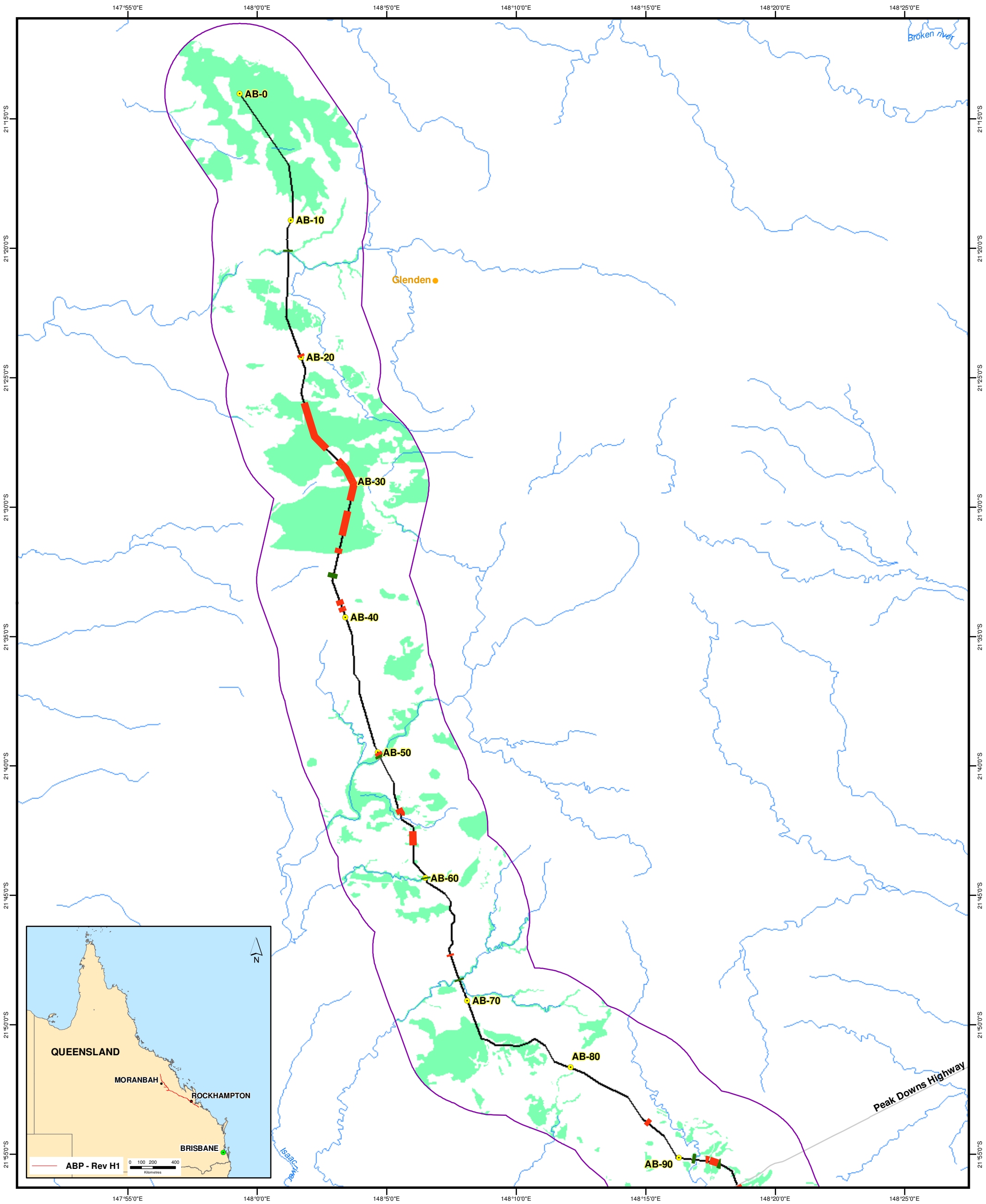

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Document
BE004_MP_006F_Koala_RevH1

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
- 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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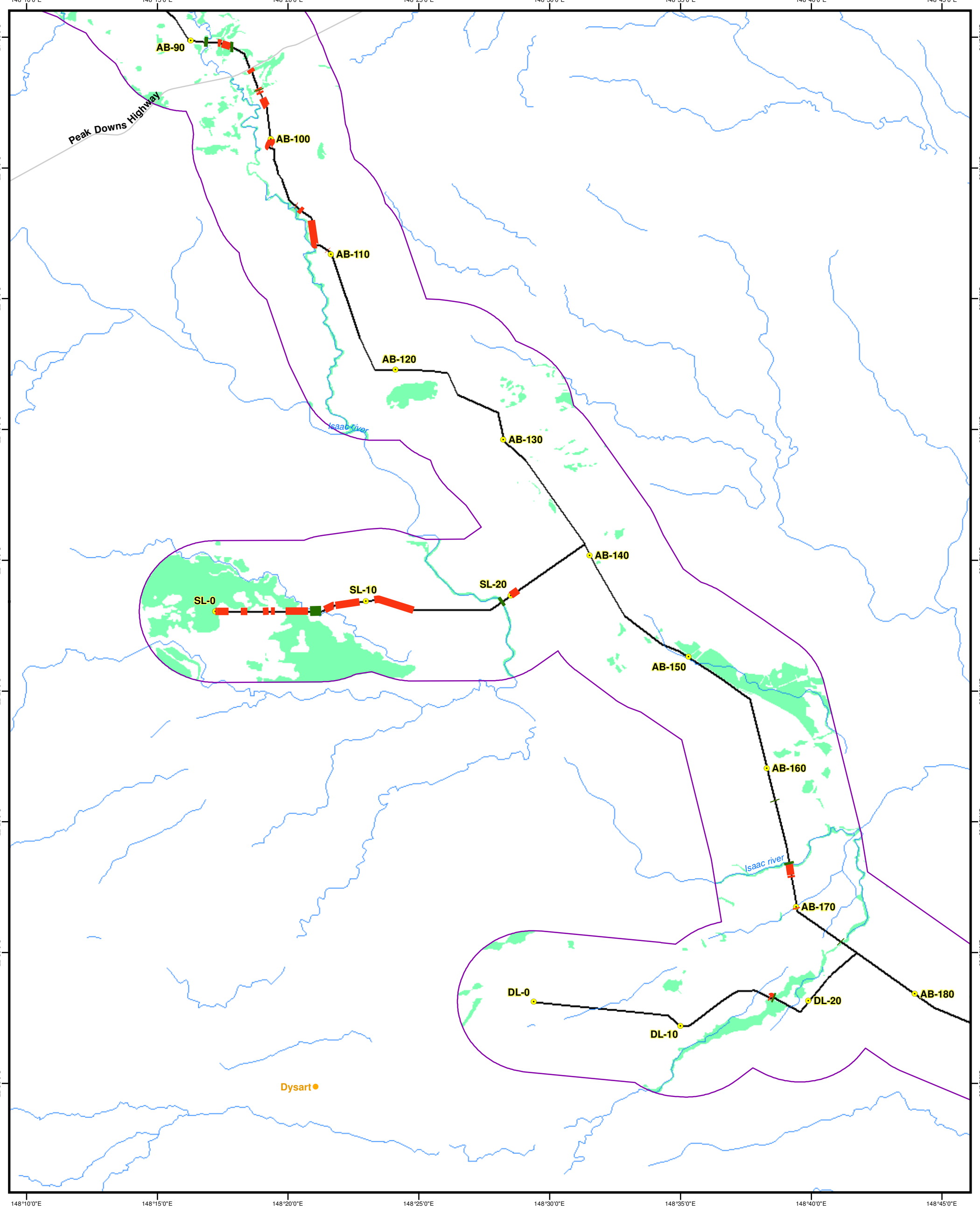
Revision H1

A3



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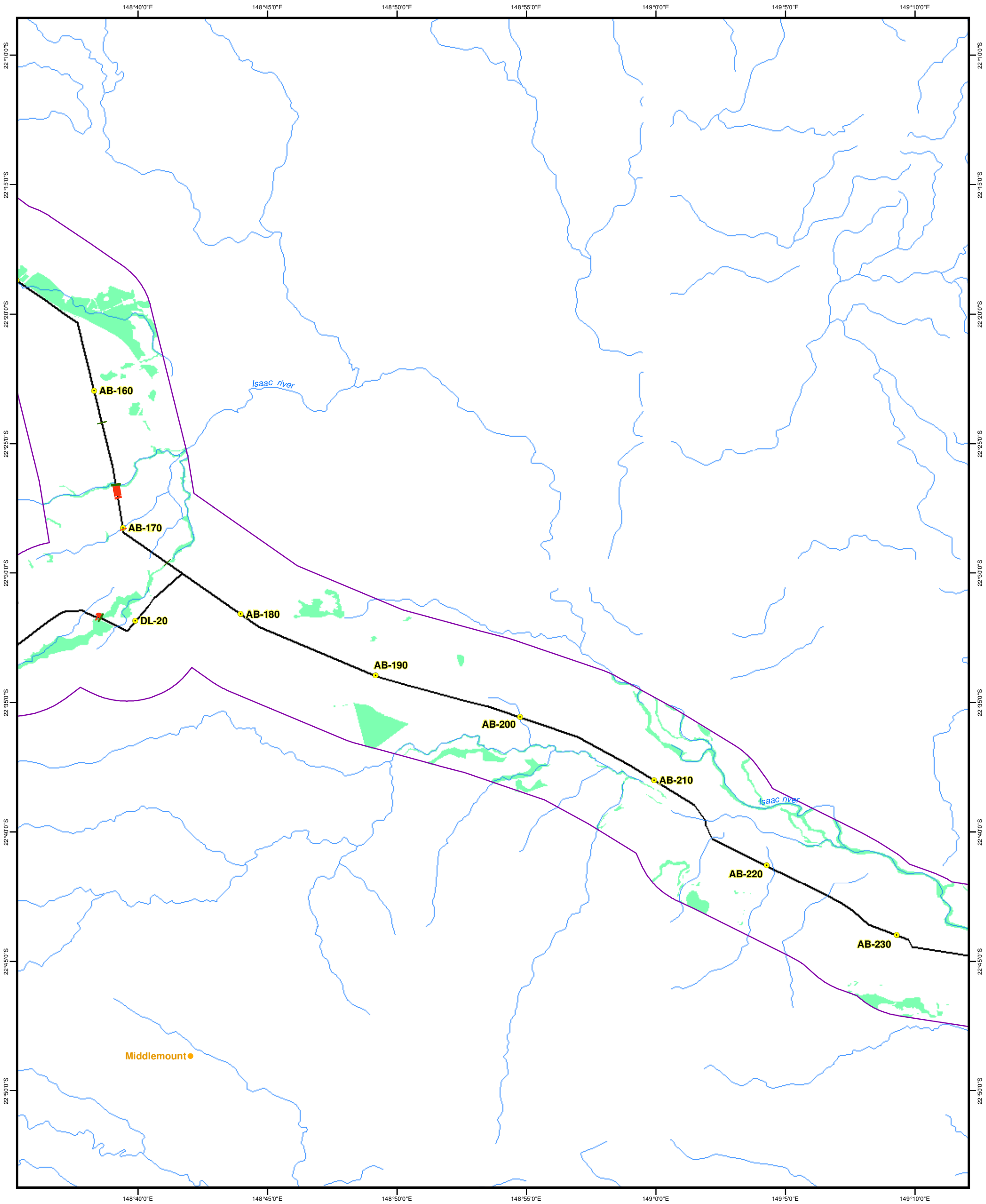

