and the location of this or these populations in relation to the footprint of the ROW.

A habitat assessment is necessary to ascertain whether habitat critical to the survival of the listed species occurs in the area. Features of the study area which should be recorded include:

- the canopy tree species composition
- the percentage of the canopy cover of each of the above species

- the vegetative ground cover (% of the ground area)
- the leaf litter cover (% of the ground area)
- the bare ground (% of the ground area)
- the area of surface water (% of the ground area)
- the distance to surface water (m) (in drought years, survival of a population may be dependent on the presence of vegetation near permanent waterways; Gordon et al, 1988).
- evidence of dogs in the area (the potential threat of mortality from dog-attacks will influence impact assessment and impact mitigation measures required).

No specific search effort is stated in the *Interim koala referral advice for proponents.*

2.6.9 Survey effort and methods undertaken for ABP

The survey effort undertaken in potential Koala habitat is summarised in Table 29. Potential habitat was considered to be eucalypt dominated woodland as well as any brigalow or cypress pine dominated vegetation communities.

Table 29 Survey effort for Koala

Season	Number of sites in REs suitable for koala	Spotlighting effort	Active search effort
Winter	35	20 person hours (at 10 sites)	28 person hours (at 28 sites)
Spring	14	20 person hours (at 10 sites)	12 person hours (at 12 sites)
Summer	5	8 person hours (at 4 sites)	3 person hours (at 3 sites)

Survey techniques included active diurnal searching and spotlighting on foot and from a car travelling at slow speed.

Active diurnal searches included direct visual observations and scat, sign, and track searches. Scat, sign and track searches target animal scats and identifiable signs such as footprints, scratches on trees and nests. Survey effort involved a minimum 30 minute search in appropriate habitat at each site.

Spotlighting survey effort involved a search for one hour, on foot, with a hand-held spotlight. Spotlighting was conducted at each site along a traverse of at least one kilometre, sampling the least disturbed parts within the habitat type. Spotlighting from a vehicle was undertaken along designated transects on roads and tracks and opportunistically during travel to, from and between sites.

2.6.10 ABP survey results

Koalas were recorded during winter and spring surveys 50 m south of KP 234.5 and 20 m south of the ROW near KP 234.8 near the Isaac River.

The Interim Koala referral advice for proponents (DSEWPaC 2012) states that habitat critical to the survival of Koala is currently considered to be woodland where:

- primary Koala food tree species comprise at least 30% of the overstorey trees
- primary Koala food tree species comprise less than 30% of the overstorey trees, but together with secondary food tree species comprise at least 50% of the overstorey trees
- primary food tree species are absent but secondary food tree species alone comprise at least 50% of the overstorey trees
- the above qualities are absent in a forest or woodland but other essential habitat features are present and adjacent to areas exhibiting the above qualities (e.g. Koalas in the Pilliga are known to escape the heat of the day by taking refuge in white cypress pines, which are not food trees)
- a relatively high density of Koalas is supported, regardless of the presence of food tree species (Koala population densities vary across their range and regional data should be used to judge relative density).

No definition of primary food trees is contained in the interim advice, however for the purposes of this report, the Australian Koala Foundation's National Koala Tree Protection List (Mitchell 2012) has been used to classify food species as either primary or secondary food species. Only 17.97 ha of critical habitat for Koala occur within the ROW.

Table 30 Extent of primary and secondary koala habitat within the ROW based on field verified RE mapping

RE Code	Short description	Potential habitat in ROW(ha)	RE in 5 km buffer (ha)	% of buffer*	Critical habitat in ROW (ha)
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	29.14	11397.97	0.25	0
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	5.30	3941.48	0.13	0
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	0.63	3235.83	0.01	0.63
11.3.7	*Corymbia* spp. woodland on alluvial plains. Sandy soils	4.24	1112.84	0.38	0
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	17.34	9112.56	0.19	17.34
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains	5.64	3088.83	0.18	0
11.3.36	*Eucalyptus crebra* and/or *E. populnea* and/or *E. melanophloia* on alluvial plains. Higher terraces	3.23	332.98	0.97	0

RE Code	Short description	Potential habitat in ROW(ha)	RE in 5 km buffer (ha)	% of buffer*	Critical habitat in ROW (ha)
11.5.3	*Eucalyptus populnea* and/or *E. melanophloia* and/or *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces	79.57	18509.98	0.42	0
11.5.9	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains/remnant surfaces. Plateaus and broad crests	26.72	6600.89	0.40	0
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland on fine-grained sedimentary rocks	0.70	1357.38	0.05	0
11.9.9	*Eucalyptus crebra* woodland on fine-grained sedimentary rocks	6.47	2837.52	0.22	0
11.11.1	*Eucalyptus crebra* +/- *Acacia rhodoxylon* woodland on old sedimentary rocks with varying degrees of metamorphism and folding	2.63	4684.21	0.05	0
11.11.4	*Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	4.58	746.07	0.61	0
11.11.15	*Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains	12.71	3842.75	0.33	0
11.11.16	*Eucalyptus cambageana*, *Acacia harpophylla* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands	1.96	211.52	0.92	0
11.12.2	*Eucalyptus melanophloia* woodland on igneous rocks	2.69	2016.34	0.13	0
Other REs containing suitable habitat in the 5 km buffer		0	36576.92	0	-
Total		203.55	109606.07	0.18	17.97

* percent of the potential habitat within the 5 km buffer which is contained within the ROW.

2.6.11 Potential impacts of ABP on Koala

2.6.11.1 Potential impacts without mitigation

Construction, operation and maintenance of the ABP has the potential to result in a number of direct and indirect impacts. Direct impacts associated with the ABP project could include:

- temporary loss of Koala habitat containing foraging and sheltering resources
- fragmentation of habitat, particularly in association with hills and ranges north of Moranbah
- potential trap provided by the open pipeline trench (trenchfall) during construction
- direct mortality through collisions with vehicles
- Indirect impacts could include:
- increase in disease such as Chlamydia and Koala Retrovirus (KoRV)

- increase in introduced predator (i.e. dog) attack
- increase in weed occurrence and edge effects leading to general degradation of habitat quality.
- impacts to water quality leading to changes in riparian vegetation / habitat quality downstream.

2.6.11.2 Assessment of potential impacts with mitigation

A range of mitigation measures can be implemented to minimise direct and indirect impacts on Koala. Suitable measures for mitigating impacts of the project on Koala will be consistent with recovery actions described in the policies of the Queensland *Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016*, and will include:

- Minimum clearing widths will be used in areas of remnant vegetation which supports high quality Koala habitat. Clearing limits will be marked on plans and on-ground to prevent accidental over-clearing.
- Staged clearing will be undertaken in areas of critical Koala habitat, encouraging fauna to relocate on their own accord into adjacent habitat prior to construction.
- Suitably qualified and experienced fauna spotter-handlers will be present during vegetation clearing to identify any Koalas and resident trees. The fauna spotter-catcher is not to physically move Koalas from a tree in which they are residing to another location. Each tree identified by the fauna spotter-catcher as being a risk to the Koala if felled, should not be felled, damaged or interfered with until the Koala has moved from the felling site of its own volition.
- Trenching will be staged to minimise the duration and length of open trench. Ramps will be used to provide a means of egress from the trench for trapped animals, refuges will be placed in the open trench overnight and trenches will be checked each morning by fauna handlers and spotter catches.
- The use of trenchless crossing techniques (eg HDD) to cross the lower Isaac River will avoid any disturbance to Eucalyptus tereticornis on the banks of the river and hence critical habitat for koala
- Waste will be managed, stored and removed from construction areas to prevent attraction of feral animals to the area.
- Weed hygiene practices will be implemented to reduce the risk of weed spread or introduction to new areas.
- Preclearance weed surveys will be conducted and any declared or other invasive weeds will be treated in accordance with weed management plan procedures.

Table 31 summarises potential direct and indirect impacts of the project on Koala populations and the mitigation measures proposed to address each potential impact. The final column of the table provides a categorisation of risk for each impact after taking into account implementation of mitigation measures. Impacts are categorised as insignificant, low, moderate or high. Impacts of habitat and fragmentation were considered to have a moderate residual impact, even after mitigation. All other impacts were assessed to have a low or insignificant residual risk after implementation of mitigation measures.

Table 31 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on Koala.

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
DIRECT IMPACTS			
Removal of habitat Temporary removal of vegetation representing potential foraging, breeding and sheltering habitat	M	-minimise areas of remnant vegetation to be cleared -clearly mark out areas to be cleared and retained -use existing cleared corridors where practicable -revegetate the ROW following construction with local native species -retain mature food trees where practicable -use trenchless construction techniques to minimise clearing at major watercourse crossings including the Isaac River and Fitzroy River -include Koala in a species management program for the ABP if trenchless crossing techniques is not utilised for the lower Isaac River	L
Trenchfall Death of individuals trapped in the trench	L	-monitoring of open trenches by fauna spotter-catcher during the construction period -minimise the length of time the trench is open	I
Fatalities Death of individuals via vehicles and equipment during clearing, construction and operation	M	- maintain an appropriate speed limit in the ROW especially in areas where the ROW goes through remnant vegetation -employ a fauna spotter catcher to identify Koalas and resident trees prior to clearing and to facilitate relocation of Koalas into adjacent habitat on their own volition	L
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of population	M	- minimise areas of remnant vegetation to be cleared -use existing cleared corridors where possible - revegetate the ROW following construction with local native species	L
INDIRECT IMPACTS			
Changes in water quality Impacts to water quality leading to changes in vegetation / habitat downstream	N/A	-no mitigation measures for water quality recommended for this species as it is not dependent on aquatic habitats or short term changes in water quality.	N/A
Increase in weed abundance -increase competition with native plant species used for foraging and shelter. -smothering of native vegetation	L	-develop and implement a Weed Management Plan -control weeds in the ROW before, during and after construction -implement site weed hygiene protocols	I
Increase in introduced predator abundance Increase in introduced predator abundance caused by increased food availability in the ROW	L	-develop and implement a Waste Management Plan -develop and implement a Pest Management Plan -provide animal proof containers for storage of food waste -educate staff about the importance of removing any food waste from the ROW -keep the work site clean of debris which could be used as shelter for introduced predators.	L
Noise and disturbance Disturbance caused by noise or human disturbance leading to stress, disease and abandonment of habitat.	L	- no night-time construction to minimise noise and disturbance when Koalas are travelling on the ground -use existing cleared corridors where practicable	I

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
Spread of disease Increase in disease such as Chlamydia and Koala Retrovirus (KoRV) due to increased stress	L	- no night-time construction to minimise noise and disturbance during koala dispersal periods to reduce stress - restrict vehicle and plant movement to designated tracks and parking areas -minimise areas of remnant vegetation to be cleared -use existing cleared corridors where practicable	I

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High

2.6.12 Evaluation under MNES significant impact guidelines

The following questions were considered to determine the significance of project impacts on koala, in accordance with the EPBC Act significant impact guidelines 1.1 (DEWHA 2009).

Is there an important population of this species in the study site?

Fauna surveys for the project were undertaken prior to the listing of Koala as vulnerable under the EPBC Act (2 May 2012), so no targeted surveys for this species were undertaken. However, fauna surveys incorporated survey techniques to detect the presence of arboreal mammals including the Koala. Scats from Koala were recorded 50 m south of KP 234.5 and 20 m south of the ROW at KP 234.8 near the Isaac River. Vegetation surveys confirmed potential habitat for Koala occurs within the footprint of the project (Table 30).

The *EPBC significant impact guidelines* states that an important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity
- populations that are near the limit of the species' range.

The Koala populations that occur within the study site are not identified in recovery plans or near the limit of the species range and are unlikely to be key source populations either for breeding or dispersal.

Will the action lead to a long-term decrease in the size of an important population of a species?

The 40 metre ROW will affect a relatively small area of potential habitat in comparison to the extent of similar habitat available in the local area. Construction of the pipeline will be progressive within the designated ROW so that only a small amount of potential habitat will be impacted at any one time. The ROW will be progressively rehabilitated immediately following construction. The majority of the ROW will be revegetated using native grasses, shrubs and trees, however a 7 metre wide track centred on the buried pipe will be kept clear of deep-rooted vegetation. Provided that mitigation measures outlined in Table 31 are implemented, it is expected that impacts will be minor and short-lived, so will not lead to a long-term decrease in the size of any Koala population. Arrow is committed to utilising trenchless techniques to cross the lower Isaac River and hence will avoid impact to this critical habitat area.

Will the action reduce the area of occupancy of an important population of a species?

The 40 metre ROW will affect a relatively small area of potential habitat in comparison to the extent of similar habitat available in the local area. The majority of the ROW will be revegetated immediately following construction using native grasses, shrubs and trees, however a 7 metre wide track centred on the buried pipe will be kept clear of deep-rooted vegetation. Provided that mitigation measures outlined in Table 31 are implemented, it is expected that impacts will be minor and short-lived, so will not reduce the area of occupancy of Koala in the medium to long term. Arrow is committed to utilising trenchless techniques to cross the lower Isaac River and hence will avoid impact to this critical habitat area.

Will the action fragment an existing important population into two or more populations?

Due to the narrow clearing footprint and short duration of the disturbance, clearing of the ROW is unlikely to fragment an existing important population of this species. Arrow is committed to utilising trenchless techniques to cross the lower Isaac River and hence will avoid impact to this critical habitat area.

Will the action adversely affect habitat critical to the survival of a species?

Construction of the ABP could temporarily impact on critical habitat, as defined by the Koala interim referral advice (DSEWPaC 2012). However, the 40 metre ROW will affect a relatively small area of potential habitat in comparison to the extent of similar habitat available in the local area. Construction of the pipeline will be progressive within the designated ROW so that only a small amount of potential habitat will be impacted at any one time. The ROW will be progressively rehabilitated immediately following construction. The majority of the ROW will be revegetated using native grasses, shrubs and trees, however a 7 metre wide track centred on the buried pipe will be kept clear of deep-rooted vegetation. Provided that mitigation measures outlined in Table 31 are implemented, it is expected that impacts will be minor and short-lived, so will not lead to a long-term adverse effect on habitat critical to the survival of Koala populations. Arrow is committed to utilising trenchless techniques to cross the lower Isaac River and hence will avoid impact to this critical habitat area.

Will the action disrupt the breeding cycle of an important population?

The narrow clearing footprint, restriction of construction works to daytime hours and temporary duration of construction works, clearing of the ROW is unlikely to disrupt the breeding cycle of any existing population of this species. Arrow is committed to utilising trenchless techniques to cross the lower Isaac River and hence will avoid impact to this critical habitat area.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Construction of the ABP could temporarily impact on Koala habitat, as defined by the Koala interim referral advice (DSEWPaC 2012). However, large amounts of suitable Koala habitat will remain adjacent to the ROW. With the implementation of identified mitigation measures and progressive rehabilitation of the ROW, the ABP is unlikely to reduce the availability or quality of habitat to the extent that the species would decline.

Will the action result in harmful invasive species becoming established in the species' habitat?

Field surveys have identified a number of weed species and feral animals in and adjacent to the ROW. It is unlikely that the action will result in an introduced species becoming more abundant in the area. Reasonable management measures, such as the removal of food waste from the ROW or induction programs which stress not feeding animals will ensure the level of risk from pests will remain unchanged as a result of the action.

Will the action result in the introduction of disease(s) that may cause the species to decline?

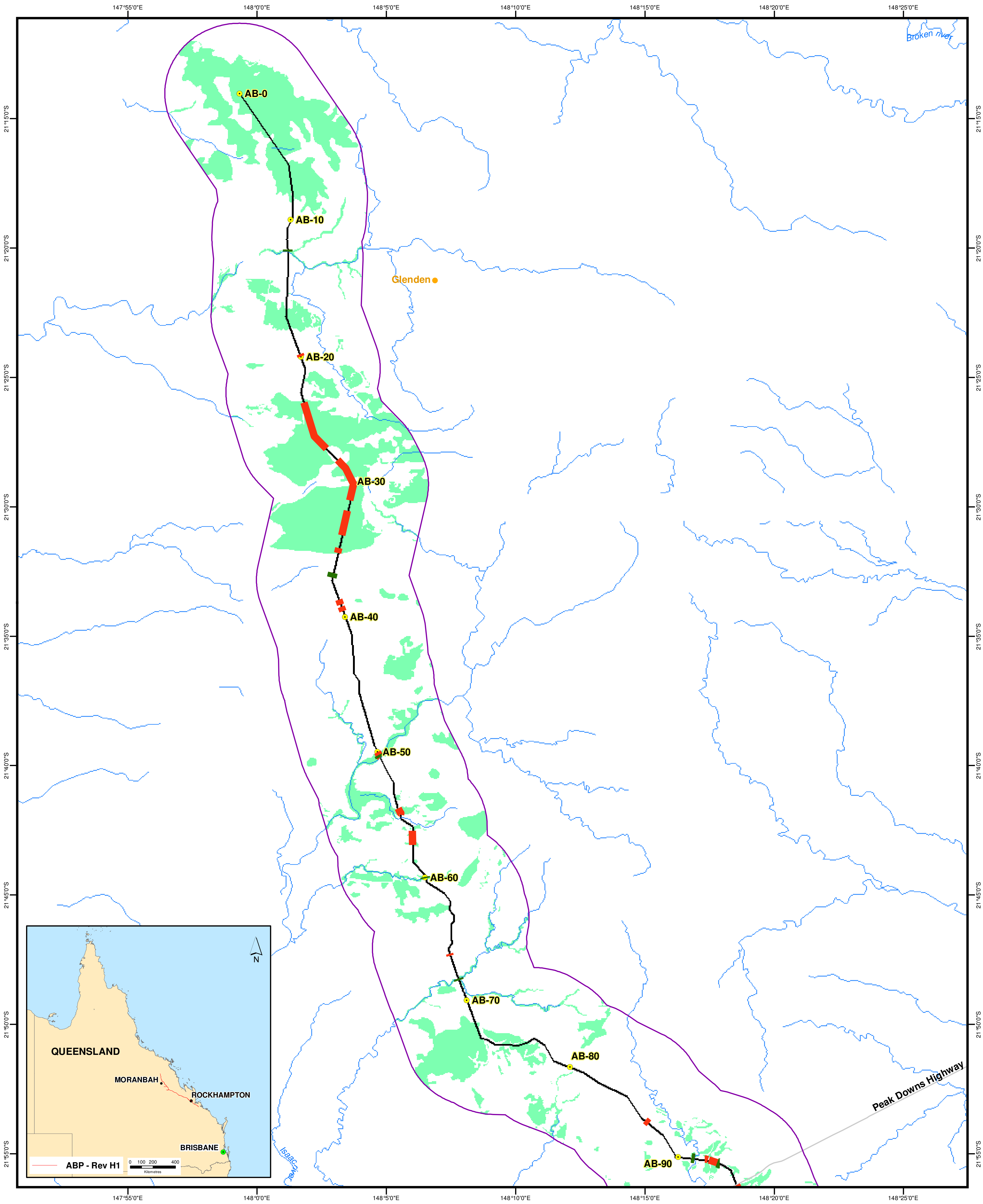
Koala populations are known to carry several diseases such as Chlamydia and Koala Retrovirus (KoRV). The interaction between habitat modification, stress and disease is complex and varies depending on host and pathogen species (Brearley et. al. 2012). Stress caused by construction noise and habitat fragmentation could potentially increase the incidence of diseases in the koala population. A number of mitigation measures will be implemented to minimise undue stress to koalas, including a 40 m wide clearing footprint, progressive construction, revegetation of the ROW after construction, daytime construction hours, and use of a fauna spotter-catcher to encourage koalas to move on their own volition. Therefore, the project is unlikely to significantly increase stress in koalas to the point where there is a significant increase in disease and a decline in the species.

Will the action interfere substantially with the recovery of the species?

Evidence of Koalas were recorded within 50 metres of the ROW. However, extensive suitable habitat occurs outside of the ROW so the action is unlikely to interfere with the recovery of the species.

2.6.13 Conclusion

The action is not likely to have a significant impact on this species. The implementation of management and mitigation measures as identified in Table 4 will reduce direct and indirect risk of impacts to this species to **Low** levels. The project will be confined to a 40 metre corridor, without impacting much larger areas of suitable habitat outside of the ROW. Arrow is committed to utilising trenchless techniques to cross the lower Isaac River and hence will avoid impact to this critical habitat area. Provided that the ROW is rehabilitated there will be no significant impacts to Koala.



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Job Number: BE004

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REV	By	CHK	Description	Date

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Datum: GDA 1994
Units: Degree

LEGEND

- ● City or town
- ⊙ Kilometre Point
- ~ Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- 🟩 Critical Habitat for Koala
- 🟥 Potential Habitat in ROW (Field Verified)
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ☐ Buffer (5 km)

Koala

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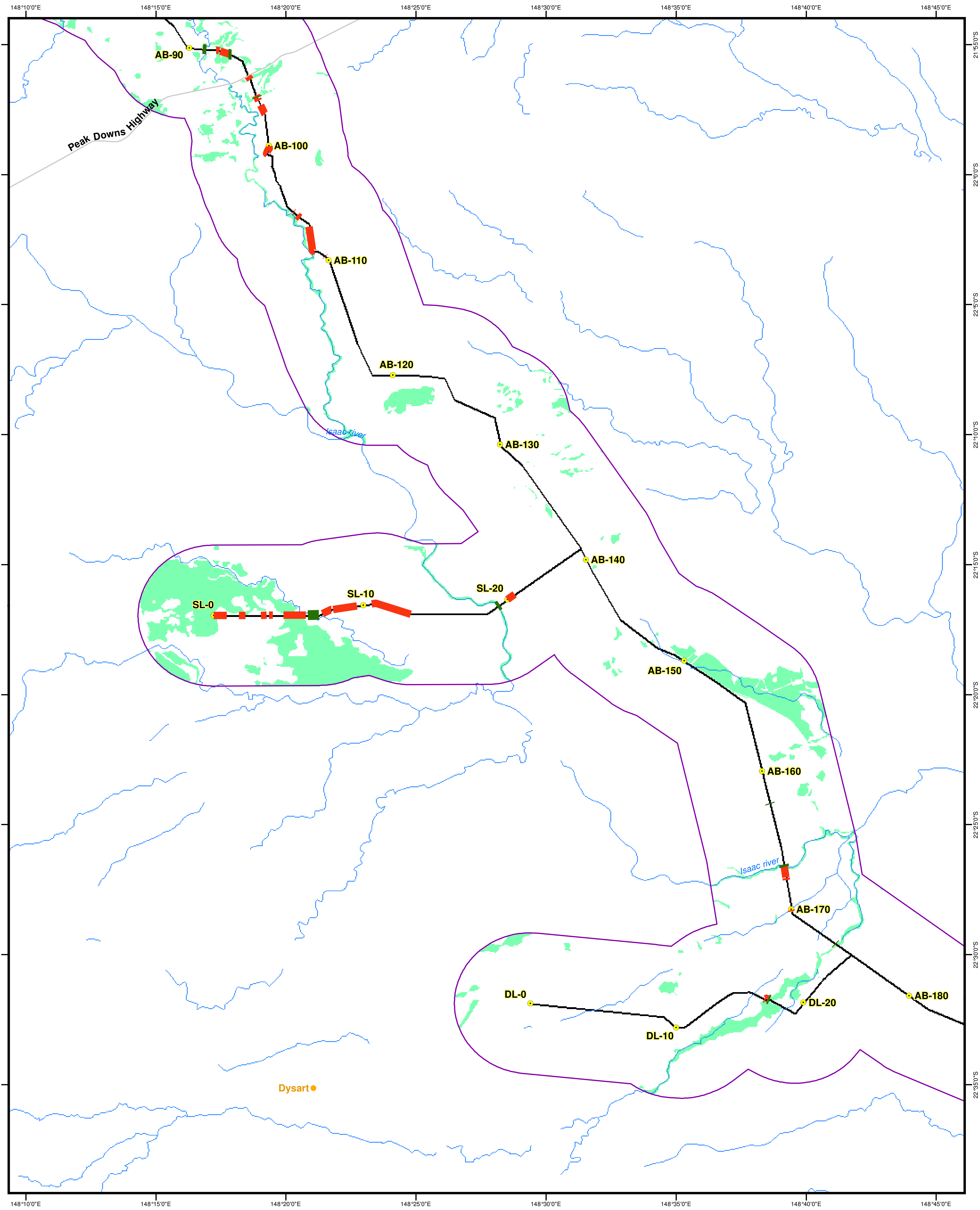
Page 1 of 7

A3



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- 🟩 **Potential Habitat in Buffer (from State RE Mapping)**
- ☐ **Buffer (5 km)**

Koala

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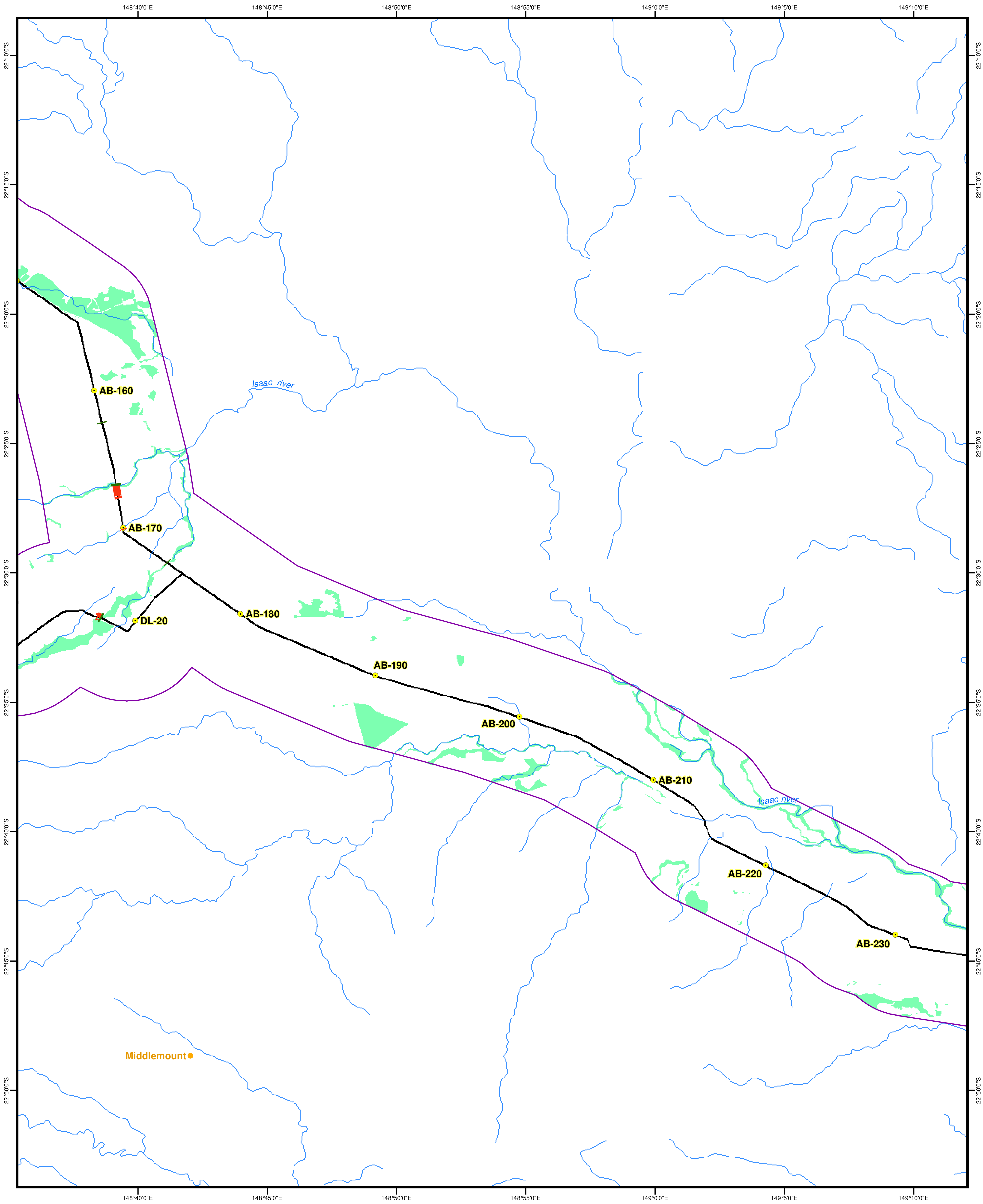
Revision H1

Page 2 of 7

A3



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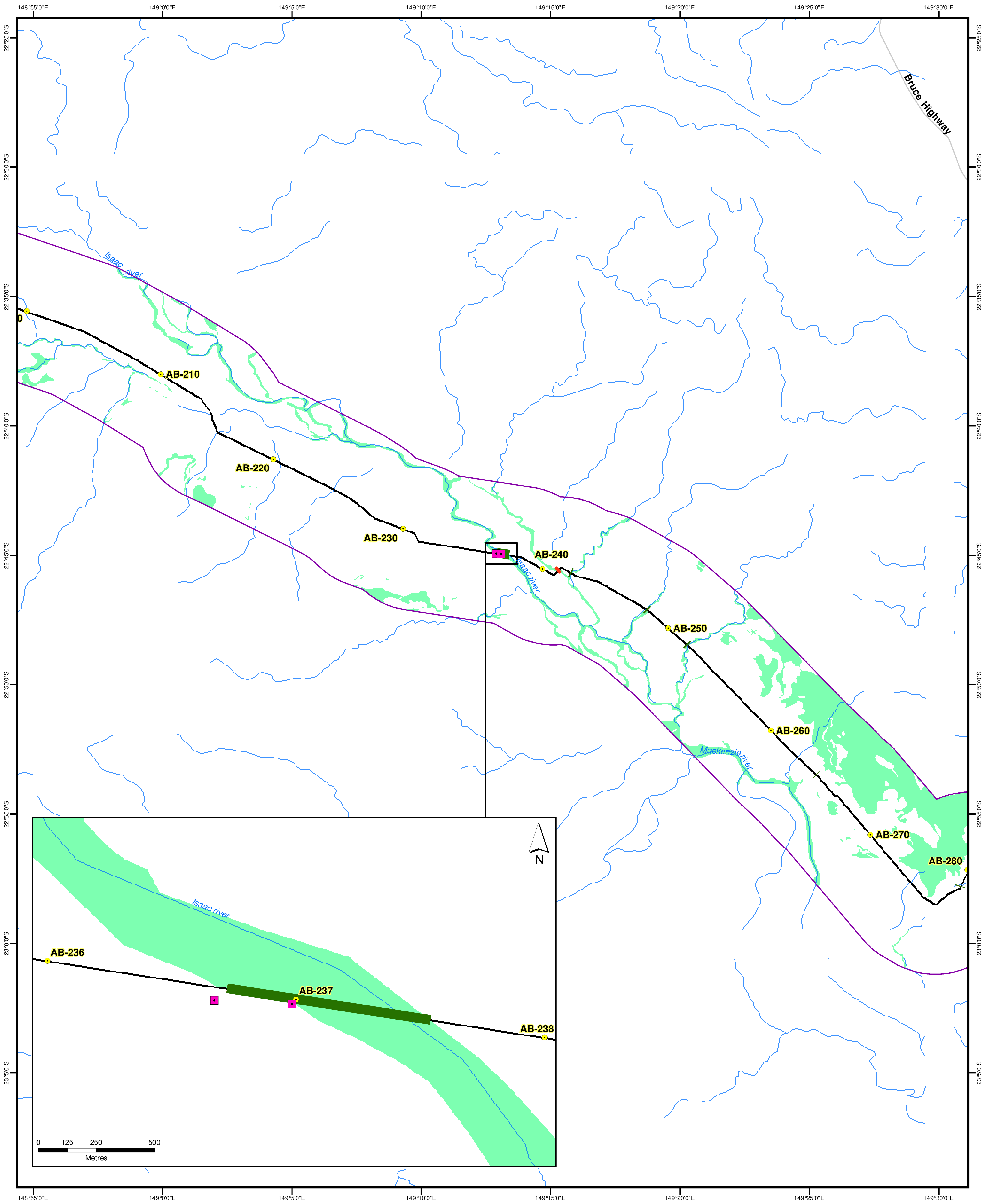

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- 🟥 **Potential Habitat in ROW (Field Verified)**
- 🟩 **Potential Habitat in Buffer (from State RE Mapping)**
- ☐ **Buffer (5 km)**

Koala

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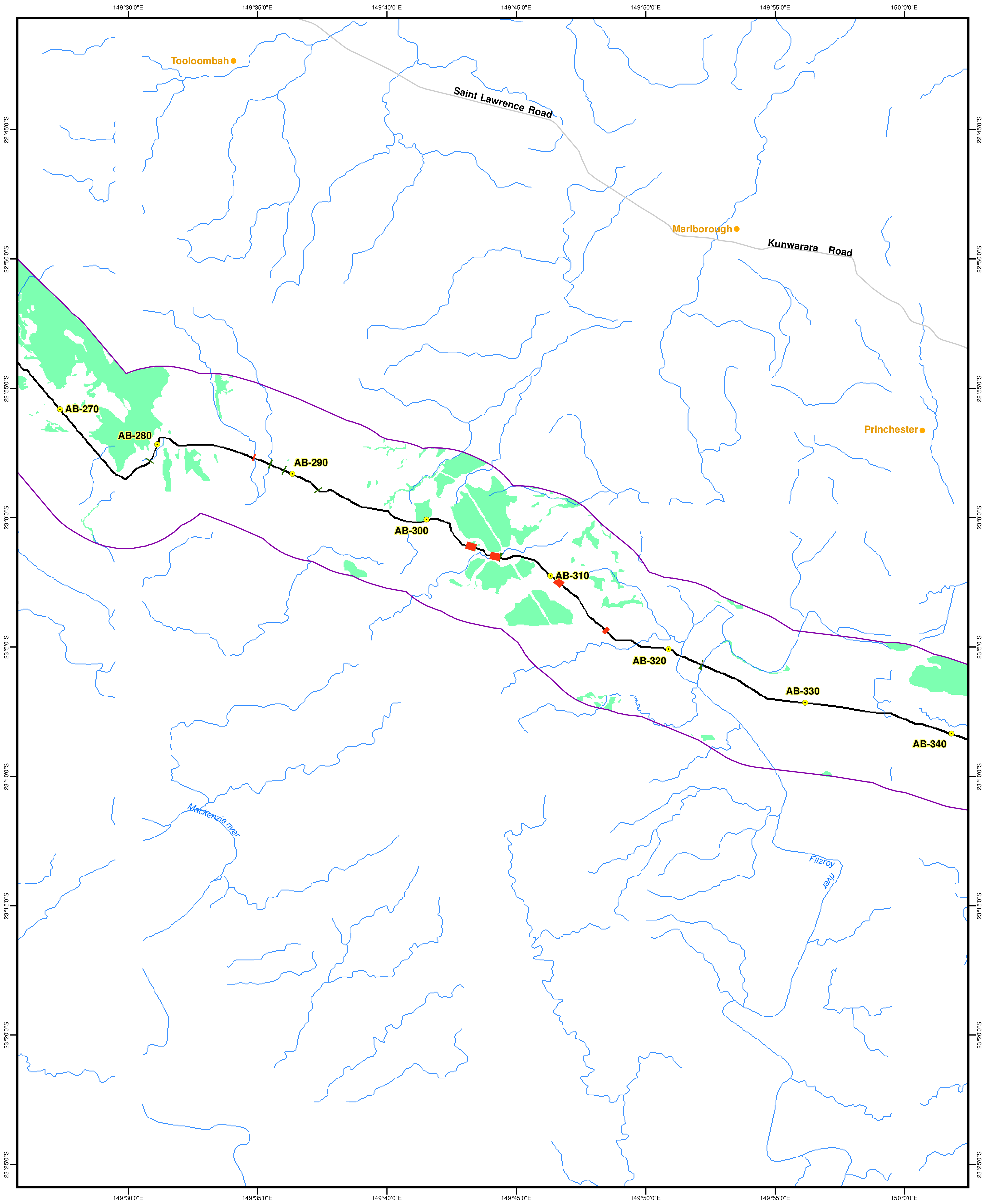
Revision H1

Page 4 of 7

A3



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🟩	Potential Habitat in Buffer (from State RE Mapping)
☐	Buffer (5 km)

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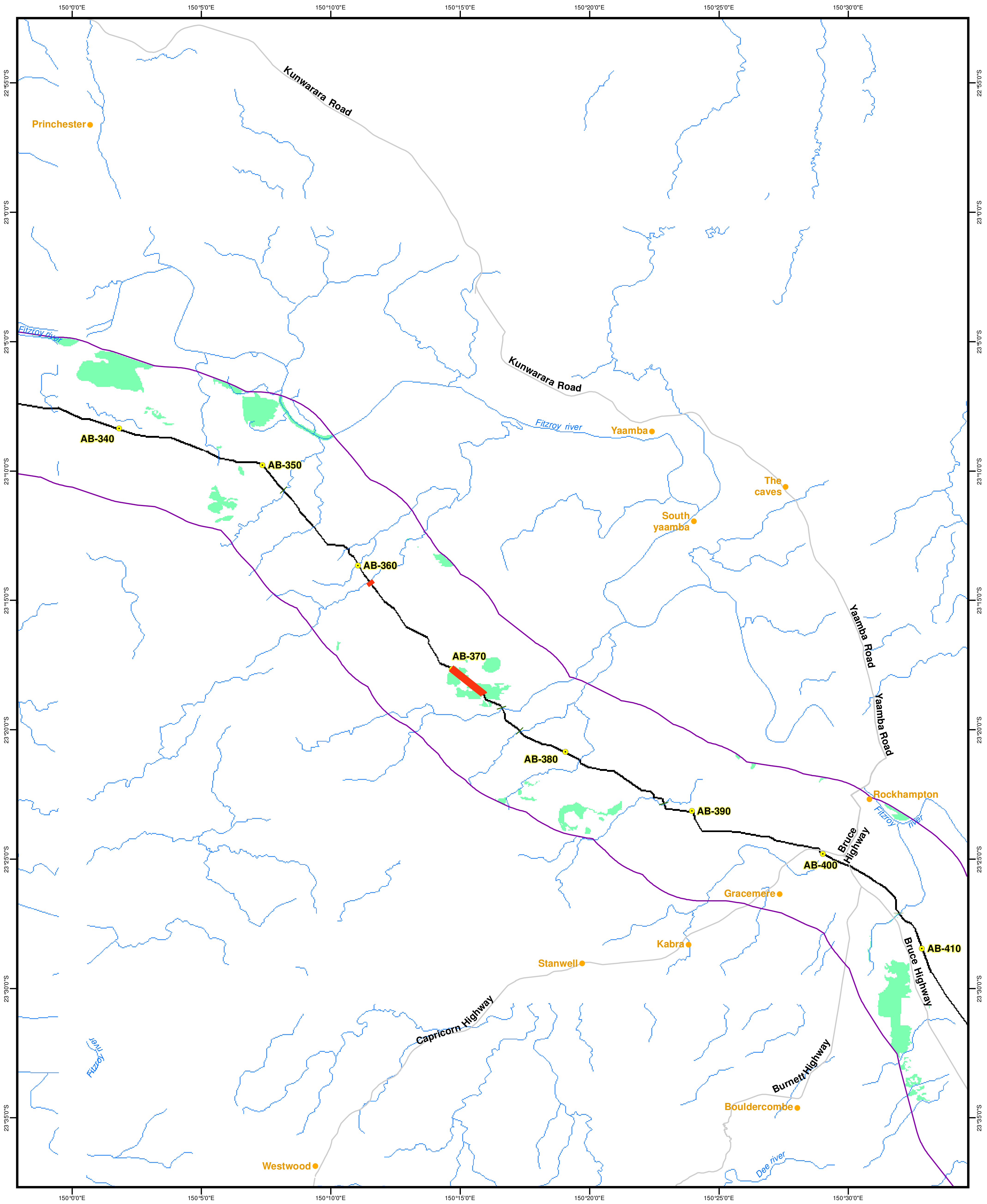
Page 5 of 7

A3



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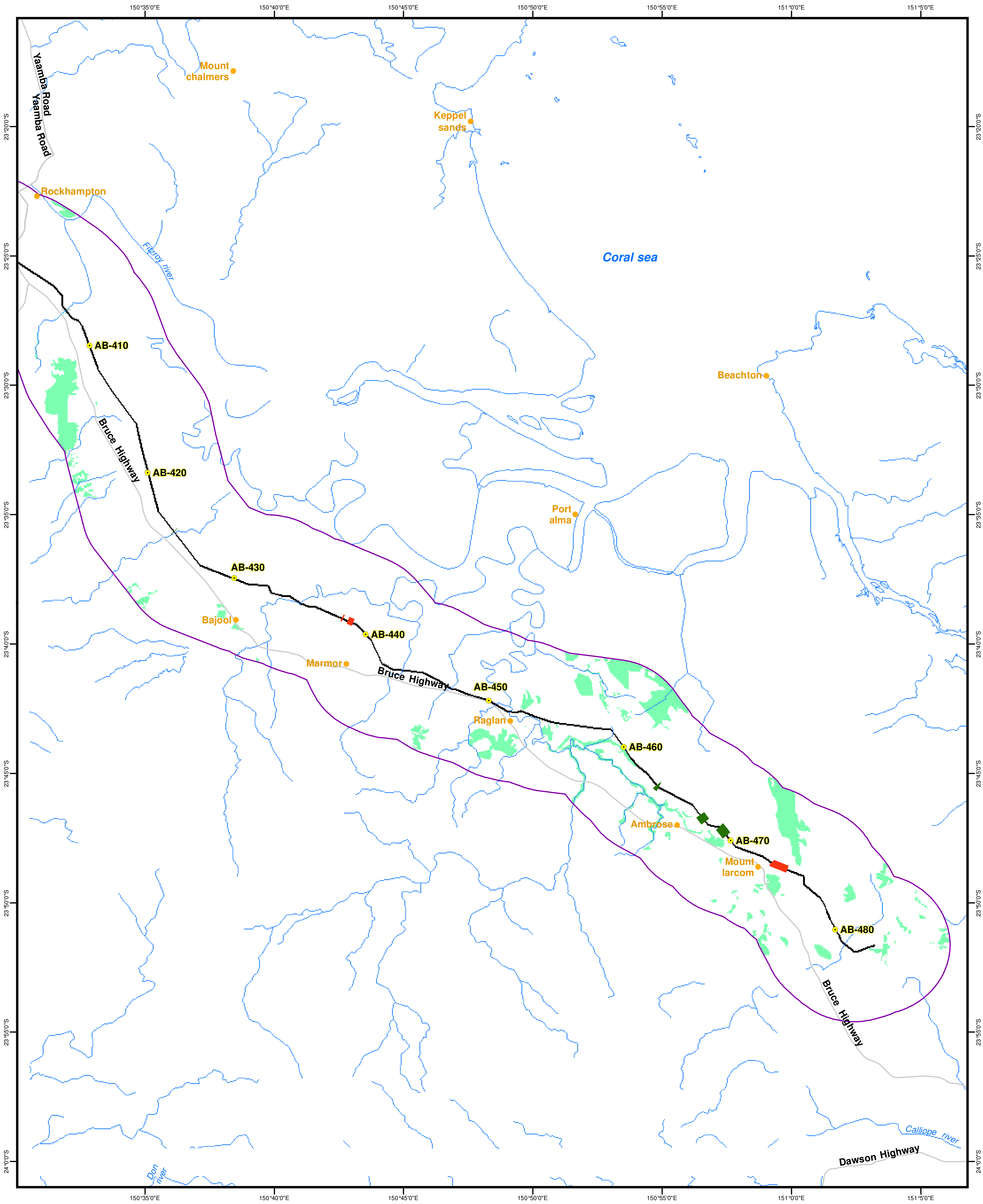
Revision H1

Page 6 of 7

A3



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☐	**Buffer (5 km)**

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Revision H1

Page 7 of 7

A3

2.7 *Pteropus poliocephalus* (Grey-headed Flying-fox)

2.7.1 Conservation Status

Queensland: Least Concern under the NC Act

National: Vulnerable under the EPBC Act

2.7.2 Description

The Grey-headed Flying-fox is a large fruit-bat reaching 230-290 mm in length and attaining a body weight of up to 1000 g (Eby & Lunney 2002). The fur is generally grey to dark grey, except for the distinctive orange/brown collar which helps to distinguish this species from other Australian flying-foxes (Hall 1987).