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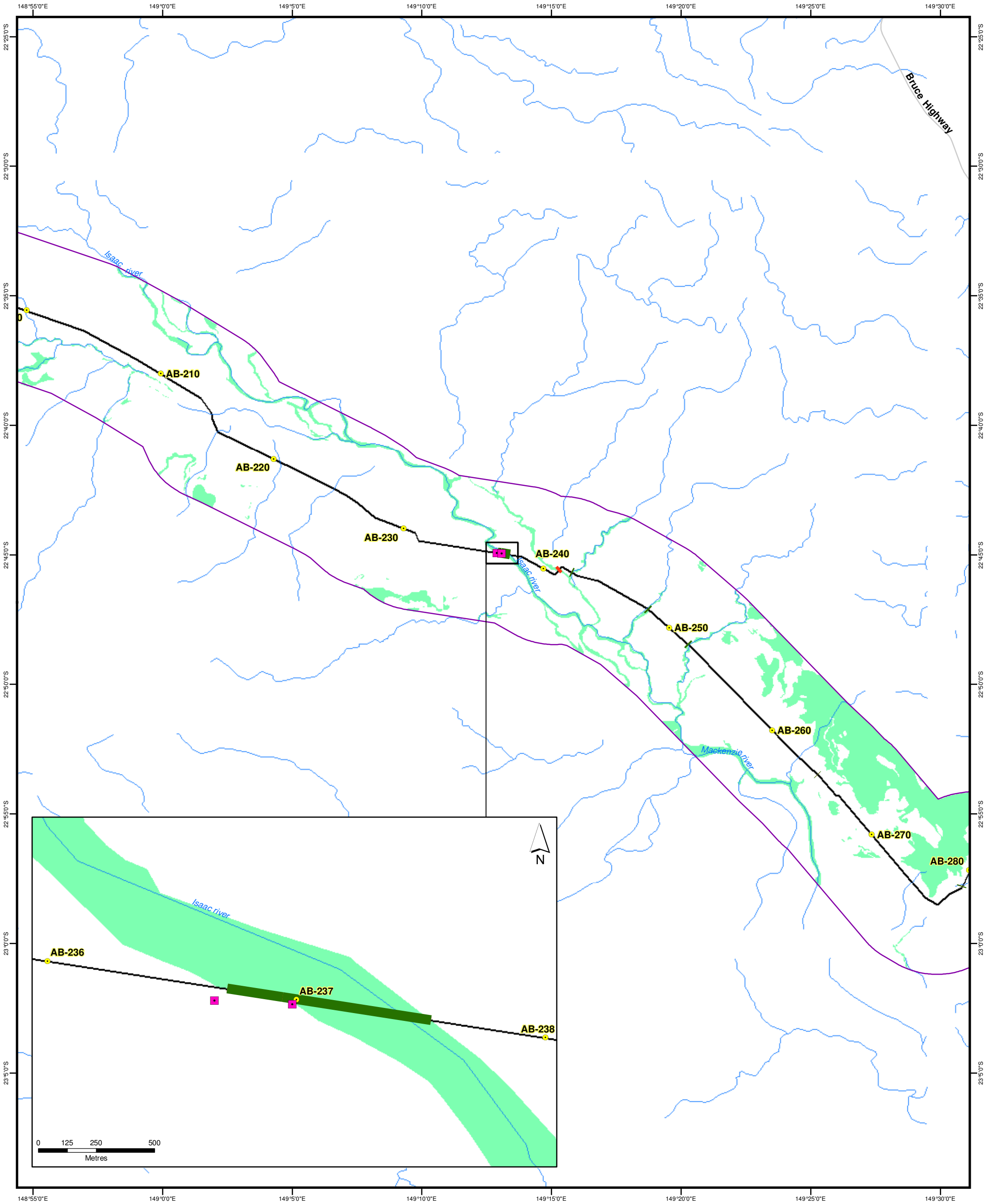

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Revision H1

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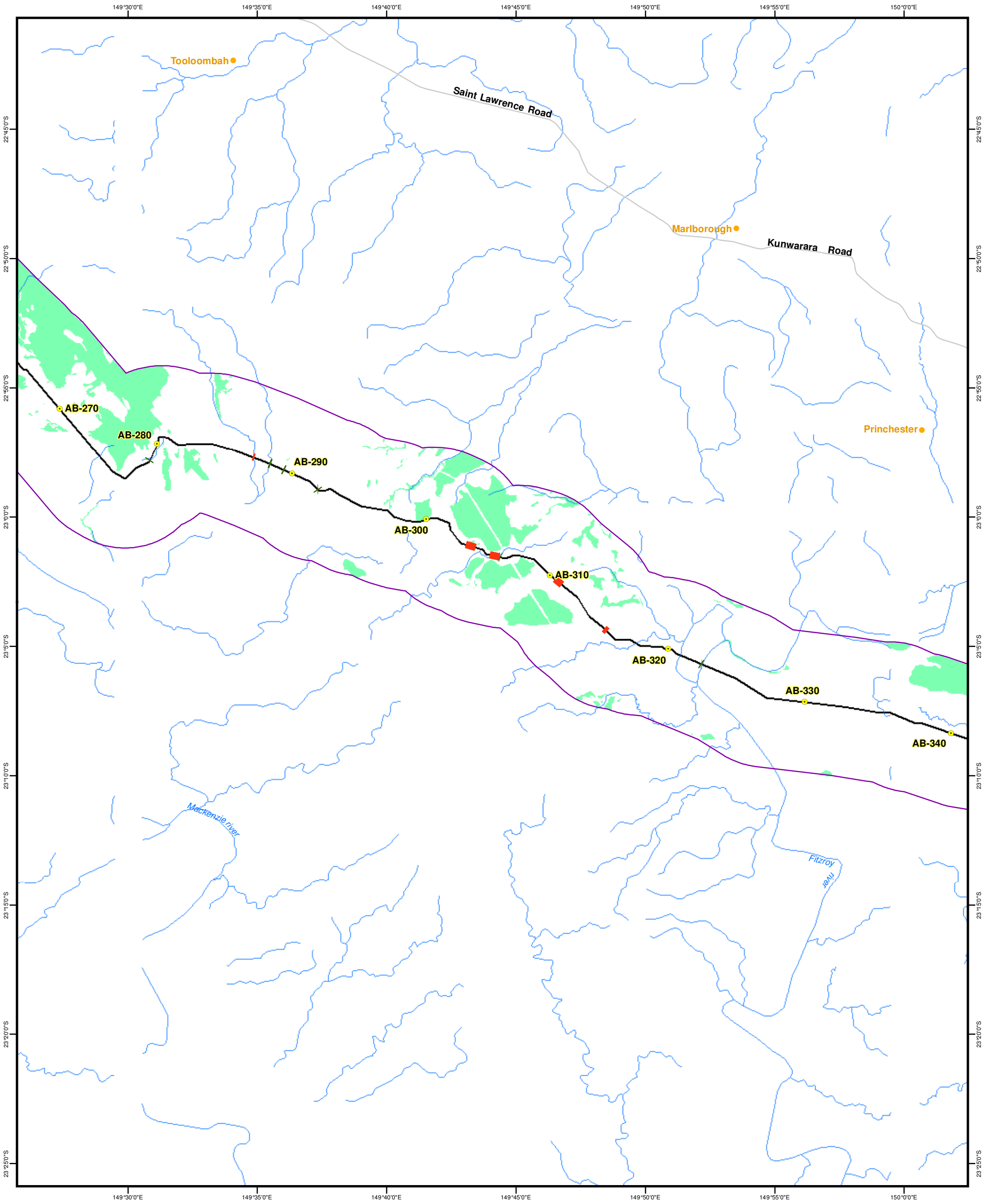

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Koala

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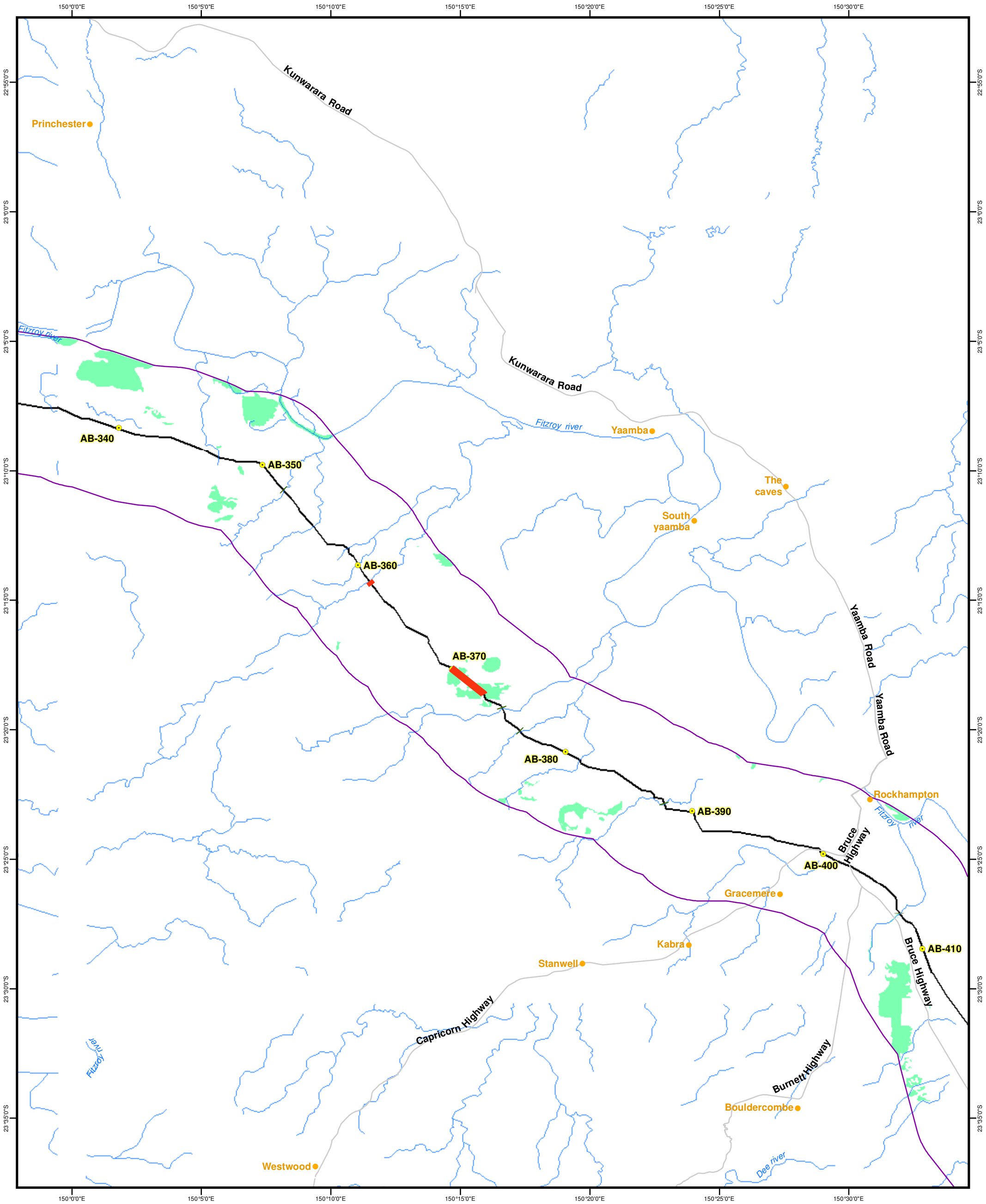