2.7.3 Distribution

The Grey-headed Flying-fox primarily occurs in the coastal belt from central Queensland to Victoria, however, it occasionally ranges into South Australia and is frequently observed west of the Great Dividing Range (Tidemann 1998). Most literature suggests that the current distribution of Grey-headed Flying-fox extends only as far north as Rockhampton, although historically it extended into north Queensland (DSEWPaC 2013). It selectively forages where food is available, therefore only a small proportion of their range is used at any one time. The relative abundance of this species varies widely within its distribution between seasons and from year to year (Eby & Lunney 2002).

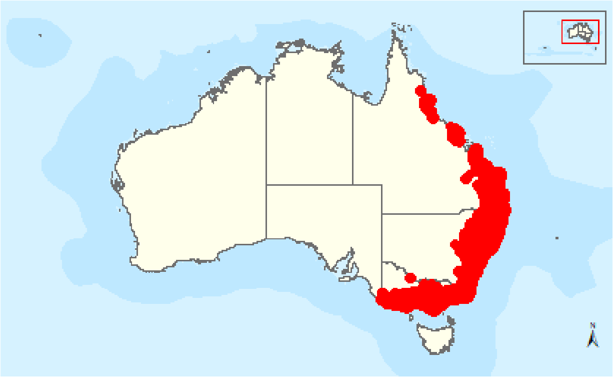


Figure 11 Distribution of *Pteropus poliocephalus*

Source: DSEWPaC 2013

2.7.4 Habitat

The Grey-headed Flying-fox typically roosts near water on exposed branches in aggregations ranging from a few individuals to over 70,000. The species utilises a range of vegetation communities including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. It is often found in highly modified vegetation in urban and suburban areas (van der Ree et al. 2006).

2.7.5 Ecology

Mating occurs in early autumn and females give birth to a single young each year in September/October after a six month gestation (Martin 2000). Initially the young are carried around by the mother but after several weeks they are left in the camp while the mother forages. The young remain in the camp until January/February when they leave to forage for themselves (Churchill 2008). The Grey-headed Flying-fox has a diverse diet of nectar, pollen and fruit which is derived from native and introduced plants. The species usually forages within 15 km of roost sites but will migrate over greater distances in response to the availability of food resources (Eby & Lunney 2002).

Breeding season

🟩 Non-breeding season	🟨 Breeding season

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟨 Young in camp	🟨 Young leave camp	🟨 Mating occurs	🟩 Gestation	🟩 Gestation	🟩 Gestation	🟩 Gestation	🟩 Gestation	🟨 Birth of young/ Gestation	🟨 Birth of young	🟨 Young in camp	🟨 Young in camp

2.7.6 Activity period

The Grey-headed Flying-fox is a highly colonial species. Camps of a few individuals to more than 70,000 form during the daytime, usually in tall closed forest near streams, rivers or estuaries. While a few of these camps are permanent and occupied year round, most are temporary and seasonal. Individuals migrate in complex patterns in response to changes in food availability. Sedentary individuals form the core population of continuously occupied camps. However, the majority are highly nomadic and move several hundred kilometres each year in largely unpredictable patterns (DSEWPaC 2010a).

2.7.7 Threats

The threats to this species include (DSEWPaC 2013a):

- habitat loss and fragmentation
- culling for orchard protection
- competition and hybridization
- pollutants, electrocution and pathogens.

2.7.8 DoE recommended survey methods

The Grey-headed Flying-fox distribution patterns are highly irregular. DoE (DSEWPaC 2010a) suggests searching relevant databases to locate camps and conduct vegetation surveys to identify feeding habitat.

The survey approach recommended by DoE (DSEWPaC 2010a) includes:

1. Prior to survey, a review of known flying fox camps should be conducted for the project area and the wider general area. The location and current occupation of many grey-headed flying-fox camps is known and the information is available from online databases such as Queensland Department of Environment and Resource Management, the Australasian Bat Society and in the literature. Knowledge about camp locations and seasonal movements is also available from local people, orchardists, apiarists, parks officers, forestry workers, wildlife groups, the flying fox carer network and traditional owners.
2. Conduct daytime field surveys for camps. They can be located;
   - while they roost
   - in flight
   - from distinct audible calls
   - by their distinct odour and droppings.
3. Qualified botanist to survey vegetation communities and food plants to confirm their presence in the project area. These areas have been mapped and the significance of each community has been ranked by Eby and Law (2008).
4. Conduct night time surveys by walking transects 100 m apart looking for feeding and flying bats. Their distinctive smell may also provide a sign of their presence.
5. Night time audio recordings at selected sites or fruiting food plants within the project area.

No specific effort is stated for the species in the *Survey guidelines for Australia's threatened bats*.

2.7.9 Survey effort and methods undertaken for ABP

Spotlight surveys were conducted to assess the presence of Grey-headed Flying-foxes in REs within their known distribution. Nine hours of spotlighting was completed during winter, 13 hours during spring and four hours during summer months. The known distribution of Grey-headed Flying foxes within the ABP is from approximately Rockhampton to Gladstone. Historically the species was also found in north Queensland but recent information suggests that the species occurs only as far north as Rockhampton (DSEWPaC, 2013a). Some of these surveys were conducted north of this distribution and therefore some of the survey effort was conducted outside of the known distribution area.

Further surveys to map the extent of the Raglan Creek camp closer to the time of construction are also recommended to ensure the camp has not moved into the ROW and to establish appropriate buffers.

2.7.10 Comparison with DoE guidelines

The effort expended during the field surveys for this species is shown in Table 32 along with the effort recommended under the DoE guidelines. It must be noted that the guidelines are recommendations only and surveys are ongoing.

Table 32 Actual and DoE recommended survey effort for grey-headed flying-fox in suitable habitat

	Actual effort (person hrs)	DSEWPaC effort (hrs)
Spotlighting and active searching	26	None reported

2.7.11 ABP Survey results

Grey-headed Flying-fox was recorded from Raglan Creek near KP 451 (revision H1), with a mixed flying-fox camp located approximately 200 m north-east of the alignment. Surveys in Spring 2012 (5 - 20 September) found that the camp consists of approximately 5% Grey-headed Flying-fox (EcoSM 2012). The exact numbers of bats in the camp could not be ascertained at the time of the survey. The survey was not conducted during the peak breeding season so it was not possible to determine if the camp was being used as a maternity roost.

No Grey-headed Flying-foxes were recorded outside of the Raglan Creek camp during spotlighting surveys in the ROW.

Table 33 shows the field verified REs and habitats in the ROW which could potentially be used by Grey-headed Flying-foxes for roosting and foraging. The table estimates habitat areas within the southern 90 km section from Rockhampton to Gladstone, based on the currently accepted northern limit of distribution at Rockhampton (DSEWPaC 2013). The ROW contains up to 1.18 ha of roosting habitat and 14 ha of foraging habitat for Grey-headed Flying-fox. None of this habitat is considered critical to the species survival as large amounts of similar habitat will remain outside of the ROW and the majority of the species range lies south of the ABP alignment. An assessment of the impacts on this potential habitat is discussed in Section 2.7.13.

Table 33 Potential habitat of Grey-headed Flying-fox within the ROW and within the species distribution (KP 380 – 483)

RE	Habitat Type	Roosting habitat in ROW (ha)	Foraging habitat in ROW (ha)	RE in 5 km buffer	% in buffer	Critical habitat in ROW (ha)
11.1.4	Mangrove forest/woodland on marine clay plains	0.75	0.75	153.28	0.49	0
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	0	0.63	1774.53	0.03	0
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	0.43	0.43	918.36	0.04	0
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains	0	5.64	1920.42	0.29	0
11.11.4	*Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	0	4.58	793.76	0.57	0
11.11.16	*Eucalyptus cambageana*, *Acacia*	0	1.96	76.55	2.56	0

RE	Habitat Type	Roosting habitat in ROW (ha)	Foraging habitat in ROW (ha)	RE in 5 km buffer	% in buffer	Critical habitat in ROW (ha)
	harpophylla woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands					
Other REs containing suitable habitat in the 5 km buffer		0	0	7834.41	0	-
Total		1.18	13.99	13471.31	0.266	0

2.7.12 Other survey results

Menkhorst and Knight (2010) suggest that the most northerly Grey-headed Flying-fox maternity camp occurs in Maryborough. Roberts et al. (2011) suggest that very few Grey-headed Flying-fox occur north of 23° S (near Rockhampton). Although the camp on Raglan Creek may not be a maternity roost, it is the most northerly camp recorded for this species and is therefore significant both locally and regionally. The next closest known flying-fox camp which may contain Grey-headed Flying-foxes is located in Gladstone (DEHP 2013). No camps north of Raglan Creek are expected to contain significant numbers of Grey-headed Flying-foxes.

2.7.13 Impacts of ABP on Grey-headed Flying-foxes

2.7.13.1 Potential impacts without mitigation

It is unlikely that any significant populations of Grey-headed Flying-fox occur north of Rockhampton so impacts to this species will be limited to suitable habitat south of Rockhampton. The camp on Raglan Creek is not in the ROW but could potentially be impacted indirectly by the construction of ABP. Potential foraging habitat occurs in all eucalypt woodlands and mangroves in the ROW south of Rockhampton. Possible impacts associated with the proposed project could include:

- temporary loss of remnant woodland vegetation that could provide roosting and foraging habitat for Grey-headed Flying-fox
- possible increase in edge effects including weed incursion and increased pest animal abundance associated with clearing through remnant vegetation
- possible changes in water quality and hydrology on Raglan Creek leading to changes in vegetation downstream, particularly impacts to roost trees.

2.7.13.2 Assessment of potential impacts with mitigation

Table 34 summarises potential direct and indirect impacts of the project on Grey-headed Flying-fox populations and proposed measures to mitigate potential impacts. The table provides a risk assessment for each impact with and without mitigation measures, assuming trenchless drilling is employed to cross Raglan Creek.

Table 34 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on Grey-headed Flying-fox.

Impact	Raw Risk before mitigation*	Mitigation measures	Residual Risk after mitigation*
DIRECT IMPACTS			
Removal of habitat Removal of remnant vegetation representing potential roosting and foraging habitat.	L	-use HDD (or similar trenchless technology) to avoid impacts on Raglan Creek - minimise areas of remnant vegetation to be cleared -use existing cleared corridors where possible -rehabilitate the ROW following construction -clearly mark out areas to be cleared and retained	I
Trenchfall Death of individuals trapped in the trench	N/A	-no mitigation measures for trenchfall are recommended for this species as it is not likely to fall in the trench	N/A
Fatalities Death of individuals via vehicles and equipment during clearing, construction and operation	N/A	-no mitigation measures to prevent direct fatalities are recommended for this species as it is not likely to get hit by vehicles or machinery	N/A
INDIRECT IMPACTS			
Changes in water quality Impacts to water quality leading to changes in vegetation / habitat downstream (especially the camp at Raglan Creek)	N/A	Temporary construction activities are unlikely to lead to changes in fly fox vegetation or habitat	N/A
Changes in hydrology Changes in wet/dry cycling of waterways caused by damming, changes in morphology or diversions causing changes to flying-fox habitat quality (especially the camp at Raglan Creek)	N/A	Temporary construction activities are unlikely to lead to changes in hydrology resulting in changes to flying fox habitat quality.	N/A
Habitat fragmentation Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of population	L	- minimise areas of remnant vegetation to be cleared -use existing cleared corridors where possible -rehabilitate the ROW following construction	I
Increase in weed abundance -increased competition with native plant species used for foraging and shelter. -smothering of native vegetation	L	-develop and implement a Weed Management Plan -control weeds in the ROW before, during and after construction -implement site weed hygiene protocols -monitor to evaluate the effectiveness of weed management	I
Increase in introduced predator abundance Increase in introduced predator abundance caused by increased food availability in the ROW	L	-develop and implement a Waste Management Plan -develop and implement a Pest Management Plan -educate staff about the importance of removing any food waste from the ROW -keep the work site clean of debris which could be used as shelter for introduced predators	I
Removal of micro-habitat Removal of potential camp trees (especially near the camp at Raglan Creek)	M	-do not remove or interfere with camp trees located within the ROW during preclearance surveys -use HDD (or similar trenchless technology) to avoid impacts on Raglan Creek -conduct a survey to map the location of the Raglan Creek camp immediately prior to construction: if the camp is found to be closer to the ROW consider establishing a 50 m buffer zone around the camp trees to stop staff and	L

Impact	Raw Risk before mitigation*	Mitigation measures	Residual Risk after mitigation*
		equipment approaching camp trees	
Noise and disturbance Disturbance caused by noise or human disturbance leading to stress, disease and abandonment of habitat	L	-if surveys confirm breeding of this species, avoid construction and other disturbance in the vicinity of camps during the breeding season (September to February) -conduct a survey to map the location of the Raglan Creek camp immediately prior to construction: if the camp is found to be closer to the ROW consider establishing a 50 m buffer zone around the camp trees to stop staff and equipment approaching camp trees -do not remove or interfere with camp trees -ensure staff are aware of the camp trees and understand the importance of not disturbing the bats	I
Spread of disease Flying foxes suffer from several diseases including Australian Bat Lyssavirus, Bat Paramyxovirus and Menangle Pig Virus. These diseases can become more prominent when the colony is under stress	L	-do not remove or interfere with camp trees -ensure staff are aware of the camp trees and understand the importance of not disturbing the bats -ensure staff members are aware that flying-foxes can carry diseases which can be passed onto humans and that they should avoid touching any bat (either dead or alive). All bat bites or scratches should be reported immediately and advice should be sought from a qualified doctor -avoid working at night when bats are active	I

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High; N/A – impact not applicable to this species.

It is unlikely that any significant populations of Grey-headed Flying-fox occurs north of Rockhampton so impacts to this species will be limited to eucalypt forests and mangroves south of Rockhampton. Roosting habitat may occur in any woodland/forest communities along waterways. While potential roosting habitat occurs within the ROW, no roosting bats were detected in the ROW. The camp on Raglan Creek is approximately 200 m downstream of the ROW but could potentially be impacted indirectly by the construction of ABP if open trenching of Raglan Creek was undertaken. The use of HDD to cross Raglan, Twelve Mile and Inkerman Creeks will minimise impacts on potential roosting habitat. Foraging may occur in all eucalypt woodlands and mangroves in the ROW in response to flowering and fruiting. The area of foraging habitat impacted by ABP will be further reduced by the use of trenchless crossing techniques (e.g. HDD) to cross Raglan, Twelve Mile and Inkerman Creeks. The majority of the ROW (except for a 7 m wide track) will be rehabilitated after construction using native grasses, shrubs and trees. Provided that proposed mitigation measures are implemented, the impact on this species from clearing of habitat is therefore considered to be **Low.**

The current camp trees on Raglan Creek are outside of the current ROW alignment, however camps do not remain static and can move from season to season (Brisbane City Council 2010). It is possible that bats could move into roosting trees within the ROW before construction commences. Surveys will be conducted prior to commencement of construction to map the extent of the Raglan Creek camp.

Direct and indirect impacts on camp trees (including existing downstream camp trees and potential camp trees within the ROW) will be avoided by using trenchless techniques (eg HDD). Indirect impacts relating to noise and disturbance could be increased if bats move into camp trees within the ROW.

A 50 m buffer around roost trees will be created, if necessary, to reduce the impacts of noise and disturbance to the camp. A new risk assessment will be undertaken if a camp is found within the ROW before construction begins or if geotechnical investigations determine that HDD cannot be used to cross Raglan Creek. Based on the use of HDD to cross Raglan Creek and the location of the camp at this time, the impact on this species from removal of camp trees is considered to be **Insignificant**.

2.7.14 Evaluation under MNES significant impact guidelines

Is there an important population of this species in the study site?

The *EPBC significant impact guidelines* states that an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity
- populations that are near the limit of the species' range.

The Grey-headed Flying-fox population that occurs at Raglan Creek is an important population as it is near the limit of the species' range. Menkhorst and Knight (2010) state that no known breeding populations occur north of Maryborough. However, further surveys are needed detect any new camp sites that establish in the ROW before construction commences. If breeding is recorded in the camp, impacts could be minimised by timing construction and other disturbance in the area to occur outside the breeding season (September to February).

Will the action lead to a long-term decrease in the size of an important population of a species?

Surveys by EcoSM suggest that the flying-fox camp on Raglan Creek contains about 5% Grey-headed Flying-foxes. Arrow proposes to utilise a trenchless technology (e.g. HDD) to cross Raglan Creek which will avoid direct impacts to the riparian vegetation that could be used as future roost trees. Provided that a 50 m buffer zone is established around any camp trees located in or adjacent to the ROW and clearing of foraging habitat is kept to a minimum, it is unlikely that the proposed action will lead to a long term decrease in the size of an important population.

Will the action reduce the area of occupancy of an important population of a species?

The camp on Raglan Creek is near the northern limits of the species' current distribution. Arrow proposes to utilise a trenchless technology (e.g. HDD) to cross Raglan Creek which will avoid direct impacts to riparian vegetation. Provided that a 50 m buffer zone is established around any camp trees found in or adjacent to the ROW and clearing of foraging habitat is minimised, it is unlikely that the proposed action will impact this camp or the occupancy of the camp. The removal of a small area of foraging habitat is unlikely to significantly impact the occupancy of the species as large amounts of similar habitat will remain outside of the ROW.

Will the action fragment an existing important population into two or more populations?

Due to the narrow clearing footprint and short duration of the disturbance, clearing of the ROW is unlikely to fragment an existing population of this species. The species is highly mobile and is not restricted to habitat within the project site.

Will the action adversely affect habitat critical to the survival of a species?

There is no habitat listed for Grey-headed Flying-fox on the Register of Critical Habitats. No habitat critical for the species survival is identified by DoE. Provided that a trenchless technology is used to cross Raglan Creek and a 50 m buffer zone is established around any camp trees found in or adjacent to the ROW, it is unlikely that the proposed action will impact any flying-fox camp. Grey-headed Flying-fox is a highly mobile species which forages over an extensive area, so clearing of the ROW is not likely to substantially reduce or adversely affect any habitat critical for the survival of this species.

Will the action disrupt the breeding cycle of an important population?

The Raglan Creek camp located 200 m from the ROW will not be directly impacted by the project and therefore will not affect the breeding cycles that may be occurring in this camp. Arrow proposes to utilise a trenchless technology (e.g. HDD) to cross Raglan Creek, which will avoid direct impacts to riparian vegetation that could be used as future camp trees. Provided that a 50 m buffer zone is established around any camp trees in or adjacent to the ROW, it is unlikely that the proposed action will impact the breeding cycle of the species.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Construction of the ABP pipeline is likely to result in a small temporary loss of potential foraging habitat for this species. However large amounts of similar and suitable habitat will remain outside of the ROW. The majority of the ROW (except for a 7m wide track) will be rehabilitated after construction using native grasses, shrubs and trees which will replace some of the habitat removed by clearing. This is a highly mobile species which forages over an extensive area and migrates in response to food availability. Clearing of the ROW is unlikely to reduce the availability of habitat to the extent that the species would decline.

Will the action result in harmful invasive species becoming established in the species' habitat?

The action is not likely to introduce pest or animal species not currently present and active in the project area. Pest and weed management plans will ensure these species are adequately managed during construction of the project so it is unlikely that the action will result in the establishment of invasive species.

Will the action result in the introduction of disease(s) that may cause the species to decline?

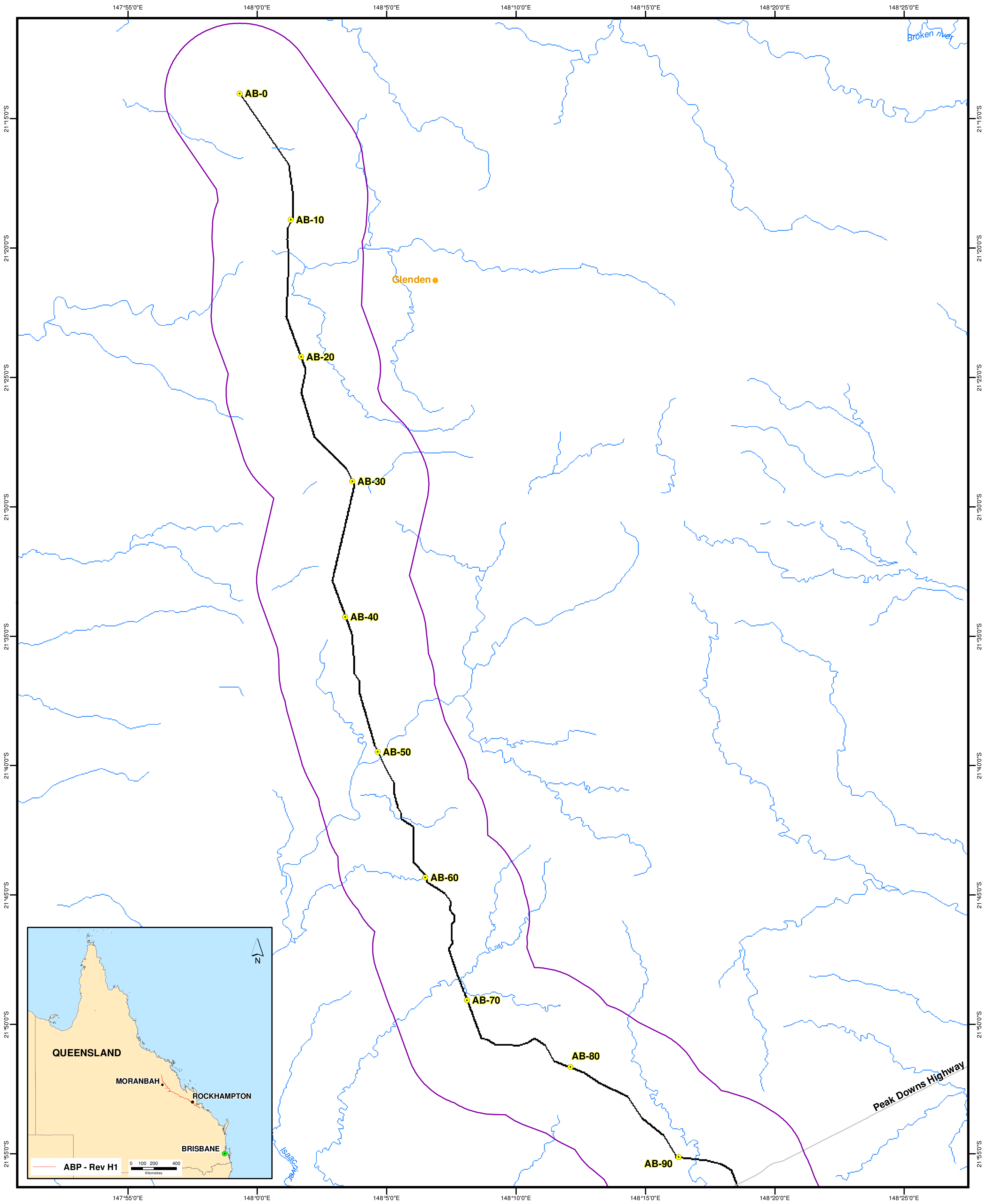
Provided that a trenchless technology such as HDD is used to cross Raglan Creek and a 50 m buffer zone is established around the any camp trees in or adjacent to the ROW, it is unlikely that the proposed action will have any direct contact with flying-foxes. It is therefore unlikely the project will result in an increase in the incidence of disease in the study area to the extent that the species would decline.

Will the action interfere substantially with the recovery of the species?

Although a small area of potential foraging habitat for this species will be cleared under the current alignment, the majority will be allowed to regenerate. Large amounts of similar habitat will remain outside of the ROW. This is a highly mobile species which forages over an extensive area and migrates in response to food availability. Provided that mitigation measures proposed in Table 3 are implemented, the action is not likely to interfere substantially with the recovery of the species.

2.7.15 Conclusion

With the mobility of this species, the relatively short-term construction impacts for the pipeline, and the successful implementation of the recommended mitigation measures, it is considered that the impact of the project on the Grey-headed Flying-fox will be of low overall significance. However, there is potential for the project to cause disturbance to the nearby roosting area at Raglan Creek. Provided that proposed mitigation (no construction within a 50 m buffer around any active roost area and use of HDD to cross Raglan Creek), the action is not considered likely to have significant impacts on this species or its habitat. Further surveys to map the extent of the Raglan Creek camp closer to the time of construction are recommended to ensure the camp has not moved into the ROW and to establish appropriate buffers.



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Document
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Job Number: BE004

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R0	BN	CF	ISSUED TO CLIENT	29/08/2013
REV	By	CHK	Description	Date

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Datum: GDA 1994
Units: Degree

LEGEND

●	**City or town**
⊙	**Kilometre Point**
~	**Waterway or Coast Line**
—	**Main roads**
—	**ABP - Rev H1**
▭	**Buffer (5 km)**

Grey-headed Flying-fox

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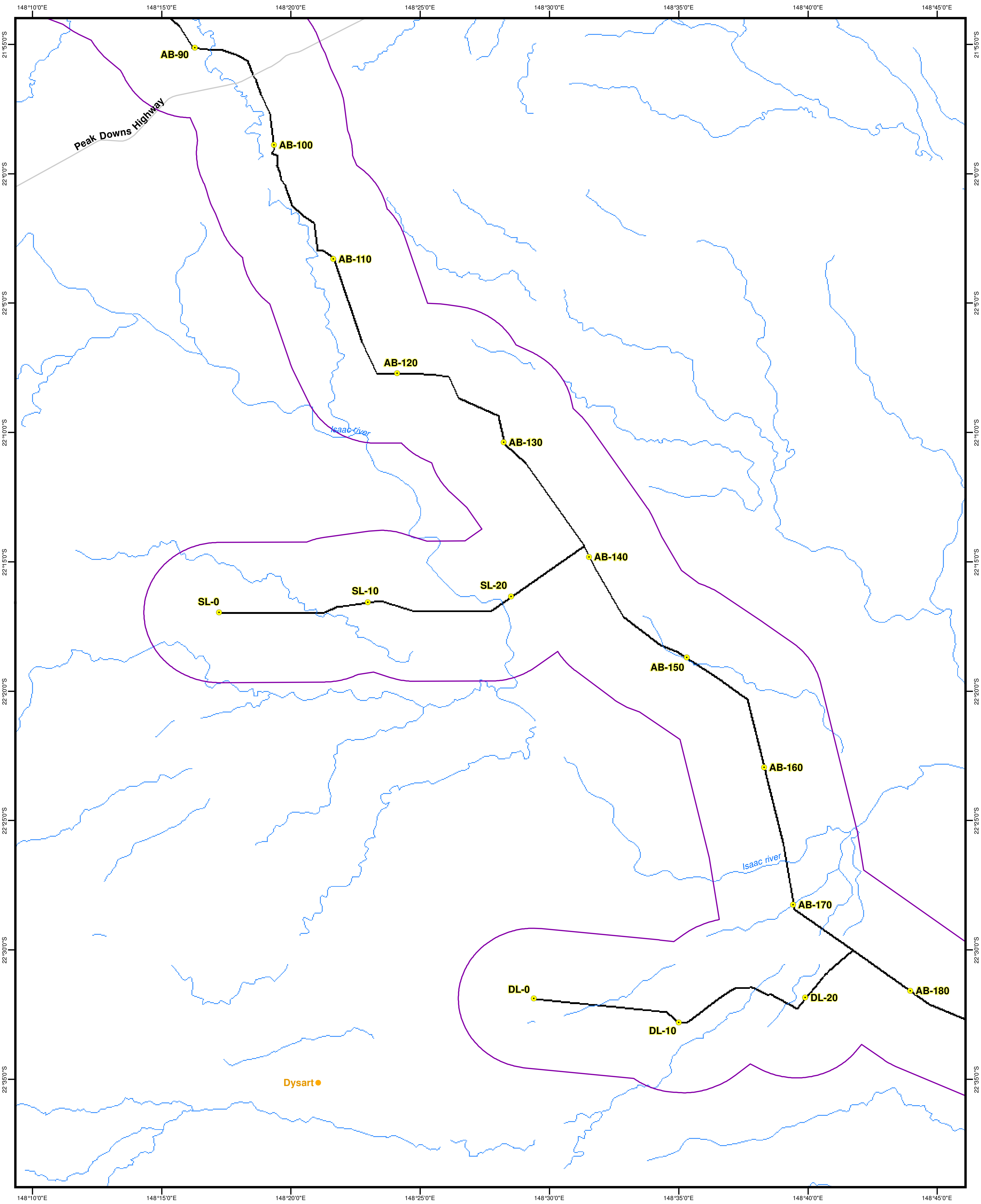
Page 1 of 7

A3



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▭	**Buffer (5 km)**

Grey-headed Flying-fox

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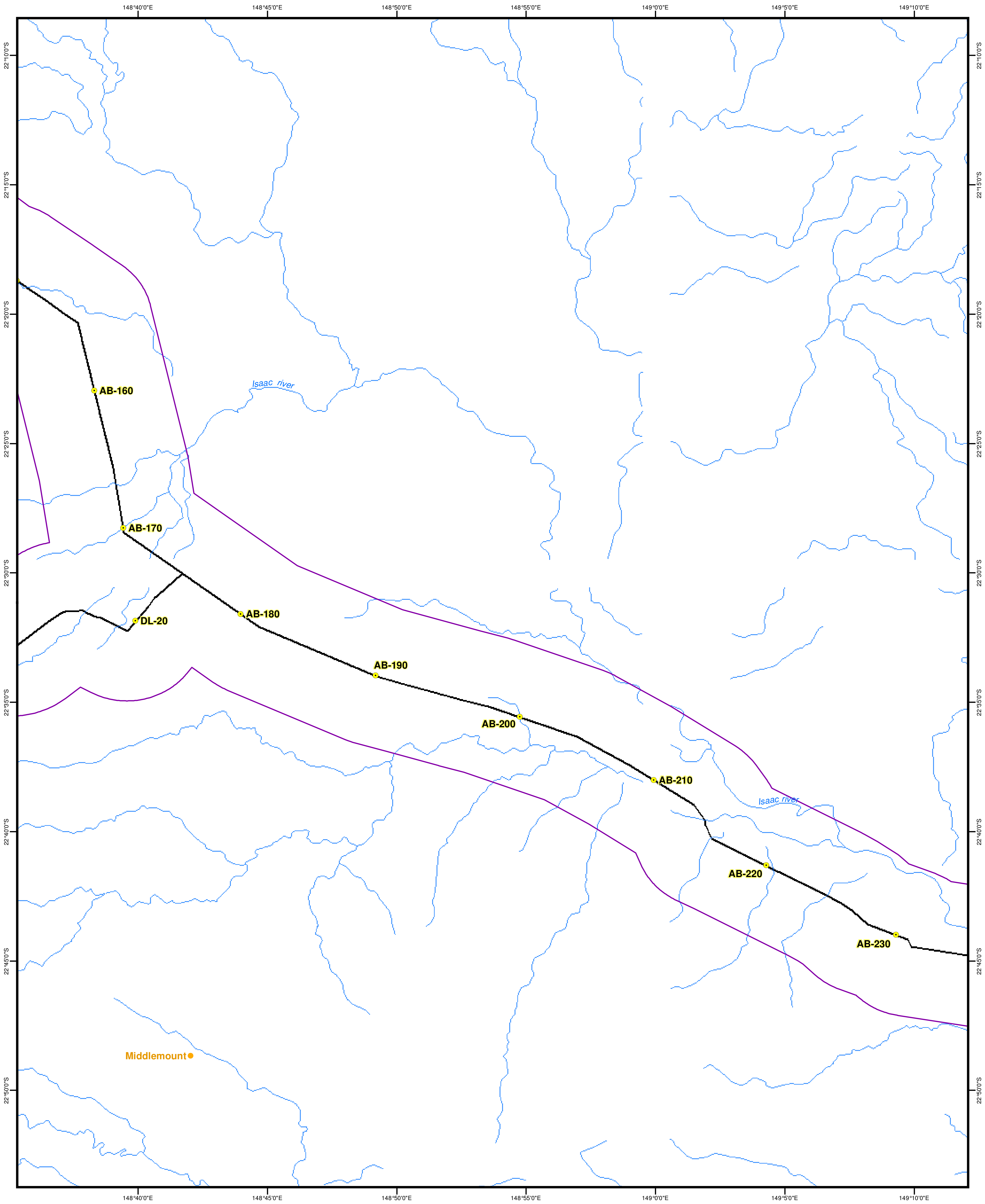
Revision H1

Page 2 of 7

A3



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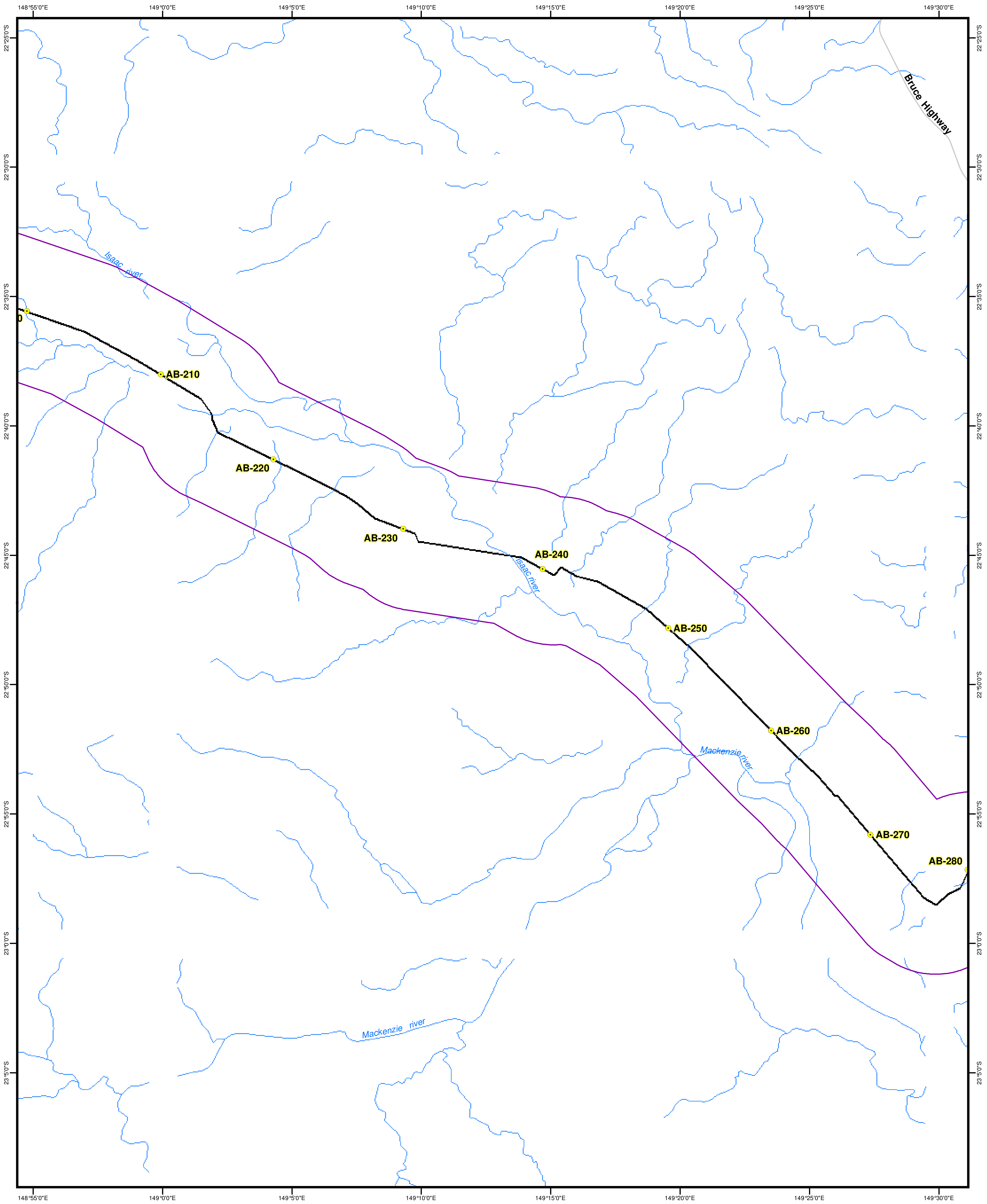
Page 3 of 7