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Koala

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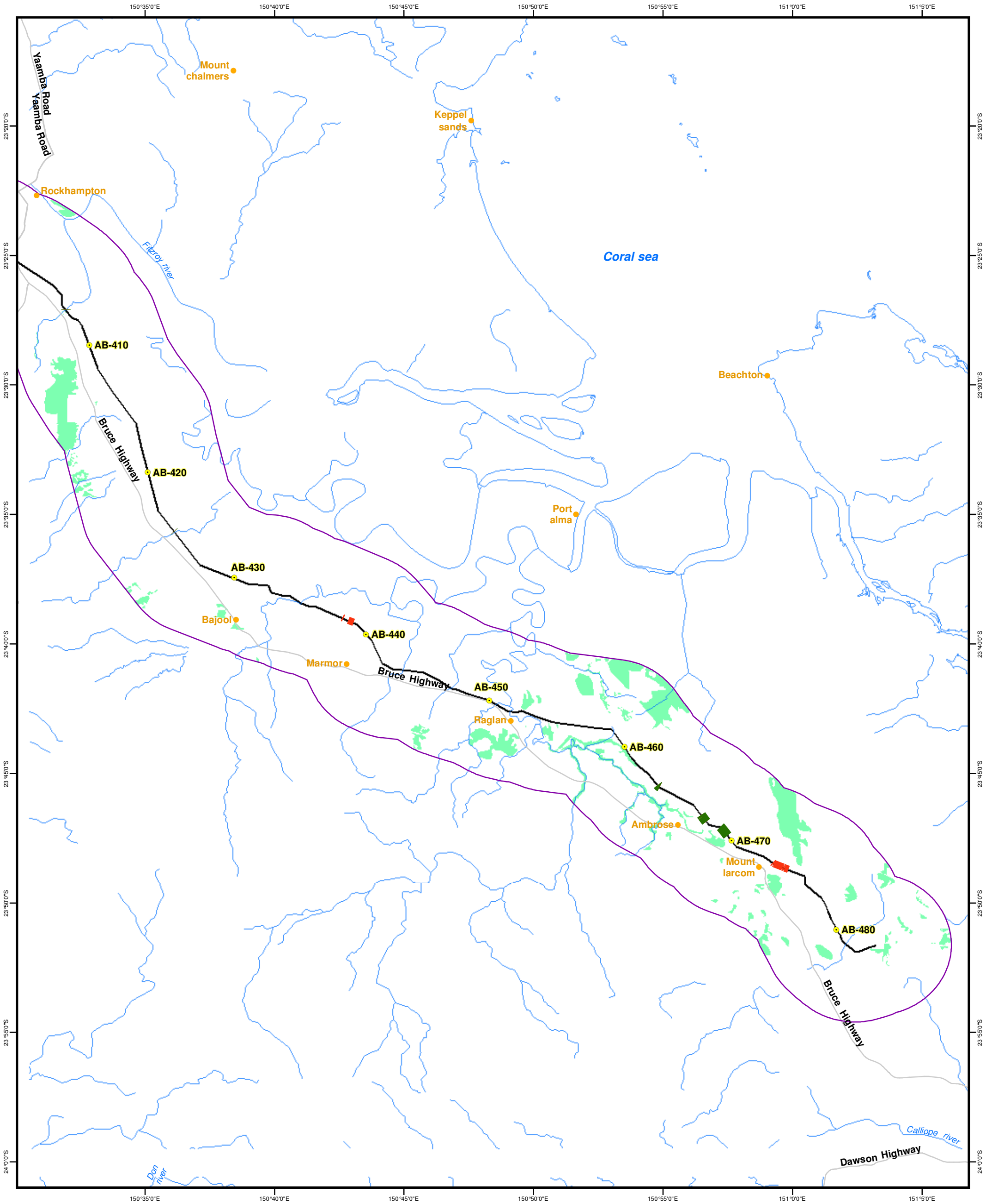

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Koala

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

2.7.1 Conservation Status

Queensland: Least Concern under the NC Act

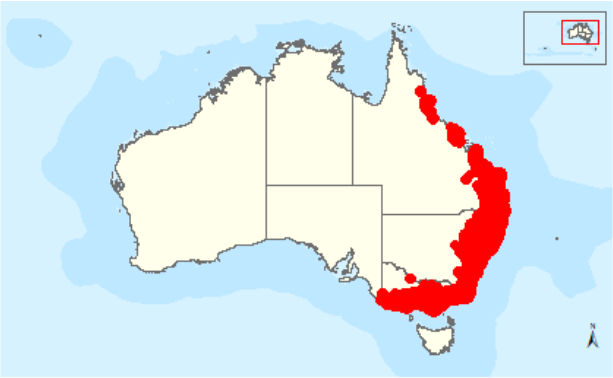
National: Vulnerable under the EPBC Act

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).



Distribution of *Pteropus poliocephalus* in Australia. 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 DSEWPaC recommended survey methods

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

The survey approach recommended by 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 to DSEWPaC guidelines

The effort expended during the field surveys for this species is shown in Table 30 along with the effort recommended under the DSEWPaC guidelines. It must be noted that the guidelines are recommendations only and surveys are ongoing.

Table 30 Actual and DSEWPaC 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 31 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 31 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	0	4.58	793.76	0.57	0

	of metamorphism and folding. Coastal ranges					
11.11.16	*Eucalyptus cambageana*, *Acacia harpophylla* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands	0	1.96	76.55	2.56	0
	Other REs containing suitable habitat in the 5 km buffer	0	0	7834.41	0	-
	Total	1.18	14	5636.9	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 3 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 32 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 equipment approaching camp trees	L
Noise and disturbance	L	-if surveys confirm breeding of this species, avoid	I

Disturbance caused by noise or human disturbance leading to stress, disease and abandonment of habitat		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	
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 DSEWPaC. 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

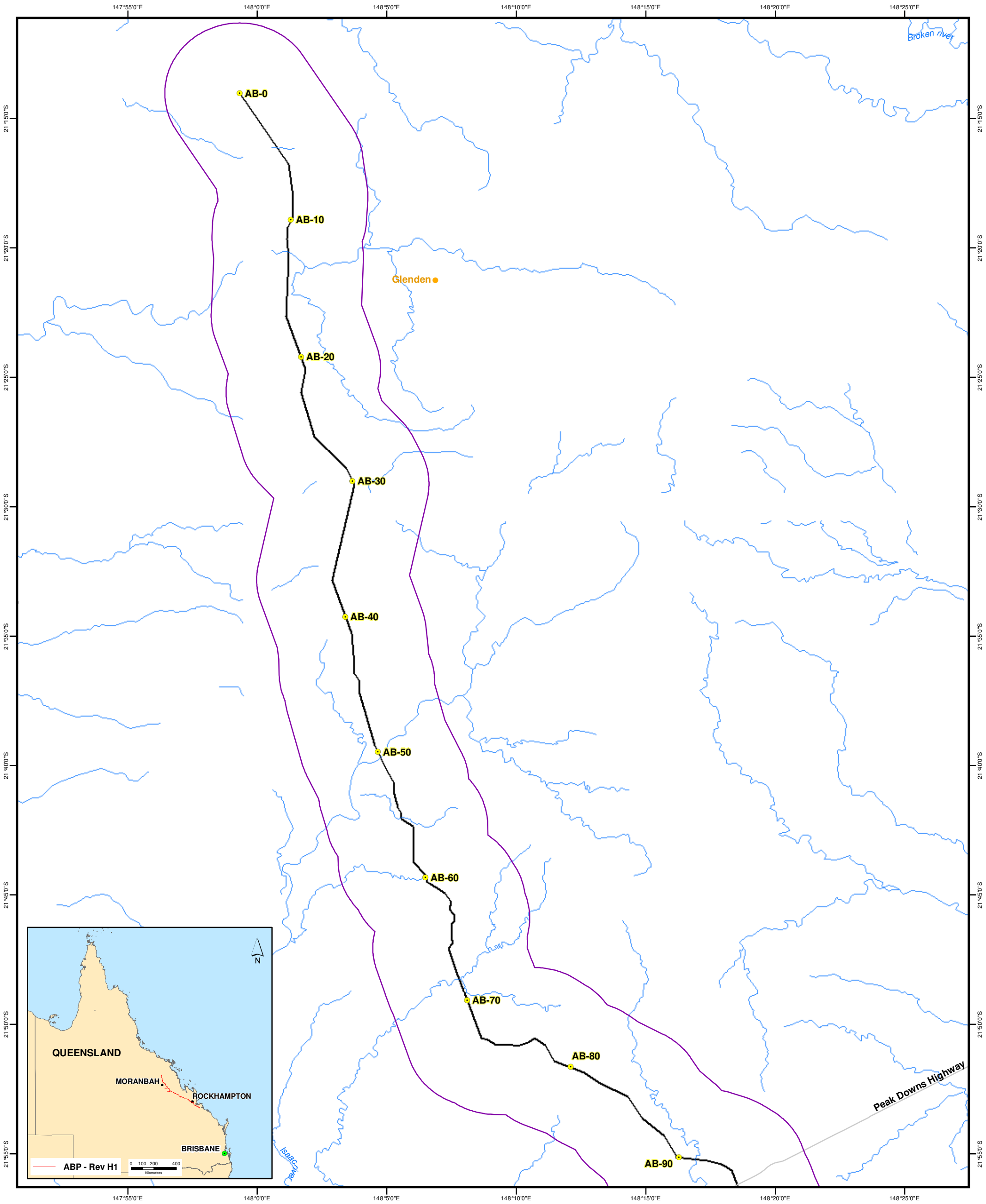
m buffer zone is established around the any camp trees in or adjacent to the ROW, it is unlikely that the proposed action will have any direct contact with flying-foxes. It is therefore unlikely the project will result in an increase in the incidence of disease in the study area to the extent that the 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
BE004_MP_006E_Grey_Headed_Flying_Fox_RevH1

Job Number: BE004

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R0	BN	CF	ISSUED TO CLIENT	29/08/2013
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Kilometres

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Coordinate System:
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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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Revision H1

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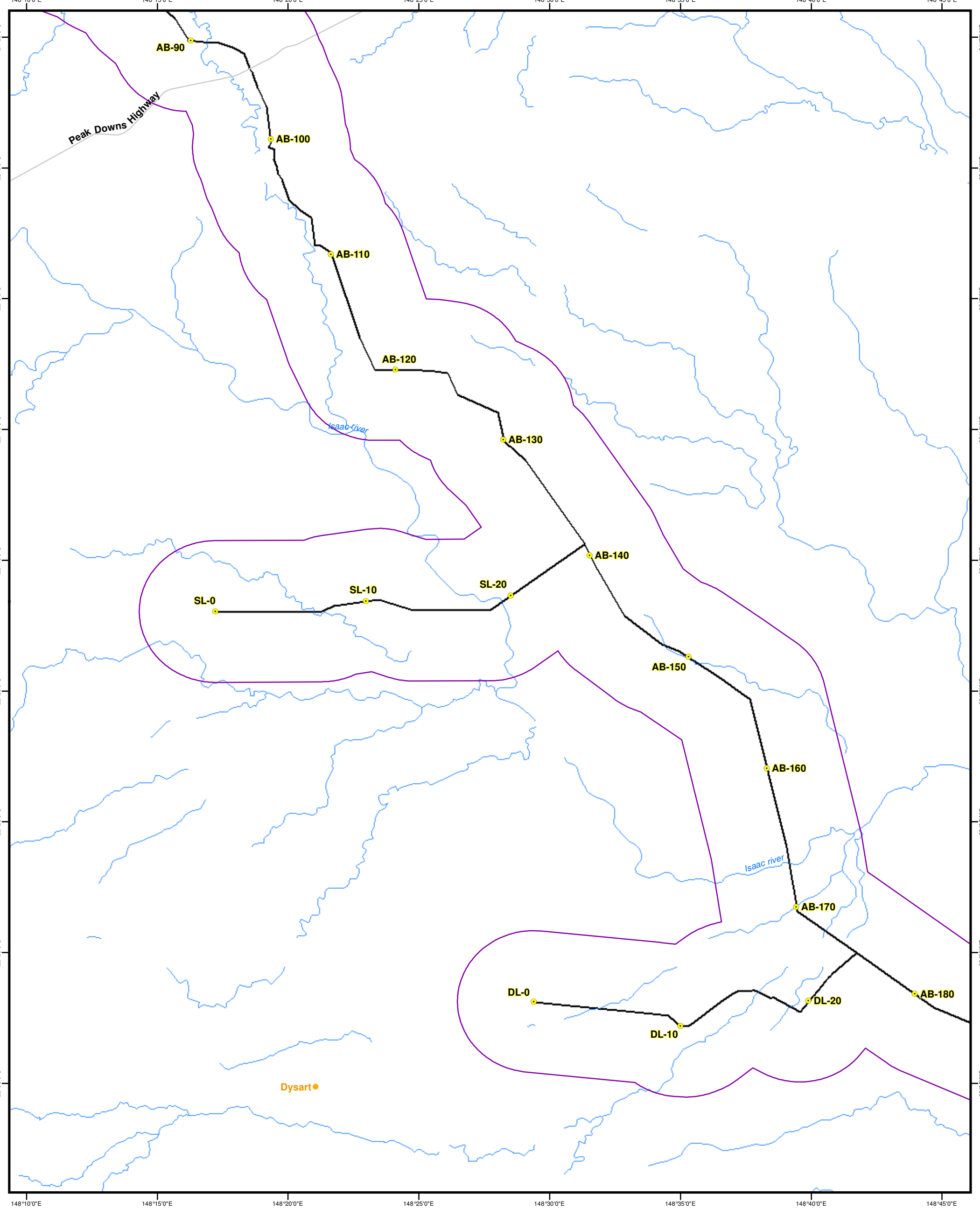

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Grey-headed Flying-fox

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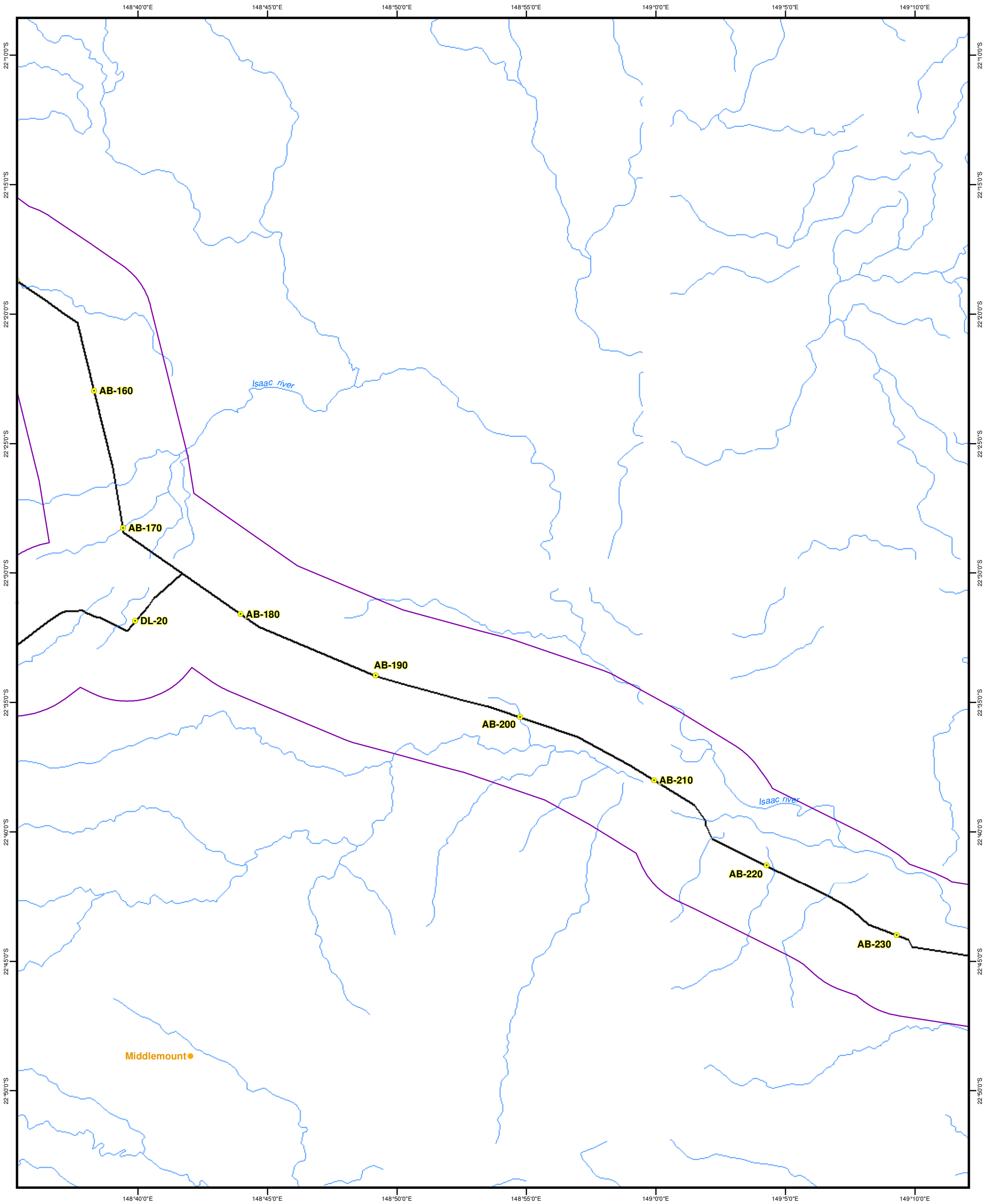

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Grey-headed Flying-fox

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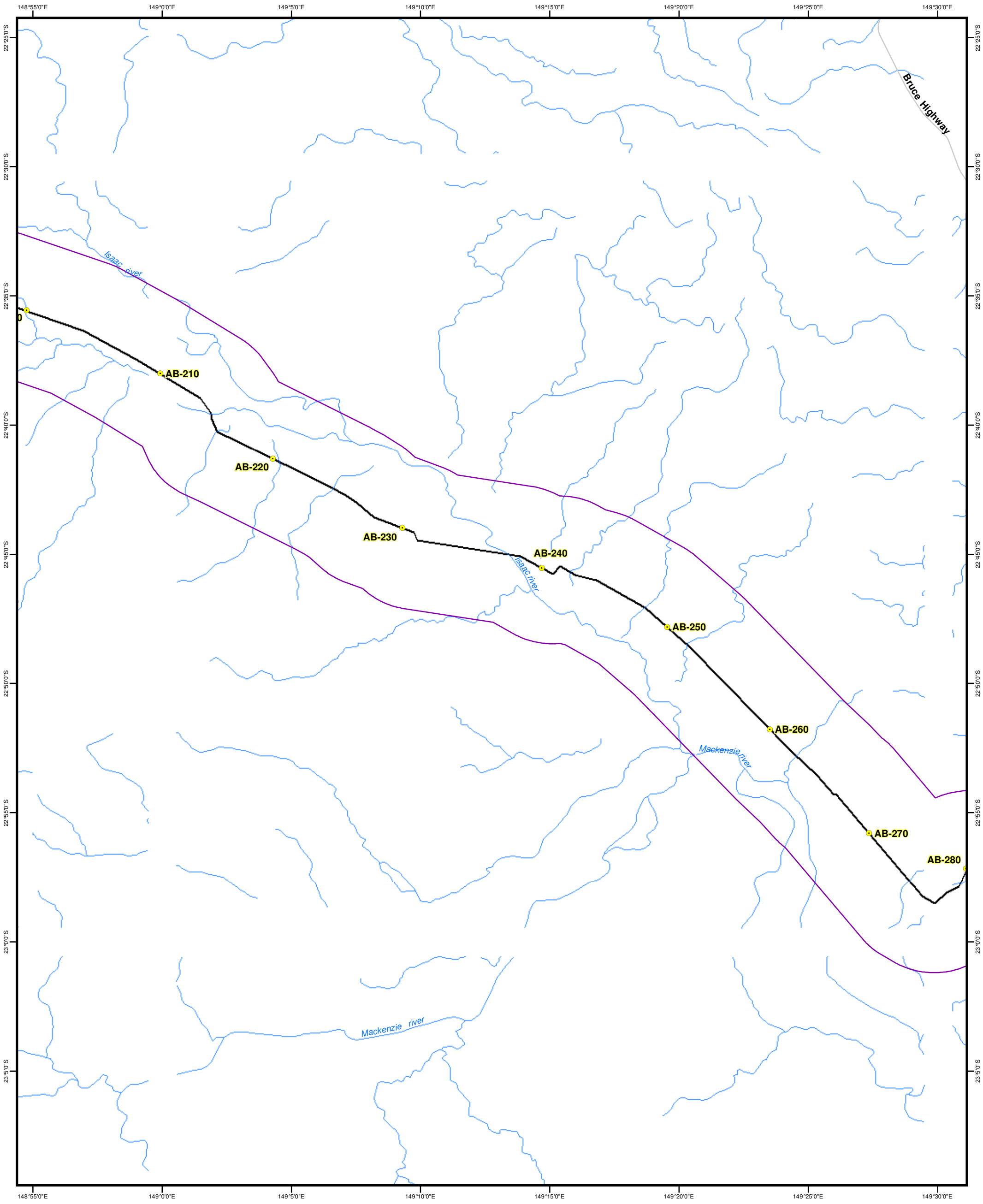