A3



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—	**ABP - Rev H1**
▭	**Buffer (5 km)**

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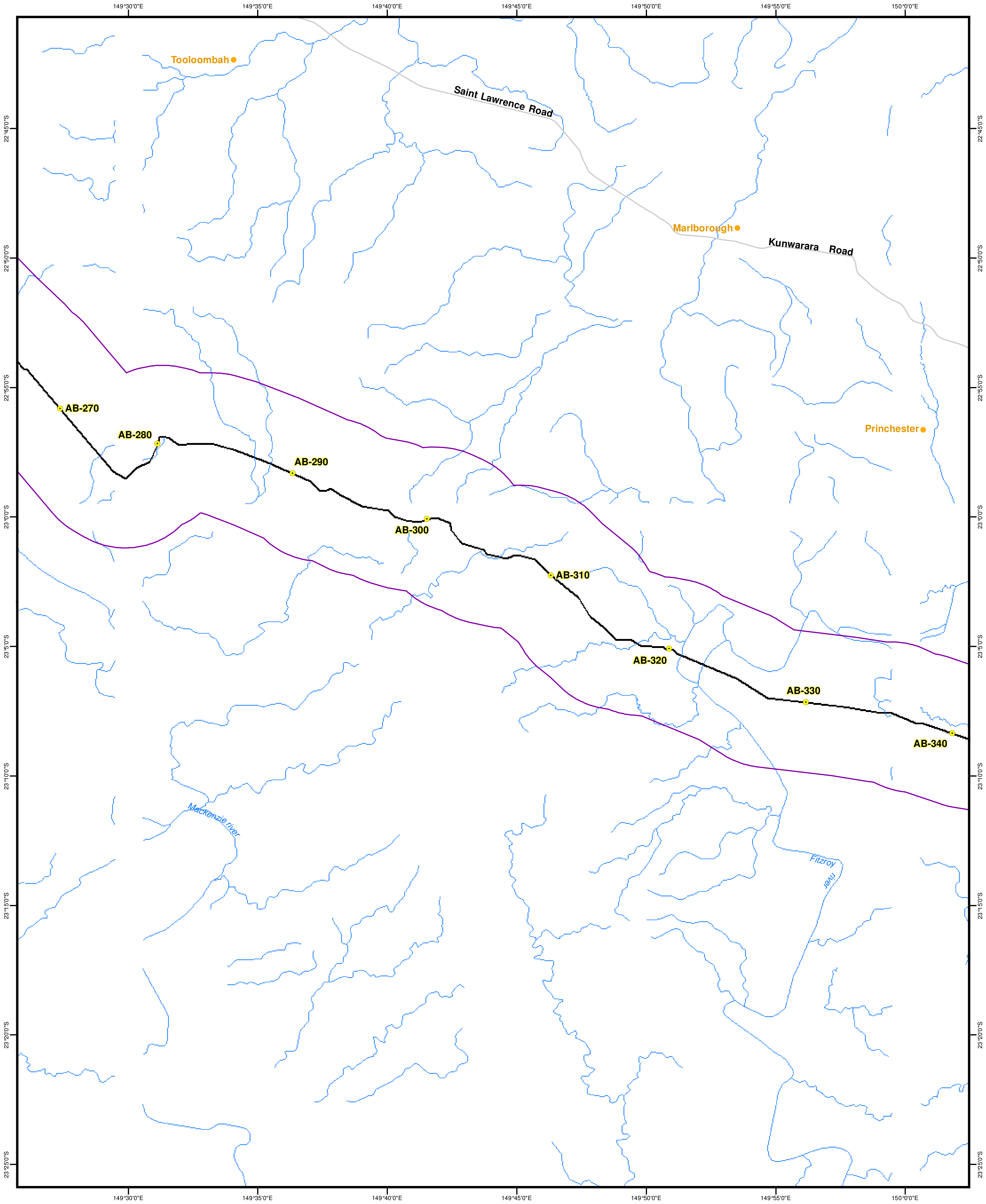
Arrow Bowen Pipeline Revision H1

Page 4 of 7

A3



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▭ Buffer (5 km)

Grey-headed Flying-fox

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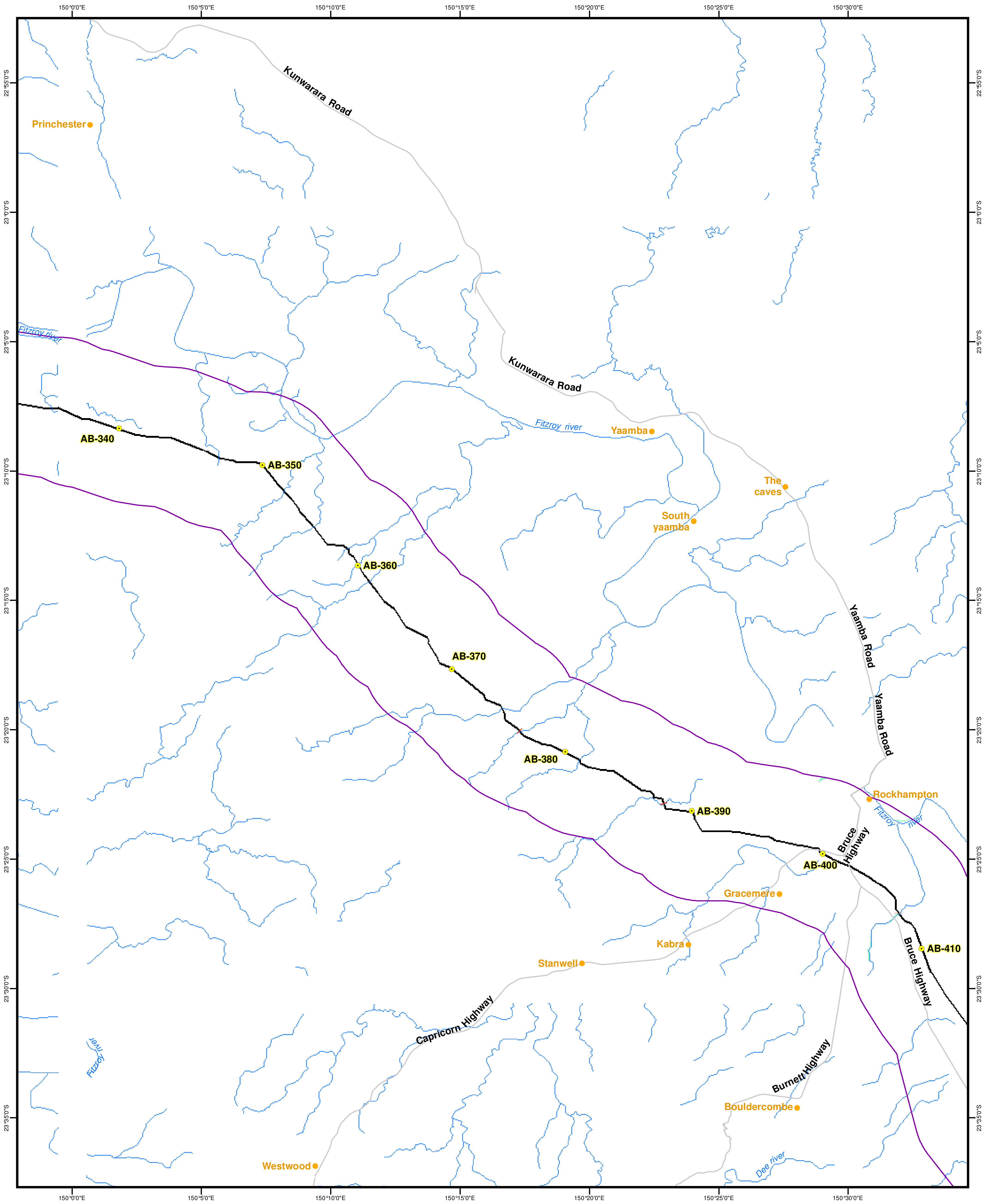
Arrow Bowen Pipeline
Revision H1

Page 5 of 7

A3



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- ~ Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- 🟥 Potential Habitat in ROW (Field Verified)
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ☐ Buffer (5 km)

Grey-headed Flying-fox

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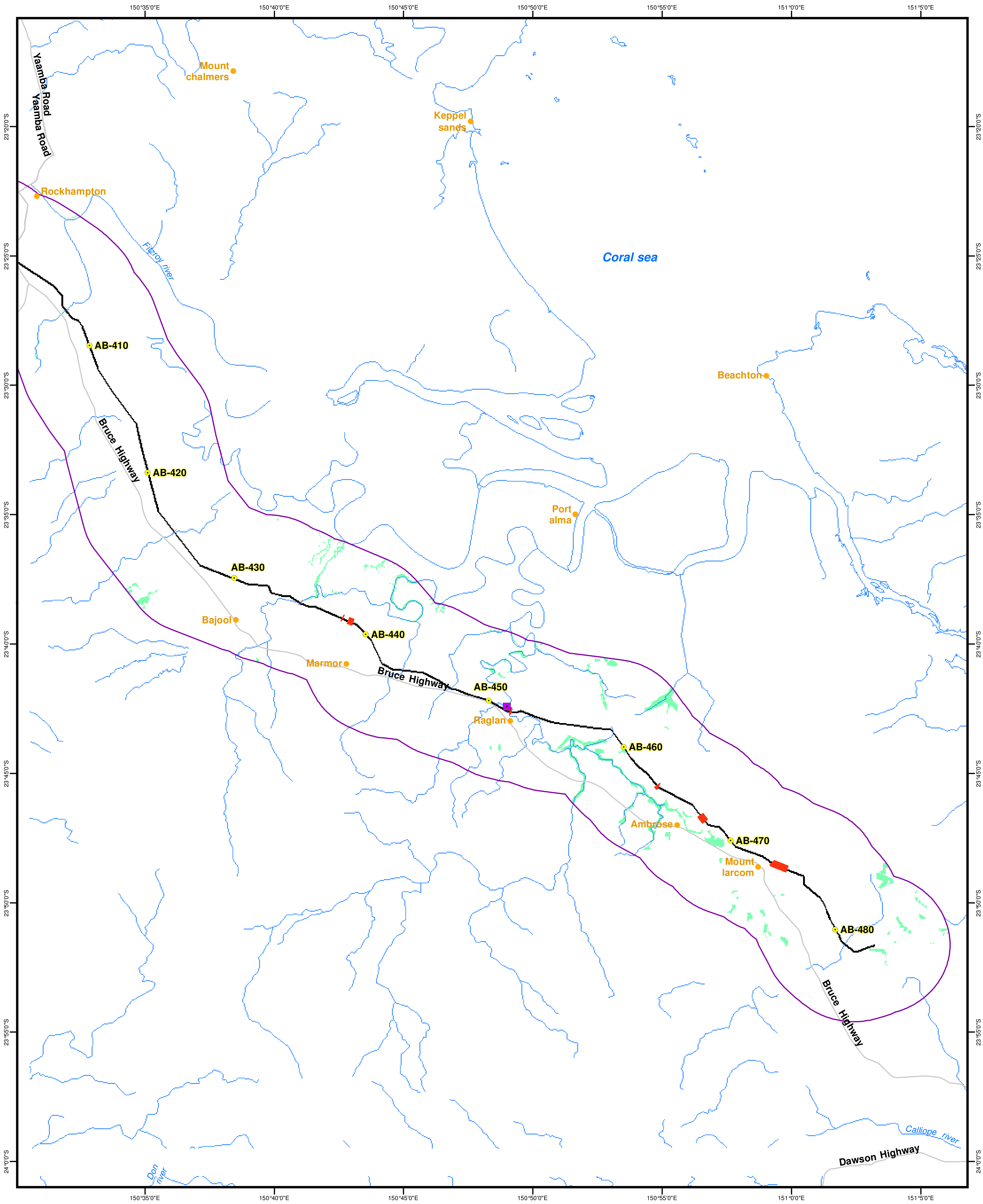
Arrow Bowen Pipeline
Revision H1

Page 6 of 7

A3



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- — Main roads
- — ABP - Rev H1
- 🟥 Potential Habitat in ROW (Field Verified)
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ☐ Buffer (5 km)

Grey-headed Flying-fox

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Revision H1

Page 7 of 7

A3

2.8 *Rheodytes leukops (Fitzroy River Turtle)*

2.8.1 Conservations Status

Queensland: Vulnerable under the NC Act

National: Vulnerable under the EPBC Act

2.8.2 Description

The Fitzroy River Turtle grows to approximately 25 cm in length (shell length) and is medium to dark brown with scattered darker spots and blotches on the upper shell surface. It has a pale yellow or cream belly and dull olive-grey legs, neck and tail. The shell is broadly oval and in hatchlings the back edge of the shell is serrated. The neck is covered with large, pointed conical tubercles (Cogger 2000). The adults have distinctive eyes with black pupils surrounded by a narrow white inner ring while the hatchlings have a metallic silvery-blue iris (Cogger 2000). The Fitzroy River Turtle has relatively long forelimbs with five long claws.

2.8.3 Distribution

The Fitzroy River Turtle is only found in the Fitzroy basin, Queensland, including the Fitzroy, Mackenzie, Dawson, Connors and Isaac Rivers and their tributaries (Queensland Conservation Council 2004). It is estimated that this species occurs in a total area of less than 10,000 km² (Cogger et al. 1993; McDonald et al. 1991).

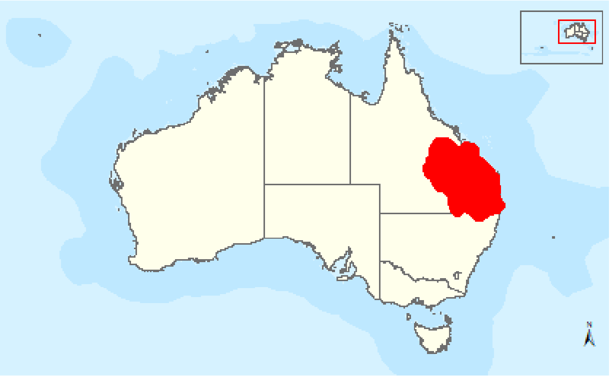


Figure 12 Distribution of *Rheodytes leucops*

Source: DSEWPaC 2013

2.8.4 Habitat

The Fitzroy River Turtle forages within riffle zones when they are flowing, and is often the most abundant species in riffle zone habitats (DERM 2011). However, riffle zones do not necessarily flow year round, especially in drought years. During the dry season, as water levels fall, turtles aggregate back to large slow-moving pools or even to isolated waterholes (dry season refugia), sheltering amongst roots or submerged timber (DERM 2011; Wilson and Swan 2010).

Based on observations within the Fitzroy Barrage, this species aggregates to breed at a restricted number of sites, with nesting occurring primarily in sand and loam alluvial deposits derived from flooding events (DERM, 2011).

2.8.5 Ecology

The Fitzroy River Turtle consumes a variety of foods including terrestrial and aquatic plant material, insects, snails and algae (Cann 1998; Tucker et al. 2001). When riffles are flowing, it feeds by scraping invertebrates, their eggs and algae from substrates (DERM 2011). As the dry season progresses, with falling water levels and drying riffle zones, the species aggregates back into the larger, less productive pools. It is dependent on access to highly productive riffle zones to provide the majority of the food resources needed for building up fat reserves and to sustain the lengthy preparation for breeding (DERM 2011).

Nesting occurs between September and October (Legler 1985; DERM 2011). Nests are 15 to 21 cm deep and are located 5 to 6 m from the water's edge and 1 to 4 m above water level on river sandbanks (DERM 2011; Cogger et al. 1993). Detailed examination of the ovaries of 18 adult females during the breeding season established that about 40% of breeding adults laid only one clutch of eggs for the breeding season and about 60% were capable of producing two clutches (DERM 2011). On average, the Fitzroy River Turtle lays 18.2 eggs in a clutch, the eggs being small relative to most Australian chelid turtles, with approximate dimensions 3.06 cm long and 2.20 cm wide (Legler 1985). Legler (1985) reported a mean incubation period of 46 days (range 41-50, n = 10) for eggs incubated at a constant temperature. However, eggs may take up to 90 days to hatch (Cann 1998).

If riffle zones fail early or if the dry season pool refugia are overstocked and the food resources are severely depleted, especially during extreme droughts, the completion of vitellogenesis (the formation and production of yolk) may be compromised (DERM 2011).

As an adaptation to its fast flowing habitats, the Fitzroy River Turtle has the ability to breathe bimodally, using either its lungs or its cloaca. To be able to breathe through its cloaca, the Fitzroy River Turtle uses a process called cloacal ventilation where water is drawn into and expelled from the cloaca at a rate of 15–60 times per minute (Limpus 2007).

Breeding season

🟩 Non-breeding season	🟨 Breeding season

🟨 Jan Juveniles hatch	🟩 Feb	🟩 Mar	🟩 Apr	🟩 May	🟩 Jun	🟩 Jul	🟩 Aug	🟨 Sep Nesting	🟨 Oct Nesting	🟨 Nov Incubation	🟨 Dec Juveniles hatch

2.8.6 Activity period

The Fitzroy River Turtle is presumed to be active in the morning and afternoon, particularly from late spring to the end of summer (DSEWPaC 2011a).

2.8.7 Threats

The threats to this species include (DSEWPaC 2013a):

- egg predation and nest destruction
- habitat degradation.

2.8.8 DoE recommended survey methods

The Fitzroy River turtle has been observed in riffle zones using a face mask and snorkel and collected by using seine netting. The use of drum traps or meat baits has been suggested although the effectiveness of these methods has not been documented (DSEWPAC 2011a).

No specific effort is stated in the *Survey guidelines for Australia's threatened reptiles*.

2.8.9 Survey effort and methods undertaken for ABP

Habitat surveys were undertaken at 18 crossings within the Fitzroy catchment. Two crossings with potential habitat were identified at the Fitzroy River and the lower Isaac River. No targeted surveys for Fitzroy River Turtle could be undertaken at the Fitzroy River due to the risk of crocodiles. Targeted surveys at the Isaac River were limited to seine netting, which is not an ideal method for surveying for this species.

2.8.10 Comparison to DoE survey guidelines

It is not possible to provide a comparison with DoE survey guidelines since no specific effort or survey methods are specified in the *Survey guidelines for Australia's threatened reptiles*. It is acknowledged that the survey effort was limited by safety constraints and a precautionary approach has been adopted for the assessment of this species.ABP survey results

This species was not recorded during surveys but is highly likely to be present in the project area. Two sites, the Fitzroy River (KP 319) and the lower Isaac River (KP 234) contain suitable habitat for the Fitzroy River Turtle. This species has been previously recorded in the vicinity of both locations (Arrow Energy 2012). No critical habitat for Fitzroy River Turtle has been identified by DoE for this species.

2.8.11 Other survey results

There are 12 records of this species from the search area in the Wildnet database, including a cluster of records at Glenroy, approximately 4 km southeast of KP 320 on the mainline.

2.8.12 Impacts of ABP on Fitzroy River Turtle

2.8.12.1 Potential impacts without mitigation

Fitzroy River Turtles inhabit creeks and rivers in the Fitzroy River System where they live in large deep pools connected by riffles. Impacts associated with the proposed project could include:

- temporary loss of riparian vegetation which provides nesting opportunities and river protection
- increase in weed incursion reducing habitat quality in nesting areas
- increased pest animal abundance associated with clearing through remnant vegetation, leading to predation of nests and hatchlings
- direct mortality through collisions with vehicles during operation and maintenance
- decreased water quality through sedimentation or release of pollutants such as hydrocarbons
- changes in hydrology.

2.8.12.2 Assessment of the potential impacts with mitigation

Table 35 summarises potential direct and indirect impacts of the project on Fitzroy River Turtle populations and proposed measures to mitigate potential impacts. The table provides a risk assessment for each impact with and without mitigation measures.

Table 35 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on Fitzroy River Turtle

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
DIRECT IMPACTS			
Removal of habitat Temporary removal of deep pools and sandy banks which contain potential foraging, breeding and sheltering habitat	M	- trenchless crossing techniques (eg HDD) will be used to cross beneath the lower Isaac River (KP 234) and Fitzroy River (KP 319), to avoid impacting likely Fitzroy River Turtle habitat at these locations (other crossings unlikely to contain significant habitat) - no disturbance to the sandy banks or deep pools in these rivers which provide habitat and breeding areas for the Fitzroy River Turtle - clearly mark out areas to be cleared and retained - no disturbance to banks or the river channel between September and January during the turtle breeding season	L
Nest destruction	M	- between September and January, potential breeding places (sand and loam banks within 6 m of the waterline) on the lower Isaac and Fitzroy Rivers will be cordoned off to exclude access by construction personnel, vehicles or plant - trenchless techniques will be used to avoid nesting habitat at Fitzroy and lower Isaac Rivers	I
Trenchfall Death of individuals trapped in the trench (overland movement of turtles in locations other than river crossings)	L	- monitoring of open trenches by fauna spotter catchers during the construction period - minimise the length of time the trench is open - construct earth ramps at regular intervals to allow animals to exit trench	I
Fatalities	M	- no vehicles or equipment to operate within the sandy banks	I

Impact	Raw Risk before mitigation	Mitigation measures	Residual Risk after mitigation
Death of individuals via vehicles and equipment during clearing, construction and operation (overland movement of turtles)		of the lower Isaac River or Fitzroy River - maintain an appropriate speed limit in the ROW - no disturbance to banks or the river channel between September and January during the turtle breeding season	
INDIRECT IMPACTS			
Changes in water quality Mobilisation of sediments and/or pollutants, affecting animal health (cloacal breathing turtles), as well as indirect impacts of altering foraging habitat (e.g. sedimentation of riffle zones, smothering plants, turbidity reducing photosynthesis) and breeding habitat (e.g. siltation of sand and loam alluvium)	L	- trenchless techniques will be used to cross beneath the lower Isaac and Fitzroy Rivers, to avoid impacting Fitzroy River Turtle habitat - no vehicles or equipment to operate within the sandy banks of the lower Isaac River or Fitzroy River -develop a sediment and erosion control plan to detail measures to control erosion and sediment run-off on floodplain and tributaries -drilling wastewater to be contained and transported off-site for disposal or irrigated on dedicated areas outside of the watercourse under relevant approval conditions	L
Changes in hydrology Changes in wet/dry cycling of waterways caused by damming, inundation or drying of riffle zones, changes in morphology or diversions	L	- trenchless techniques will be used to cross beneath the lower Isaac and Fitzroy Rivers, to avoid the need for temporary damming and open trenching	I
Habitat fragmentation Fragmentation of habitat leading to a reduction in size, increased edge effects and isolation of population	L	- trenchless techniques will be used to cross beneath the lower Isaac and Fitzroy Rivers, to avoid the need for temporary damming and restriction of aquatic fauna movement	I
Increase in weed abundance - increased competition with native plant species used for foraging and shelter - smothering of native vegetation	L	- develop and implement a Weed Management Plan - control weeds in the ROW before, during and after construction - implement site weed hygiene protocols	I
Increase in introduced predator abundance Increase in introduced predator abundance caused by increased food availability in the ROW	L	- avoid clearing vegetation within the watercourse banks of the lower Isaac and Fitzroy Rivers by trenchless construction techniques and utilising existing access ways through these watercourses -develop and implement a Waste Management Plan -develop and implement a Pest Management Plan - -educate staff about the importance of removing any food waste from the ROW - -keep the work site clean of debris which could be used as shelter for introduced predators	L

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High

The most significant potential impact to Fitzroy River Turtle would be the loss of aquatic habitat and/or destruction of nests on the sandy banks of the lower Isaac River and Fitzroy River crossings. However, Arrow is committed to using trenchless crossing techniques under the lower Isaac River at KP 234 and Fitzroy River at KP 319 to avoid impact from loss of habitat / breeding areas. Any disturbance in the vicinity of these watercourses would be of short duration and no significant long term impacts are expected. The risk associated with the impact of the removal of habitat on this species is likely to be low.

Pre-clearance surveys will be conducted at all waterway crossings with potential Fitzroy

River Turtle habitat. A 50 m (minimum) buffer will be established around any nest sites located during pre-clearing surveys and trenchless techniques will be used to avoid impacts. The potential impacts on Fitzroy River Turtles from nest destruction is likely to be insignificant,

The action is not expected to change water chemistry or hydrological conditions at water course crossings. Provided that proposed mitigation measures are implemented (e.g. trenchless crossing of lower Isaac and Fitzroy Rivers, implementation of sediment and erosion control plan), the risk associated with impacts on water quality and hydrology are likely to be low.

Introduced predators and weeds are present in the area, but the action is not expected to change the risks to the species associated with pests or weeds. Reasonable management measures, such as the removal of food waste from the ROW and implementation of pest and weed management plans will ensure a Low level risk from pests.

Overall the impact of the ABP project on Fitzroy River Turtle is considered to be **Low** provided that all the mitigation measures listed in Table 35 are implemented.

2.8.13 Evaluation under MNES significant impact guidelines

Based on field habitat assessments, potential habitat for the Fitzroy River Turtle along the ABP route is restricted to the proposed lower Isaac and Fitzroy River crossings (KP 234 and 319), where this species is considered likely to occur (Arrow Energy 2012).

Will the action lead to a long-term decrease in the size of an important population of a species?

Through impact avoidance at the Isaac and Fitzroy Rivers, via the implementation of trenchless pipeline construction techniques, establishment of a 50 m buffer around any identified nests and avoidance of deep pools and sandy banks which provide potential habitat / breeding areas, the action is not expected to directly impact on the size of any Fitzroy River Turtle population. By mitigating indirect impacts on water quality and hydrology, and managing weed and predator risks (Table 1), residual impacts on adjacent and downstream habitats are unlikely to lead to a decline in any population of Fitzroy River Turtle.

Will the action reduce the area of occupancy of an important population of a species?

The action is not expected to reduce the capacity of this species to occupy identified potential habitat. The action will not introduce any barriers to aquatic fauna movement and is unlikely to prevent an important population from occupying the ROW.

Will the action fragment an existing important population into two or more populations?

The ABP pipeline will not create any permanent barriers (physical or behavioural) to aquatic fauna movement and is unlikely to fragment important populations of any turtle species.

Will the action adversely affect habitat critical to the survival of a species?

Important breeding and foraging habitat occurs in the deep pools and sandy banks associated with the lower Isaac and Fitzroy Rivers. However, through impact avoidance as outlined above, the action is not expected to have any direct or indirect impacts on habitat for the Fitzroy River Turtle.

Will the action disrupt the breeding cycle of an important population?

The action is unlikely to affect the breeding cycle of this species. Pre-clearing checks will be conducted for suitable nesting sites within the ROW and, in the event of a nest being located, a 50 m (minimum) buffer zone will be established to prevent disturbance to the breeding cycle. No long term impacts to this species are likely from the operational phase of the Project.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Important breeding and foraging habitat occurs in the deep pools and sandy banks associated with the lower Isaac and Fitzroy Rivers. However, through impact avoidance as outlined above, the action will not modify, destroy, isolate or decrease potential habitat in the Fitzroy basin. Any disturbance at creek crossings will be short in duration and no long term effects are likely following rehabilitation.

Will the action result in establishment of harmful invasive species becoming established in the species' habitat?

Introduced predators and weeds are present in the area, but the action is not expected to change the risks to the species associated with pests or weeds. Reasonable management measures, such as the removal of food waste from the ROW and implementation of pest and weed management plans will ensure a Low level risk from pests.

Will the action result in the introduction of disease(s) that may cause the species to decline?

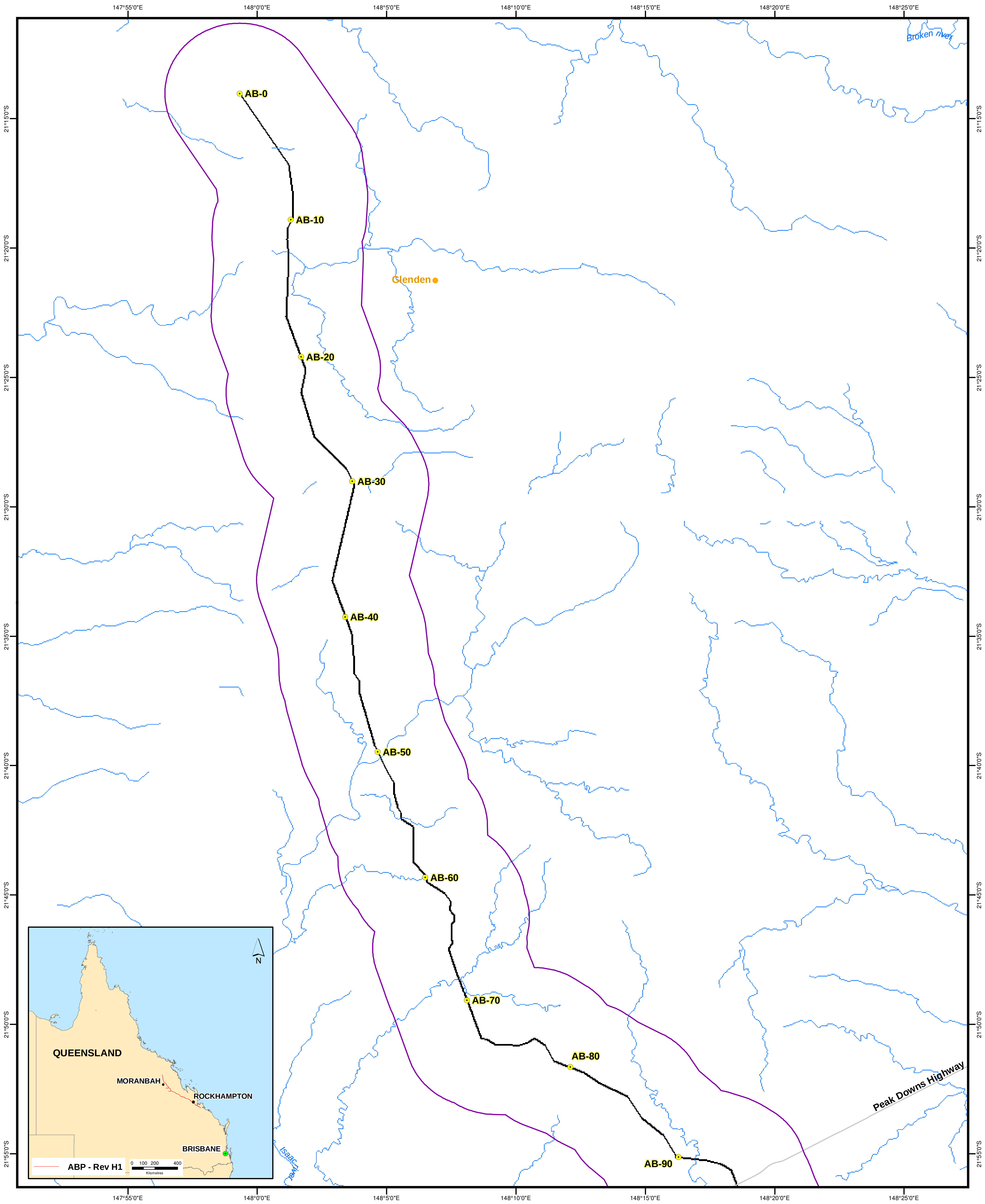
The proposed vegetation clearing, pipeline placement, and reinstatement works are unlikely to result in significantly improved conditions for diseases that may cause the Fitzroy River Turtle to decline.

Will the action interfere substantially with the recovery of the species?

Construction planning for the Project is undertaken on the basis of avoidance of impact. Any disturbance of potential habitat for this species is likely to be short in duration and minor, so no long term effects are likely following rehabilitation. The risk of interference with the long term recovery of this species is considered to be low.

2.8.14 Conclusion

Important breeding and foraging habitat for Fitzroy River Turtle is likely to occur within the watercourse of the lower Isaac and Fitzroy River crossings (KP 234 and 319). Trenchless crossing techniques are proposed at these crossings to avoid direct impacts. Provided that mitigation measures proposed in this assessment are effectively implemented, it is considered likely that any impacts of the proposed pipeline construction works on the Fitzroy River Turtle will be **low** and of a short term nature.