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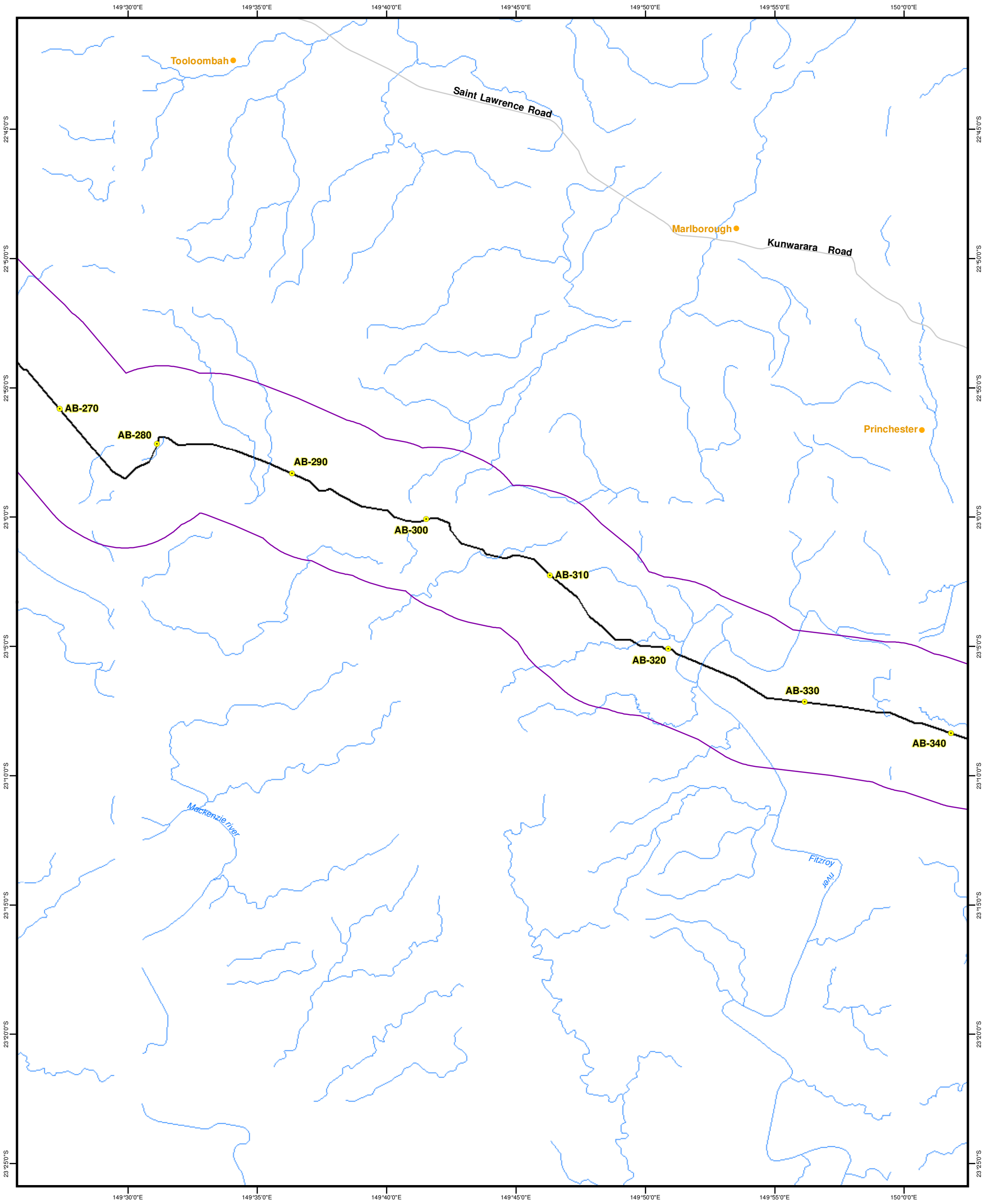

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Grey-headed Flying-fox

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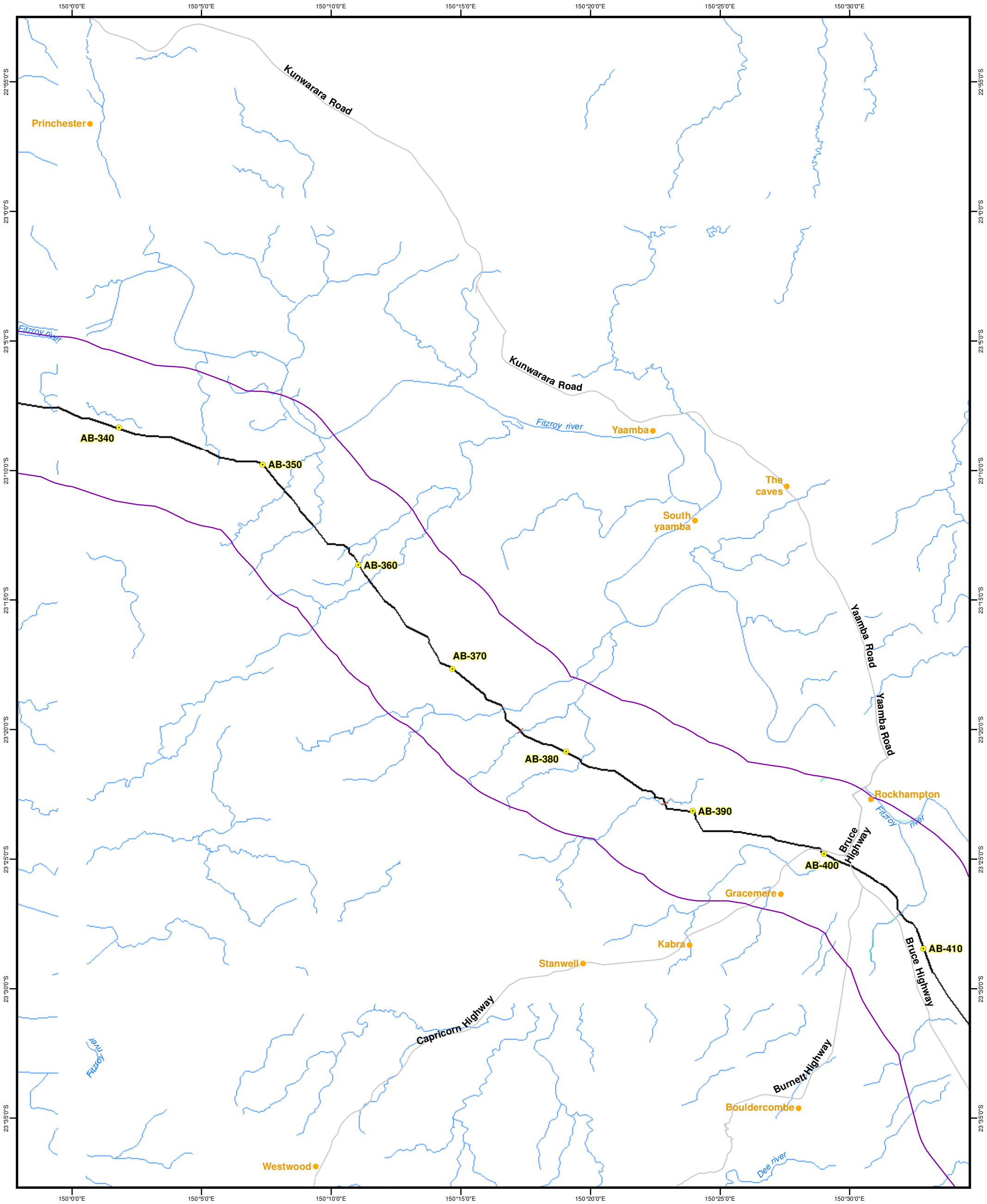

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LEGEND

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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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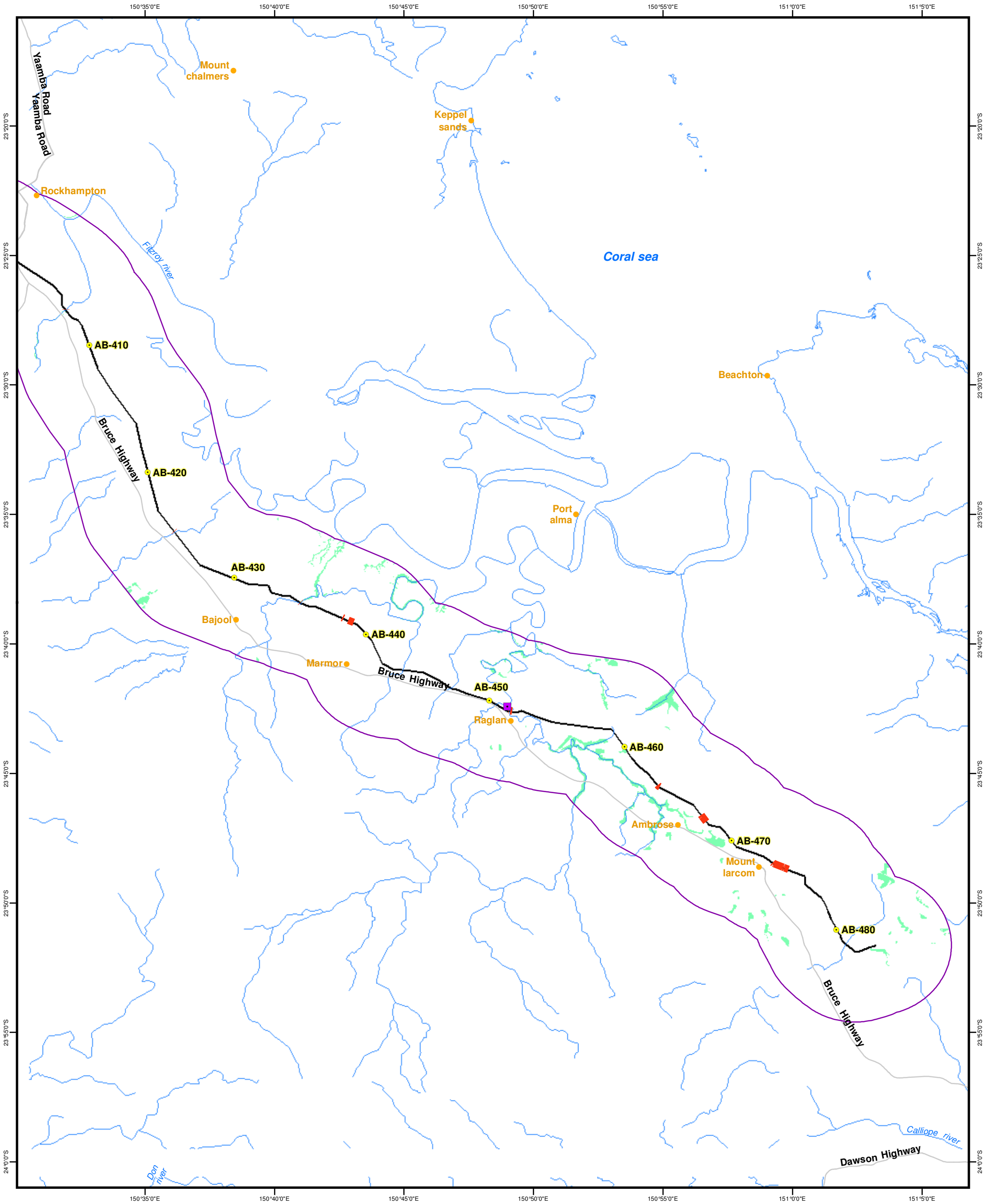

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- Grey-headed Flying-fox Survey Records
- Waterway or Coast Line
- Main roads
- ABP - Rev H1
- Potential Habitat in ROW (Field Verified)
- Potential Habitat in Buffer (from State RE Mapping)
- Buffer (5 km)

Grey-headed Flying-fox

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Revision H1

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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).

Distribution of ***Rheodytes leucops*** in Australia. 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	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Juveniles hatch								Nesting	Nesting	Incubation	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 DSEWPac 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 DSEWPaC survey guidelines

It is not possible to provide a comparison with DSEWPaC 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 DSEWPaC 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 33 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 33 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 Death of individuals via vehicles and equipment during clearing, construction and operation (overland movement of turtles)	M	- no vehicles or equipment to operate within the sandy banks 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	I
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 33 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?

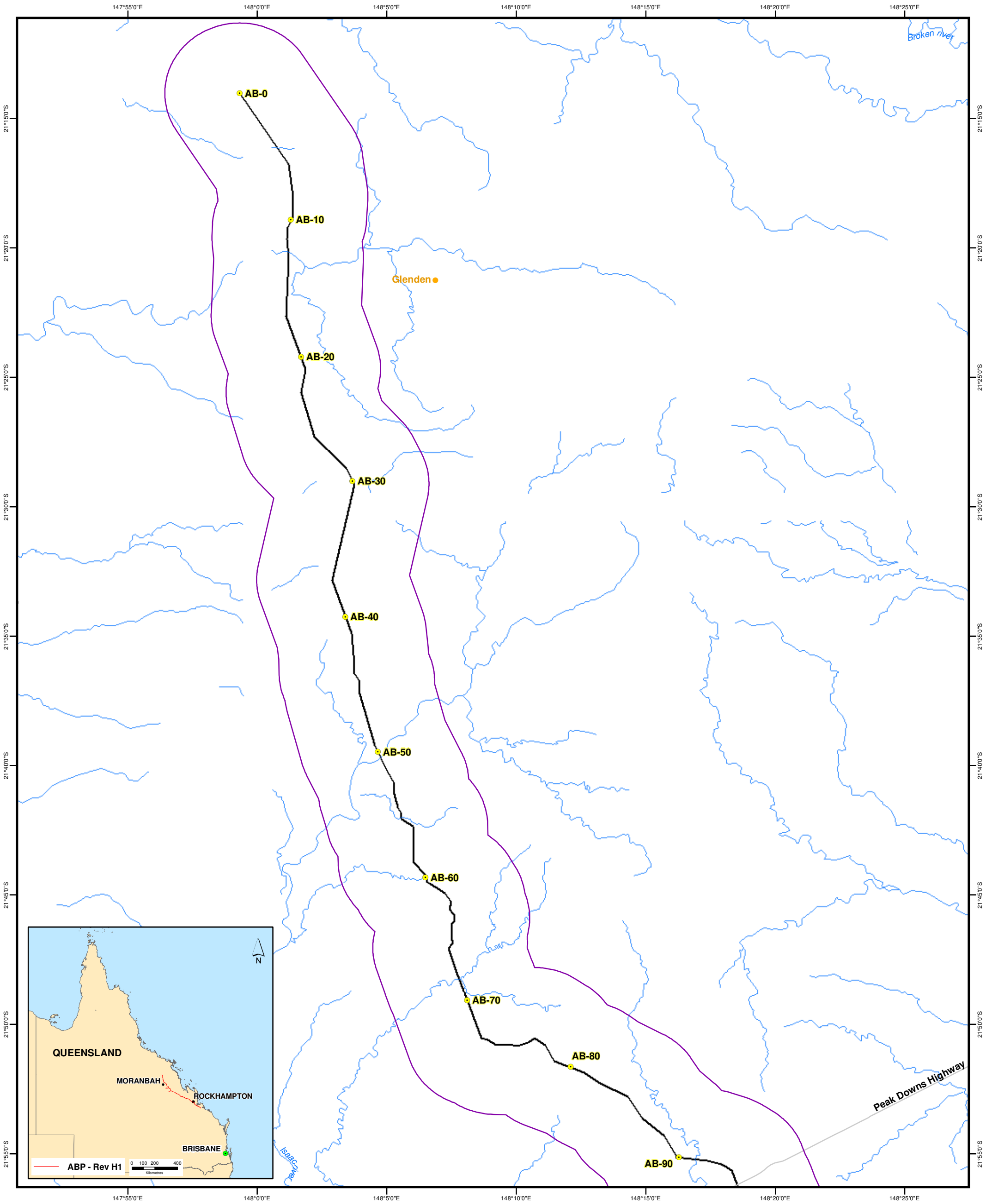
The proposed vegetation clearing, pipeline placement, and reinstatement works are unlikely to result in significantly improved conditions for diseases that may cause the Fitzroy River Turtle to decline.

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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- Main roads
- ABP - Rev H1
- Buffer (5 km)

Fitzroy River Turtle

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
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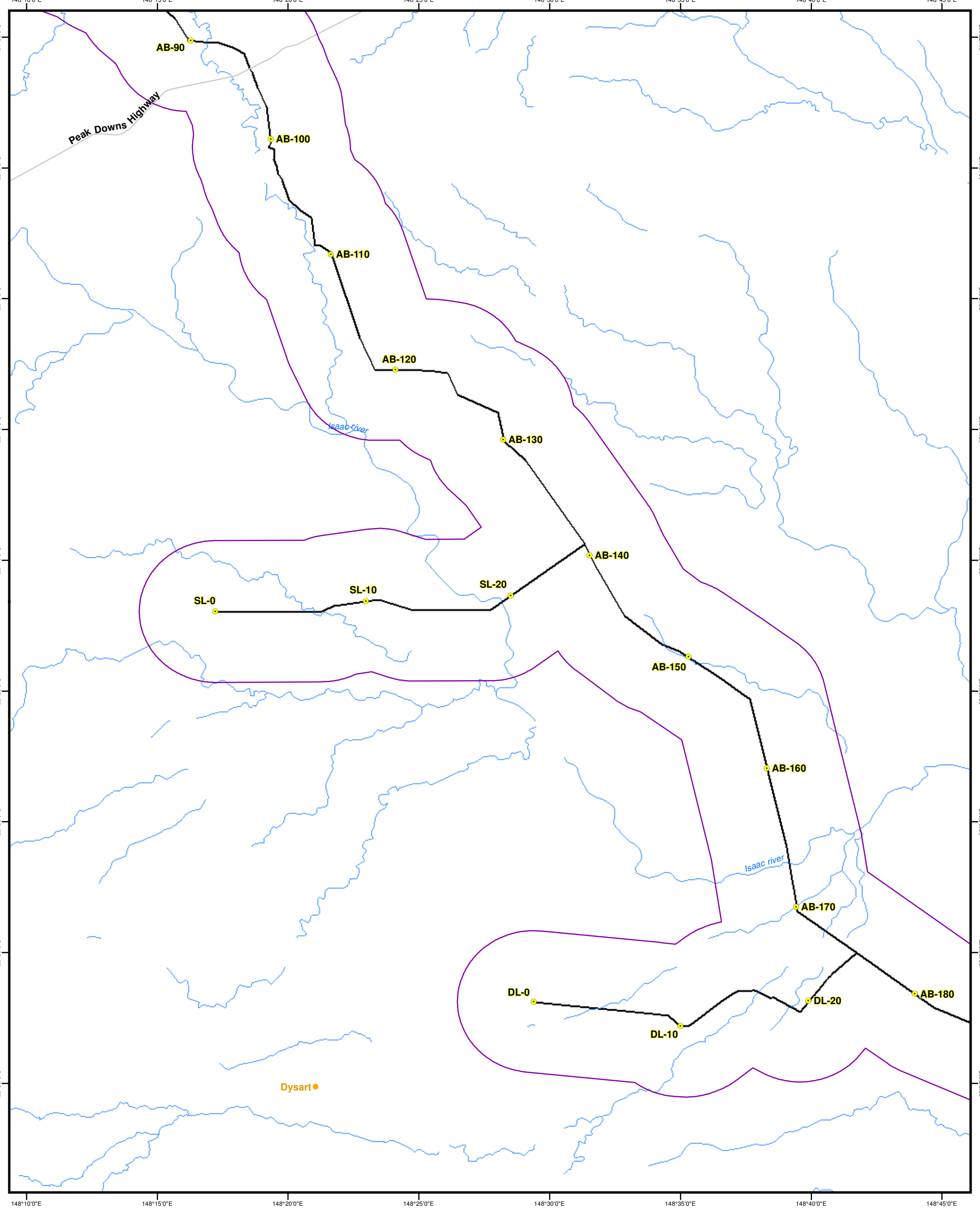

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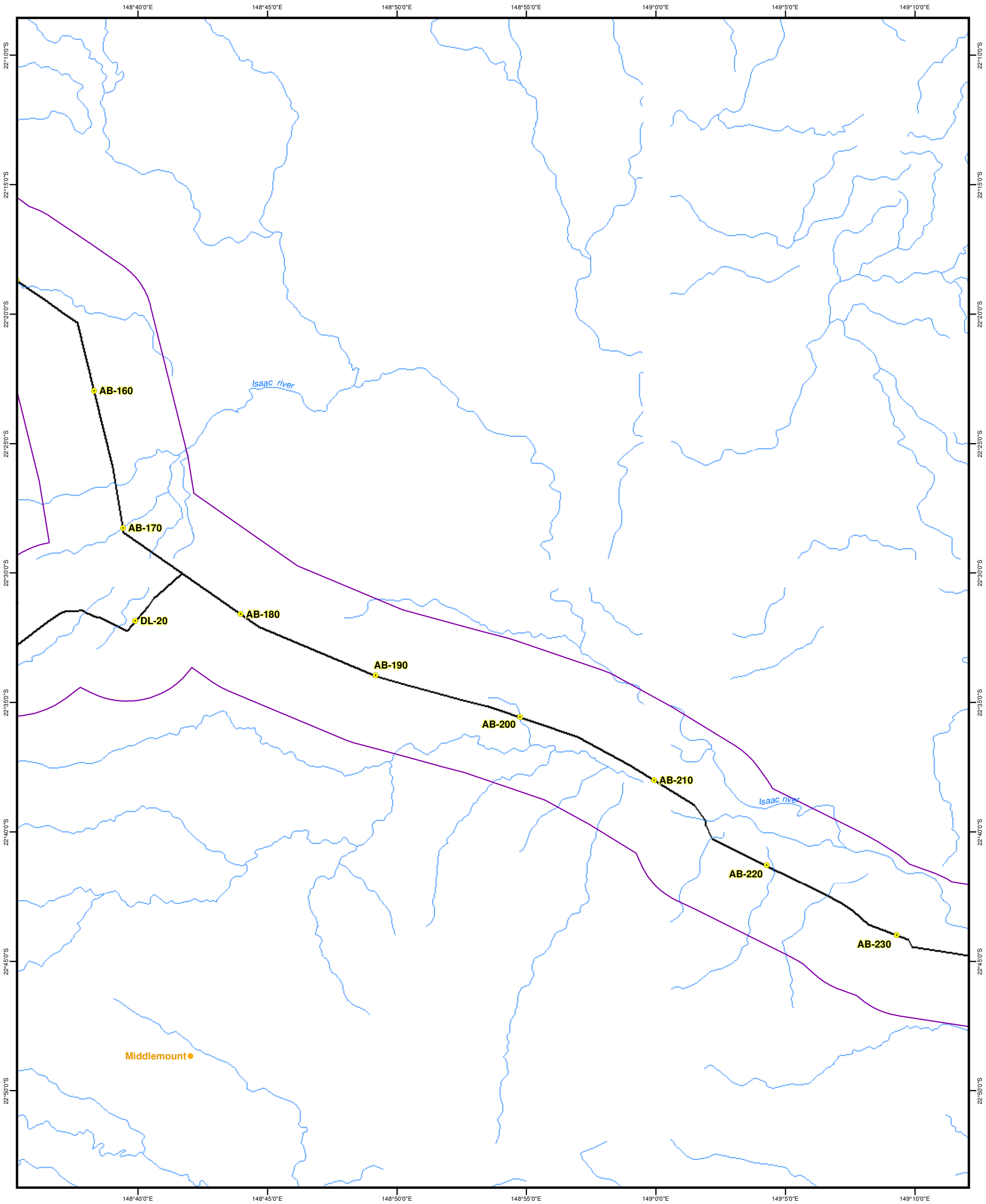