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Document
BE004_MP_006K_Fitzroy_River_Turtle

Job Number: BE004

Approved GIS Team Leader	BN			30/08/2013
R0	BN	CF	ISSUED TO CLIENT	29/08/2013
REV	By	CHK	Description	Date

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Kilometres

Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

●	City or town
●	Kilometre Point
~	Waterway or Coast Line
—	Main roads
—	ABP - Rev H1
☐	Buffer (5 km)

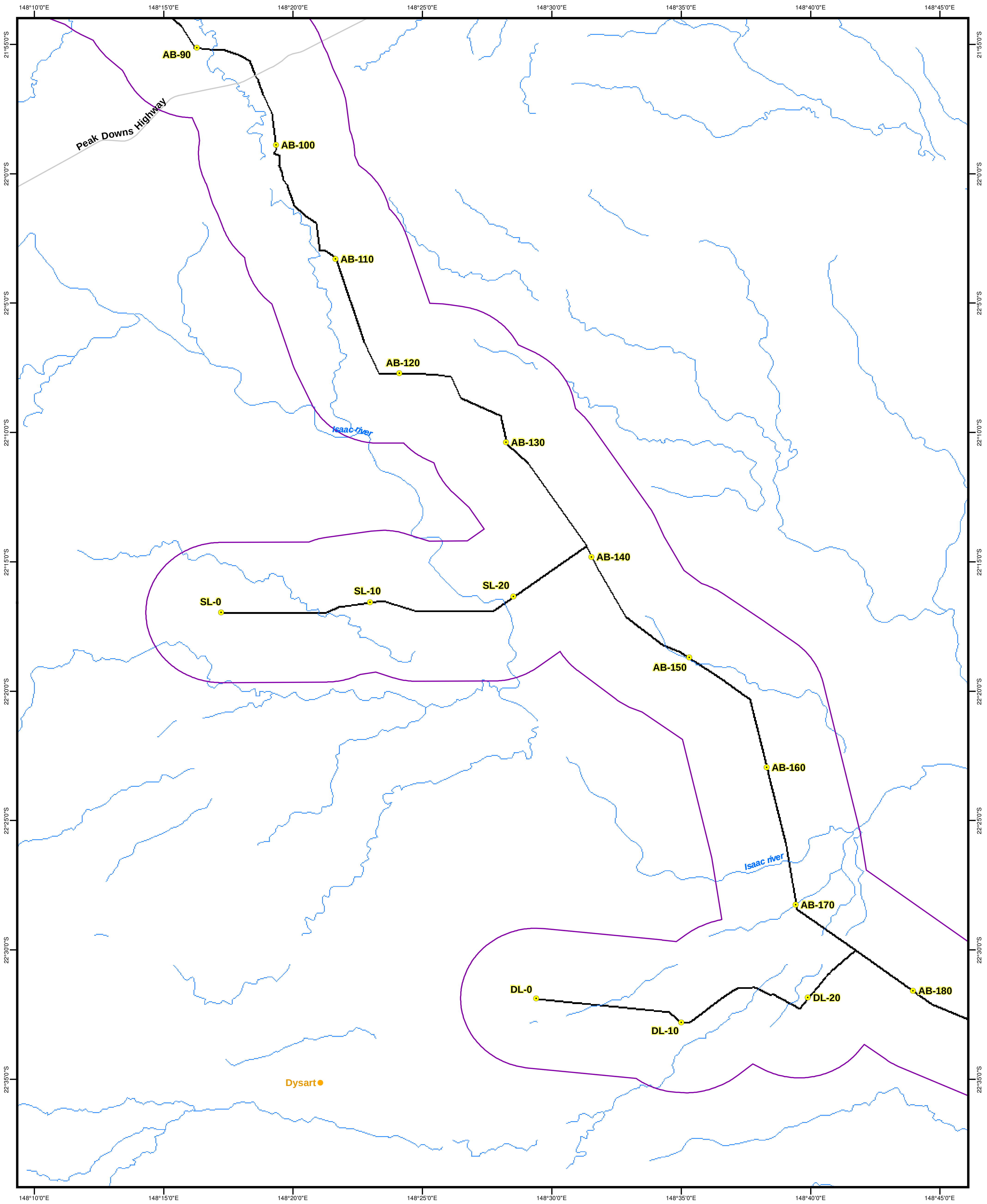
Fitzroy River Turtle

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 1 of 7

A3



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- **Main roads**
- **ABP - Rev H1**
- ☐ **Buffer (5 km)**

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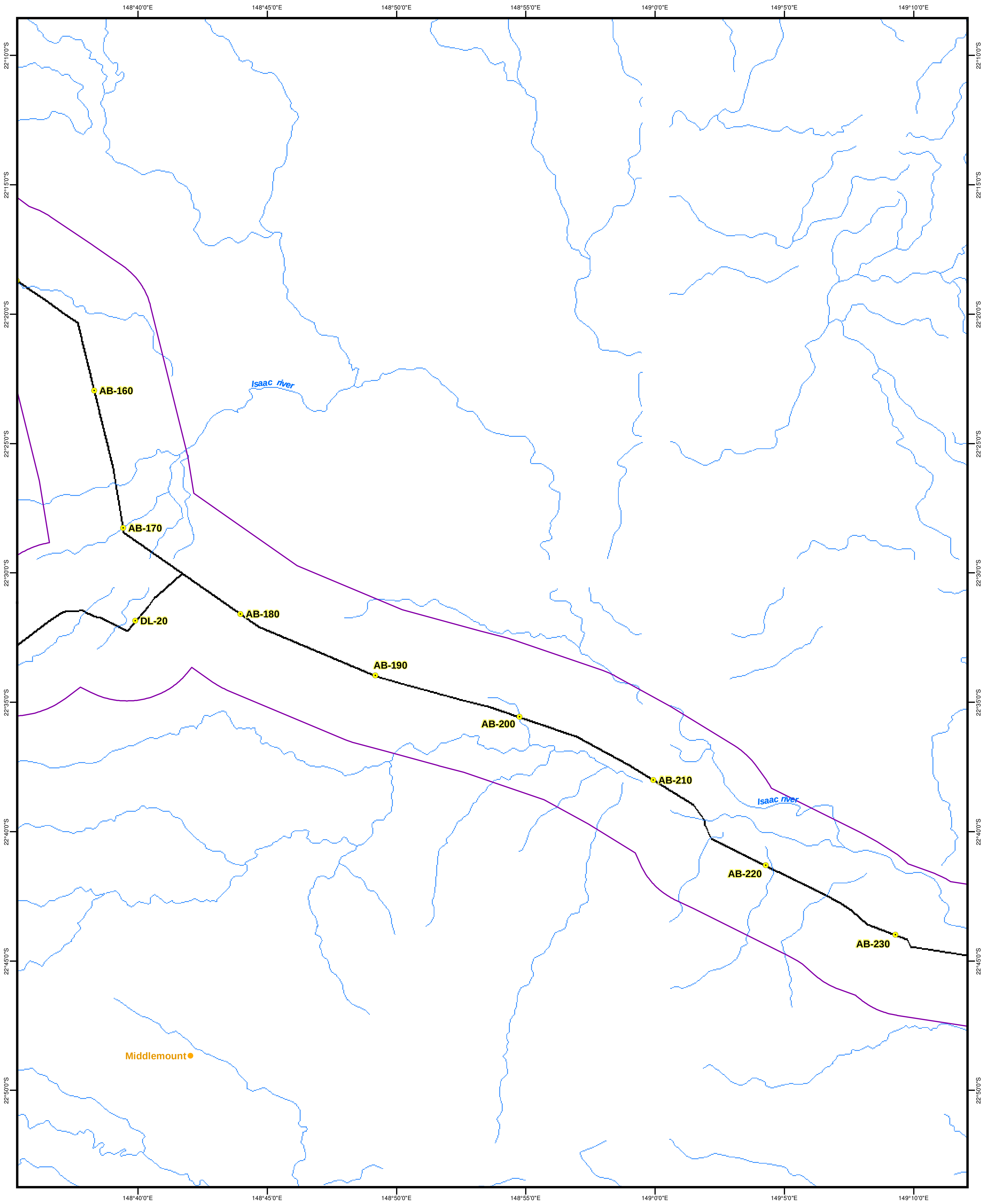
Page 2 of 7

A3



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⊙	**Kilometre Point**
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—	**ABP - Rev H1**
☐	**Buffer (5 km)**

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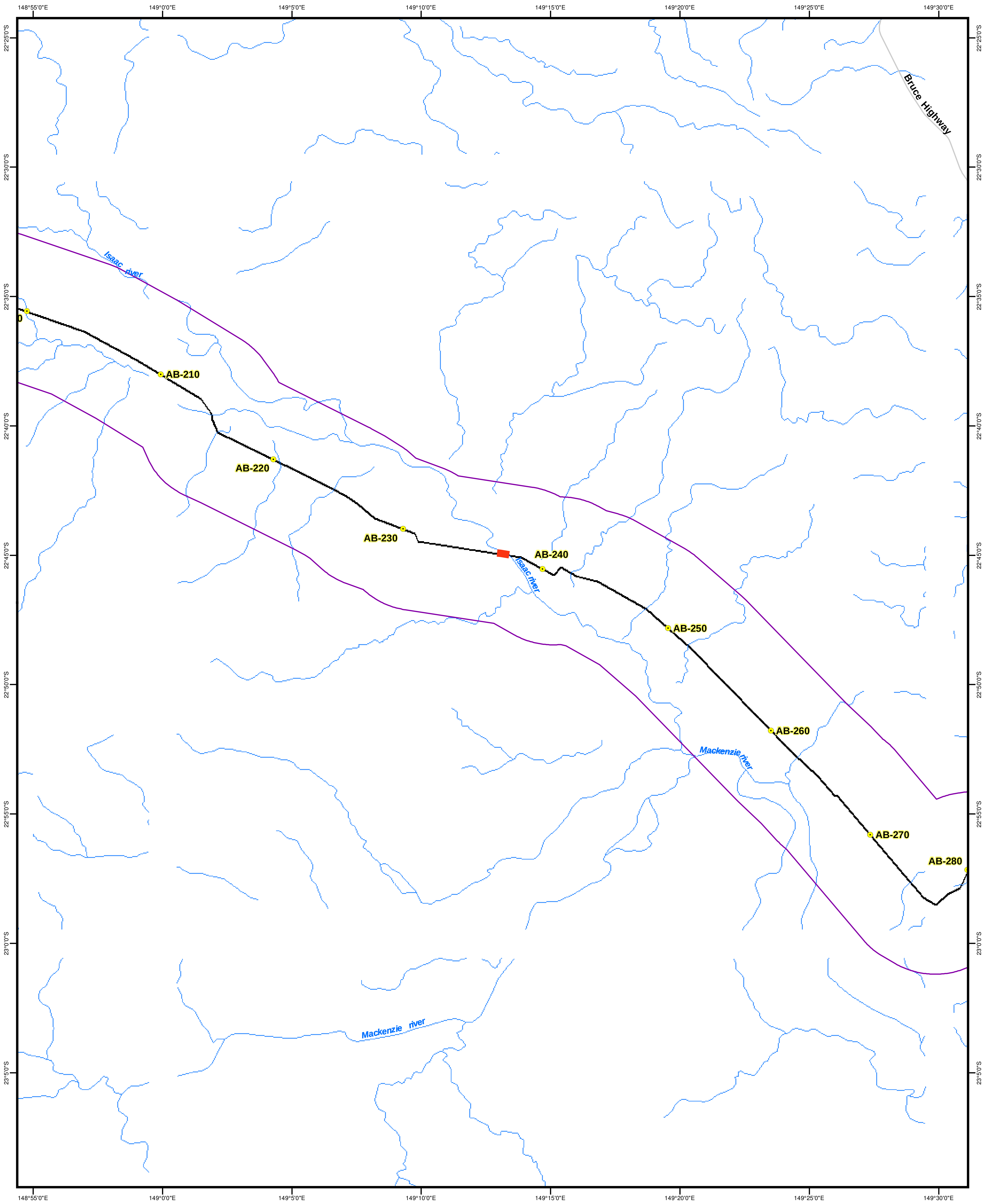
Arrow Bowen Pipeline Revision H1

Page 3 of 7

A3



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Datum: GDA 1994
Units: Degree

LEGEND

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~	Waterway or Coast Line
—	Main roads
—	ABP - Rev H1
🟥	Potential Habitat in ROW (Field Verified)
☐	Buffer (5 km)

Fitzroy River Turtle

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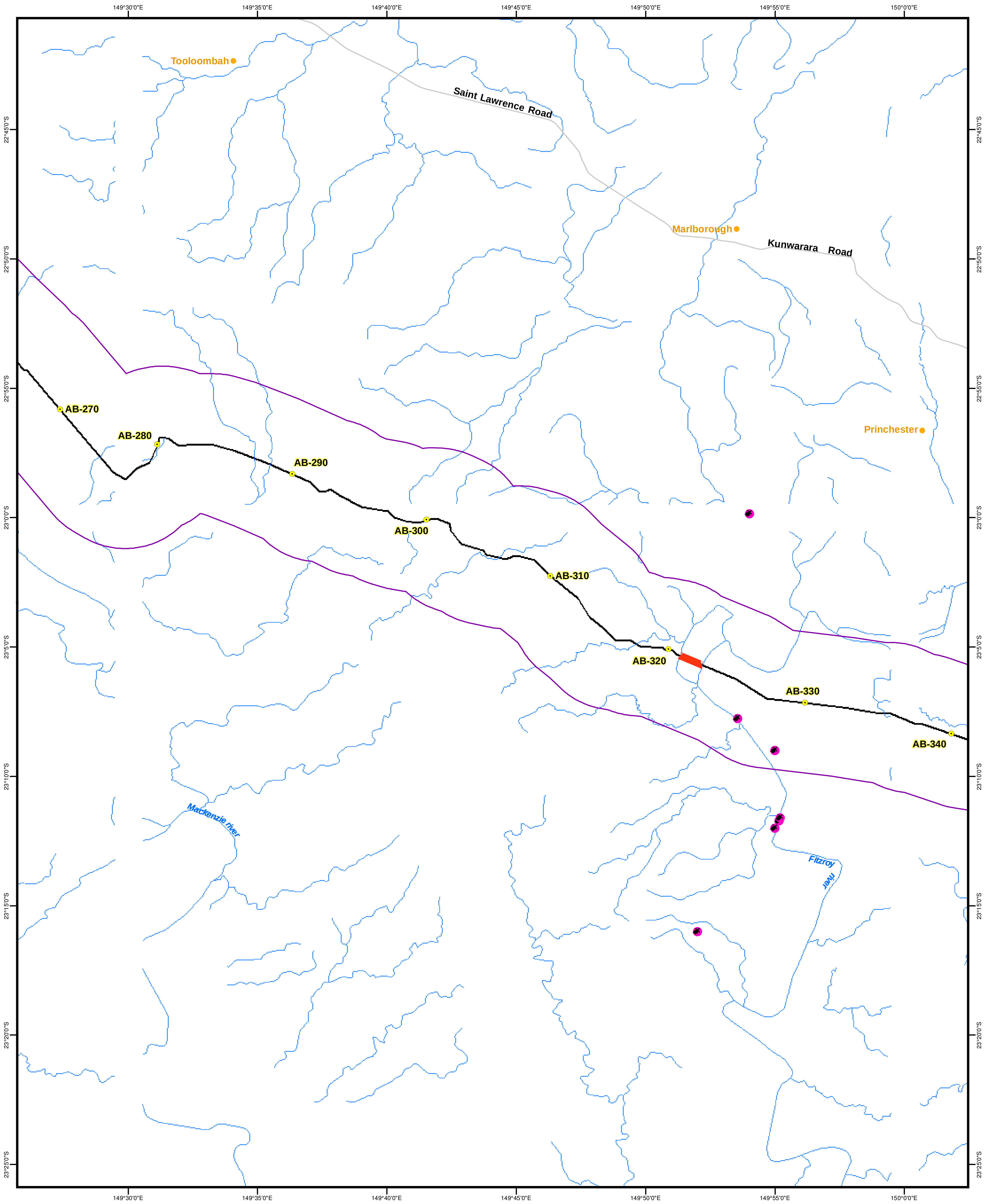
Page 4 of 7

A3



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LEGEND

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- ● **Kilometre Point**
- ● **Queensland Museum Fitzroy River Turtle Records**
- **Waterway or Coast Line**
- **Main roads**
- **ABP - Rev H1**
- 🟥 **Potential Habitat in ROW (Field Verified)**
- ☐ **Buffer (5 km)**

Fitzroy River Turtle

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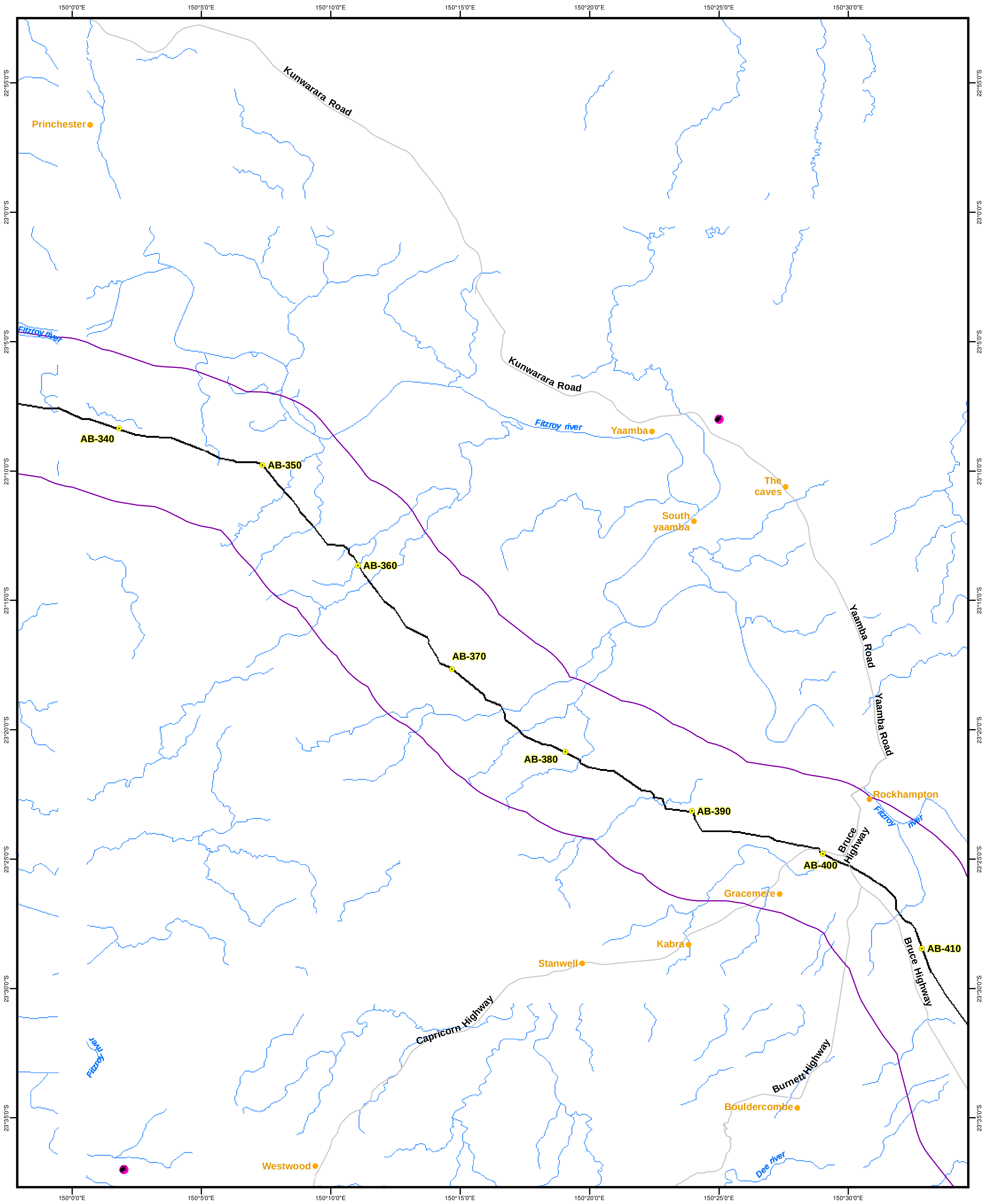
Page 5 of 7

A3



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LEGEND

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- ● Queensland Museum Fitzroy River Turtle Records
- ~ Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- ▭ Buffer (5 km)

Fitzroy River Turtle

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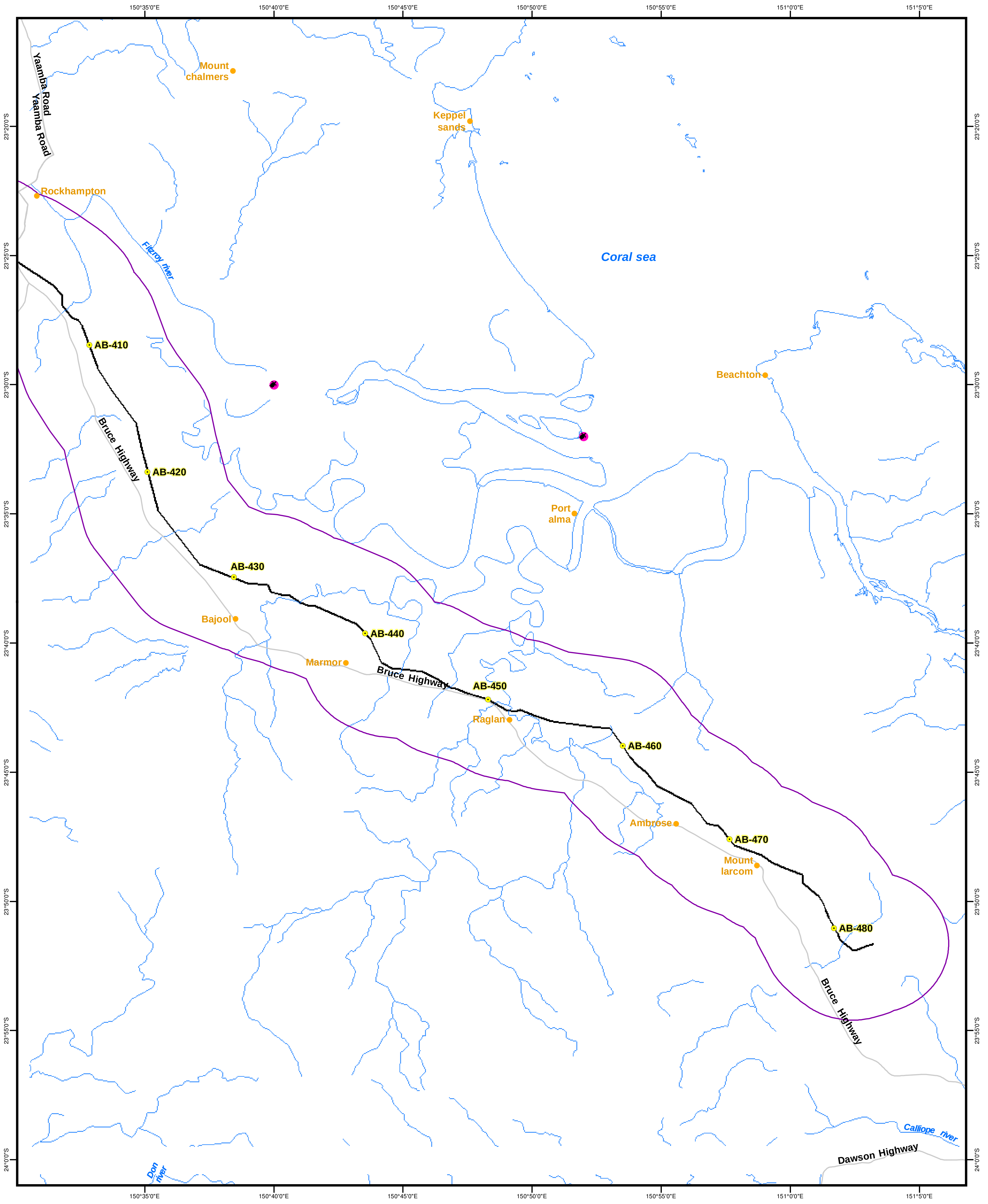
Revision H1

Page 6 of 7

A3



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Fitzroy River Turtle

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Page 7 of 7

A3

2.9 *Xeromys myoides* (Water Mouse)

2.9.1 Conservation Status

Queensland: Vulnerable under the NC Act

National: Vulnerable under the EPBC Act

2.9.2 Description

The Water Mouse is a small rodent with a short, very dense and silky fur that is dark slate-grey above and pure white below. The average head and body length is around 100 mm with a maximum head and body length of 126 mm. The hindfeet are not webbed, thus distinguishing it from the Water Rat. The Water Mouse has very small eyes and ears that are round and short (DSEWPaC, 2013a).

2.9.3 Distribution

The Water Mouse has been recorded in coastal areas of New Guinea, the Northern Territory and Queensland (Figure 13). In south-east Queensland, the species occurs between Hervey Bay and the Coomera River. In central Queensland, the species occurs between Agnes Water and Cannonvale. The species has also been detected on several islands off the southern Queensland coast including North Stradbroke, South Stradbroke, Bribie and Fraser Islands (DSEWPaC 2013a)

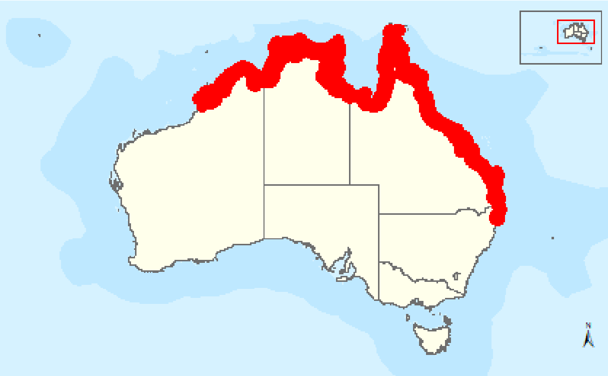


Figure 13 Distribution of *Xeromys myoides*

Source: DSEWPaC 2013a

2.9.4 Habitat

The Water Mouse is found in mangroves and associated coastal habitats including saltmarsh, sedgelands, clay pans, heathlands and freshwater wetlands. The Water Mouse forages amongst the mangroves when the tide is low and then returns to the adjacent areas for shelter at high tide. In central Queensland, the species has only been captured in the high inter-tidal zone in tall, closed fringing mangrove forest and saline grasslands and reed swamps adjacent to mangroves (Ball 2004).

2.9.5 Ecology

The Water Mouse is thought to be totally nocturnal and creates a variety of mound nests or burrows for breeding and refuge from predators and the high tide. The different types of nests include free-standing, termitarium-like mound nests or mounds at the base of mangrove trees, mound nests on small elevated ‘islands' within the tidal zone, mound nests or holes in supralittoral banks, nests inside hollow tree trunks, and nests in spoil heaps (Van Dyck & Gynther 2003). In central Queensland, nesting seems to be restricted to mud ramps constructed between the buttress roots of *Ceriops tagal* or more commonly *Bruguiera parviflora* or *B. gymnorrhiza* (Ball 2004).

A study in south-east Queensland has found that up to eight individuals of both sexes may share a nest, although, there is usually only one sexually active male present. The nests may be used over a number of years by successive generations. The Water Mouse may be capable of breeding throughout the year (Van Dyck 1996).

The species’ diet in south-east and central Queensland are similar and consist of a range of marine species such as crustaceans, polyclad flatworms, pulmonates and bivalves (Van Dyck 1996) that are common on intertidal saltmarsh habitats (Breitfuss et al. 2004).

Breeding season

					Potential breeding season						
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

2.9.6 Activity period

The Water Mouse is thought to be totally nocturnal. Gynther & Janetzki (2008) have observed the Water Mouse travelling distances of up to 3 km a night within home ranges averaging 0.7 ha. Males are thought to have a larger home range than females but estimates differ greatly between studies, possibly due to variability in microhabitat at different sites (Van Dyck 1996).

2.9.7 Threats

Threat overview

The principal threat to the survival of the Water Mouse is the removal and degradation of habitat as a result of development actions.

In central Queensland, the habitats used by this species are often directly adjacent to terrestrial areas that are subject to ongoing disturbance, modification and clearing (Ball 2004).

Habitat removal

Water Mouse habitat has been cleared to accommodate significant urban expansion along the coast. Mangrove and adjacent saltmarsh and freshwater wetland habitats have been affected by human development and infrastructure (DERM 2010).

Alteration of natural hydrology

The *Draft National Recovery Plan for the Water Mouse* (DERM 2010) lists the following alterations to hydrology as threats to the Water Mouse:

- changes in natural hydrology including increased freshwater inflows and sedimentation from storm water run-off
- physical changes to saltmarsh such as runnelling or bundwall construction that modify tidal amplitude and frequency of inundation
- modified water levels and salinity in tidal waterways
- drainage of coastal and terrestrial wetlands.

Indirect impacts on the Water Mouse from artificial physical processes such as the alteration of overland water flows have been observed in central Queensland (Ball 2004). For example, increased stormwater runoff from expanding urbanisation causes changes to salinity and sediment loads that are detrimental to populations of grapsid crabs, a major food source of the Water Mouse (Ball et al. 2006).

Fragmentation

One of the most important threatening processes for the Water Mouse is the fragmentation of freshwater and intertidal wetland communities. Fragmentation of these areas can reduce potential feeding resources and nesting opportunities, extend edge effects, promote weed invasion and increase pest densities or their impacts on native fauna (DERM 2010). Fragmented populations of Water Mouse are thought to be at high risk of local extinction through fox and possibly cat predation (DERM 2010). Fragmentation also restricts recruitment or re-colonisation from adjacent areas (Gynther & Janetzki 2008). Clearing to the edges of mangrove habitat is evident in central Queensland (Ball 2004) and is likely to have impacts on local Water Mouse populations.

Acid sulfate exposure

Disturbance or exposure of acid sulfate soils to the atmosphere can release sulfuric acid and mobilise toxic quantities of iron, aluminium and heavy metals. An estimated 2.3 million ha of acid sulfate soils occur along 6500 km of the Queensland coastline (DERM 2010), coinciding with known and potential Water Mouse habitat. Acid sulfate soils can have a number of negative implications for the Water Mouse relating to habitat degradation and poor plant productivity and, most significantly, can impact negatively on important food resources such as crustaceans, marine pulmonates and molluscs.

Predation

Significant threats to populations of the Water Mouse are likely to include predation pressures from native and introduced fauna, including feral and domestic dogs, foxes and cats (DERM 2010).

Other threats

Other threats to the Water Mouse identified by DERM (2010) include:

- herbicides, pesticides and oil pollution
- use of recreational vehicles in intertidal areas
- any prolonged or intensive wave action from recreational vessels
- fire in the supralittoral zone
- destruction or degradation of habitat by feral and hard-hoofed animals.

2.9.8 DoE recommended survey effort

The EPBC Act survey guidelines for Australia's threatened mammals (DSEWPaC 2011b), recommends the following survey methods for the Water Mouse. Best practice surveys for this species include the implementation of all primary survey techniques either with or without the use of supplementary survey techniques (DSEWPaC 2011b).

Primary survey techniques

Habitat assessment, daytime searches and Elliott trapping are the three most reliable methods for detecting the presence of the Water Mouse. Surveyors should examine aerial photos and topographical maps before commencing a habitat assessment or trapping program. This will target and identify elevated, dry supralittoral areas within mangrove communities which may support active nest mounds.

Daytime searching

Daytime searches should include transect style searches spaced at 50-100 metre intervals, or in quadrats, and involve one to two hours spent looking for nesting structures for every one hectare of intertidal or supralittoral Water Mouse habitat.

Elliott trapping

Elliott trapping (Size A) must be carried out at night. Elliott trapping is the only reliable method for estimating Water Mouse population density. Elliott traps should be baited with pilchards cut in half, mullet pieces or commercial cat food. The minimum survey effort required to trap the Water Mouse is 400 trap nights per four to five hectares of potential Water Mouse habitat.

Supplementary survey techniques

Pitfall trapping, spotlighting and hair tubing can be used to increase the probability of detecting the Water Mouse. However, these techniques are not required where primary techniques are implemented.

Similar species in range

This species can readily be separated from the sympatric water rat by its much smaller size, lack of partially webbed hindfeet, and lack of the distinctive white-tipped tail. It can be separated from the sympatric black rat by the tail (not significantly longer than the head and body length), its short ears, sleek grey dorsal fur and white belly fur (Menkhorst & Knight 2004).

2.9.9 Survey effort and methods undertaken for ABP

Targeted surveys for the Water Mouse were completed in December 2011 at two sites containing suitable tidal habitat, Inkerman Creek (ABP Rev. H1 KP 435) and Raglan Creek (KP 451.5) within the Stanwell Gladstone Infrastructure Corridor.

A total of four Elliot trap lines were established in suitable Water Mouse habitat on each creek. Twenty-five small Elliott traps were placed in each trap line with 15 to 25 m between each trap. Trap lines were in place for 4 nights at each site, giving a total effort of 800 trap nights.

Traps were baited with locally caught baitfish and were set just above the tidal limit to avoid inundation. Elliott traps were checked every morning and then reset in the evening to ensure that any animals caught were not left to dehydrate during the course of the day.

2.9.10 Comparison with DoE survey guidelines

The effort conducted during the field surveys for this species is shown in Table 36 along with the effort recommended under the DoE guidelines. It must be noted that the guidelines are recommendations only and surveys are ongoing.

Table 36 Actual and DoE recommended survey effort for Water Mouse in suitable habitat

Method	Actual effort	SEWPC
Elliot trapping	800 trap nights	400 trap nights (based on 1.66 ha impacted)

2.9.11 ABP survey results

One Water Mouse individual was recorded approximately 300 m downstream of KP 435 (H1 alignment) on Inkerman Creek. The field surveys also identified potential habitat for Water Mouse at KP 451.5 on Raglan Creek. Desktop searches did not identify any previous records of Water Mouse on Inkerman Creek but the area is mapped as likely habitat for Water Mouse by DSEWPaC (2009). The tidal/supratidal section of Inkerman Creek is likely to be habitat for Water Mouse.

Based on field verified RE mapping, approximately 1.66 ha of REs 11.1.1, 11.1.2, 11.1.4 occurs within the ROW and could provide potential foraging, breeding and sheltering habitat (Table 27). The *Draft significant impact guidelines for the vulnerable water mouse* state that critical habitat for water mouse includes "*mangrove communities and other intertidal communities or coastal freshwater wetlands with intact hydrology, prey resources, nest mounds and/or natural features such as a supralittoral bank to enable the construction of nests.*"

Table 37 provides an analysis of critical habitat features within the ROW at Inkerman and Raglan Creeks. Based on this analysis, all 1.66 ha of potential Water Mouse habitat in the creek crossings could be considered critical habitat.

Table 37 Critical habitat features for Water Mouse at Inkerman and Raglan Creeks.

Critical habitat feature*	Inkerman Creek	Raglan Creek
		
Mangrove / intertidal / freshwater wetland	Young mangrove and saltwater couch *Meets criterion although better habitat occurs 200 m downstream**	Mangroves and saltwater couch *Meets criterion**
Intact hydrology	Tidal flows observed *Meets criterion**	Tidal flows observed *Meets criterion**
Prey resources	Intertidal fauna communities observed *Meets criterion**	Intertidal fauna communities observed *Meets criterion**
Nest mounds	None observed	None observed
Natural features for nest construction	Supralittoral mounds with saltwater couch observed *Meets criterion**	Supralittoral banks and hollow bearing mangroves present *Meets criterion**
Conclusion	Meets criteria for critical habitat* but is considered marginal in comparison to mature mangrove communities downstream.	Meets criteria for critical habitat* but is considered marginal in comparison to mangrove communities downstream.

*as defined in the *Draft significant impact guidelines for the vulnerable water mouse*.

None of this critical habitat will be impacted if HDD is used to cross Raglan and Inkerman Creek. An assessment of the impacts on this potential habitat is discussed in Section 1.1.11.

Table 38 Remnant REs that contain potential habitat for Water Mouse within the ROW.

RE	Habitat Type	Potential habitat in the ROW (ha)	Potential habitat in the 5 km buffer (ha)	% of buffer*	Critical habitat in the ROW (ha)
11.1.1	*Sporobolus virginicus* grassland on marine clay plains	0.67	214.25	0.312	0.67

RE	Habitat Type	Potential habitat in the ROW (ha)	Potential habitat in the 5 km buffer (ha)	% of buffer*	Critical habitat in the ROW (ha)
11.1.2	Samphire forbland on marine clay plains	0.24	4710.58	0.005	0.24
11.1.4	Mangrove forest/woodland on marine clay plains	0.75	523.94	0.14	0.75
	Other REs containing suitable habitat in the 5 km buffer	0	0	0	-
	Total	1.66	5448.77	0.30	1.66

* percent of the potential habitat within the 5 km buffer which is contained within the ROW.

2.9.12 Impacts of ABP on Water Mouse

2.9.12.1 Potential impacts without mitigation

Water Mouse was found on Inkerman Creek south of Rockhampton but could also potentially occur on Raglan Creek. Potential impacts include:

- temporary loss of potential habitat for Water Mouse
- increase in pest animal abundance
- reduction in habitat quality caused by increased weed abundance
- direct mortality through collisions with vehicles
- indirect impacts on habitat caused by changes in water quality and hydrology.

2.9.12.2 Assessment of potential impacts with mitigation

The potential impacts and the mitigation measures to reduce the risk to Water Mouse from construction of ABP are listed in Table 39.

Table 39 Impacts and mitigation measures associated with construction of the ABP on Water Mouse.

Impact	Impact before mitigation*	Mitigation measures	Impact after mitigation*
DIRECT IMPACTS			
Removal of habitat · Removal of estuarine vegetation , representing potential foraging, breeding and breeding habitat	L	· use trenchless crossing technology (e.g. HDD) to cross Inkerman and Raglan Creeks · minimise areas of remnant vegetation to be cleared · minimise areas to be cleared in marine habitats · use existing cleared corridors where possible · clearly mark out areas to be cleared and retained · rehabilitate the ROW following construction	L
Trenchfall · Death of individuals trapped in	L	· use trenchless crossing technology to cross Inkerman	I

Impact	Impact before mitigation*	Mitigation measures	Impact after mitigation*
the trench		and Raglan Creeks · monitoring of open trenches by fauna spotter catchers in marine areas during the construction period · minimise the length of time the trench is open · if possible, install drift fencing to prevent animals from falling in the trench · install ramps in the trenches to allow animals to escape	
Fatalities · Death of individuals via vehicles and equipment during clearing, construction and operation	L	· use trenchless crossing technology to cross Inkerman and Raglan Creeks · employ a spotter catcher to check microhabitat prior to clearing to remove individuals before clearing commences · employ a spotter catcher to be on hand during clearing to move displaced animals	I
INDIRECT IMPACTS		·	
Changes in water quality · Impacts to water quality upstream leading to changes in vegetation/habitat downstream	L	· use trenchless crossing technology to cross Inkerman and Raglan Creeks to avoid impacts on water quality · conduct water quality monitoring upstream, at creek crossings and downstream of creek crossings to monitor water quality parameters · develop and implement a sediment and erosion control plan · install sediment and erosion control fencing in soils that are prone to erosion	I
Changes in hydrology · Changes in wet/dry cycling of waterways caused by damming, changes in morphology or diversions	L	· use trenchless crossing technology to cross Inkerman and Raglan Creeks to avoid impacting the existing hydrology of these creeks	I
Habitat fragmentation · Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of population	L	· use trenchless crossing technology to cross Inkerman and Raglan · minimise areas of remnant vegetation to be cleared · use existing cleared corridors where practicable · rehabilitate the ROW following construction	I
Increase in weed abundance · Increase competition with native plant species used for foraging and shelter. · Smothering of native vegetation	L	· develop and implement a weed management plan · control weeds in the ROW before and after construction · implement site weed hygiene protocols	I
Increase in introduced predator abundance · Increase in introduced predator abundance caused by increased food availability in the ROW	L	· develop and implement a Waste Management Plan · develop and implement a Pest Management Plan · educate staff about the importance of removing any food waste from the ROW · keep the work site clean of debris which could be used as -shelter for introduced predators	I
Removal of micro-habitat	M	· use trenchless crossing technology to cross Inkerman	L

Impact	Impact before mitigation*	Mitigation measures	Impact after mitigation*
- Removal of nest mounds or hollow trees		and Raglan - do not remove or interfere with nest mounds or hollow trees - establish a 50 m buffer zone around marine habitat with known Water Mouse populations and exclude construction activities from this area	
Noise and disturbance - Disturbance caused by noise or human disturbance leading to stress, disease and abandonment of habitat.	L	- conduct surveys prior to construction to identify and mark out nest mounds or potential habitat trees - establish a 50 m buffer zone around known Water Mouse populations and exclude construction activities from this area	I
Spread of disease	NA	- no mitigation measures for reducing the spread of disease are recommended for this species as there are no known diseases for this species which could be spread by human activities	NA

I- Insignificant, L- Low, M – Moderate, H – High, E- Extremely High; NA – impact not applicable to this species.

The construction of ABP could impact on 1.6 ha of RE 11.1.1, 11.1.2 and 11.1.4 within the ROW, representing potential foraging, breeding and sheltering habitat. Arrow proposes to utilise a trenchless technology (e.g. HDD) to cross Inkerman and Raglan Creeks, which will avoid all impacts to critical Water Mouse habitat. Should further geotechnical studies preclude the use of trenchless techniques to cross these watercourses, Arrow has produced a species management plan which assesses the potential impacts of alternative crossing methods to this species and details mitigation measures to reduce these impacts (Appendix 3).

Further surveys will be conducted in 2014 to map extent of habitat within the ROW and determine the presence or absence of Water Mouse in suitable habitat on Raglan Creek. These surveys will help to determine the amount of habitat to be impacted and to develop mitigation measures to reduce impact. Provided that trenchless crossing techniques are used at Inkerman and Raglan Creeks, and a 50 m buffer is established around known populations, the impact on this species from clearing of habitat is considered to be **Low**.

Water Mouse forage in estuarine habitats during the low tide. The prey species for Water Mouse includes estuarine worms, mussels and crabs which rely on tidal inundation. Impacts (such as changes to water chemistry or hydrology) which may affect these Water Mouse prey species could result in a significant impact on Water Mouse populations. The impacts from construction are temporary and would not result in long term changes in chemistry or flow regimes. The use of trenchless crossing techniques should avoid impacts on hydrology and reduce the risks of impacting water quality. Therefore the impacts relating to water quality and hydrology on Water Mouse populations are likely to be **Low / Insignificant**.

Further surveys will be conducted in 2014 to map the extent of habitat within the ROW and determine the presence or absence of Water Mouse in suitable habitat on Inkerman and

Raglan Creeks. In the event that further populations are identified a 50 m buffer will be established around any marine habitat containing an identified Water Mouse population. No clearing or construction activities will be undertaken within the buffer, unless authorised by an approved Management Plan. Provided that HDD is used at Inkerman and Raglan Creeks, and a 50 m buffer is established around known populations, the impact on the microhabitat of Water Mouse is likely to be **Low**.

Construction of the pipeline is not expected to change the risks to the water mouse from the introduction of pests. Introduced predators (such as foxes and cats) are present and active in the area. Reasonable management measures, such as the removal of food waste from the ROW or induction programs which stress the importance of not feeding animals will ensure a **Low** level of risk from pests

2.9.13 Evaluation under MNES significant impact guidelines

A Water Mouse population is regarded as an important population if it:

- shows evidence of recent activity (e.g. nest mounds, plastering, middens)
- occurs in habitat critical to the survival of the species
- occurs in a protected area (e.g. Great Sandy National Park)
- occurs at or near the limits of the range of one of the regional populations
- occurs at or near the limits of the species’ range
- has been the subject of long-term monitoring
- preserves high genetic diversity for the species.

The population on Inkerman Creek could be considered an important population because animals were found and signs of recent activity were observed. It is also likely that the areas of RE 11.1.1, 11.1.2 and 11.1.4 on Raglan and Inkerman Creek within the ROW constitute habitat critical for the species survival as they contains mangrove communities and other intertidal communities with intact hydrology, prey resources and natural features to enable the construction of nests.

Will the action lead to a long-term decrease in the size of an important population of a species?

Water Mouse was recorded approximately 300 m from KP 435 on Inkerman Creek. The population is considered important because an individual was captured in critical habitat. However, Arrow is committed to the use of trenchless crossing techniques to cross Inkerman Creek which will avoid the impact to Water Mouse habitat. Further surveys to identify and map potential Water Mouse habitat and assess the population at these locations on Raglan and Inkerman Creeks will be conducted in 2014. Impacts from construction will be of a short duration and habitat will be avoided by trenchless crossing techniques, therefore it is unlikely that the action will lead to a long term decrease in an important population.