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- Kilometre Point
- Waterway or Coast Line
- ABP - Rev H1
- Buffer (5 km)

Fitzroy River Turtle

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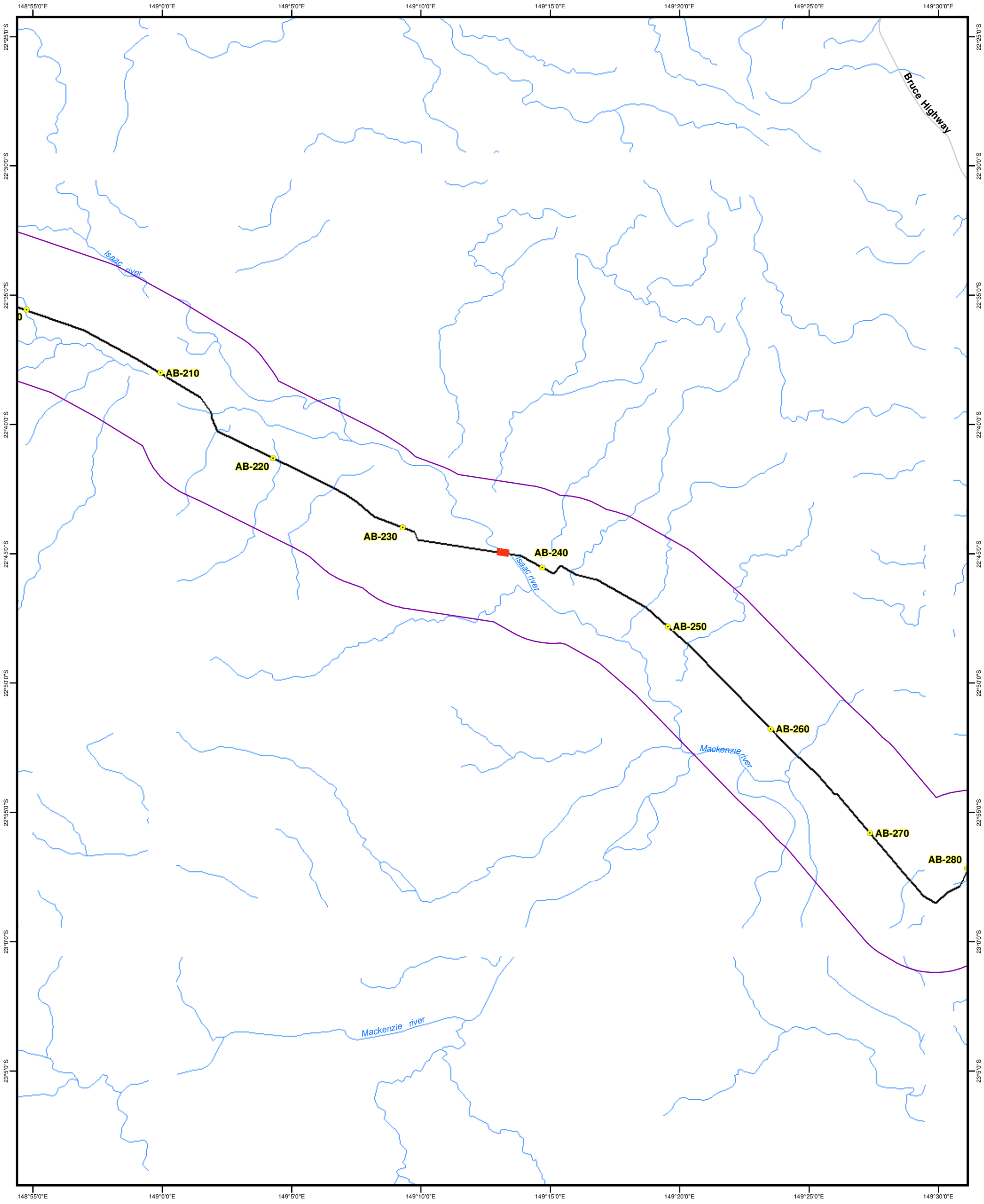

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- Potential Habitat in ROW (Field Verified)
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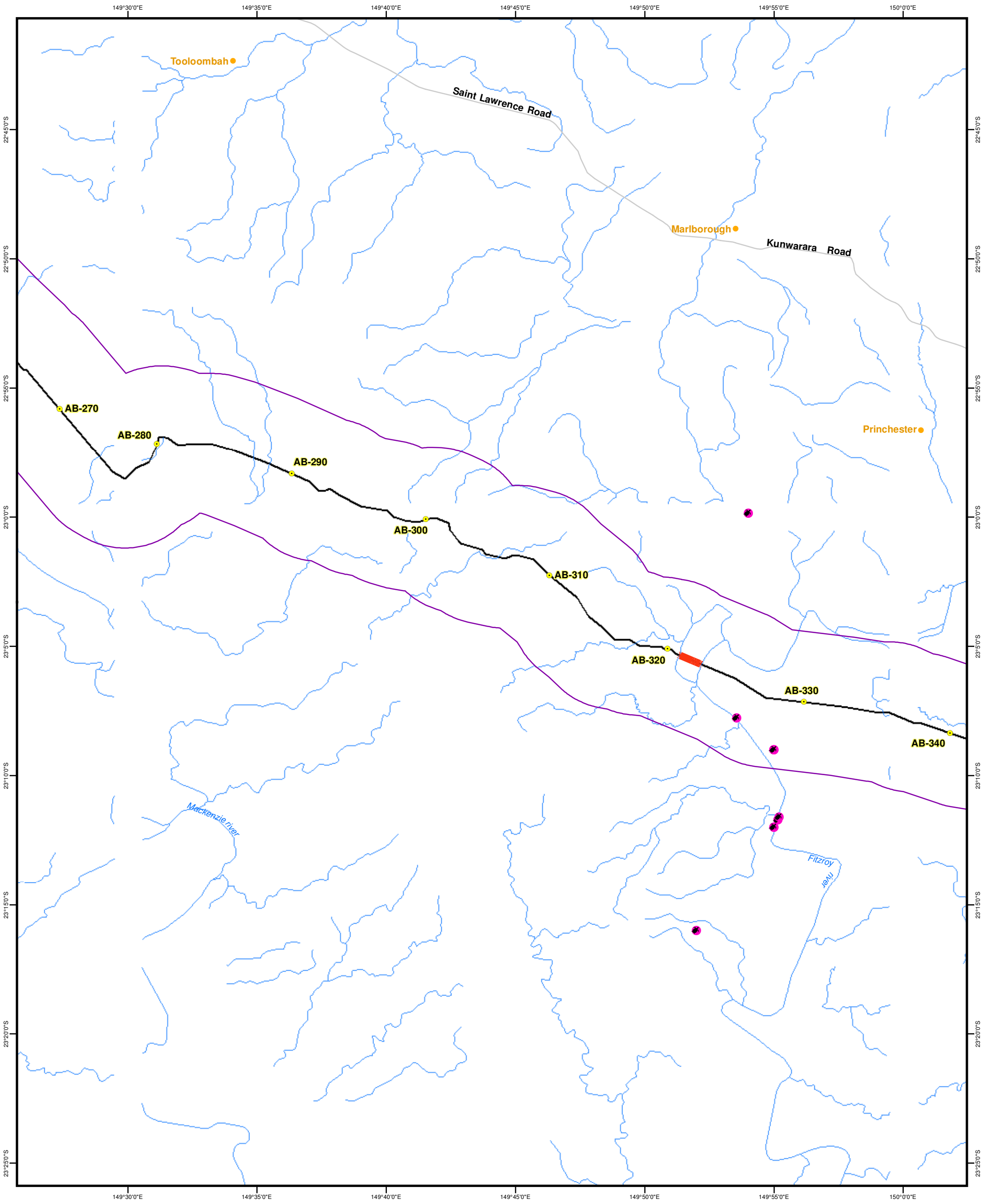

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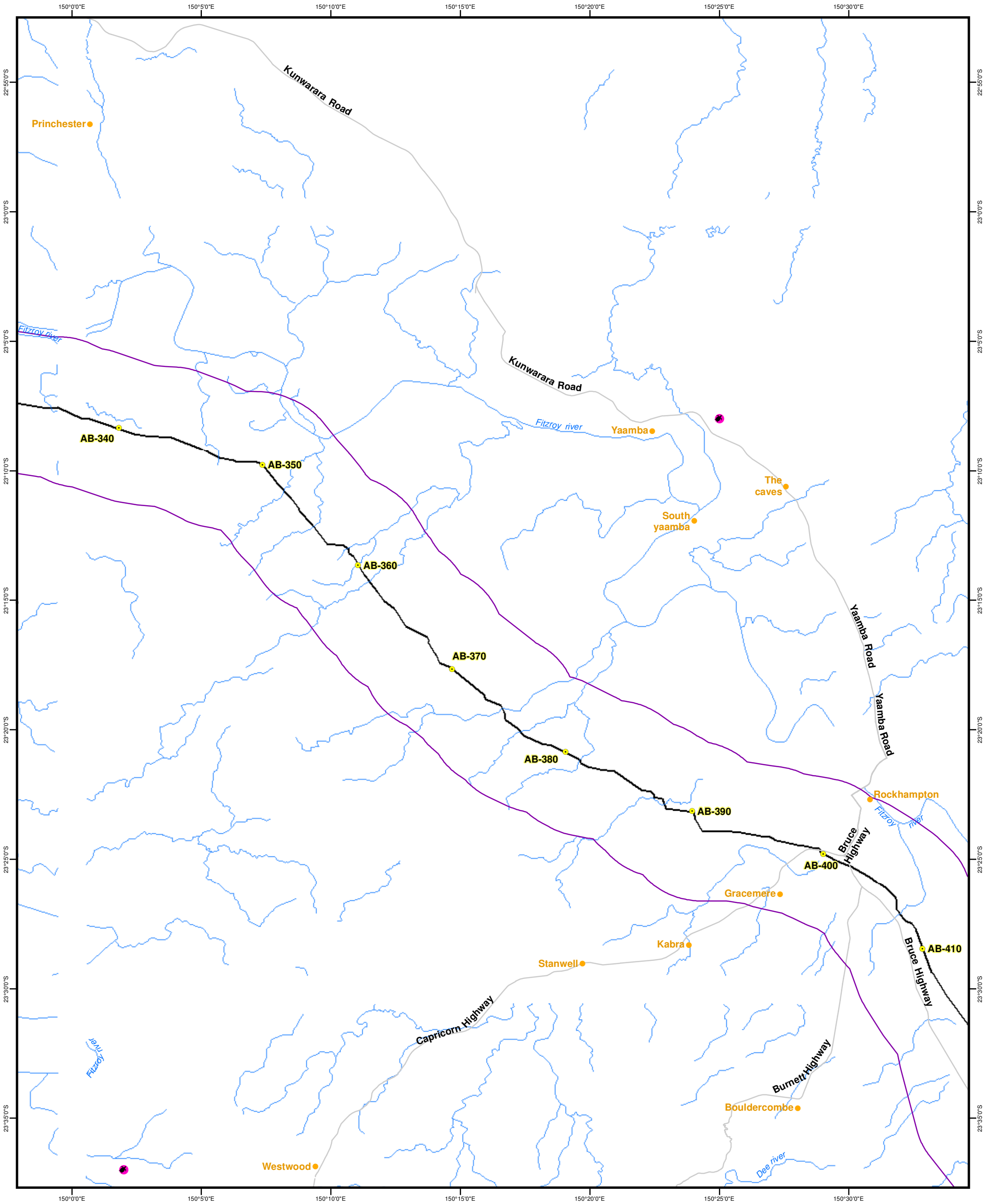