Will the action reduce the area of occupancy of an important population of a species?

It is unlikely that the action will lead to a reduction in the area of occupancy of an important population. Impacts associated with construction are short term and will be mitigated through rehabilitation of disturbed areas. Operational impacts will be associated with infrequent inspections and assessments and are likely to be insignificant. Further surveys to identify and map potential Water Mouse habitat and assess the population at Raglan and Inkerman Creeks will be conducted in 2014.

Will the action fragment an existing important population into two or more populations?

Field assessment and targeted searches for this species have not identified Water Mouse populations within the ROW, therefore the action will not fragment an existing important population. Further surveys to identify and map potential Water Mouse habitat and assess the population at Raglan and Inkerman Creeks will be conducted in 2014.

Will the action adversely affect habitat critical to the survival of a species?

Inkerman and Raglan Creeks are likely to contain habitat critical to the survival of the species as they contain mangroves and other intertidal communities with intact hydrology, prey resources and natural features to enable the construction of nests. However, only Raglan and Inkerman Creeks contain suitable habitat for Water Mouse within the ROW. Provided that trenchless crossing techniques are used and the listed mitigation measures are implemented, no Water Mouse critical habitat on Inkerman and Raglan Creeks will be directly or indirectly impacted by the pipeline.

Will the action disrupt the breeding cycle of an important population?

The Water Mouse is presumed to breed throughout the year and construction timing cannot be used to avoid or mitigate impact. The establishment of a 50 m buffer around nests and known populations as well as the use of trenchless technology to cross these creeks will ensure that breeding of the water Mouse will not be affected by the action.

Will the action modify, destroy or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Construction impacts will be a short term disturbance to a maximum of 1.66 ha of potential habitat, and most of this will be avoided by the planned use of trenchless crossing techniques. Following construction the ROW will be rehabilitated to a level comparable to adjacent areas. The action is unlikely to result in a decrease in availability or quality of habitat to an extent that would affect the species.

Will the action result in establishment of harmful invasive species becoming established in the species' habitat?

Introduced predators and weeds are present in the area. Reasonable management measures, such as the removal of food waste from the ROW or induction programs which stress the importance of not feeding animals will ensure the level of risk from pests remain unchanged as a result of the action.

Will the action result in the introduction of disease(s) that may cause the species to decline?

There are no known diseases of Water Mouse which could be introduced to the area through construction.

Will the action interfere substantially with the recovery of the species?

The overall objective of the *National recovery plan for Water Mouse (False Water Rat) Xeromys myoides* (DERM, 2010) is to improve the conservation status of the Water Mouse and its habitat through habitat protection, reducing threats to species' survival, research and increasing public participation in recovery activities. The plan has five main objectives:

- identify habitats supporting populations of the Water Mouse and map the current distribution
- describe key biological and ecological features of the Water Mouse and its habitat
- monitor population trends and identify and manage threats to species' survival
- rehabilitate habitat to expand extant populations
- increase public awareness of, and involvement in, Water Mouse conservation.

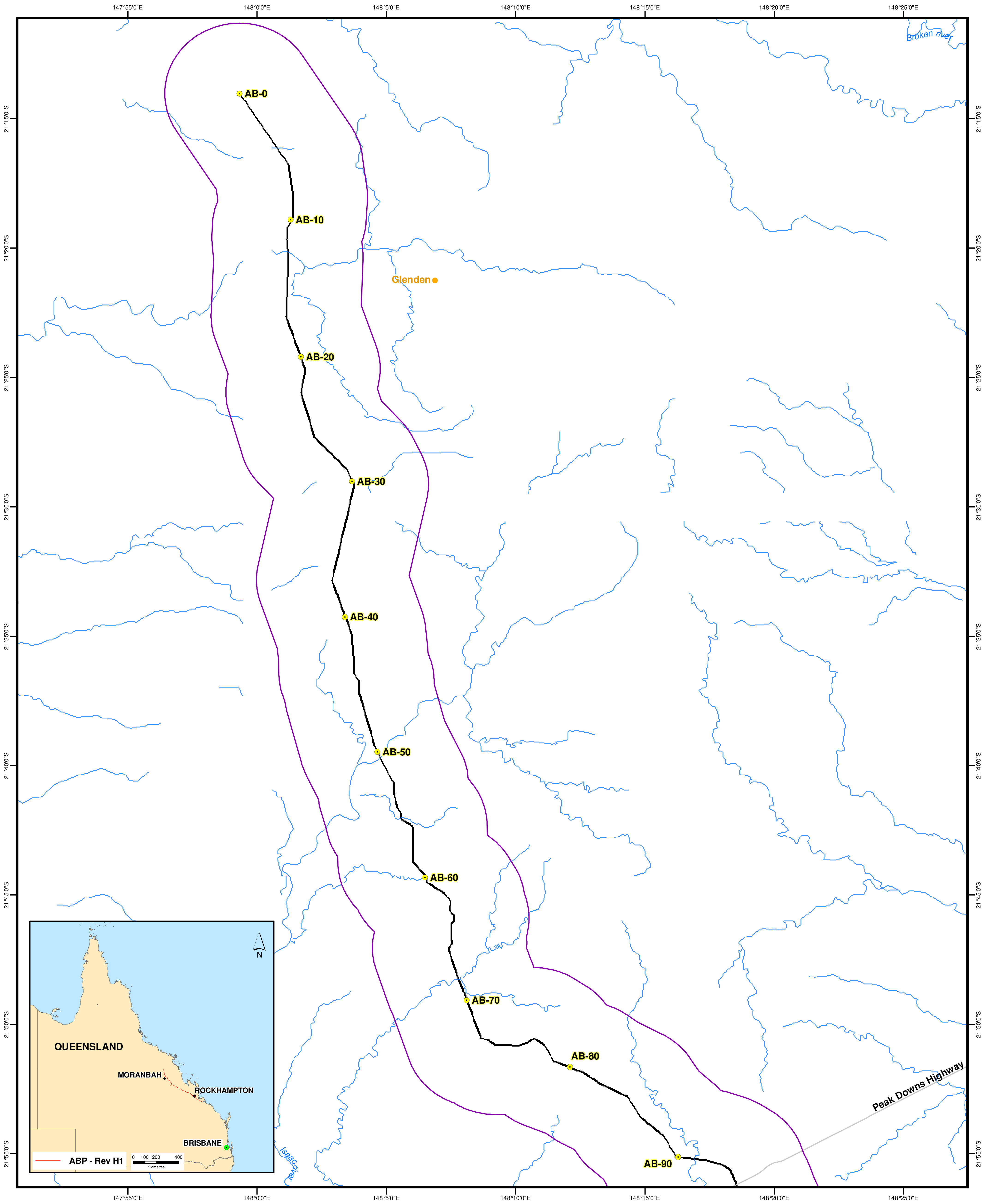
The plan also identifies risks to Water Mouse populations such as habitat loss, fragmentation, changes in hydrology and inappropriate burning.

Arrow is planning to avoid impacts on habitats through use of trenchless techniques on Inkerman and Raglan Creeks. Any disturbance of potential habitat for this species is likely to be minor and of a short duration. A no-burning policy will be adopted for the Project. The Project will not result in changes to the hydrological regime for the watercourse crossings.

Based on the information from previous surveys and the successful implementation of proposed mitigation measures, the action is very unlikely to impact on Water Mouse populations or interfere with the species' recovery.

2.9.14 Conclusion

Surveys detected one population of Water Mouse approximately 300 m downstream of the ROW at Inkerman Creek. Arrow is planning to avoid impacts on habitats through use of trenchless techniques on Inkerman and Raglan Creeks. Any disturbance of potential habitat for this species is likely to be minor and of a short duration. The proposed action is unlikely to significantly impact Water Mouse populations. Further surveys will be conducted to identify potential habitat, clarify potential impacts and refine mitigation measures.



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Document
BE004_MP_006G_Water_Mouse_RevH1

Job Number: BE004

Approved GIS Team Leader		BN		18/11/2013
R0	BN	CF	ISSUED TO CLIENT	29/08/2013
REV	By	CHK	Description	Date

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Kilometres

Scale: 1:250,000 when printed at A3

Coordinate System:
GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND
- ● City or town
- ⊙ Kilometre Point
- 〜 Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- ▭ Buffer (5 km)

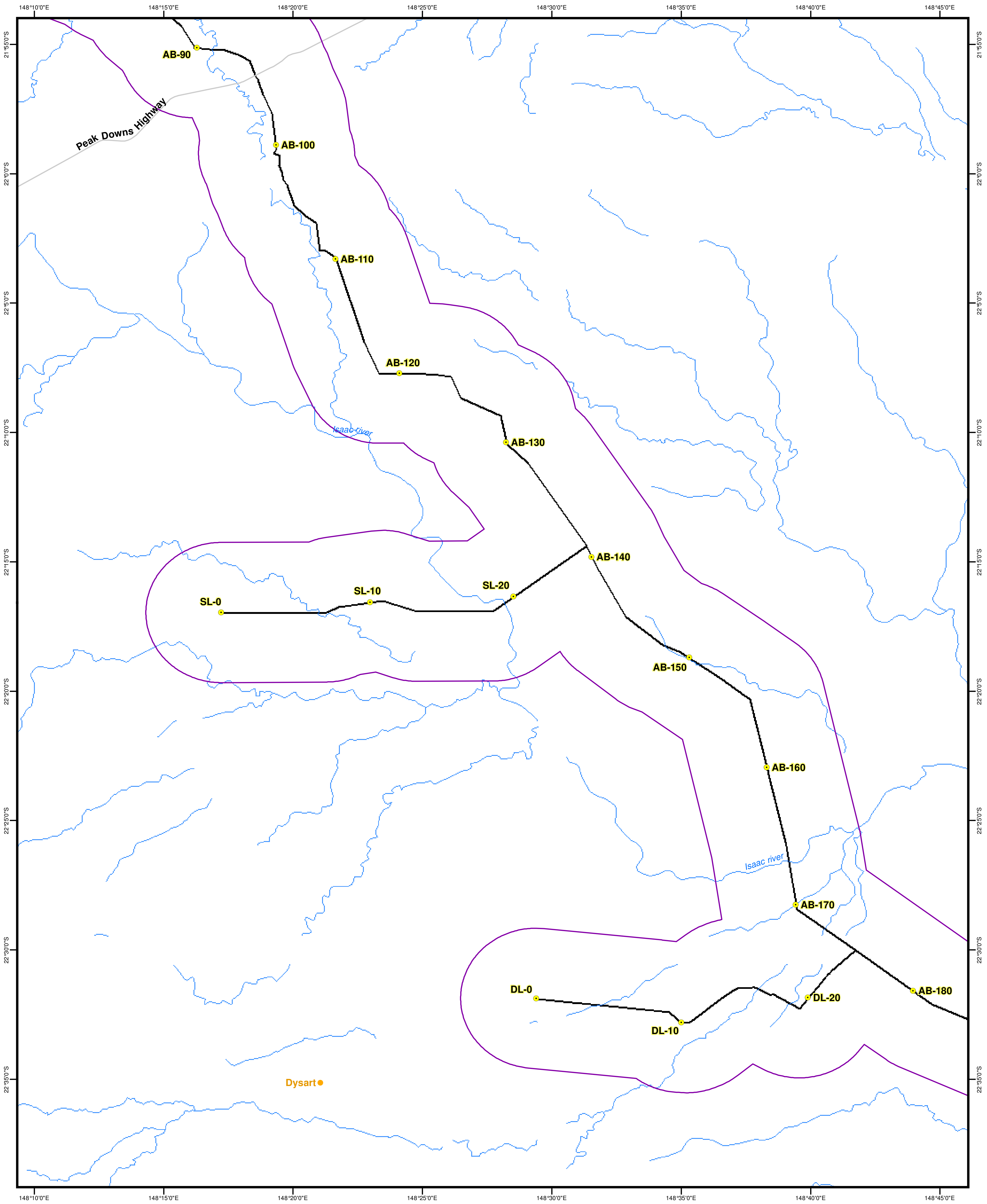
Habitat for Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline Revision H1

Page 1 of 7

A3



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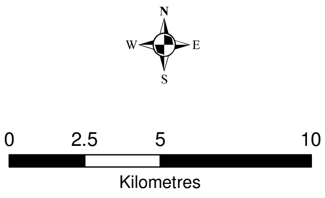

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▭ Buffer (5 km)

Habitat for Water Mouse

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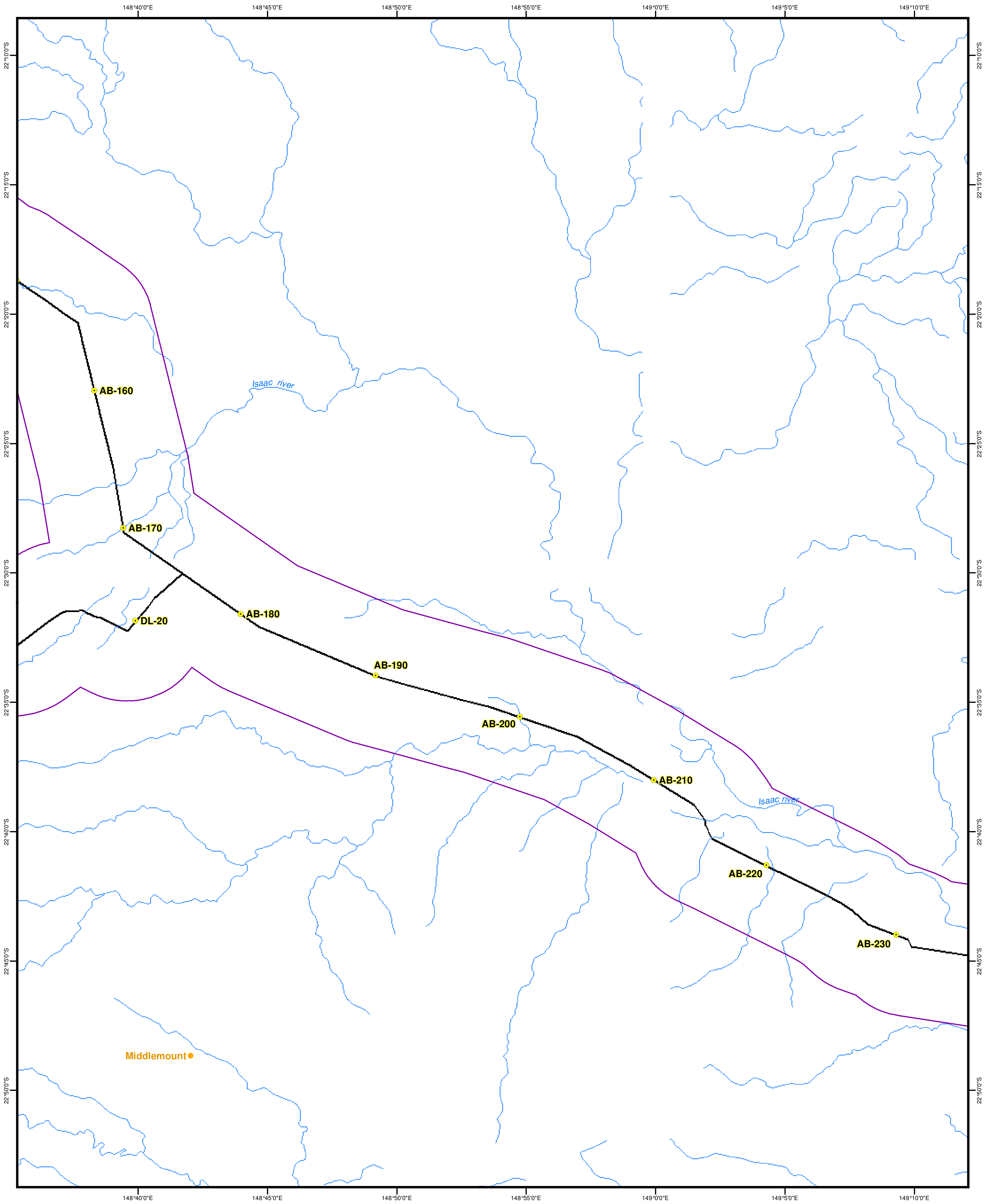
Page 2 of 7

A3



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- ▭ Buffer (5 km)

Habitat for Water Mouse

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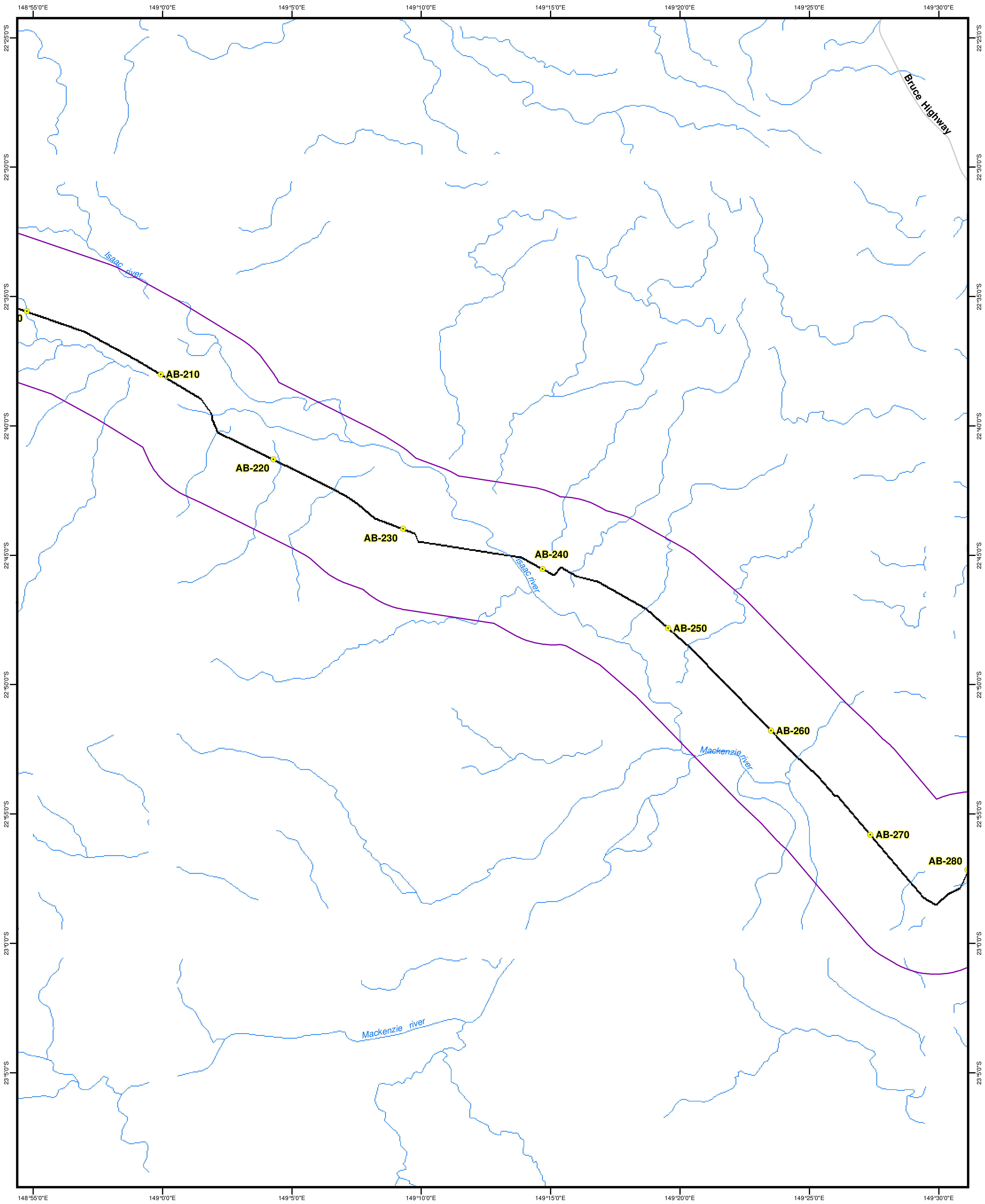
Arrow Bowen Pipeline
Revision H1

Page 3 of 7

A3



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—	**Main roads**
—	**ABP - Rev H1**
▭	**Buffer (5 km)**

Habitat for Water Mouse

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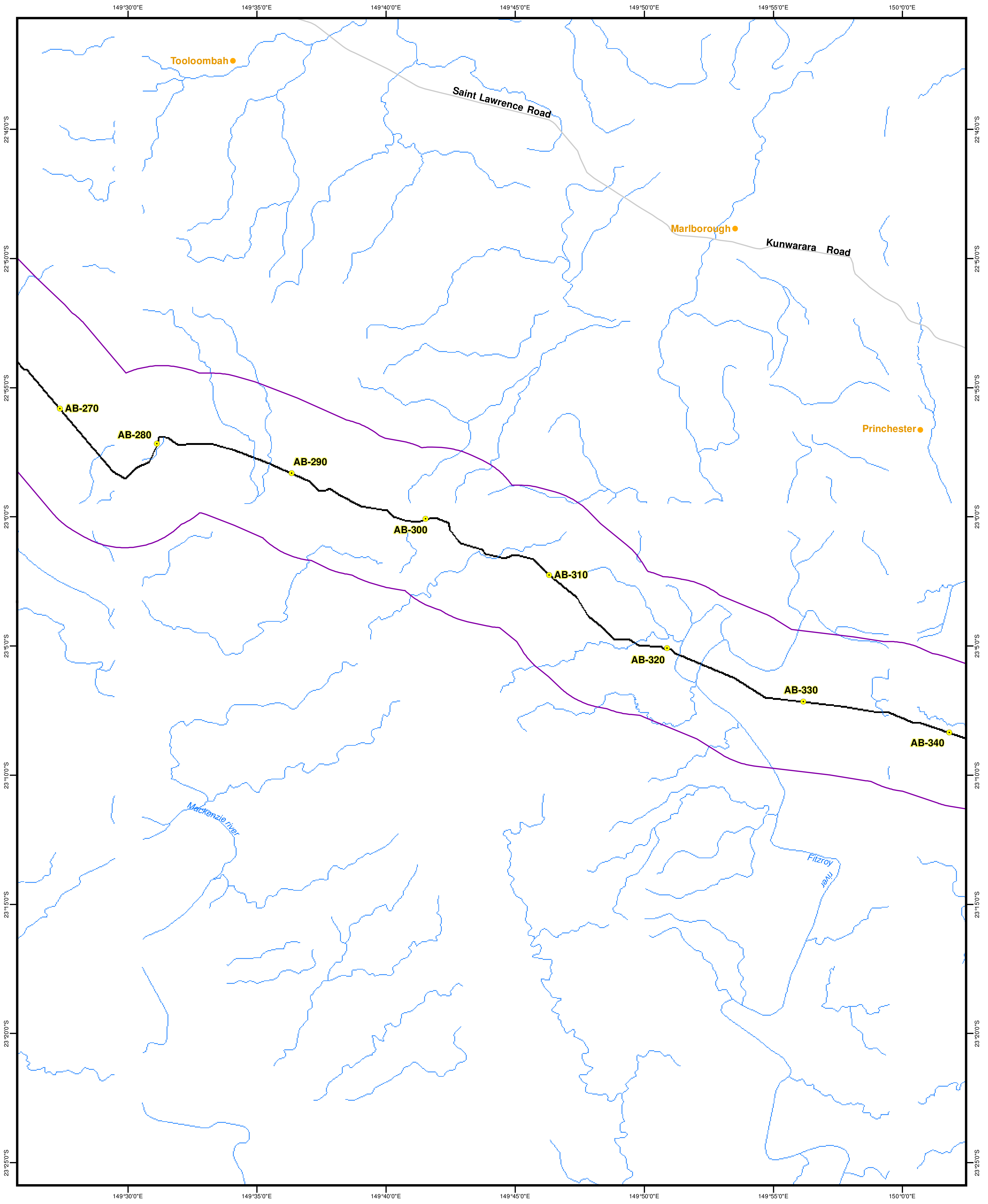
Arrow Bowen Pipeline
Revision H1

Page 4 of 7

A3



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⊙ Kilometre Point
Waterway or Coast Line
Main roads
ABP - Rev H1
☐ Buffer (5 km)

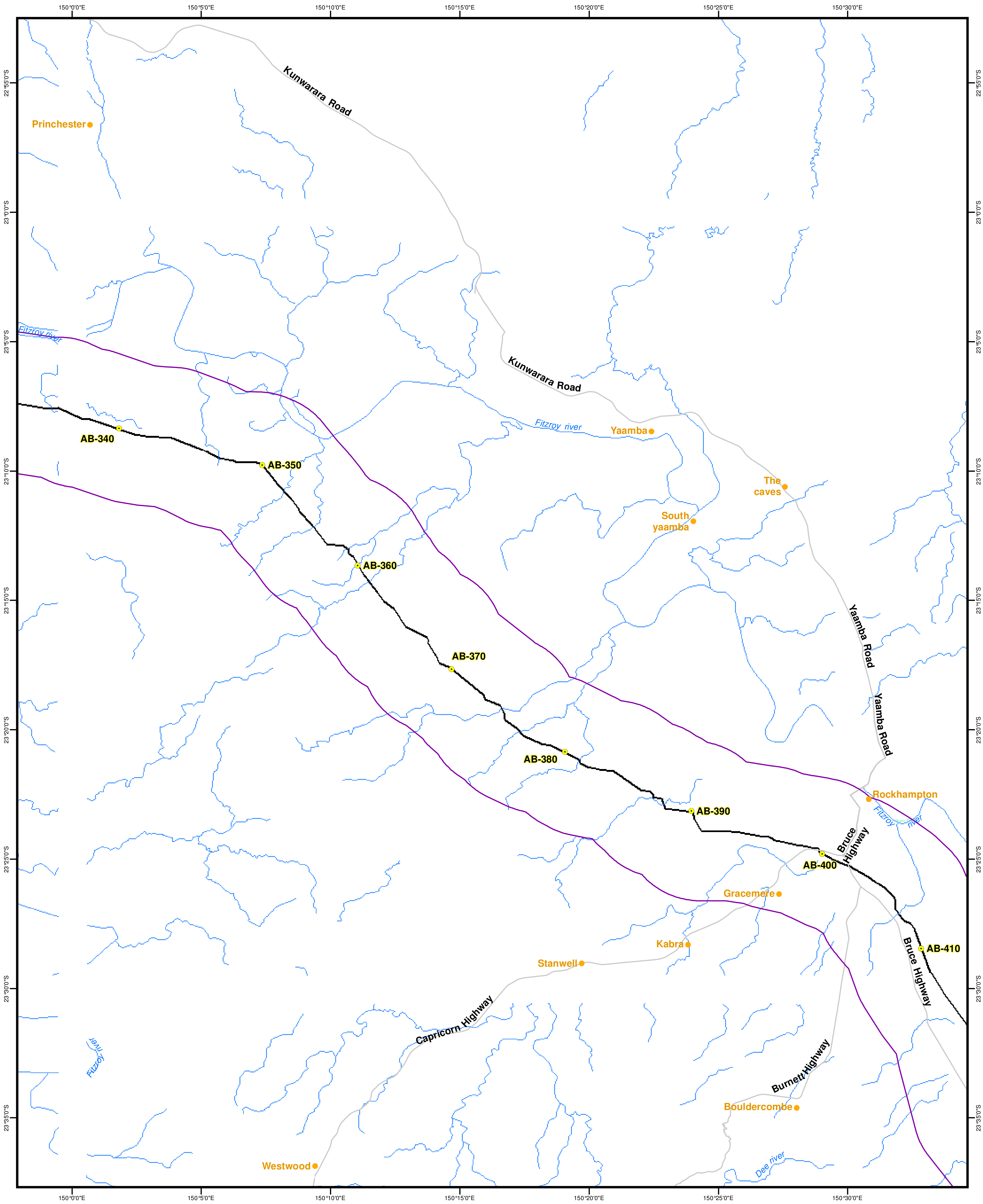
Habitat for Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline Revision H1

Page 5 of 7

A3



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Datum: GDA 1994
Units: Degree

LEGEND

- ● City or town
- ⊙ Kilometre Point
- ～ Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ☐ Buffer (5 km)

Habitat for Water Mouse

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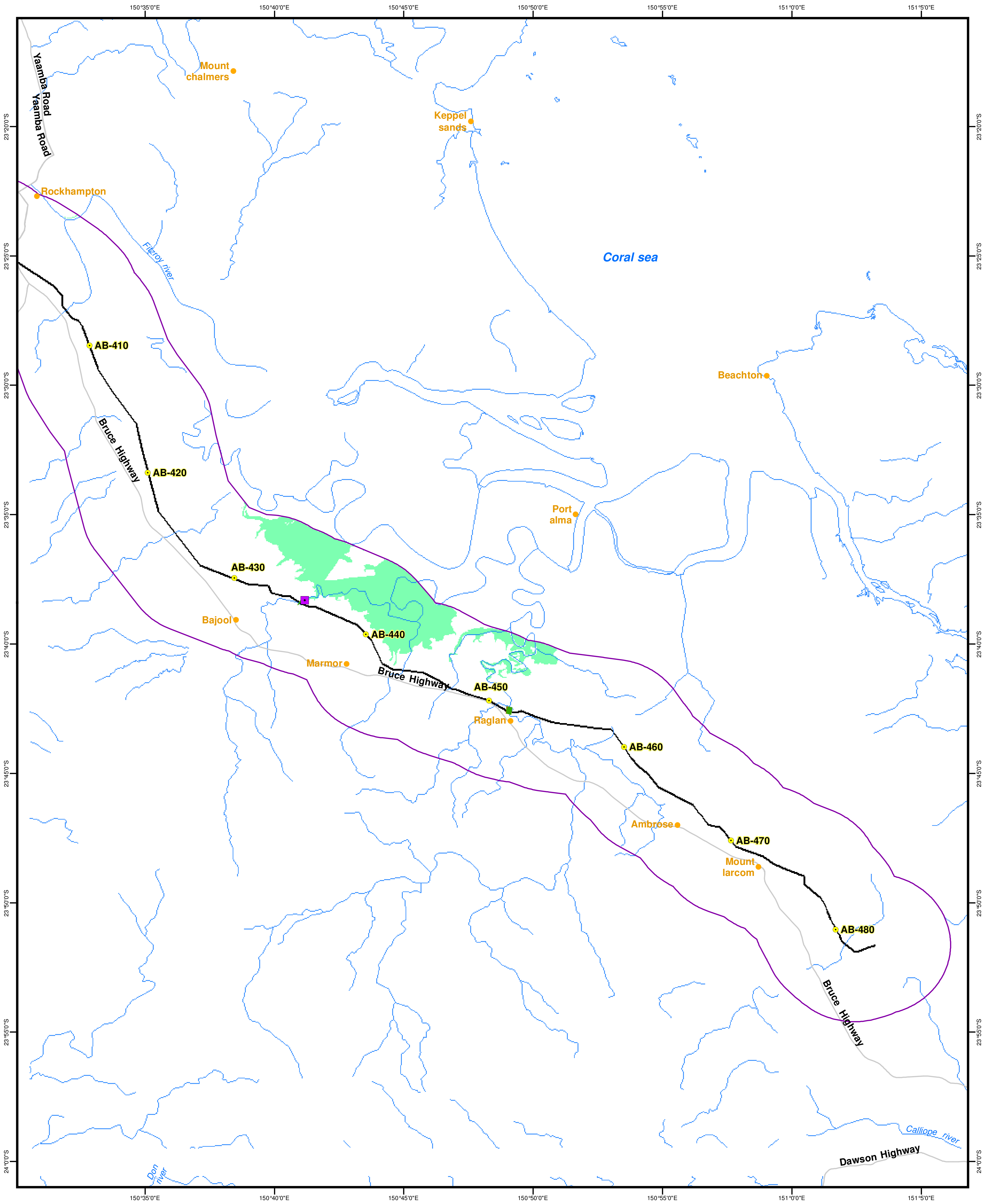
Page 6 of 7

A3



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REV	By	CHK	Description	Date

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Datum: GDA 1994
Units: Degree

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- ⊙ Kilometre Point
- ~ Waterway or Coast Line
- — Main roads
- — ABP - Rev H1
- ▪ Water Mouse Survey Records
- 🟩 Critical habitat for Water Mouse as defined in the Draft Significant Impact Guidelines (surveyed as marginal habitat)
- 🟥 Potential Habitat in ROW (Field Verified)
- 🟩 Potential Habitat in Buffer (from State RE Mapping)
- ▭ Buffer (5 km)

Habitat for Water Mouse

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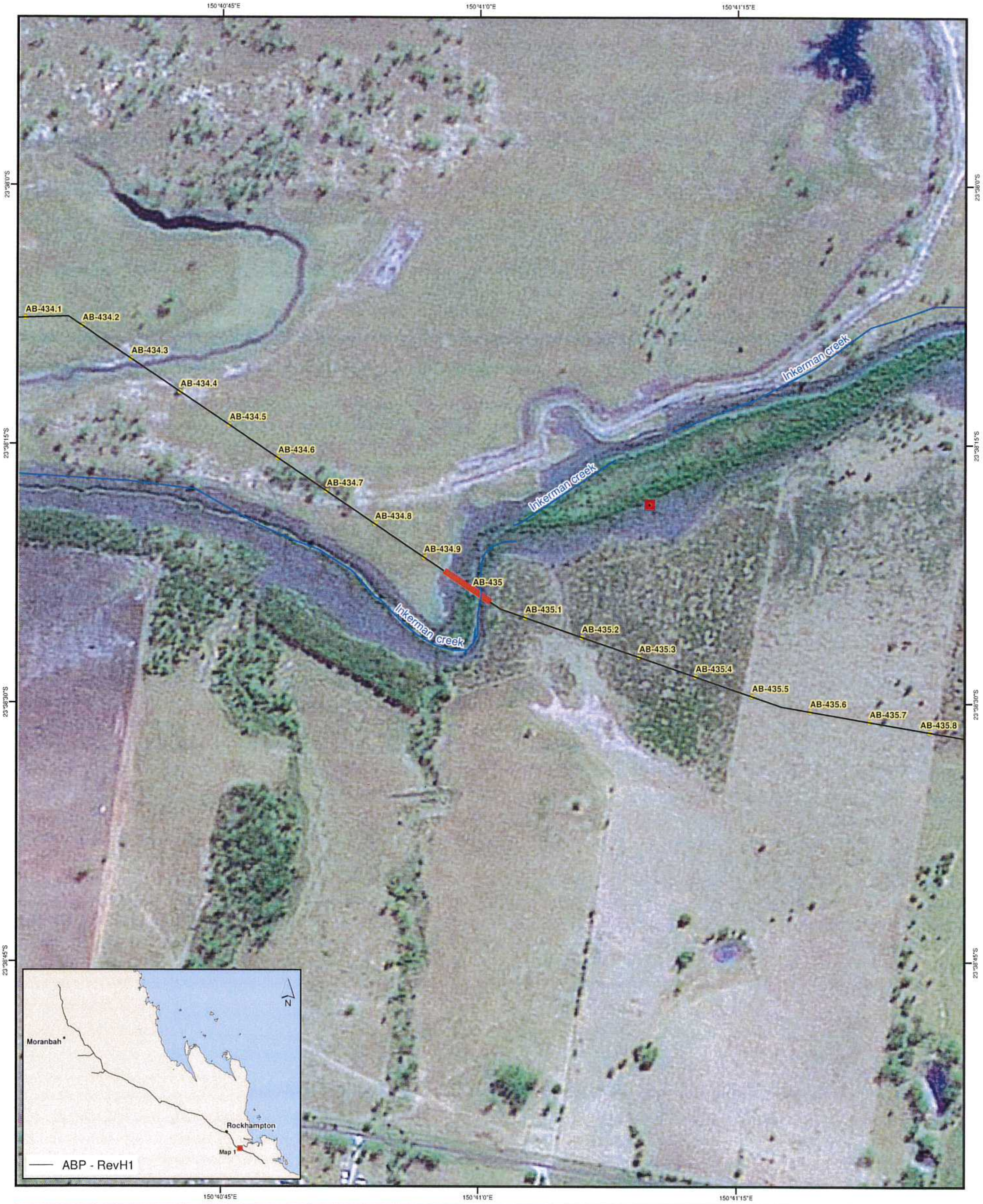
Arrow Bowen Pipeline Revision H1

Page 7 of 7

A3



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BE004_MP_002_Critical_habitat_for_Water_Mouse_F

Job Number: BE004

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REV	By	CHK	Description	Date

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Metres

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Coordinate System:
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Datum: GDA 1994
Units: Degree

LEGEND

■	Water Mouse Record
▨	Critical habitat for Water Mouse as defined in the Draft Significant Impact Guidelines (surveyed as marginal habitat)
—	ABP Route - Rev H1
~	Waterway

Habitat for Water Mouse

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Revision H1

Map 1 of 2 - Inkerman creek - AB-434.3 to AB-435.6

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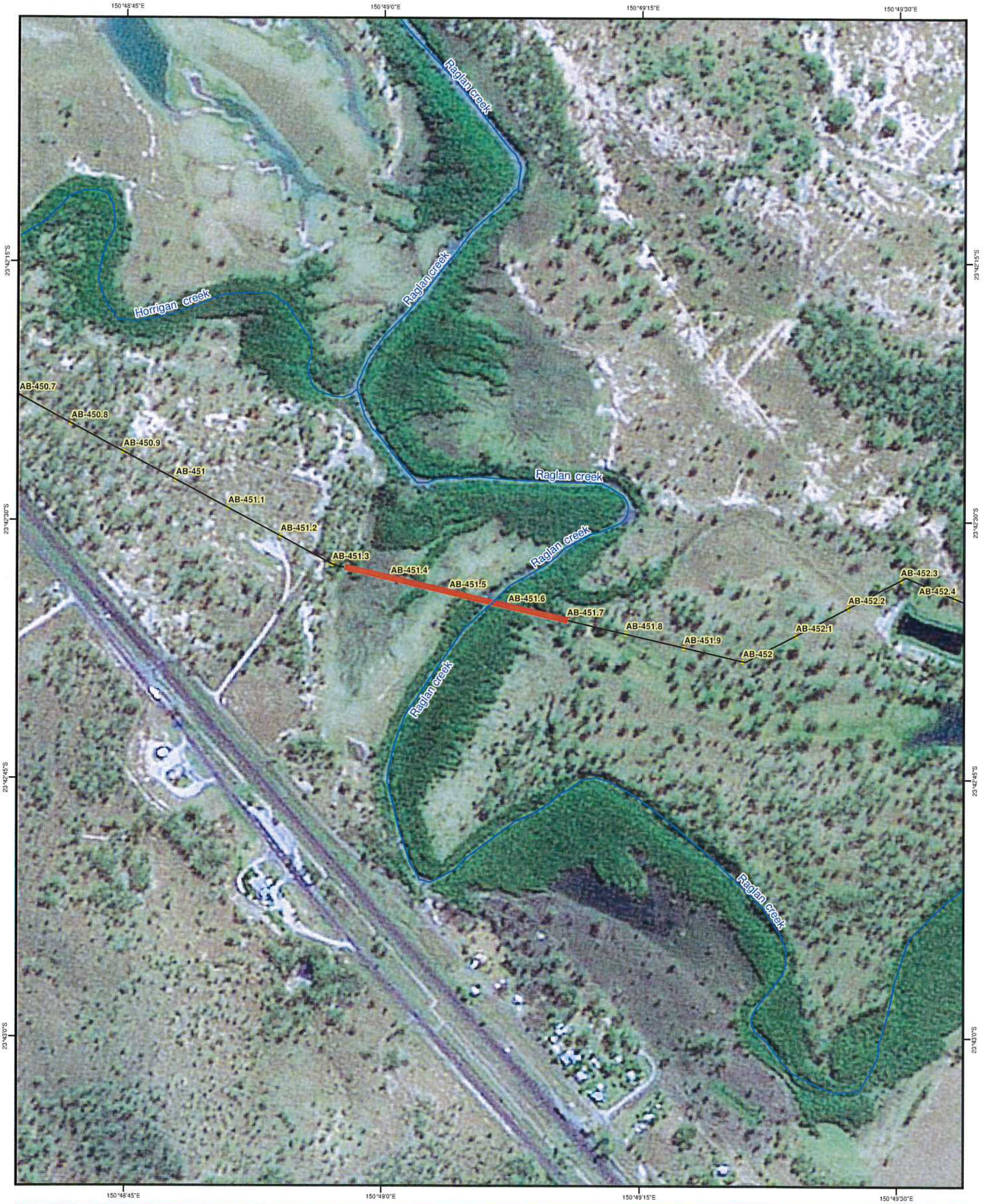

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REV	By	CHK	Description	Date

N W E S

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Metres

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Coordinate System:
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Datum: GDA 1994
Units: Degree

LEGEND

🟥	Critical habitat for Water Mouse as defined in the Draft Significant Impact Guidelines (surveyed as marginal habitat)
—	ABP Route - Rev H1
~	Waterway

Habitat for Water Mouse

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Revision H1

Map 2 of 2 - Raglan creek - AB-450.9 to AB-452.2

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3 Rehabilitation

Table 40 summarises rehabilitation measures proposed to restore ecological values impacted by the ABP. The table includes performance criteria and monitoring methods to measure success of rehabilitation measures. Note that this table does not incorporate some mitigation measures that are directly associated with construction works or are included in other plans (e.g. Construction Environment Management Plan, Sediment and Erosion Control Plan, Aquatic Values Management Plan, Soil Management Plan, Acid Sulfate Soil Management Plan, Weed Management Plan).

3.1 Rehabilitation Program

Arrow is developing a Rehabilitation Program that will form part of the project Environmental Management Plan. The key objectives of the Rehabilitation Program are to ensure that:

- sites used for construction and operation are returned to a safe, non-polluting, stable and self-sustaining level
- all statutory requirements pertaining to rehabilitation and landscaping are met.

The aim of rehabilitation works is to rehabilitate impacted environments to as a minimum, their pre-existing condition. This is a particular prerequisite for all significant ecological communities, protected areas and other sensitive areas identified within the ABP ROW.

Broad completion criteria that will be used to assess the success of rehabilitation will include:

- the similarity between the rehabilitated landforms and the selected analogue sites
- the stability of the landform and its resistance to erosion
- whether appropriate drainage patterns have been restored, either naturally or through shaping activities during the rehabilitation program
- the degree to which the surface conditions are conducive to plant establishment
- whether the site conditions and existing habitat components provide resources, including for fauna movement, foraging habitat and/or shelter
- compliance with the relevant standards
- public safety issues (e.g. signage).

At a minimum, ABP will:

- rehabilitate the ROW to an agreed final land use (e.g. reshaped to a stable landform similar to that of surrounding undisturbed areas with a self-sustaining vegetation cover, or capable of sustaining pre-disturbance rural practices)
- commit that all reasonable and practicable measures are taken to:
  - re-establish drainage lines
  - reinstate the top layer of the soil profile

- control erosion and weeds
- promote and establish a healthy and suitable vegetation growth.

The Rehabilitation Program will be supported by numerous other site/activity based management plans, including a Construction Environment Management Plan, Erosion and Sediment Control Plan, Soils Management Plan, Acid Sulfate Soil Management Plan, Noise and Vibration Management Plan, Waste Management Plan, Aquatic Values Management Plan, Weed Management Plan, Significant Species Management Plan and Offset Management Plan.

The Construction Contractor will be responsible for developing and implementing a Rehabilitation Management Plan in accordance with the measures and principles identified within this program. The Rehabilitation Management Plan will set out specific details of rehabilitation goals, objectives, indicators, staged completion criteria and contingency plans if staged criteria are not met. Annual reports on the rehabilitation will be submitted as part of annual returns on the Environmental Authority.

3.2 General rehabilitation measures

Clean up, restoration and rehabilitation measures will be applied to all areas disturbed during construction, including the ROW and access tracks, as soon as practicable after pipe laying and backfill. Generally, clean up and rehabilitation will involve removal of foreign material (construction material and waste), surface contouring, respreading topsoil, respreading vegetation (e.g. mulch) and reseeding / revegetation.

Generally the landscape will be rehabilitated to pre-existing contours (allowing for some settling) with natural drainage lines restored and protected. In certain cases, rehabilitation will be tailored to site-specific conditions in consultation with the landholder. To promote vegetation regrowth and protect against the loss of topsoil, the ROW surface will normally be lightly scarified or ripped (if required) prior to respreading of topsoil. Temporary access ways and causeways will be removed following consultation with landholders.

Rehabilitation will be undertaken in accordance with best practice and will ensure that:

- topsoil cover is re-established and all land and waterways disturbed by project activities are returned to a stable condition as soon as practicable after construction
- land is returned as close as possible to its previous productivity
- stable landforms are re-established to original topographic contours
- natural drainage patterns are reinstated
- erosion controls (e.g. contour banks) are installed in erosion prone areas
- vegetation cover sufficient to stabilise topsoil is established
- declared weed species are controlled
- disturbed habitats in areas of significant ecological value are recreated
- fences and gates are restored

- pipeline marker signs are installed.

Table 40: Proposed rehabilitation measures relevant to restoration of ecological values

Management measures	Performance indicators	Monitoring
Landform		
Erosion and sediment control measures will be implemented in accordance with the Erosion and Sediment Control Plan. Problem soils (e.g. sodic, saline and acid sulfate soils) will be managed in accordance with the Soil Management Plan. Good quality soils and crop land will be managed in accordance with the Soils Management Plan. Construction of the project will be progressed sequentially, with cleanup, restoration and rehabilitation initiated immediately after backfilling is complete. Beneficial use of cleared material (e.g. rocks, logs, hollows, other vegetation) will be maximised. This will include redistribution of material over the ROW, where agreed with the landholder. Compaction relief will be undertaken before respreading topsoil, to promote vegetation regrowth, protect against topsoil loss, improve water infiltration and minimise rilling. The pipeline construction area will be re-profiled to original or stable contours, re-establishing surface drainage lines and other land features.	Disturbed land reinstated to the pre-disturbed soil suitability class. Landform is stable with no subsidence or erosion gullies. No significant changes in local hydrology. No complaints from landholders relating to land reinstatement or productivity.	Conduct post-construction audits annually for two years to evaluate revegetation, erosion control, weed control, watercourse integrity and success of bed and bank re-profiling. Monitor water chemistry, sediment and turbidity loadings in downstream water bodies during and after construction.
Fire		
A no burning policy will be implemented. An Emergency Response Plan will be prepared to ensure there is an appropriate response to emergencies (such as bushfire). Fire-fighting equipment and personnel trained in fire fighting will be deployed in accordance with the Construction Environment Management Plan.	No fires caused by pipeline activities.	Log and investigate all fire-related incidents.
Waste		
Waste will be managed in accordance with the Waste Management Plan.	No contamination to soils, surface water or groundwater.	Pipeline patrols will monitor the effectiveness of clean-up activities.

Management measures	Performance indicators	Monitoring
All pipeline packaging waste material (e.g. ropes and straps) will be removed from the ROW and disposed in accordance with local government requirements. General refuse will be collected and transported to a Local Government approved disposal site.		
Water		
Reinstate watercourse banks as near as possible to their former profile, stabilised and re-vegetated as necessary to prevent scouring. Replace natural bed surface wherever possible (e.g. cobbles, coarse gravels). Stabilise the channel and embankments in unstable soils (e.g. sandy soils). Inspection and monitoring of watercourses will be ongoing during operation and remedial action will be initiated where required.	Watercourse banks are stable with no subsidence or erosion gullies. Water quality of receiving water comparable to non-disturbed areas. No significant difference between upstream and downstream watercourse sediment and turbidity values from rehabilitated areas.	Visual inspections and photographic representation of bank reinstatement after construction of watercourse crossings. Conduct water quality monitoring program during and after construction (for a minimum of 4 weeks after rehabilitation works are completed). Conduct post-construction audits annually for two years to evaluate watercourse integrity and success of bed and bank re-profiling.
Vegetation		
Implement weed treatment program along the ROW in accordance with Weed Management Plan (in consultation with local landholders). Re-establish vegetation cover as soon as possible after construction. Native trees and shrubs will be allowed to naturally regenerate (except for those areas that are required to be kept free of trees for pipeline protection and maintenance purposes). Revegetation / reseeding efforts will be based on soil types, existing local vegetation characteristics and endemism of selected species. When rehabilitating native vegetation: · collect local provenance seed/vegetative material wherever practicable · source local indigenous species, preferably from a local seed bank.	Criteria will compare rehabilitation areas to adjacent reference sites and will include: · percentage cover of native vegetation · percentage cover of weeds · native species diversity. No introduction or spread of weeds from construction or rehabilitation activities.	Rehabilitation success will be monitored until regrowth meets performance criteria. Photo monitoring will be conducted at appropriate points identified before construction. Presence and abundance of weeds will be monitored biannually during construction and for a period of two years following construction. Monitoring in areas of known mother of millions and parthenium infestations should be

Management measures	Performance indicators	Monitoring
Rework rehabilitation areas where monitoring indicates performance indicators are not being achieved. Support rehabilitation activities with offset areas as agreed with relevant state or Commonwealth agencies.		undertaken quarterly or in accordance with respective landholder agreements.
Habitat		
Ensure site is free of food scraps and other waste material that could attract introduced fauna following construction. Reinstate habitat features such as rocks, logs and hollows in the ROW where practical. Reinstate aquatic habitat features such as woody snags in watercourses where practical.	Establishment criteria for fauna habitat will include: · quantities of refugia and shelters · percentage cover of vegetation litter. No introduction or spread of feral animals from construction or rehabilitation activities.	Monitor habitat values annually until regrowth meets performance criteria. Conduct post-construction audits annually for two years to evaluate presence and abundance of feral animals.

3.3 Habitat rehabilitation measures

Rehabilitation management measures will be developed for the following broad habitat types:

- woodland / open forest /grassland on alluvial soils, cracking clay soils, old sand plains and rocky/stony soils
- watercourse / wetland / estuarine habitats
- grazing and cropping farmland.

For each habitat type, the goal of rehabilitation will be to achieve a self-sustaining ecosystem that provides habitat for native flora and fauna. Table 41 identifies proposed measures and performance indicators for each habitat.

Table 41: Proposed rehabilitation measures for specific habitat types

Management measures	Performance indicators	Monitoring
Woodland / open forest /grassland on alluvial soils, cracking clay soils, old sand plains and rocky/stony soils		
Rehabilitate by natural regeneration or using seed or vegetative material from the following collection hierarchy: • large populations of native species from the same RE in the local area • large populations of native species from the same RE in the region • other populations of native species in the local area • other populations of native species in the region • native species collected by commercial suppliers from the region. Scarify or rip ROW after construction and before respreading topsoil to reduce soil compaction, improve water infiltration, minimise erosion and promote vegetation regrowth. Stockpile trees cleared within the ROW during construction and place back in the ROW following completion of construction, where agreed with the landholder. Undertake appropriate revegetation to supplement natural regeneration in sensitive areas where necessary. These may include: · planting of native species in areas of habitat for significant flora or fauna species · re-seeding and / or revegetation in areas of poor or no regrowth.	Establishment criteria will include: · percentage cover of native species · percentage cover of weeds · native species diversity.	Rehabilitation success will be monitored and compared with analogue sites. Photo monitoring will be conducted at reference points identified before construction. Presence and abundance of weeds will be monitored biannually during construction and for a period of two years following construction. Monitoring in areas of known parthenium infestations should be undertaken quarterly or in accordance with respective landholder concerns.
Watercourse / wetland / estuarine habitats		
Rehabilitate by natural regeneration or using seed or vegetative material from the following collection hierarchy: • large populations of native species from the same RE in the local area • large populations of native species from the same RE in the region • other populations of native species in the local area • other populations of native species in the region • native species collected by commercial suppliers from the region. Reinstate watercourse banks as near as possible to their former profile, stabilised and re-vegetated as necessary to prevent scouring. Replace natural bed surface wherever possible (e.g. cobbles, coarse gravels).	Establishment criteria will include: · percentage cover of native species · percentage cover of weeds · native species diversity. Watercourse banks are stable with no subsidence or erosion gullies. Water quality of receiving water comparable to non-disturbed areas.	Rehabilitation success will be monitored and compared with analogue sites. Visual inspections and photographic representation of bank reinstatement after construction of watercourse crossings. Conduct water quality monitoring program before, during and after construction (for a minimum of 4 weeks after rehabilitation works are completed). Conduct post-construction audits annually for

Management measures	Performance indicators	Monitoring
Stabilise the channel and embankments in unstable soils (e.g. sandy soils). Undertake appropriate revegetation to supplement natural regeneration in sensitive areas where necessary. These may include: · planting of native species in areas of habitat for significant flora or fauna species · re-seeding and / or revegetation in areas of poor or no regrowth. Develop offset plans to compensate for any residual impacts on wetland / estuarine habitats where required.		two years to evaluate integrity of watercourse / wetland habitat and success of bed and bank re-profiling.
Grazing and cropping farmland		
Re-establish soil profiles, scarify or rip ROW after construction and before respreading topsoil to reduce soil compaction, improve water infiltration and promote vegetation regrowth. Undertake soil treatments in accordance with Soils Management Plan. Re-establish pasture grass mix following consultation with grazier. Enable re-establishment of existing cropping regime following consultation with owner.	Productivity of ROW comparable to adjacent farming area.	Monitor productivity of ROW and adjacent farming area.

3.4 Monitoring and reporting

Following construction, monitoring of rehabilitated areas will be undertaken in accordance with approval conditions. Table 40 and Table 41 summarise proposed performance criteria and monitoring actions.

Monitoring and reporting of rehabilitation measures will be undertaken according to the following schedule:

- Once planting has commenced, regular weekly inspections will be carried out to monitor watering requirements at each location for a period of three months. Monthly inspections will then commence for a further period of six months.
- Weekly inspections will be conducted to monitor and record the success of planting regimes for a period of six months after plantings have commenced.
- Quarterly photographs will be taken from reference points to determine the success or otherwise of the landscaping and rehabilitation works. These will be included in environmental reports. This will be carried out for a minimum of two years after plantings have commenced.
- A monitoring and evaluation report will be prepared and will include details on species survival, natural recruitment, percentage coverage of the rehabilitation area and percentage and species of weeds in the rehabilitated areas. In addition the following will also be recorded:
    - planning and impact assessment details
    - activity site location and site access details
    - commencement and completion dates
    - the area of native vegetation removed, and the amounts of material excavated and fill placed
    - the disposal location/s and quantity of spoil material removed
    - the disposal location/s and quantity of native vegetation removed
    - impact management and rehabilitation details
    - before, during and post activity photographs of the site
    - any incidents of unanticipated failure of management methods and subsequent remedial action
    - any notable fauna activity.

Any incident that results in the injury or fatality of an animal will be recorded and reported to DEHP as relevant.

Annual reports on the rehabilitation will be submitted as part of annual returns on the Environmental Authority as required.

3.5 Contingency measures

The rehabilitation program incorporates a contingency plan to address any non-conformance with performance criteria identified during monitoring. When monitoring detects a significant non-conformance, a contingency plan will:

- investigate and identify causes of non-conformance
- develop and implement measures to mitigate identified causes of non-conformance
- undertake further rehabilitation works to meet performance criteria
- conduct more detailed monitoring of rehabilitation progress, if required to ensure success.

More detailed performance criteria, including staged criteria to monitor success at specific stages of the rehabilitation process, will be developed in the rehabilitation plan and associated management plans. Broad criteria identified by the rehabilitation program include:

- measures of erosion and sediment loss (e.g. signs of surface erosion, increased water turbidity and sediment loads)
- measures of watercourse bank stability
- water quality of receiving waters in comparison to non-disturbed waterways
- measures of revegetation success (e.g. native species diversity, percentage cover of native flora species and weeds within rehabilitation areas in comparison to adjacent analogue sites)
- measures of habitat quality (e.g. percentage cover of litter, quantity of habitat features such as logs and rocks in comparison to adjacent analogue sites).

Arrow will require performance guarantees from the Construction Contractor with respect to rehabilitation. The contract has a 2 year contract liability period with any failure within this time subject to an additional 12 month guarantee period. The Queensland Department of Environment and Heritage Protection also maintains a bank guarantee for the Project which covers rehabilitation. The site/activity based management plans (such as Soils Management Plan, Erosion and Sediment Control Plan) will remain active until the rehabilitation of the ROW meets performance criteria. Site/activity based management plans will be reviewed following construction to ensure these are relevant to the risks associated with operational impacts.

Rehabilitation and monitoring programs will continue until all relevant performance criteria are met. The strategy of requiring constructor contract guarantees combined with continuing rehabilitation and monitoring programs until performance criteria are achieved will reduce the risk of failure to Low levels.

3.6 Continuous improvement

The rehabilitation program will undergo regular review and improvement, based on:

- results of ongoing field surveys and trials
- improvements in knowledge of species and communities
- changes in technology and rehabilitation practice
- revisions of proposed route alignments
- changes in statutory requirements.

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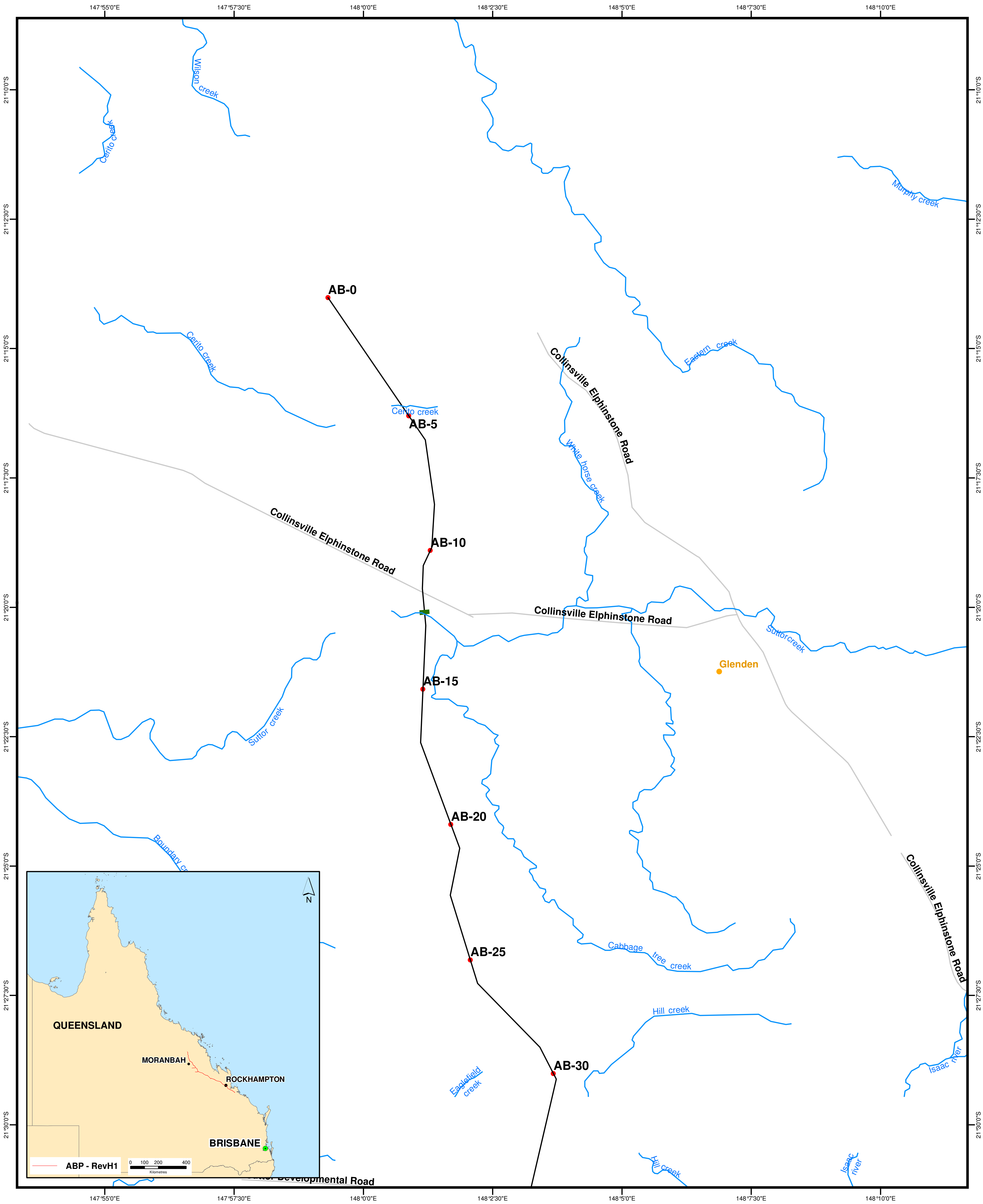
5 Appendices

Appendix 1 – Overview map of critical habitat for EPBC listed fauna species



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🟩 **Critical Habitat for Koala**

ABP Route - Rev H1

Waterway

Main roads

Overview of critical habitat for EPBC listed fauna species

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Revision H1

Page 1 of 18

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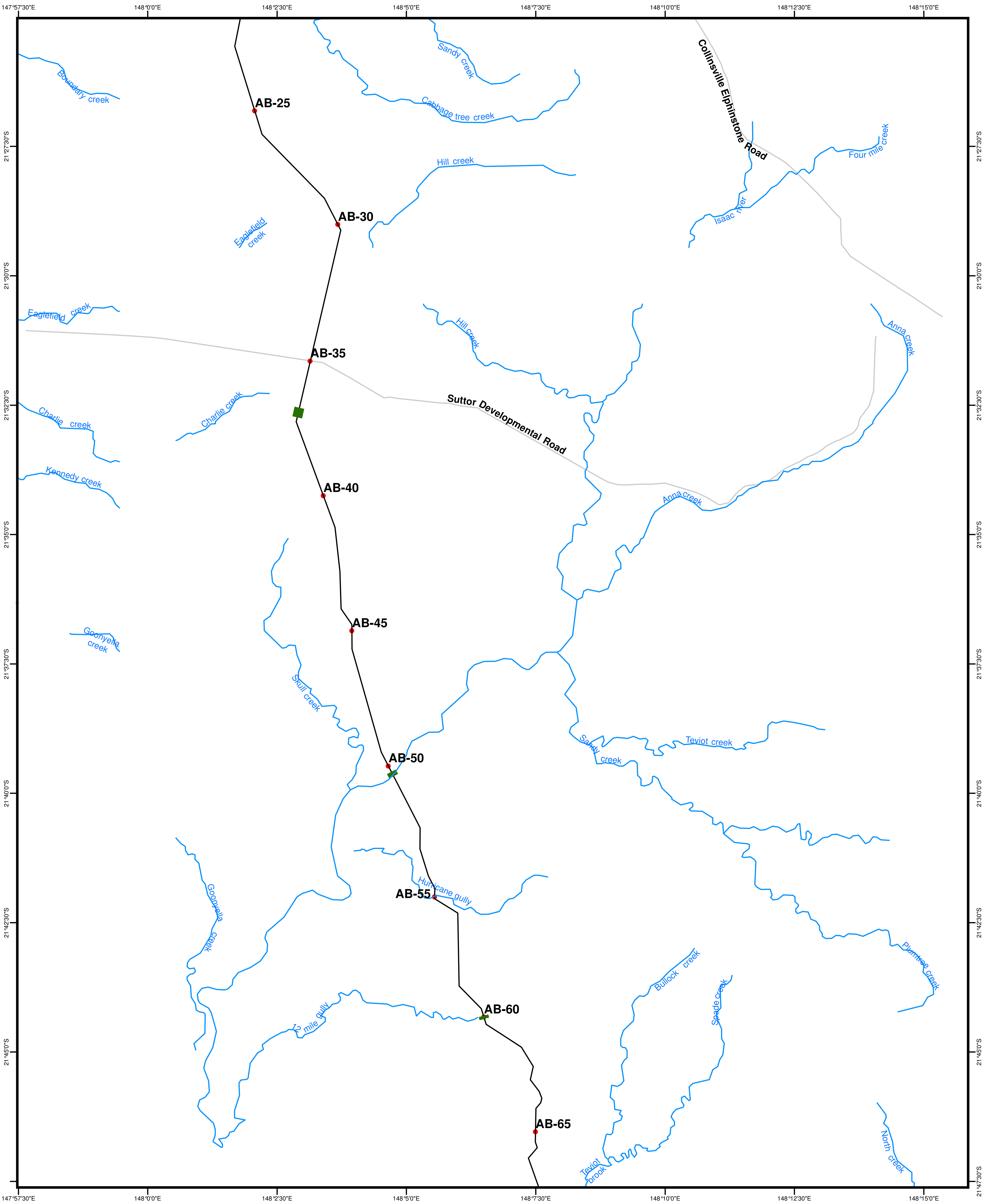

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🟩 **Critical Habitat for Koala**

ABP Route - Rev H1

Waterway

Main roads

Overview of critical habitat for EPBC listed fauna species

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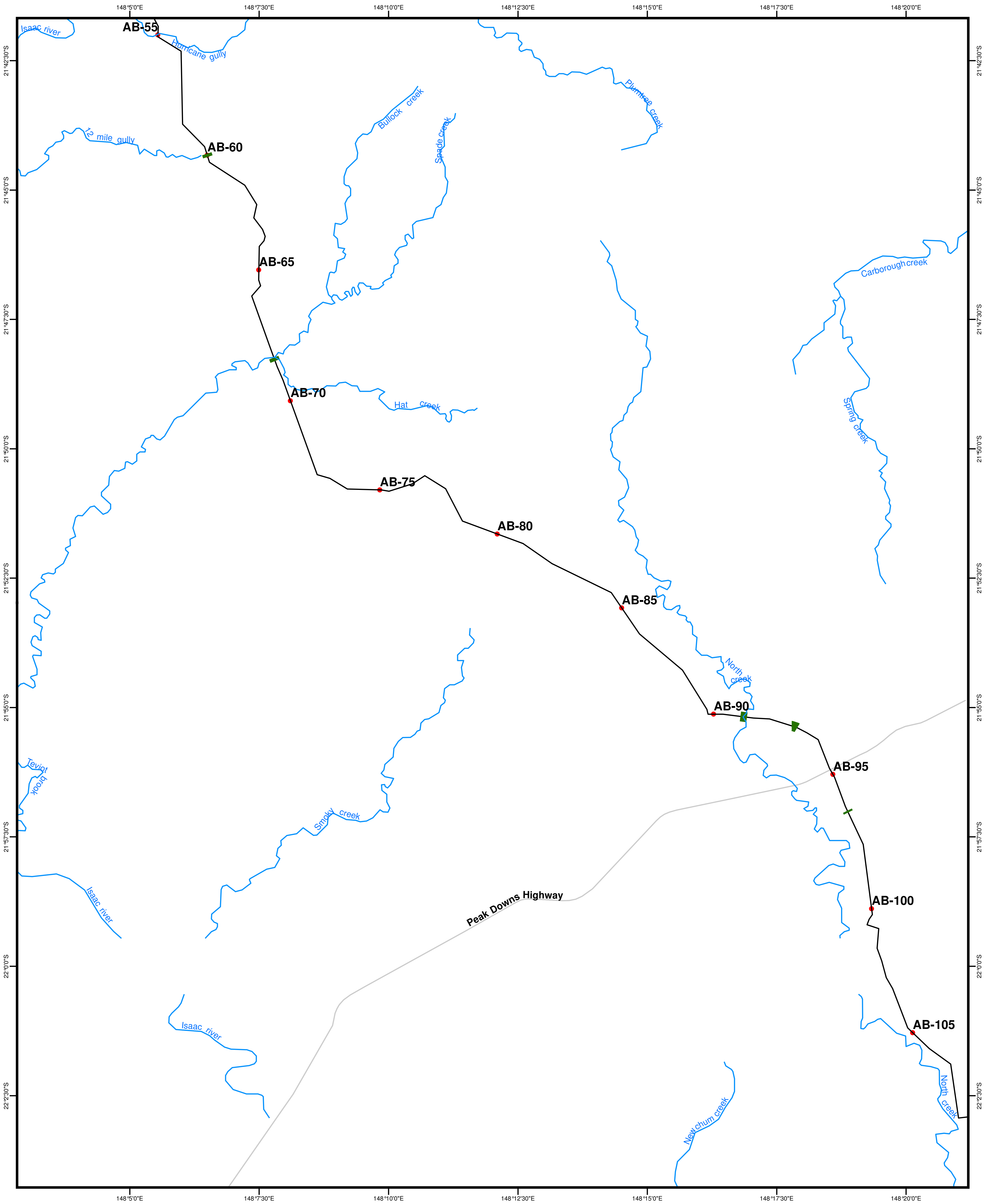

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🟩 **Critical Habitat for Koala**

ABP Route - Rev H1

Waterway

Main roads

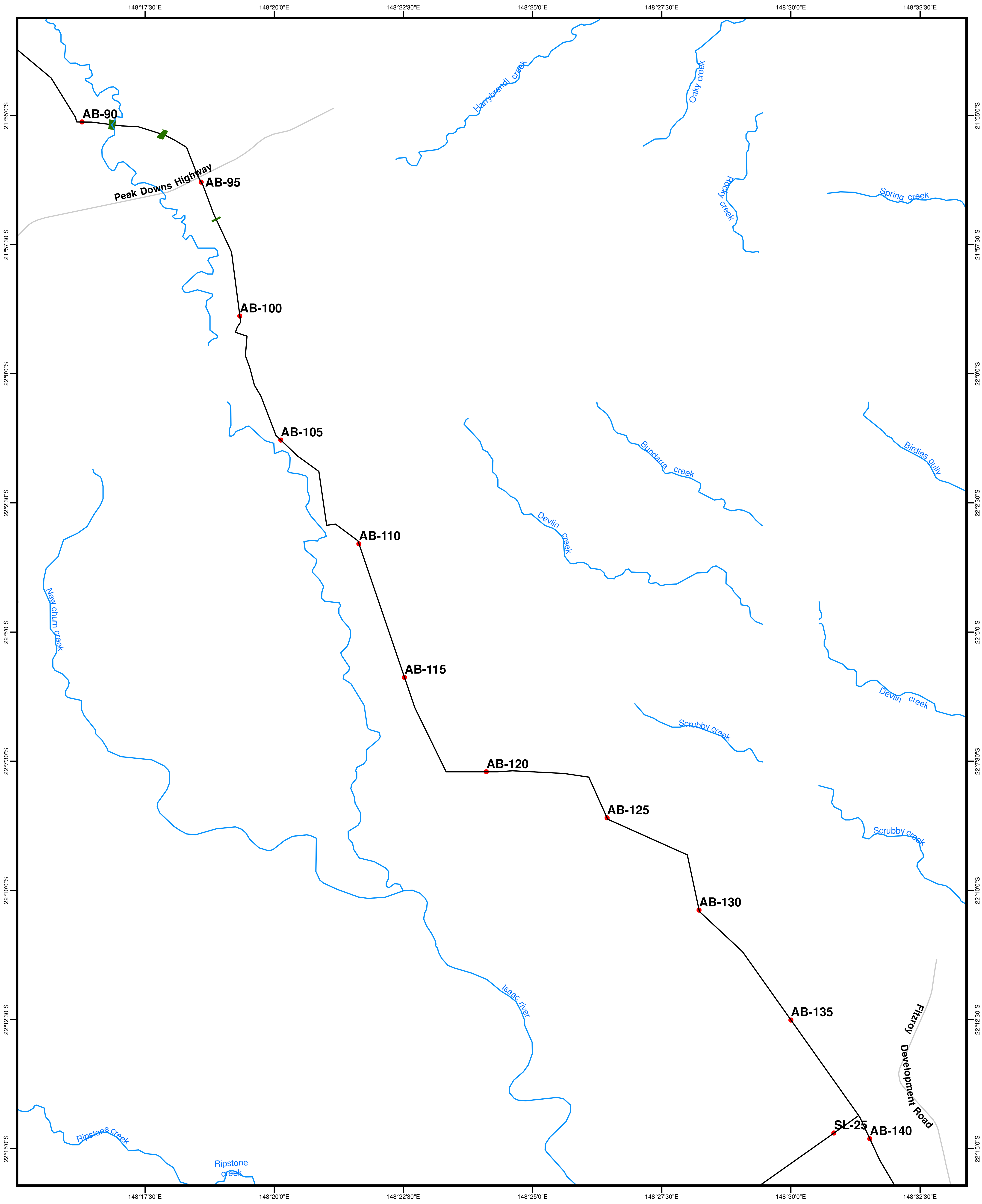
Overview of critical habitat for EPBC listed fauna species

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 3 of 18

A3



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🟩 **Critical Habitat for Koala**

— **ABP Route - Rev H1**

~ **Waterway**

— **Main roads**

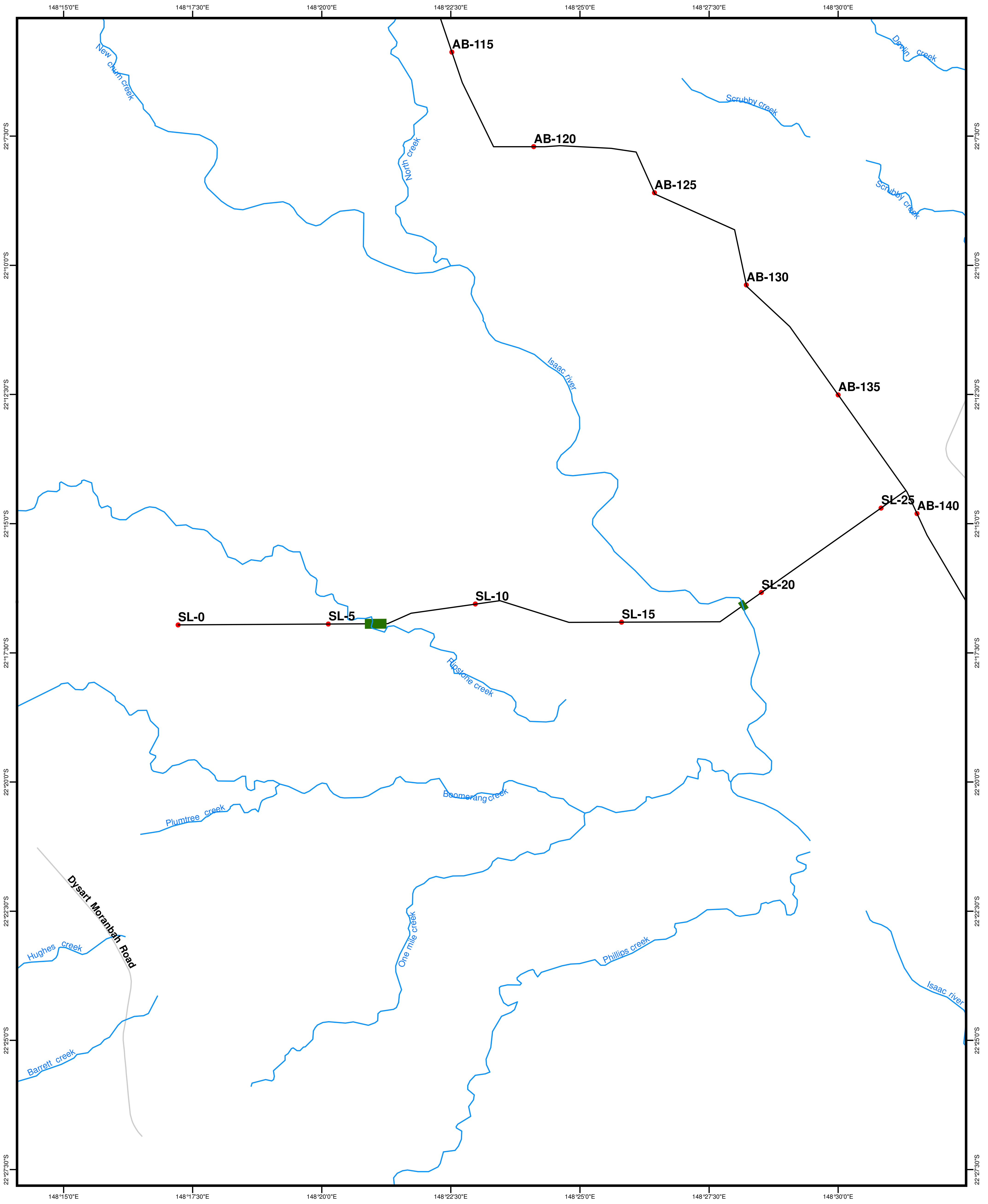
Overview of critical habitat for EPBC listed fauna species

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 4 of 18

A3



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🟩 **Critical Habitat for Koala**

ABP Route - Rev H1

Waterway

Main roads

Overview of critical habitat for EPBC listed fauna species

Arrow Energy Pty Ltd

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Revision H1

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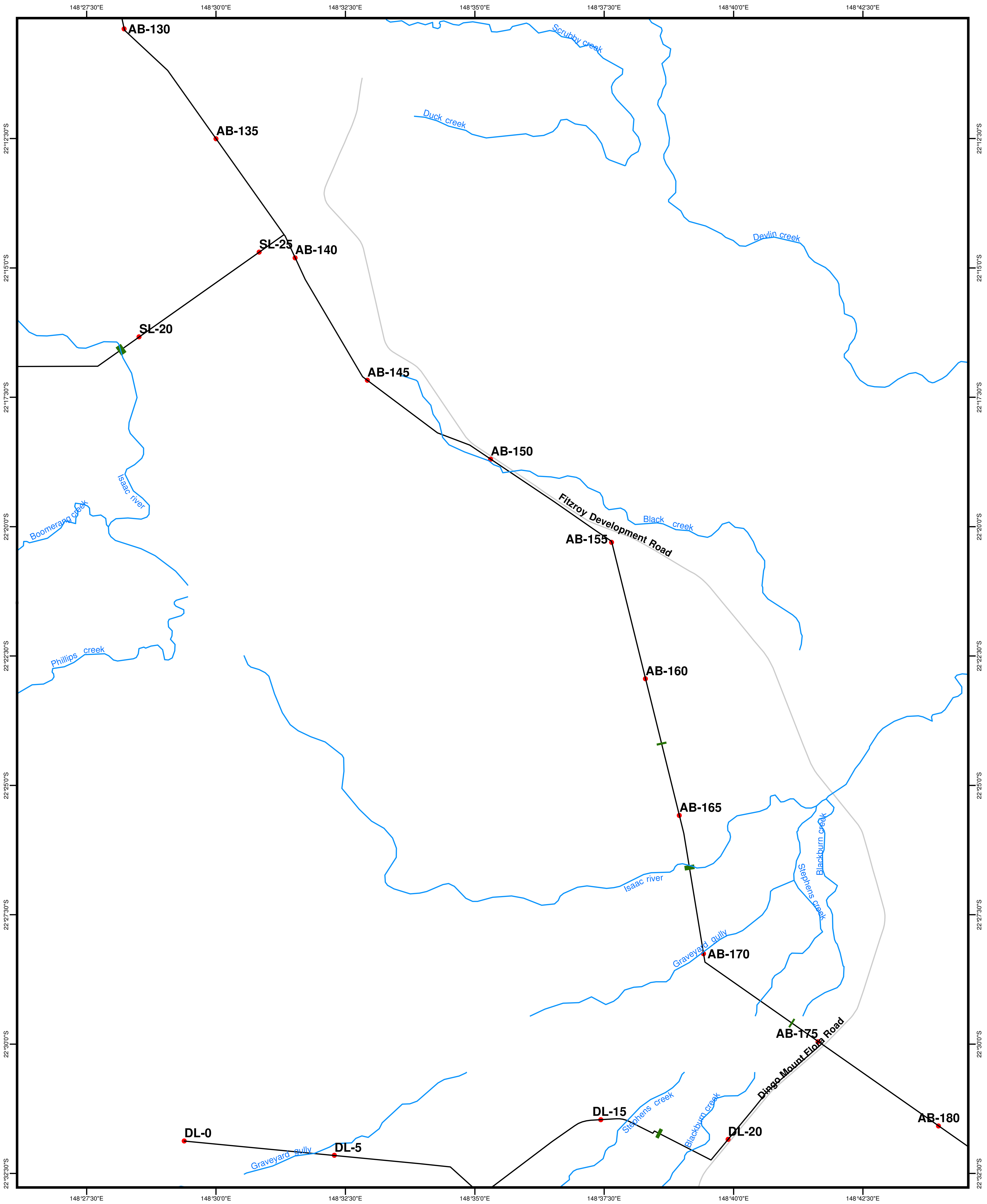

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- 🟩 **Critical Habitat for Koala**
- **ABP Route - Rev H1**
- **Waterway**
- **Main roads**

Overview of critical habitat for EPBC listed fauna species

Arrow Energy Pty Ltd

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Revision H1

Page 6 of 18

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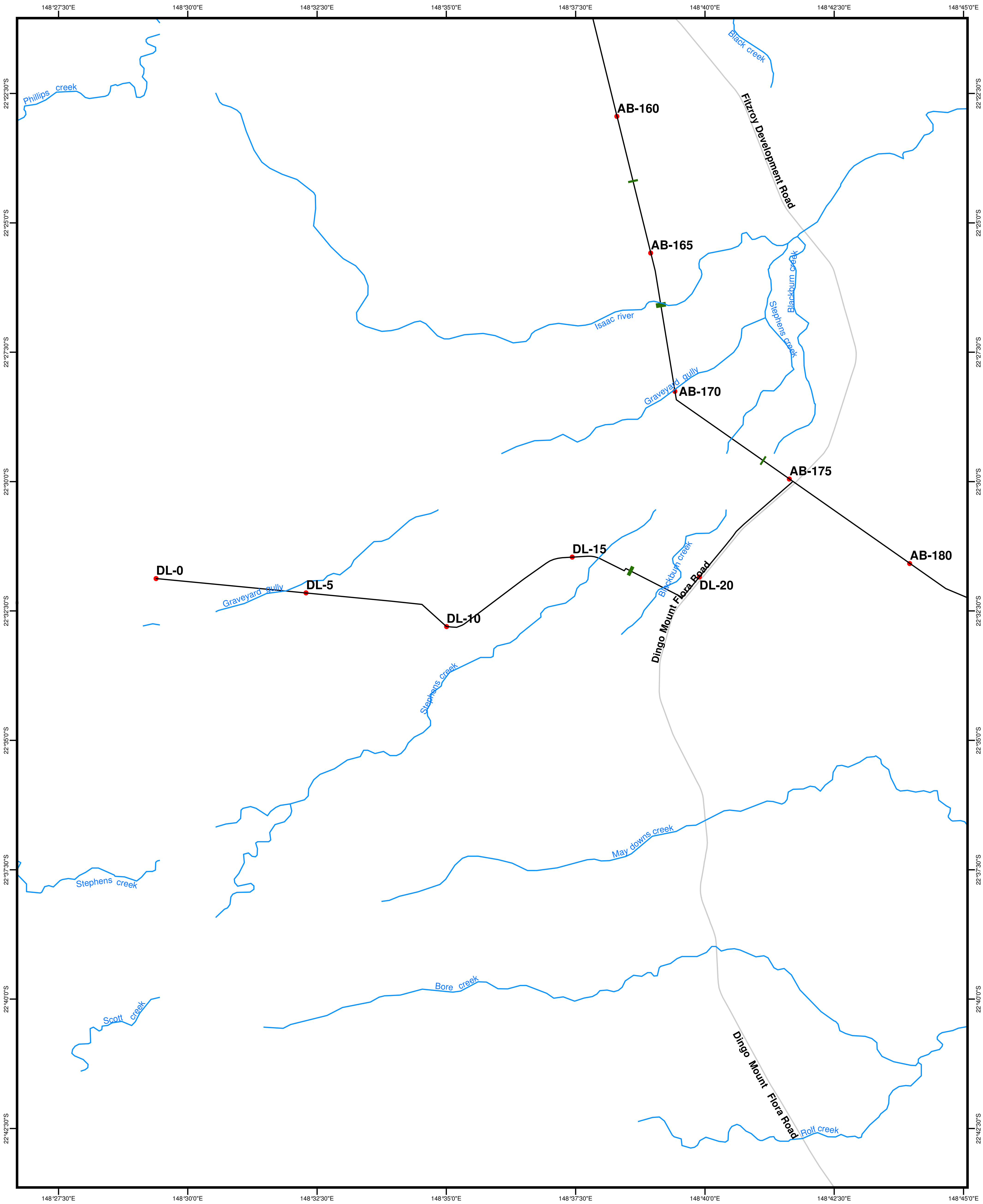

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🟩 **Critical Habitat for Koala**

— **ABP Route - Rev H1**

~ **Waterway**

— **Main roads**

Overview of critical habitat for EPBC listed fauna species

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 7 of 18

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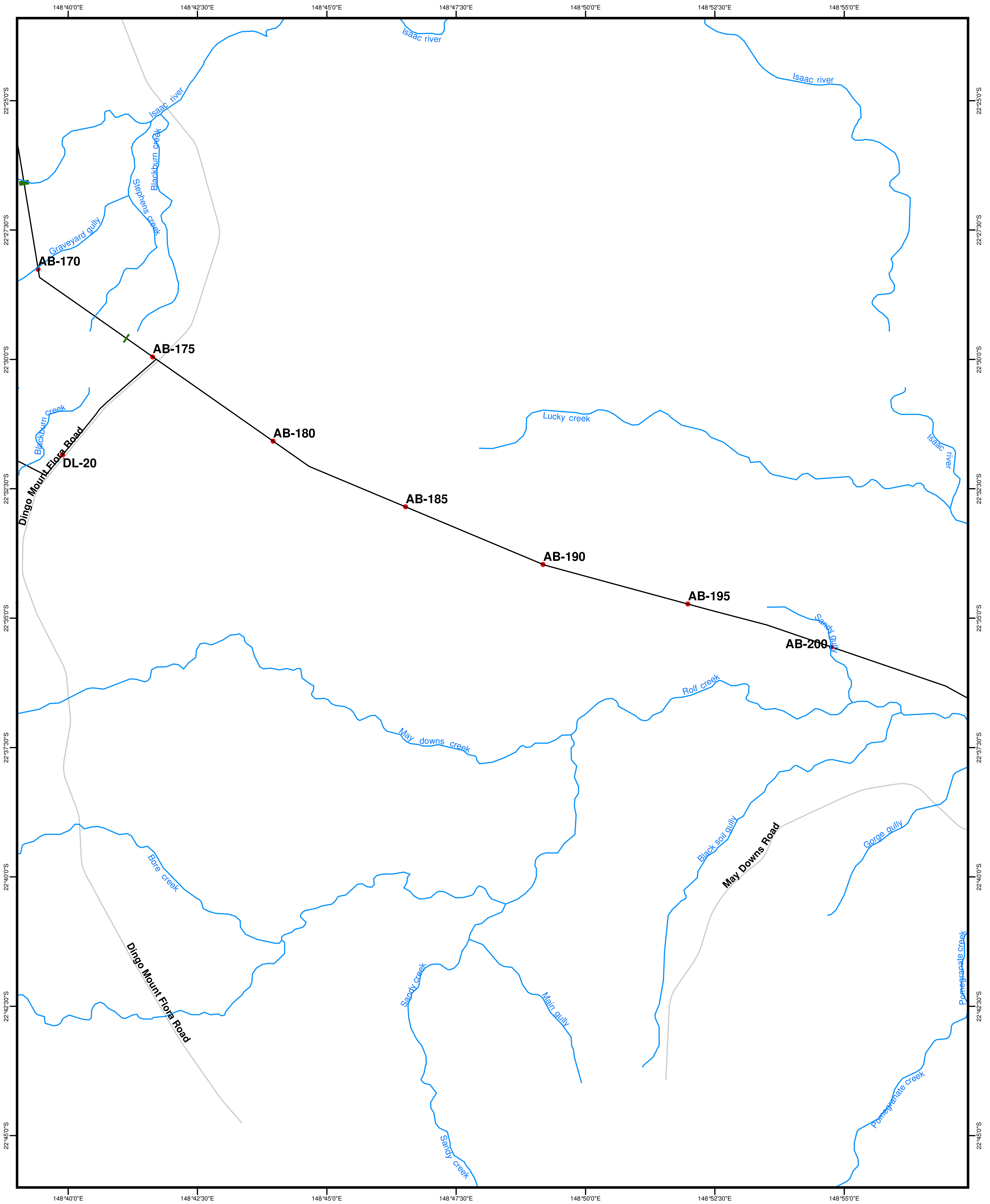

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🟩 **Critical Habitat for Koala**

— **ABP Route - Rev H1**

〰 **Waterway**

— **Main roads**

Overview of critical habitat for EPBC listed fauna species

Arrow Energy Pty Ltd

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Revision H1

Page 8 of 18

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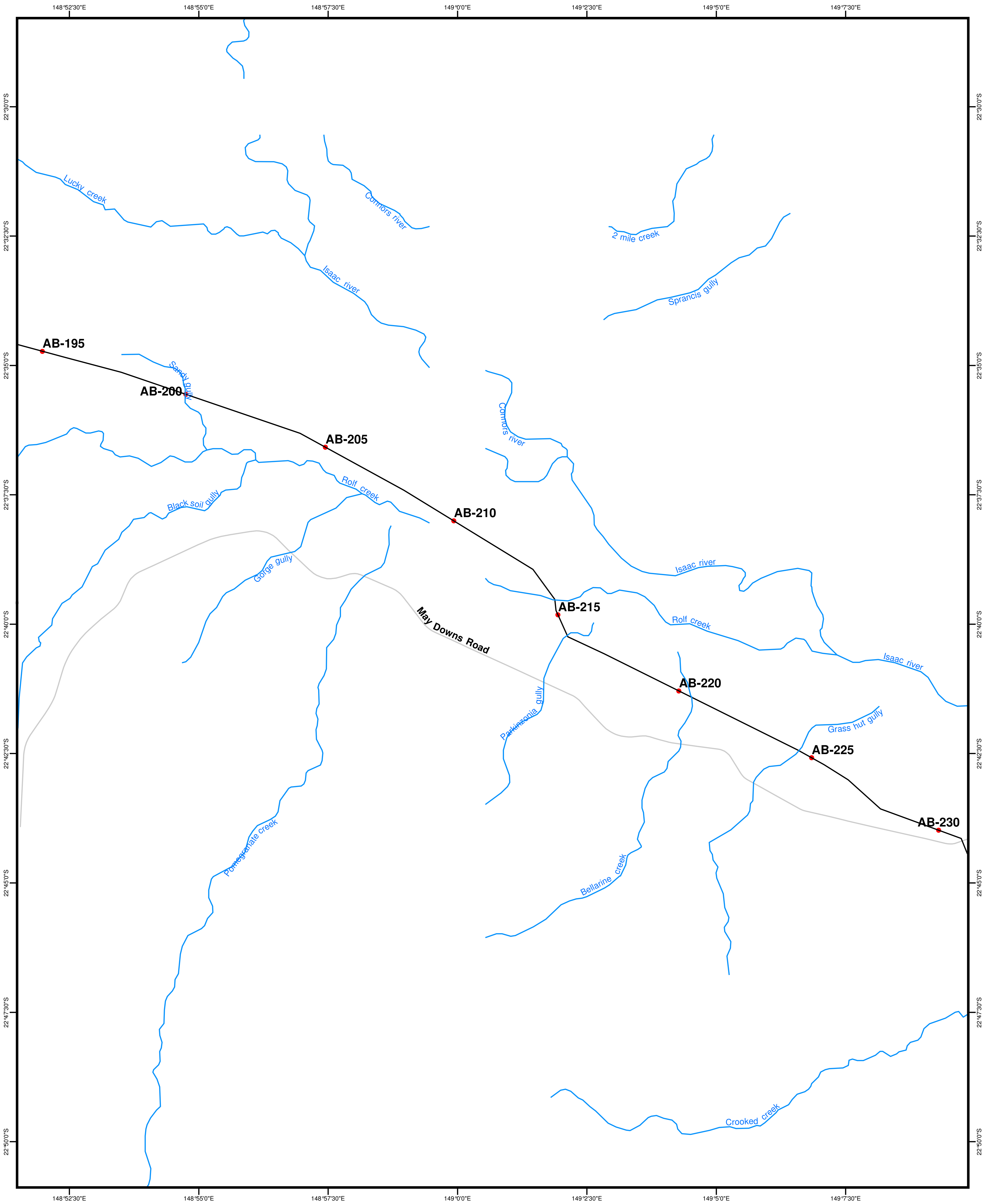

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- — **ABP Route - Rev H1**
- 〰 **Waterway**
- — **Main roads**

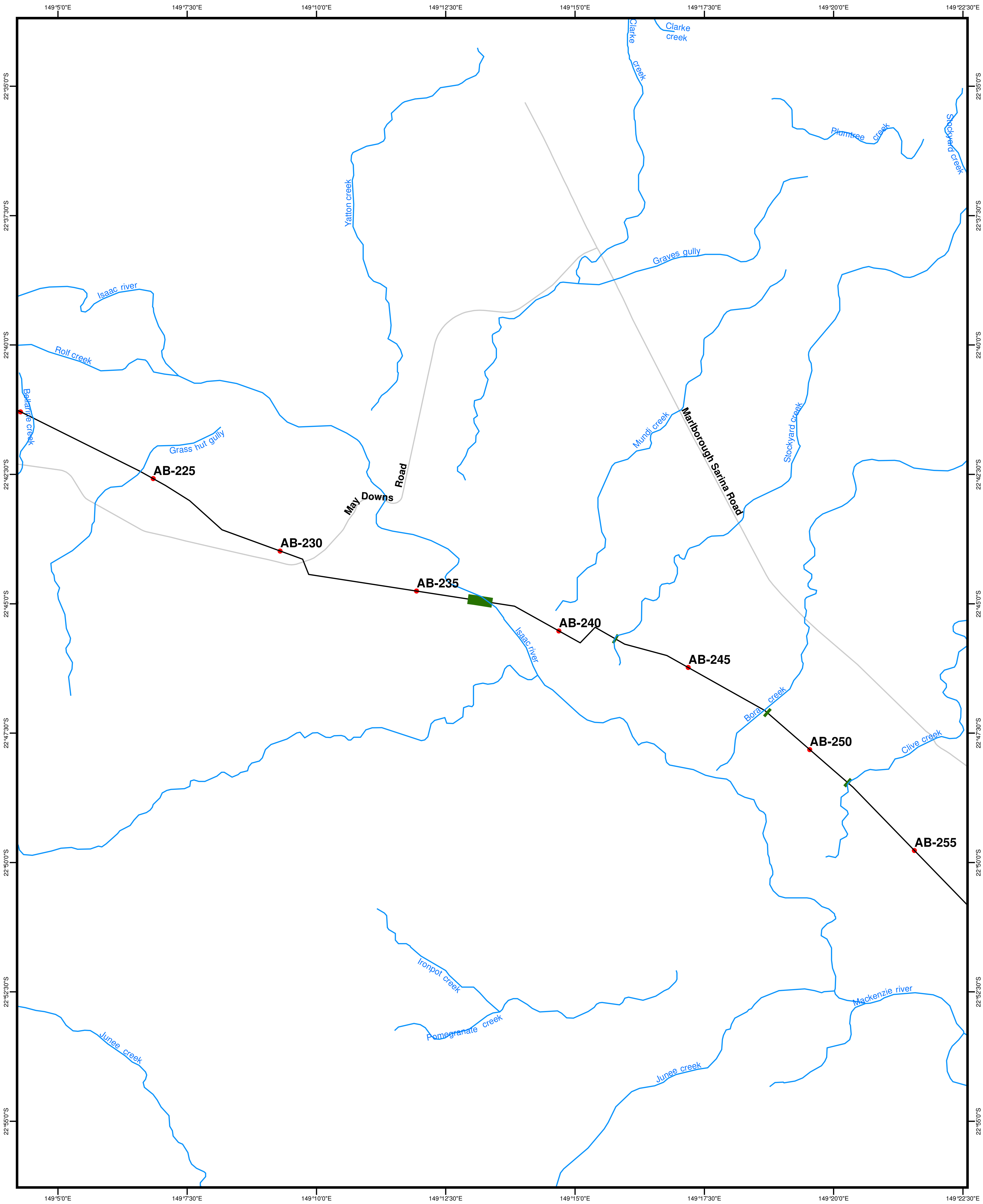
Overview of critical habitat for EPBC listed fauna species

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Page 9 of 18

A3



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— **Main roads**

Overview of critical habitat for EPBC listed fauna species

Arrow Energy Pty Ltd

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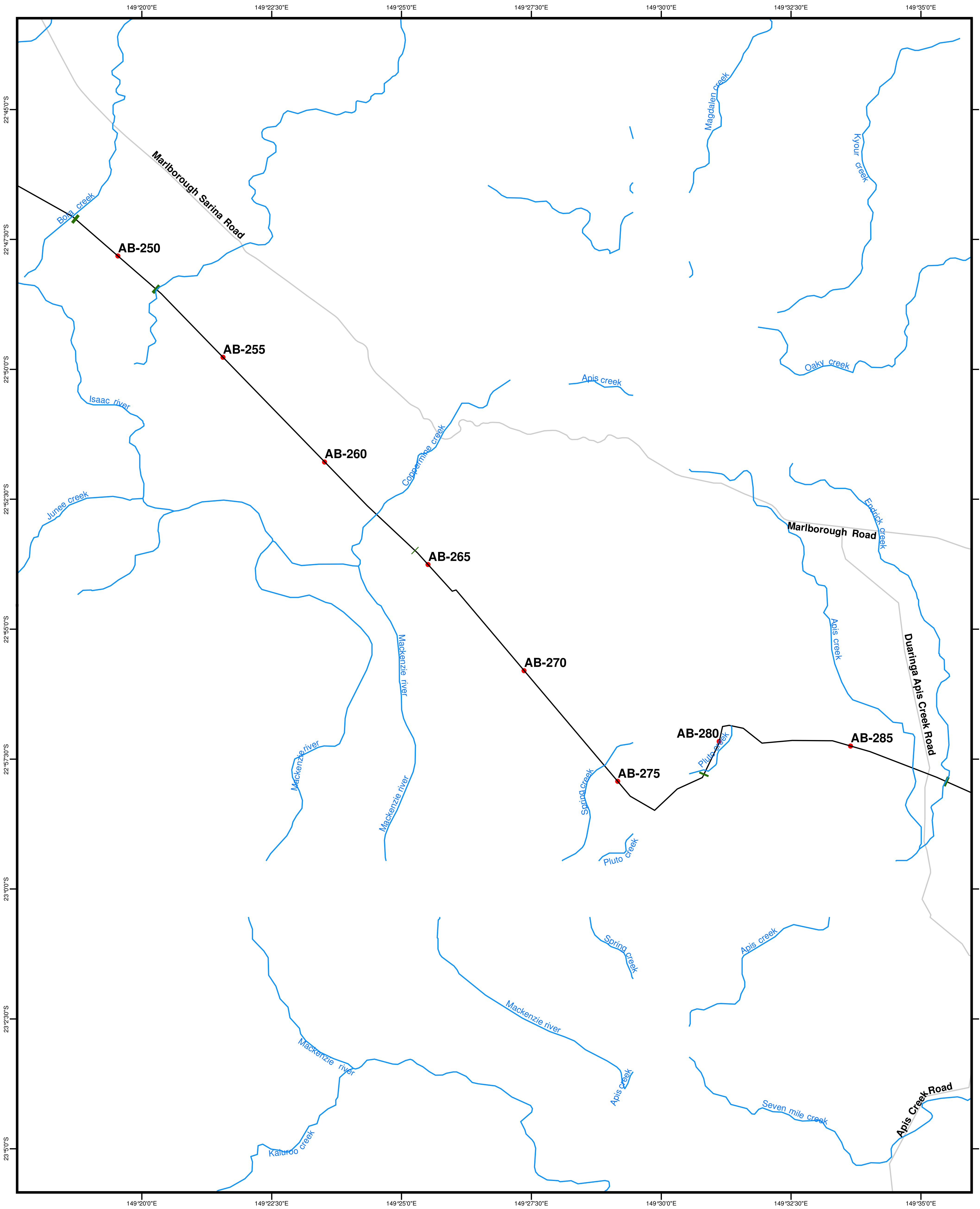
Revision H1

Page 10 of 18

A3



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🟩 **Critical Habitat for Koala**

— **ABP Route - Rev H1**

〰 **Waterway**

— **Main roads**

Overview of critical habitat for EPBC listed fauna species

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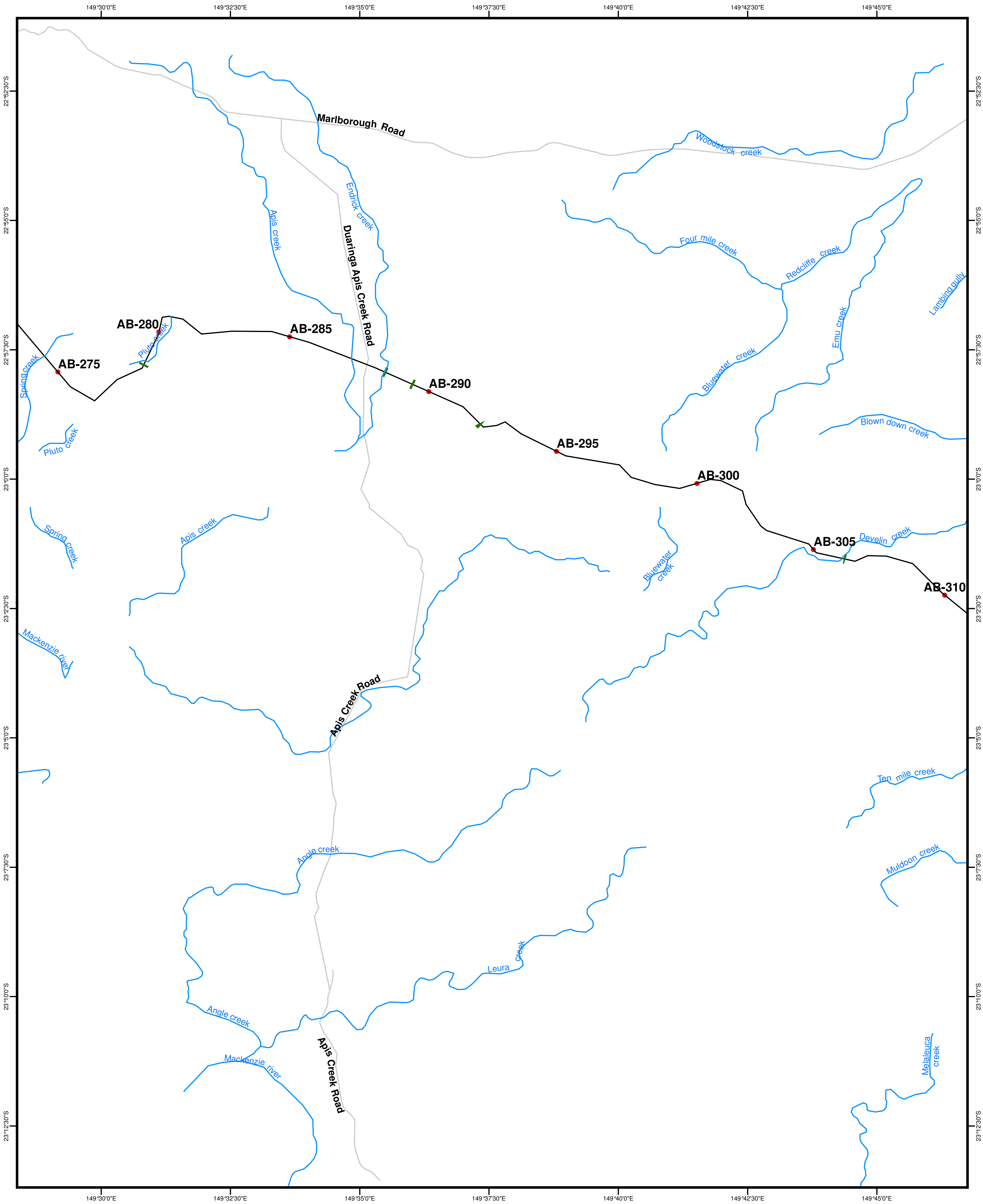
Revision H1

Page 11 of 18

A3



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- 🟩 **Critical Habitat for Koala**
- **ABP Route - Rev H1**
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- **Main roads**

Overview of critical habitat for EPBC listed fauna species

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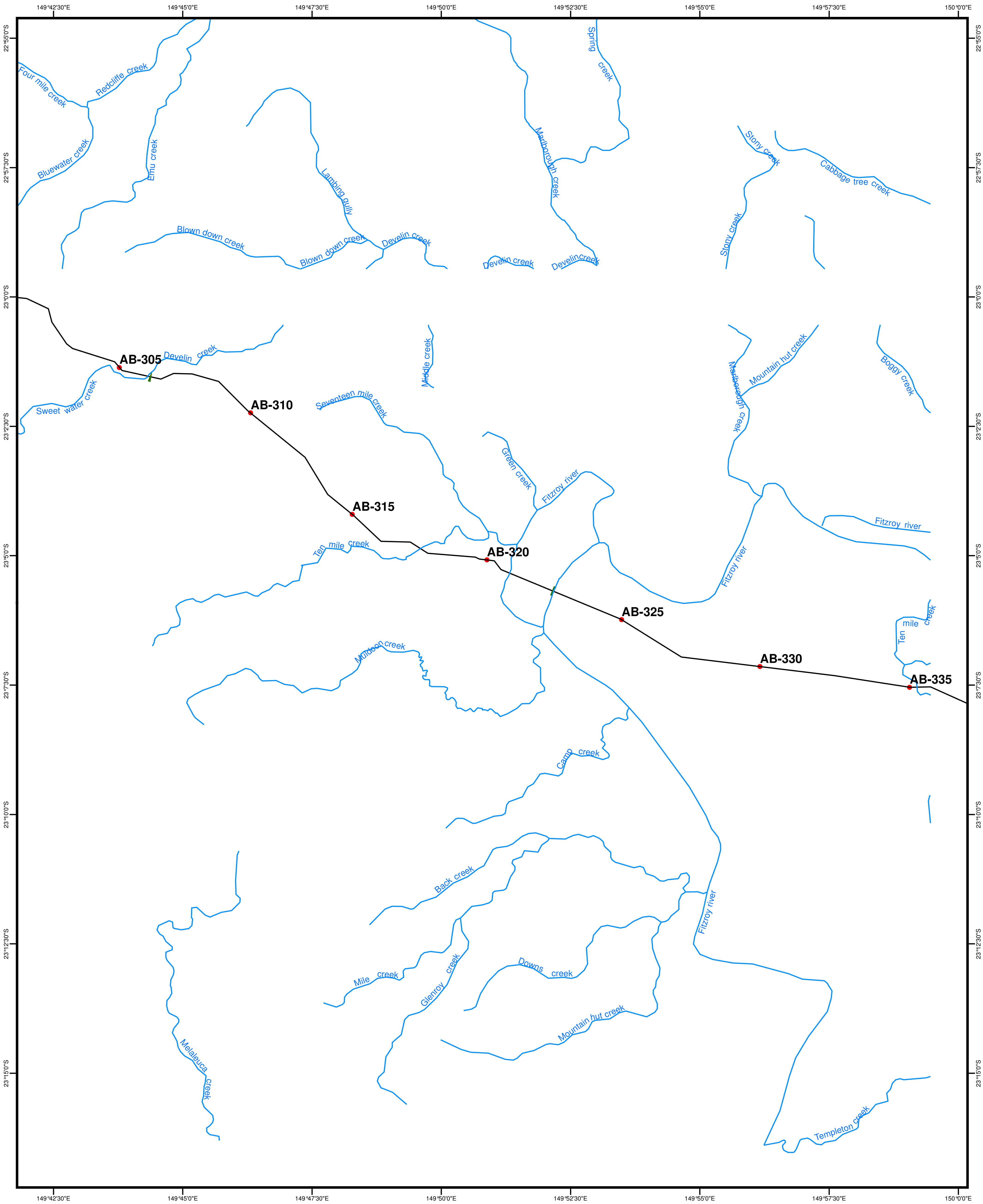

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🟩 **Critical Habitat for Koala**

— **ABP Route - Rev H1**

〰 **Waterway**

Overview of critical habitat for EPBC listed fauna species

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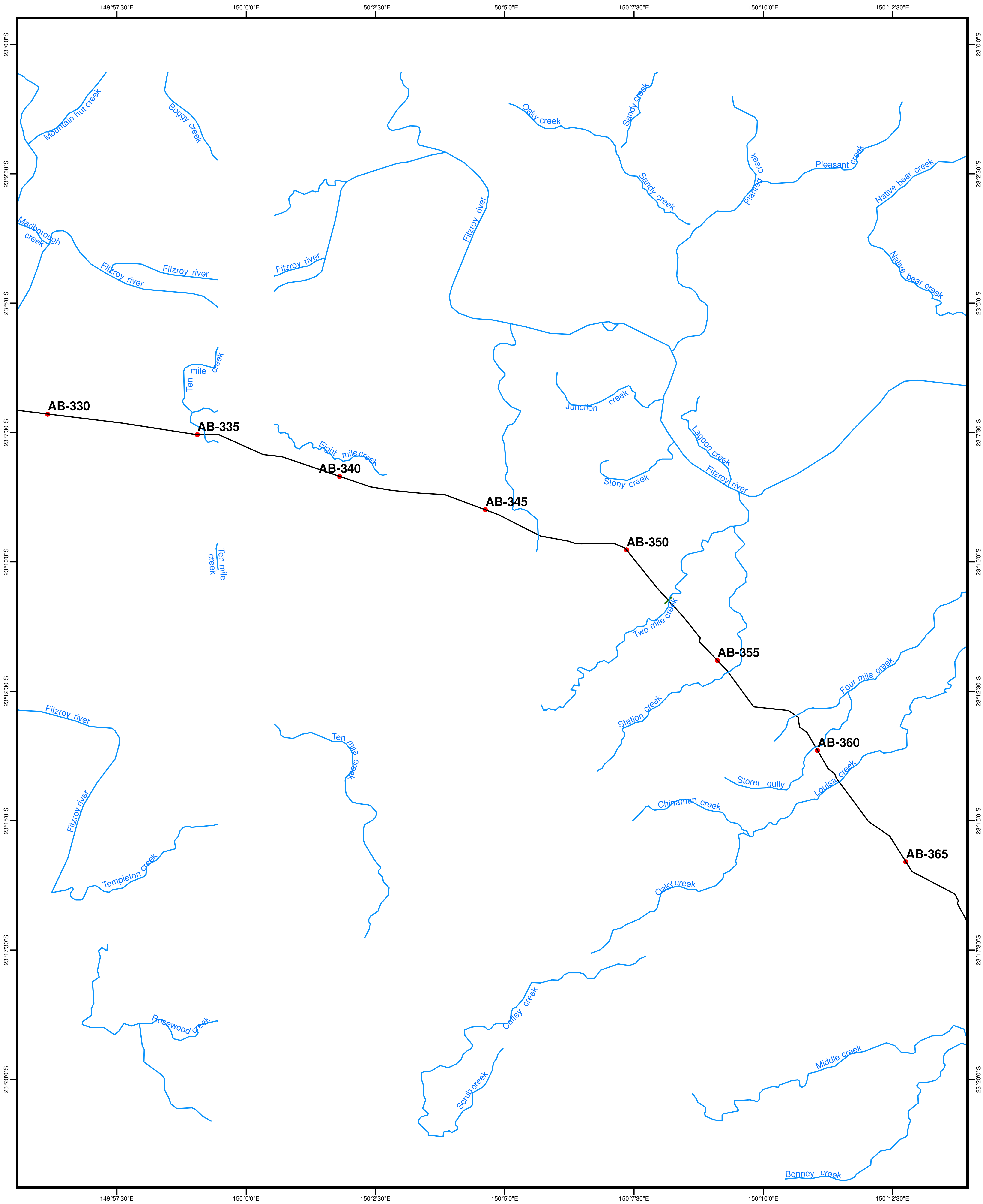
Arrow Bowen Pipeline Revision H1

Page 13 of 18

A3



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— **ABP Route - Rev H1**

〰 **Waterway**

Overview of critical habitat for EPBC listed fauna species

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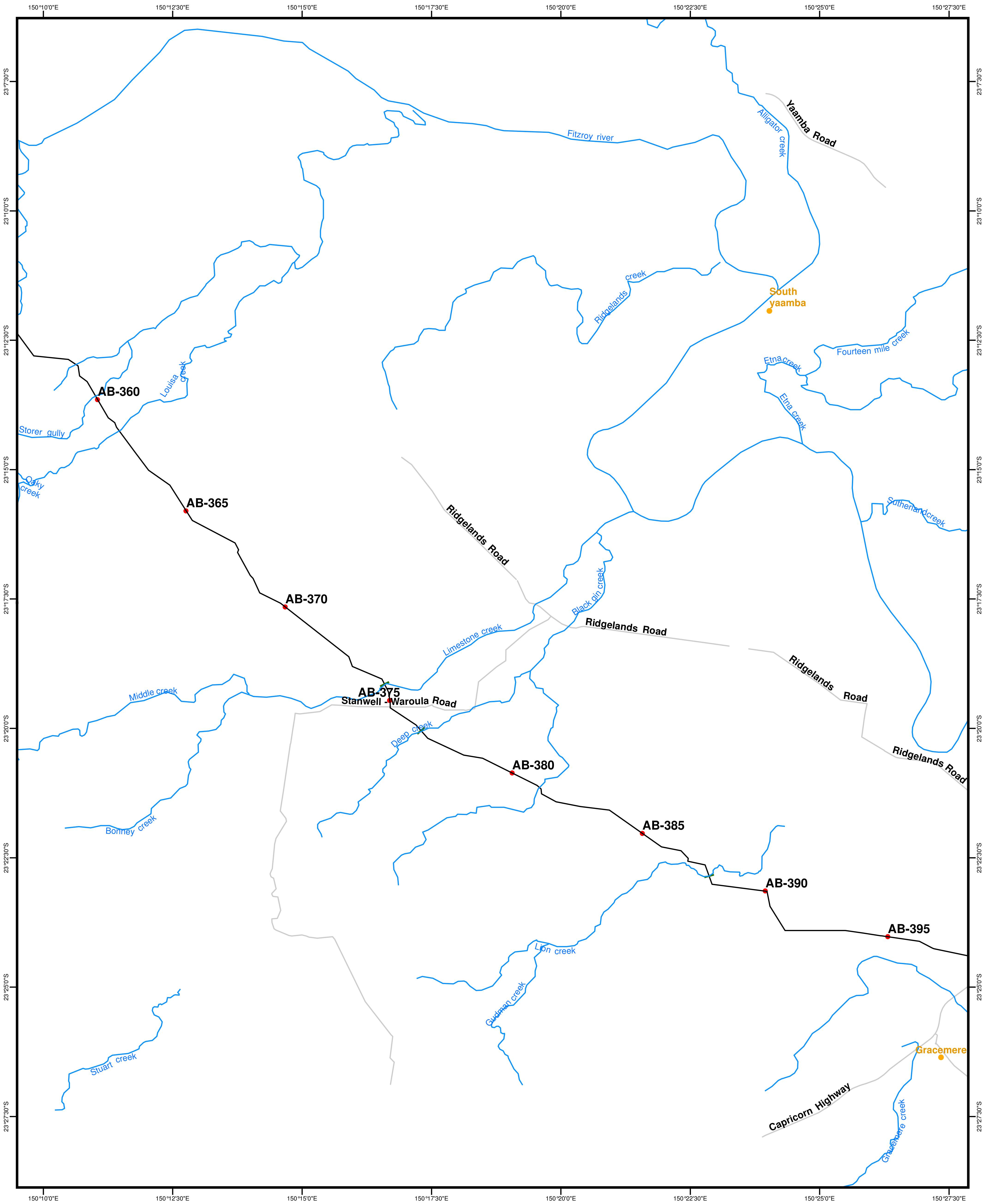
Arrow Bowen Pipeline
Revision H1

Page 14 of 18

A3



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— Main roads

Overview of critical habitat for EPBC listed fauna species

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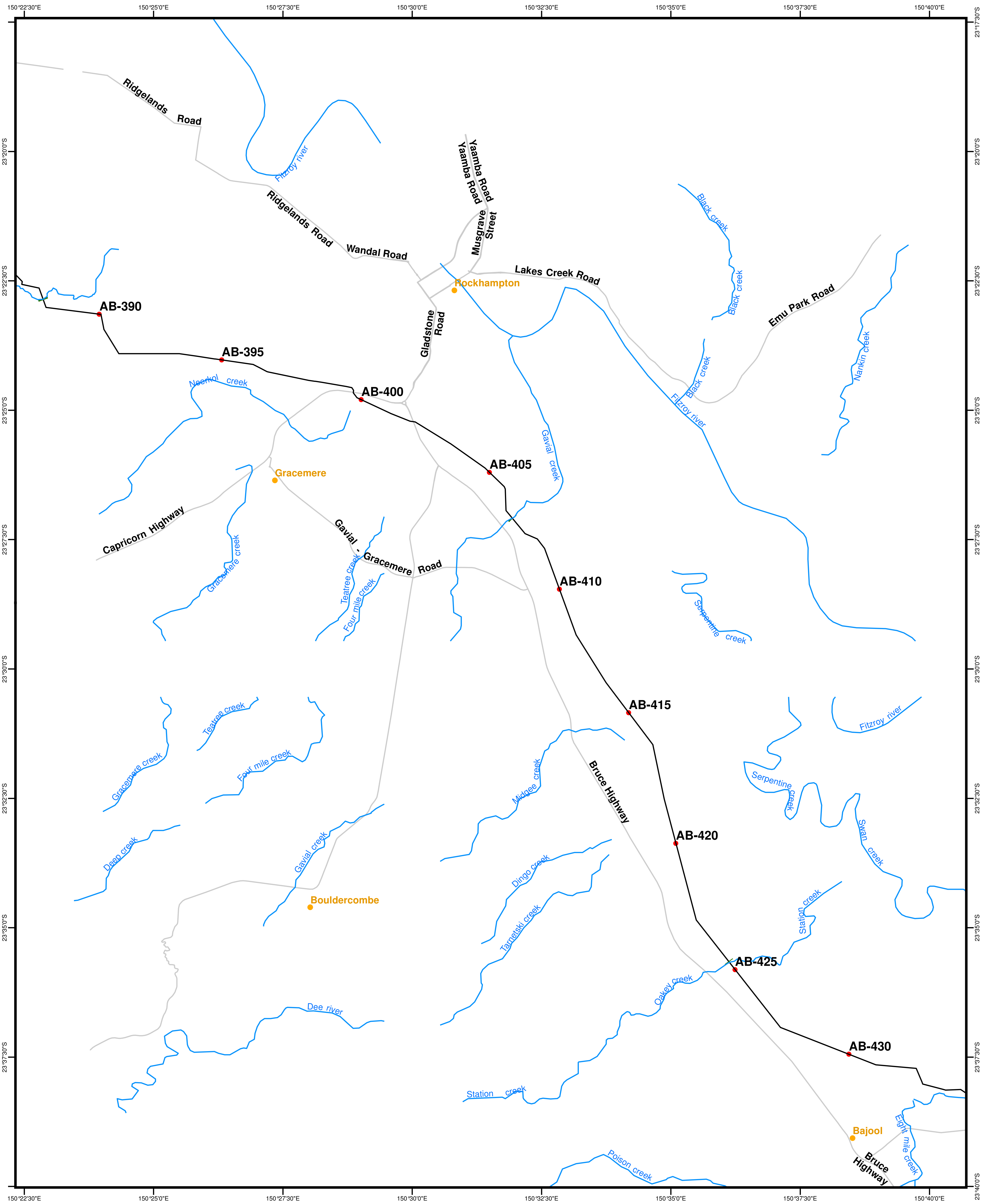
Arrow Bowen Pipeline
Revision H1

Page 15 of 18

A3



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Overview of critical habitat for EPBC listed fauna species

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Arrow Bowen Pipeline
Revision H1

Page 16 of 18

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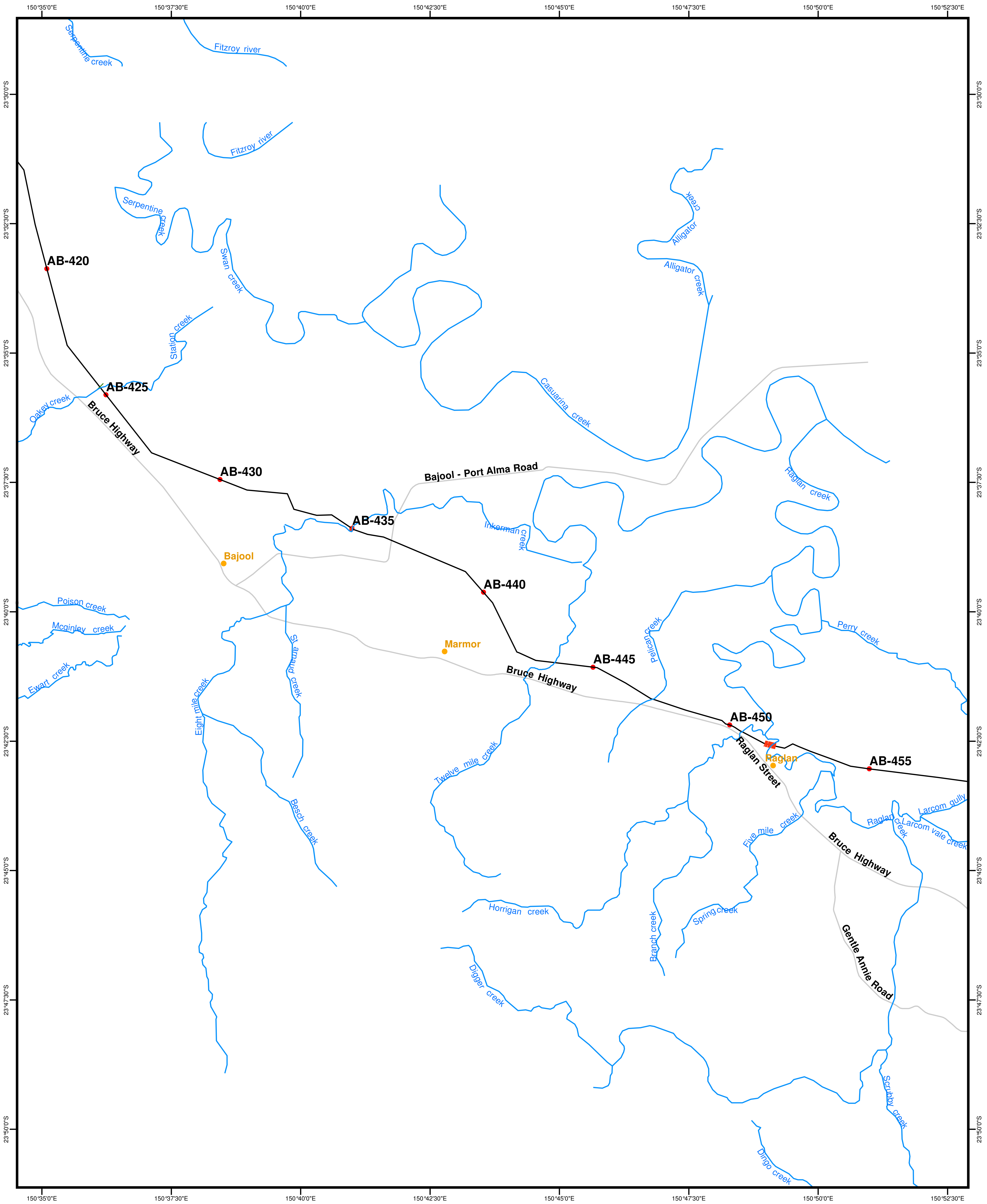

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🟩 Critical Habitat for Koala

🟥 Critical habitat for Water Mouse as defined in the Draft Significant Impact Guidelines (surveyed as marginal habitat)

— ABP Route - Rev H1

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— Main roads

Overview of critical habitat for EPBC listed fauna species

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Revision H1

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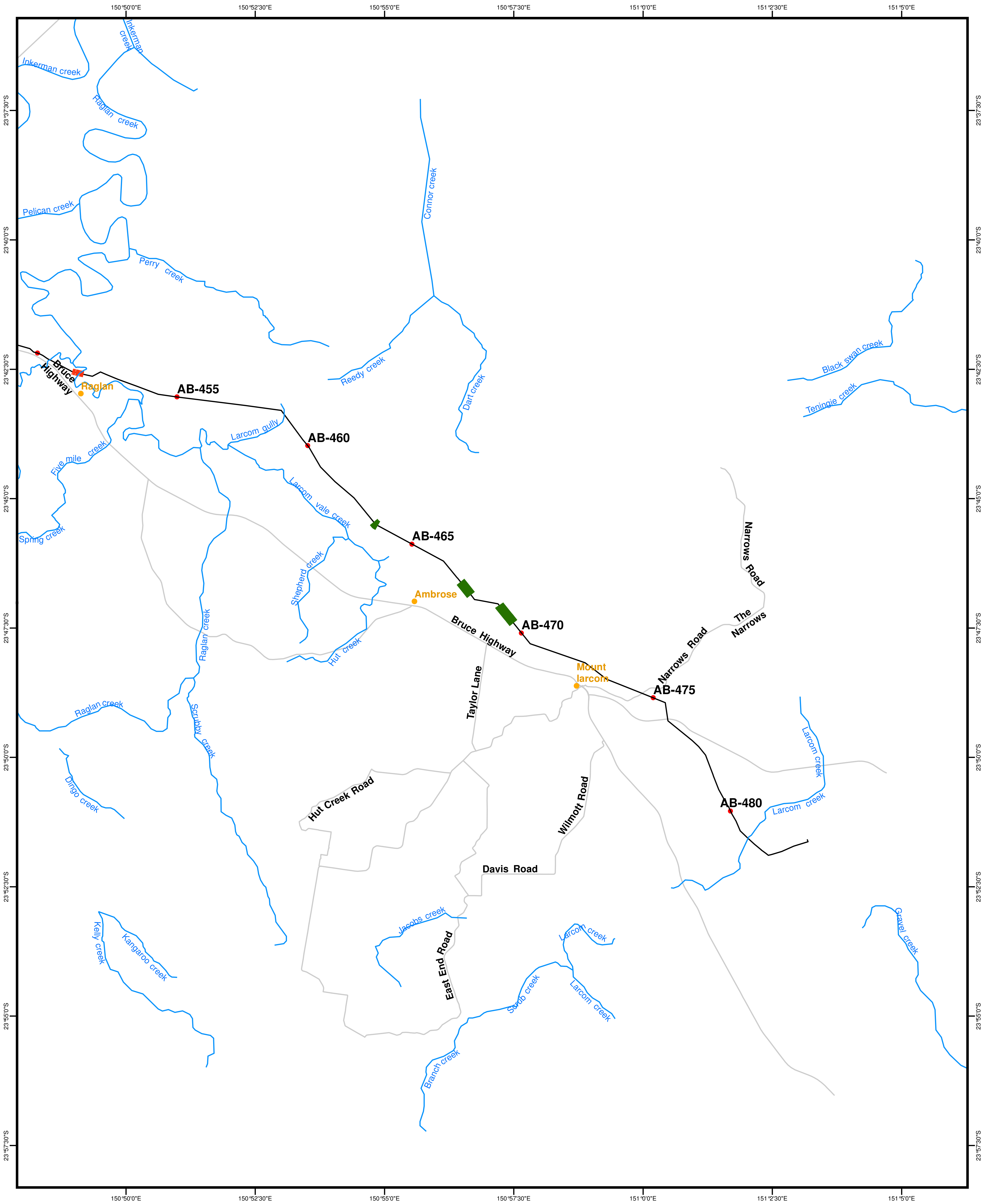

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- 🟥 Critical habitat for Water Mouse as defined in the Draft Significant Impact Guidelines (surveyed as marginal habitat)
- ― ABP Route - Rev H1
- ∿ Waterway
- ― Main roads

Overview of critical habitat for EPBC listed fauna species

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Appendix 2 – *Epthianura crocea macgregori* (Dawson Yellow Chat) Management Plan

Management Plan for Yellow Chat (Dawson) (*Epthianura crocea macgregori*) - trenching of the Arrow Bowen Pipeline

November 2013

ARROW ENERGY

Introduction

This management plan outlines the management measures to be implemented should trenching be required upstream of potential Yellow Chat habitat on Inkerman, Twelve Mile and Raglan Creeks in the unlikely event that trenchless techniques cannot be utilized due to geotechnical constraints. This plan should be read in conjunction with the Yellow Chat dossier.

Context

The Dawson Yellow Chat is a small, yellow bird which is restricted to coastal areas of central Queensland. They occur on marine plains, grass-sedge wetlands or supratidal saltmarshes that are temporarily flooded. They are listed as Critically Endangered under the *Environment Protection and Biodiversity Conservation Act* 1999.

Targeted surveys for Dawson Yellow Chat were undertaken in December 2011 and March 2012. The species was recorded on Twelve Mile Creek approximately 1 km north (downstream) of the proposed crossing of the ABP pipeline at KP 443.7. Birdlife Australia has records of Yellow Chat on Twelve Mile Creek 250 m upstream of the pipeline. Surveys in October 2013 at Inkerman, Twelve Mile and Raglan Creeks did not record Yellow Chats within the ROW. During the same surveys, habitat assessments were conducted to classify potential habitat at the crossing points as either marginal or critical habitat. Critical habitat is defined in the National Recovery Plan (Houston and Melzer, 2008) as wetlands and associated grasslands on seasonally inundated marine plains that contain shallow braided channels, and depressions with a mosaic of dense sedge-beds, grasslands, tall samphire and areas of mud and/or shallow water. Marginal habitat is defined as other areas of coastal wetlands which do not contain critical habitat features. Based on this definition, areas that are dominated by mangroves and saltwater couch (*Sporobulus virginicus*) and do not contain significant areas of samphire and sedge beds are considered to be marginal habitat. It is unlikely that breeding occurs in marginal habitats but they may be used for foraging during the breeding season.

Habitat at the Raglan Creek crossing point consists of saltwater couch grassland and mangroves lining a tidal watercourse (REs 11.1.4 and 11.1.1). This habitat is considered to be marginal habitat as it does not contain significant areas of samphire or sedgelands and no previous surveys have recorded birds in or adjacent to this location.

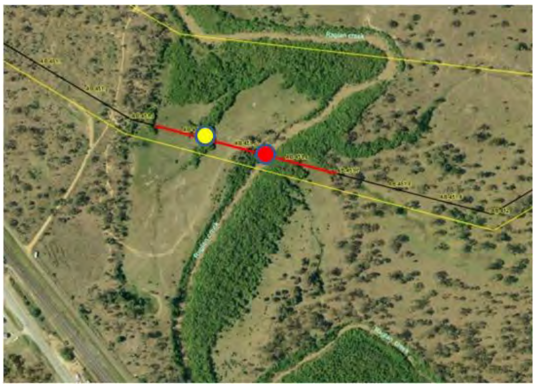
The habitat on Inkerman Creek consisted of saltwater couch grasslands with small mangroves and scattered samphires (REs 11.1.4 and 11.1.1). Based on this assessment, the habitat is considered to be marginal.

Yellow Chat have been recorded both upstream and downstream of the Twelve Mile Creek crossing. Habitat at this crossing consists of a freshwater creek lined with a narrow band of *Typha* sp. and saltwater couch with cleared paddock on either side. This habitat is considered to be marginal as it does not contain areas of samphire or significant amounts of sedges. Although birds have been recorded near this crossing previously, it is unlikely that the habitat is suitable for breeding but may be used for foraging during the breeding season.

Based on this information, a total of 1.25 ha of marginal habitat could be impacted on Inkerman, Raglan and Twelve Mile Creeks (Table 2). All of this habitat would be avoided if trenchless techniques are used to cross these creeks.

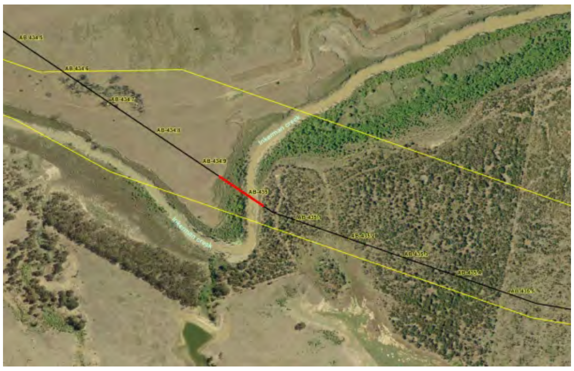
Raglan Creek crossing. ABP will cross several patches of mangrove and saltwater couch habitat at Raglan Creek. The photograph shows one mangrove patch crossed by ABP (represented by the yellow dot in the map below). This habitat is considered to be marginal.

Raglan Creek crossing. Crossing of the larger channel on Raglan Creek (red dot in map below). This habitat is considered to be marginal.



Aerial image showing the crossing point at **Raglan Creek**. Yellow lines indicate the boundaries of the SGIC. Recent surveys have found that the habitat at this crossing point is marginal and is unlikely to contain significant populations of Yellow Chat.

Inkerman creek crossing. The habitat at this creek crossing includes saltwater couch grasslands adjacent to young mangroves. Yellow Chat have been recorded downstream of this point but the crossing point contains marginal habitat.



Aerial image showing the crossing point at **Inkerman Creek**. Yellow lines represent the boundaries of the SGIC. The red line represents the potential habitat at the crossing point. This habitat is considered to be marginal.

Twelve Mile Creek. The habitat at the crossing point consists of freshwater wetland with fringing freshwater plants and *Sporobulus* grasslands. Yellow Chat have been recorded both east and west of this point but the habitat is considered to be marginal.

Aerial image showing the crossing point at **Twelve Mile Creek**. The yellow line shows the boundaries of the SGIC. The red line represents the marginal habitat at the crossing point. Yellow Chats have been recorded both east and west of this point.

Impacts

In the unlikely event that opening trenching is required to cross Raglan, Twelve Mile and Inkerman Creeks, potential direct impacts within the ROW could include:

- loss of potential habitat
- mortality of adults.

Yellow Chats have been recorded by Birds Australia and Yellow Chat expert, Wayne Houston, downstream of the crossing points on Twelve Mile, Raglan and Inkerman Creeks. Trenching of the ABP across these creeks could indirectly impact these downstream Yellow Chat populations. Indirect impacts associated with trenching could include:

- downstream impacts on habitat caused by changes in water quality and hydrology
- increase in weed abundance
- increase in pest animal abundance
- noise and disturbance.

Table 1 shows the potential impacts to the Dawson Yellow Chat, with an assessment of the raw risk rating before mitigation and the residual risk after mitigation. The management strategies used to mitigate potential impacts are detailed in Table 2.

Table 2 identifies:

- management objectives for mitigating potential direct and indirect impacts
- performance criteria and monitoring tasks for measuring the success of management strategies
- corrective measures to address any non-compliance with performance criteria.

Table 1 Potential impacts of trenching Raglan, Twelve Mile and Inkerman Creeks on Dawson Yellow Chat. Management strategies are listed in Table 2.

Potential Impact	Raw risk (before mitigation)	Residual risk (after mitigation)
DIRECT IMPACTS		
Removal of habitat* · Temporary removal of marginal wetland habitat which could provide potential foraging and sheltering habitat	L	L
Mortality of adults · Loss of individuals through vehicle or equipment strike	L	L
INDIRECT IMPACTS		
Changes in hydrology · Changes in wet/ dry season cycle leading to changes in vegetation in downstream Dawson Yellow Chat habitat	L	l

Potential Impact	Raw risk (before mitigation)	Residual risk (after mitigation)
Changes in water quality · Sedimentation of the waterway caused by erosion in the ROW leading to changes in downstream Dawson Yellow Chat habitat · Pollution of waterways by hydrocarbons	M	L
Dust · Smothering of plants used for shelter and foraging	I	I
Noise and disturbance* · Displacement of individuals into more marginal habitat leading to decreased survival and overall decline in population	I	I
Increase in weed abundance · Smothering of downstream vegetation by weeds potentially leading to loss of plant diversity and displacement of native plants	L	I
Increase in pest animal abundance · Introduction of exotic predators to habitat i.e. foxes, cats, dogs leading to increased predation on Dawson Yellow Chats · Increased opportunity for competitors which prefer disturbed habitats	L	I
Increase in fire frequency · Increased chances of wildfire during construction, e.g. sparks from welding, personnel smoking	L	I

Ratings: I-Insignificant, L- Low, M – Moderate,

Table 2 Management strategies and performance criteria to assess effectiveness of management measures.

Performance objective	Management strategies	Performance criteria	Monitoring	Corrective Action
Avoid or minimise the impacts of temporary removal of Yellow Chat habitat	· Minimise area of habitat to be cleared in ROW by utilising existing clearing and reducing ROW width. Record clearing areas and habitat to be retained on alignment sheets. · Clearly mark out areas to be cleared and retained. · Erect barriers around retained habitat to restrict access and avoid disturbance. · Rehabilitate the ROW following construction. · A suitably qualified and experienced fauna spotter/ handler will be present during vegetation clearing to minimise the potential harm to fauna species and recover any injured fauna.	· Compliance with clearing permits. · Disturbance of Yellow Chat during construction of the pipeline and associated access tracks. · Disturbance of potential and critical habitat outside designated areas.	· Inspect cleared areas and audit of compliance with clearing permits. · Record recovered and released, injured or dead Yellow Chat. · Inspect adjacent habitat for signs of disturbance caused by construction activities.	· Report to relevant authorities. · Revise management strategies to prevent recurrence. · Rehabilitate any adjacent disturbed areas.
Minimise deaths of Yellow Chat by vehicle and machinery strike	· Reduce vehicle speeds in vicinity of Raglan, Twelve Mile and Inkerman Creeks. · A suitably qualified and experienced fauna spotter/ handler will be present during vegetation clearing to minimise the potential harm to fauna species and recover any injured fauna. · All fauna captured during the preconstruction survey and spotter/catcher activities should be re-located	· No vehicle speeding breaches. · Recorded injury or deaths of fauna.	· IVMS reports. · Records of fauna translocations. · Records of injury or deaths of fauna.	· Driver training programs. · Report to relevant authorities. · Revise spotter catcher procedures to prevent recurrence.

Performance objective	Management strategies	Performance criteria	Monitoring	Corrective Action
Minimise changes to waterway hydrology	· Construction of watercourse crossings will be scheduled outside of the wet season · Construction will be scheduled during times of minimal tidal flow (neap tides) where practicable to reduce the need for bunding. · Flows will be reinstated at each flowing watercourse crossing site as soon as trenching is completed. · Water diversions will be undertaken for the shortest period of time possible. · Flume pipes or coffer dams will be used to allow free movement of tidal waters during construction where required. · Bunds installed to reduce tidal intrusions during construction will be in place for the shortest possible time and will be fully removed immediately after construction. · Bank morphology and topography will be reinstated immediately after construction to reduce erosion. · An aquatic values management plan for Inkerman, Twelve Mile and Raglan Creeks will be developed and implemented.	· Compliance with permits (including waterway barrier permits) in accordance with the SP Act and Fisheries Act.	· Audit Species Specific Management Plan and Aquatic Values Management Plan.	· Report to relevant authorities. · Revise management strategies to prevent recurrence.

Performance objective	Management strategies	Performance criteria	Monitoring	Corrective Action
Minimise impacts to water quality	· Water quality will be monitored upstream, and downstream of creek crossings to monitor water quality parameters. · An Erosion and Sediment Control Plan will be prepared and implemented and will include installing and maintaining sediment control devices around exposed areas and earthworks adjacent to aquatic habitats. · Bank morphology and topography will be reinstated as near as practicable to the original profile to reduce erosion. · Construction in Yellow Chat habitat will be undertaken outside the wet season when runoff is less likely. · Install and maintain sediment curtains during and for one month following construction. · Construction will be undertaken during periods of minimum tidal variation to reduce water flow. · An aquatic values management plan for Inkerman, Twelve Mile and Raglan Creeks will be developed and implemented.	· Crossing in accordance with the methodology described in the Aquatic Values Management Plan. · Changes in water quality parameters.	· Monitoring and maintaining water quality (before, during and after construction).	Report to relevant authorities. · Revise management strategies to prevent recurrence.
Minimise noise and disturbance in Yellow Chat habitat	· Where possible work on Inkerman and Twelve Mile Creeks will not be conducted at night to reduce disturbance through noise and light.	· Disturbance of Dawson Yellow Chat during construction of the pipeline and associated access tracks.	· Record recovered and released, injured or dead Yellow Chat.	· Report to relevant authorities. · Revise management strategies to prevent recurrence.
Reduce dust emissions during construction	· An air quality management plan will be developed and implemented to manage dust.	· Dust on vegetation in adjacent Dawson Yellow Chat habitat.	· Dust levels on vegetation to be monitored	· Report to relevant authorities. · Revise management strategies to prevent recurrence.

Performance objective	Management strategies	Performance criteria	Monitoring	Corrective Action
Minimise the spread of weeds as a result of construction activities.	- Weeds in the ROW will be controlled before and after construction. - Site weed hygiene protocols will be implemented for all equipment and vehicles entering the ROW. - Develop and implement a Weed Management Plan in accordance with Arrow's Pest Management Program.	- Presence of pest or weed species. - Treatment of declared plants within the ROW promptly following their discovery.	- Monitoring of weed infestations within disturbed areas should occur twice during construction and then biannually for a period of two years following construction. - Following the two year period, the frequency of monitoring should be reconsidered dependent on the success of control.	- Implement measures (e.g. controlled spraying or pulling) to remove invasive species, should weed or pest species associated with Project activities be detected.
Minimise the spread of pest animals	- Develop and implement a Pest Management Plan in accordance with Arrow's Pest Management Program - Staff will be educated about the importance of removing any food waste from the ROW. - The work site will be kept clean of debris which could be used as -shelter for introduced predators.	- Presence of introduced fauna in the ROW.	- Monitoring of introduced fauna abundance.	- Introduce control measures if pest animal abundance increased above pre-construction levels.
No unintended fires in or adjacent to the ROW	- A no burning policy will be implemented.	- Number of unintended fires within the ROW or in adjacent habitat.	- Record incidences of fire.	- Report to relevant authorities. - Revise management strategies to prevent recurrence.

Reporting

The following will be required to assess the effectiveness of mitigation measures and for reporting to DoE:

- submission of checklists to record the effectiveness of flora and fauna protection measures – completed and reviewed by manager / supervisor
- maintain a washdown register of vehicle, plant and equipment declared freed of weeds and copies of all washdown certificates
- maintain IVMS records
- maintain records of clearing activities
- maintain records of weed spraying and or removal
- maintain records of weed inspections
- maintain records of species and number of recovered and released, injured or dead Yellow Chat
- maintain records of any non-compliances, incidents or accidents.

Revision history

Revision No.	Revision date	Details	Prepared by	Reviewed by	Approved by
	7/11/13	Yellow Chat MP	Carissa Free	Con Lokkers	Alan House
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Appendix 3 – *Xeromys myoides* (Water Mouse) Management Plan

Management Plan for Water Mouse (*Xeromys myoides)* - trenching of the Arrow Bowen Pipeline

November 2013

ARROW ENERGY

Introduction

This management plan outlines the management measures to be implemented should trenching be required upstream of potential Water Mouse habitat on Inkerman and Raglan Creeks in the unlikely event that trenchless techniques cannot be utilized due to geotechnical constraints

It will be further developed prior to the commencement of construction should trenching be required. The Water Mouse Management Plan will align with, and contribute to, work undertaken by other CSG pipeline proponents and Arrow Energy's Curtis island LNG Project as relevant.

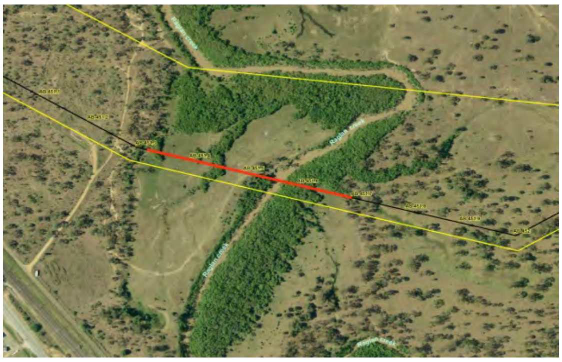
Context

The Water Mouse is a small rodent with a short, very dense and silky fur that is dark slate-grey above and pure white below. In central Queensland, the species occurs between Agnes Water and Cannonvale. It is found in mangroves and associated coastal habitats including saltmarsh, sedgelands, clay pans, heathlands and freshwater wetlands.

Targeted surveys for the Water Mouse were conducted in December 2011 at two sites containing suitable tidal habitat, Inkerman Creek (ABP Rev. H1 KP 435) and Raglan Creek (KP 451.5) within the Stanwell Gladstone Infrastructure Corridor. During the surveys one Water Mouse was recorded approximately 262 m downstream of KP 435 (H1 alignment) on Inkerman Creek. Recent surveys in October 2013 at Inkerman and Raglan Creeks did not detect Water Mouse or their signs (e.g. nest mounds, food remains) within the ROW. A total of 1.66 ha of critical habitat (as defined in the *Draft significant impact guidelines for the vulnerable water mouse*) could be potentially impacted by trenching Inkerman and Raglan Creek if no management measures were to be implemented. However, this habitat is marginal in comparison to downstream habitats and is unlikely to be used by a significant number of Water Mouse.

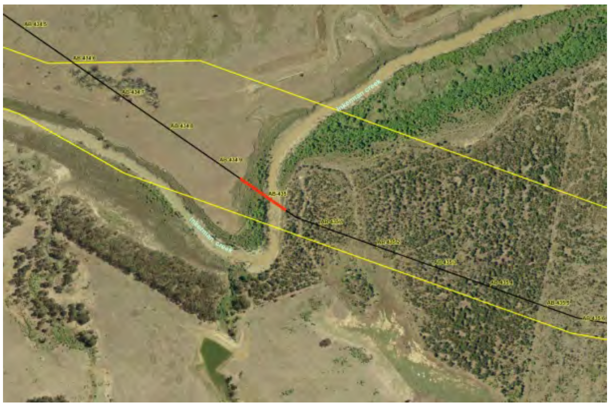
Raglan Creek crossing. ABP will cross several patches of mangrove habitat at Raglan Creek. The photograph shows one mangrove patch crossed by ABP. The mangroves at this point are narrow (approximately 3 m wide) and are only inundated at the highest tides. This habitat is marginal for Water Mouse in comparison to downstream habitats and would only represent occasional foraging habitat for this species if it occurs at Raglan Creek.

Raglan Creek crossing. Crossing of the larger channel on Raglan Creek. The photograph shows the mangroves (and other plants and weeds) high above the channel which reduces the foraging habitat for the Water Mouse on the northern side of the channel.



Aerial image showing the crossing point at **Raglan Creek**.

Inkerman Creek Crossing. The habitat at this creek crossing includes *Sporobulus* grasslands adjacent to mangroves.



Aerial image showing the crossing point at **Inkerman Creek**. The habitat at the crossing point is marginal in comparison to habitat downstream. Water Mouse were recorded 260 m north-east of this point.

Impacts

In the unlikely event that open trenching is required to cross Raglan and Inkerman Creeks the potential impacts could include:

- temporary loss of marginal habitat for Water Mouse
- increase in pest animal abundance
- reduction in adjacent habitat quality caused by increased weed abundance
- indirect downstream impacts on habitat caused by changes in water quality and hydrology.

Table 1 shows the potential impacts to Water Mouse, the raw risk rating (before mitigation) and the residual risk (after mitigation) to Water Mouse populations. The management strategies used to determine the residual risk are detailed in Table 2.

Table 2 details:

- management objectives for mitigating these potential impacts
- performance criteria and monitoring tasks for measuring the success of management strategies
- corrective measures to address any non-compliance with performance criteria.

Table 1 Potential impacts on Water Mouse from trenching Raglan and Inkerman Creeks. Management strategies are listed in Table 2.

Impact	Raw risk (before management strategies)	Residual risk (after management strategies implemented)
DIRECT IMPACTS		
Removal of habitat · Removal of estuarine vegetation, representing potential foraging, breeding and breeding habitat	M	L
Trenchfall · Death of individuals trapped in the trench	L	I
Fatalities · Death of individuals via vehicles and equipment during clearing, construction and operation	L	I
INDIRECT IMPACTS		
Changes in water quality · Impacts to downstream water quality leading to changes in vegetation/habitat downstream	L	I
Changes in hydrology · Changes in wet/dry cycling of waterways caused by damming, changes in morphology or diversions	L	I
Habitat fragmentation · Fragmentation of habitat leading to a reduction in remnant size, increased edge effects and isolation of population.	L	I

Impact	Raw risk (before management strategies)	Residual risk (after management strategies implemented)
Increase in weed abundance · Increase competition with native plant species used for foraging and shelter · Smothering of native vegetation	L	I
Increase in introduced predator abundance · Increase in introduced predator abundance caused by increased food availability in the ROW	L	I
Removal of micro-habitat · Removal of nest mounds or hollow trees	M	L
Noise and disturbance · Disturbance caused by noise or human disturbance leading to stress, disease and abandonment of habitat	L	I

Table 2 Management strategies and performance criteria to assess effectiveness of management measures.

Performance objective	Management strategies	Performance criteria	Monitoring	Corrective Action
Avoid or minimise the impacts of temporary removal of Water Mouse habitat	· Pre-clearance survey and recording of any Water Mouse mounds within or immediately adjacent to the ROW · Minimise area of habitat in ROW by utilising existing clearing and reducing ROW width to 20 m for the crossing of the creek and adjacent mangrove areas. Record on alignment sheets. · Clearly mark out areas to be cleared and retained. Erect barriers around retained habitat to restrict access and avoid disturbance. · Rehabilitate the ROW following construction.	· Compliance with clearing permits. · Disturbance of Water Mouse during construction of the pipeline and associated access tracks. · Disturbance of mangrove vegetation outside designated areas.	· Inspect cleared areas and audit of compliance with clearing permits. · Record recovered and released, injured or dead Water Mouse. · Inspect adjacent habitat for signs of disturbance caused by construction activities.	· Report to relevant authorities. · Revise management strategies to prevent recurrence. · Rehabilitate any adjacent disturbed areas.
Protect fauna from trenchfall and recover fauna affected by construction activities.	· Ramps (with slopes of no greater than 50%) will be installed in the trench to allow the easy egress of fauna from the trench at the watercourse crossing. · A qualified and experienced fauna spotted / handler should check the trench for captured fauna at least daily, preferably in the morning to remove animals prior to the heat of the day. · All fauna captured during the preconstruction survey and spotter/catcher activities should be re-located. · The length of time that the trench is open shall be minimised through staging of trenching activities to minimise the potential for the pipeline to impact on local populations of fauna.	· Recorded injury or deaths of fauna. · Records of fauna recovery of trench fall and translocation.	· Records of trench monitoring by spotter /handler. · Records of fauna translocations. · Records of injury or deaths of fauna.	· Report to relevant authorities. · Revise spotter catcher procedures to prevent recurrence.
Minimise impacts to water quality	· Water quality will be monitored upstream, at creek crossings and downstream of creek crossings to monitor water quality parameters. · An Erosion and Sediment Control Plan will be prepared and implemented and will include installing and maintaining sediment control devices around exposed areas and earthworks adjacent to aquatic habitats. · Bank morphology and topography will be reinstated as near as practicable to the original profile to	· Crossing in accordance with the methodology described in the Aquatic Values Management Plan. · Changes in water quality parameters.	· Monitoring and maintaining water quality (before, during and after construction).	· Report to relevant authorities. · Revise management strategies to prevent recurrence.

Performance objective	Management strategies	Performance criteria	Monitoring	Corrective Action
	reduce erosion. · Construction at Water Mouse habitat should be undertaken outside the wet season when runoff is less likely. · Construction will be undertaken during periods of minimum tidal variation to reduce water flow. · An aquatic values management plan for Inkerman and Raglan Creeks will be developed			
Minimise changes to waterway hydrology	· Construction of watercourse crossings will be scheduled outside the wet season wherever practicable when these intermittent streams traversed by the pipeline are generally not in flow. · Flows will be reinstated at each flowing watercourse crossing site as soon as trenching is completed · Water diversions will be undertaken for the shortest period of time possible. · Flume pipes or coffer dams will be used to allow free movement of tidal waters during construction where required. · Bunds installed to reduce tidal intrusions during construction will be in place for the shortest possible time and will be fully removed immediately after construction. · Construction will be scheduled during times of minimal tidal flow (neap tides) where practicable to reduce the need for bunding. · Bank morphology and topography will be reintstated immediately after construction to reduce erosion. · An aquatic values management plan for Inkerman and Raglan Creeks will be developed.	· Compliance with permits (including waterway barrier permits) in accordance with the SP Act and Fisheries Act.	· Audit Species Specific Management Plan and Aquatic Values Management Plan.	· Report to relevant authorities. Revise management strategies to prevent recurrence.

Performance objective	Management strategies	Performance criteria	Monitoring	Corrective Action
Minimise habitat fragmentation to retain habitat, reduce edge effects and facilitate fauna movement	· Clearing of temporary areas for the purposes of laydown areas and vehicle turn around areas will not be undertaken within 50m each side of the watercourse · Where the ROW is to be reduced (e.g. sensitive watercourse crossings or sensitive habitat areas), this will be recorded on alignment sheets. · Existing cleared corridors will be used where practicable. · Clearly mark out areas to be cleared and retained. Erect barriers around retained habitat to restrict access and avoid disturbance. · Rehabilitate the ROW following construction	· Compliance with clearing permits. · Disturbance of Water Mouse during construction of the pipeline and associated access tracks. · Disturbance of mangrove vegetation outside designated areas.	· Inspection of cleared areas and audit of compliance with clearing permits. · Compliance with preconstruction survey results. · Presence of habitat shelters associated with the ROW. · Records of habitat creation using cleared vegetation.	· Report to relevant authorities. Revise management strategies to prevent recurrence.
Minimise the spread of weeds as a result of construction activities.	· Weeds in the ROW will be controlled before and after construction. · Site weed hygiene protocols will be implemented for all equipment and vehicles entering the ROW. · Develop and implement a Weed Management Plan with reference to Arrow's Pest Management Program.	· Distribution of pest or weed species. · Treatment of declared plants within the ROW promptly following their discovery.	· Monitoring of weed infestations within disturbed areas should occur twice during construction and then biannually for a period of two years following construction. · Following the two year period, the frequency of monitoring should be reconsidered dependent on the success of control.	· Implement measures (e.g. controlled spraying or pulling) to remove invasive species, should weed or pest species associated with Project activities be detected.
Minimise the removal of Water Mouse microhabitat features	· A pre-clearance survey will be conducted to identify any nest mounds within the ROW prior to construction If a mound is found within the ROW during pre-clearance surveys and impact is unavoidable, a plan will be developed in consultation with DEHP to relocate the nest and/or to create artificial nesting structures outside of the ROW.	· Compliance with clearing permits. · Number of mounds avoided in the ROW · Disturbance of Water Mouse during construction of the pipeline and associated access tracks. · Disturbance of mangrove vegetation outside designated areas.	· Inspect cleared areas and audit of compliance with clearing permits. · Record recovered and released, injured or dead Water Mouse. · Inspect adjacent habitat for signs of disturbance caused by construction activities.	· Report to relevant authorities. · Revise management strategies to prevent recurrence. · Rehabilitate any adjacent disturbed areas.

Performance objective	Management strategies	Performance criteria	Monitoring	Corrective Action
Minimise noise and disturbance in Water Mouse habitat	· A 50 m buffer zone will be established around known Water Mouse populations and construction activities will be excluded from this area · Where possible work on Inkerman and Raglan Creeks will not be conducted at night to reduce disturbance through noise. Where this is not possible, night time noise will be reduced as much as practicable. · Work lights will be pointed away from Water Mouse habitat.	· Disturbance of Water Mouse during construction of the pipeline and associated access tracks.	· Record Water Mouse disturbances.	· Report to relevant authorities. · Revise management strategies to prevent recurrence.

Monitoring

A Water Mouse Monitoring Program will be developed to manage the activities described in Table 2 should trenching be required. The Program will be established prior to the commencement of construction and will be maintained for the duration of construction. Monitoring of Water Mouse will be continued on a monthly basis for 6 months after construction is completed.

Reporting

The following will be required to assess the effectiveness of mitigation measures and for reporting to DoE:

- submission of checklists to record the effectiveness of flora and fauna protection measures – completed and reviewed by manager / supervisor
- maintain a washdown register of vehicle, plant and equipment declared freed of weeds and copies of all washdown certificates
- maintain records of clearing activities
- maintain records of weed spraying and or removal
- maintain records of weed inspections
- maintain records of species and number of fauna removed from the pipeline trench
- maintain records of any non-compliances, incidents or accidents.

Revision history

Revision No.	Revision date	Details	Prepared by	Reviewed by	Approved by
Draft	4/11/13	Water Mouse MP	Carissa Free	Con Lokkers	Alan House
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