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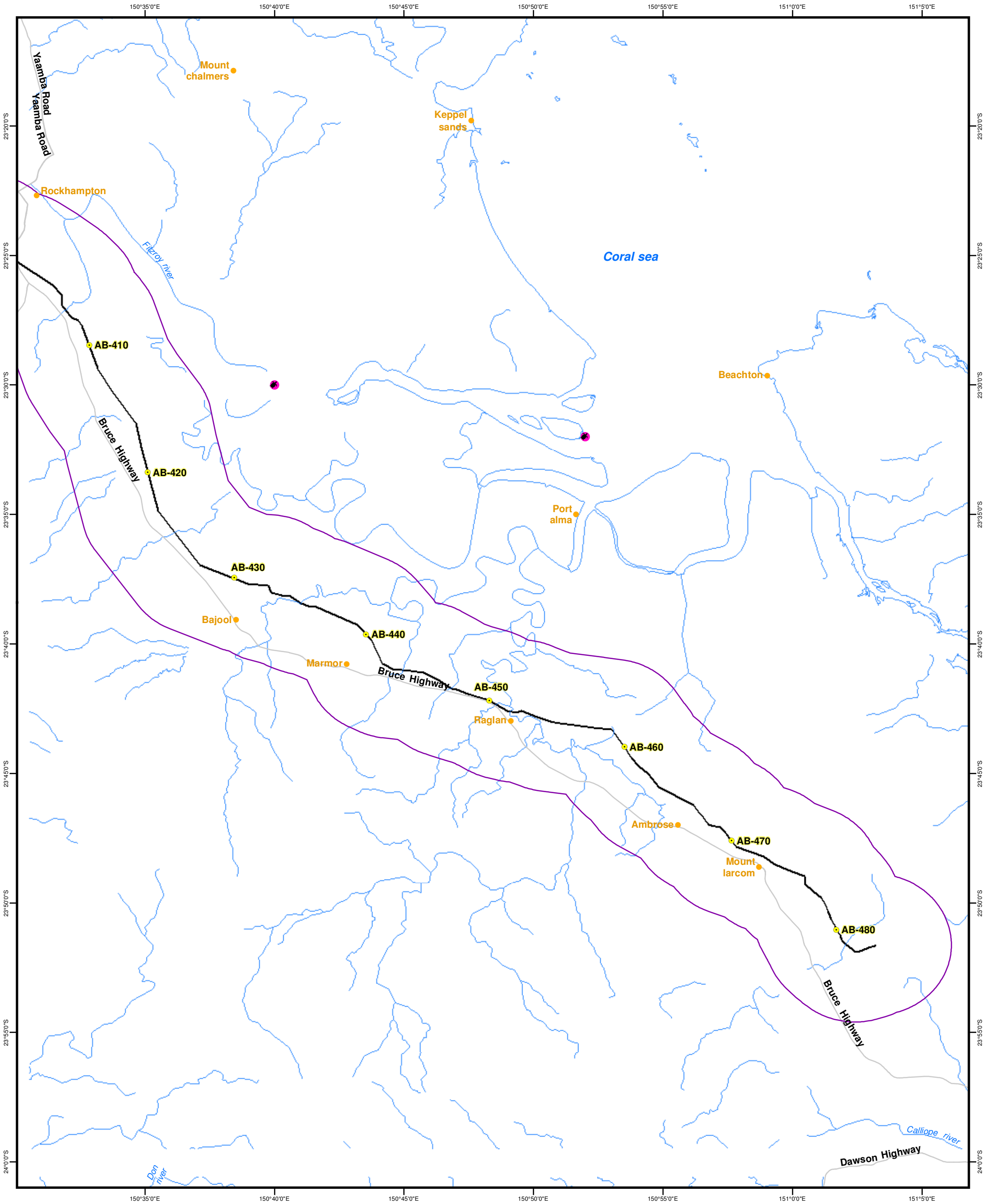

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2.9 *Xeromys myoides* (Water Mouse)

2.9.1 Conservation Status

Queensland: Vulnerable under the NC Act

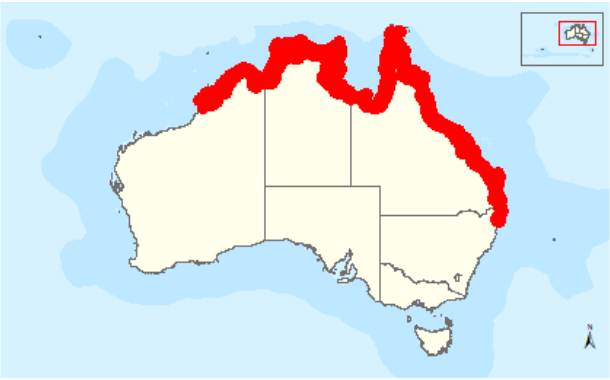
National: Vulnerable under the EPBC Act

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 (Fig. 1). 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).



Distribution of ***Xeromys myoides*** in Australia. 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 DSEWPaC 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 DSEWPaC survey guidelines

The effort conducted during the field surveys for this species is shown in Table 34 along with the effort recommended under the DSEWPaC guidelines. It must be noted that the guidelines are recommendations only and surveys are ongoing.

Table 34 Actual and DSEWPaC 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 25). 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."* According this definition, all 1.66 ha of potential Water Mouse habitat in the ROW could be considered critical habitat for the survival of the species. 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 35 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
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 3.

Table 36 Raw Risk (before mitigation) and Residual Risk (after mitigation) associated with construction of the ABP on Water Mouse.

Impact	Raw Risk before mitigation*	Mitigation measures	Residual Risk 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 the trench	L	-use trenchless crossing technology to cross Inkerman 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	I
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 Removal of nest mounds or hollow trees	M	-use trenchless crossing technology to cross Inkerman and Raglan -do not remove or interfere with nest mounds or hollow trees	L

		-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 remove all impacts to critical Water Mouse habitat. Should further studies preclude the use of trenchless techniques to cross these watercourses, Arrow will produce a species management plan which will assess the potential impacts of alternative crossing methods to this species and detail mitigation measures to reduce these impacts.

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.

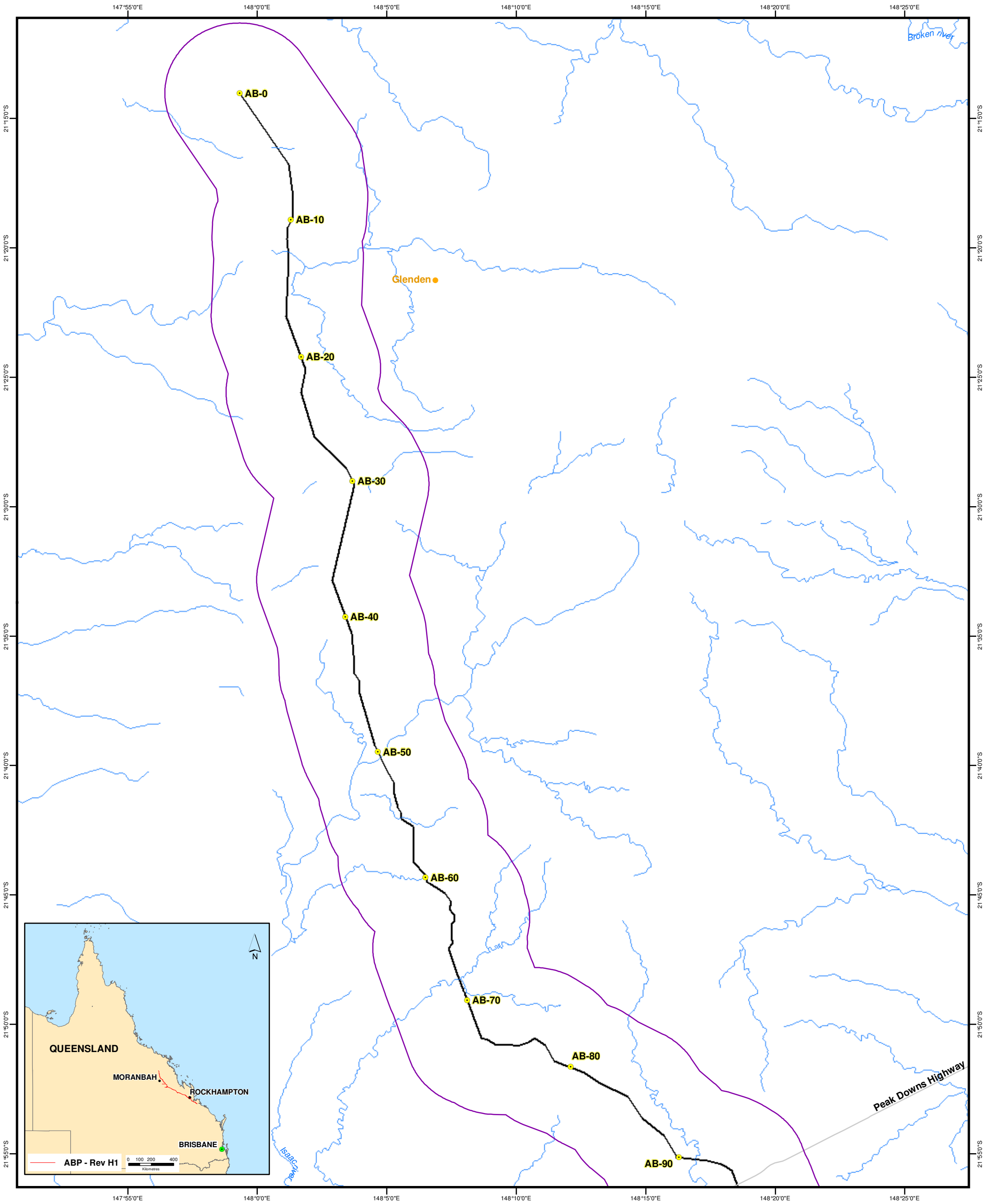
The plan also identifies risks to Water Mouse populations such as habitat loss, fragmentation, changes in hydrology and inappropriate burning.

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 to cross 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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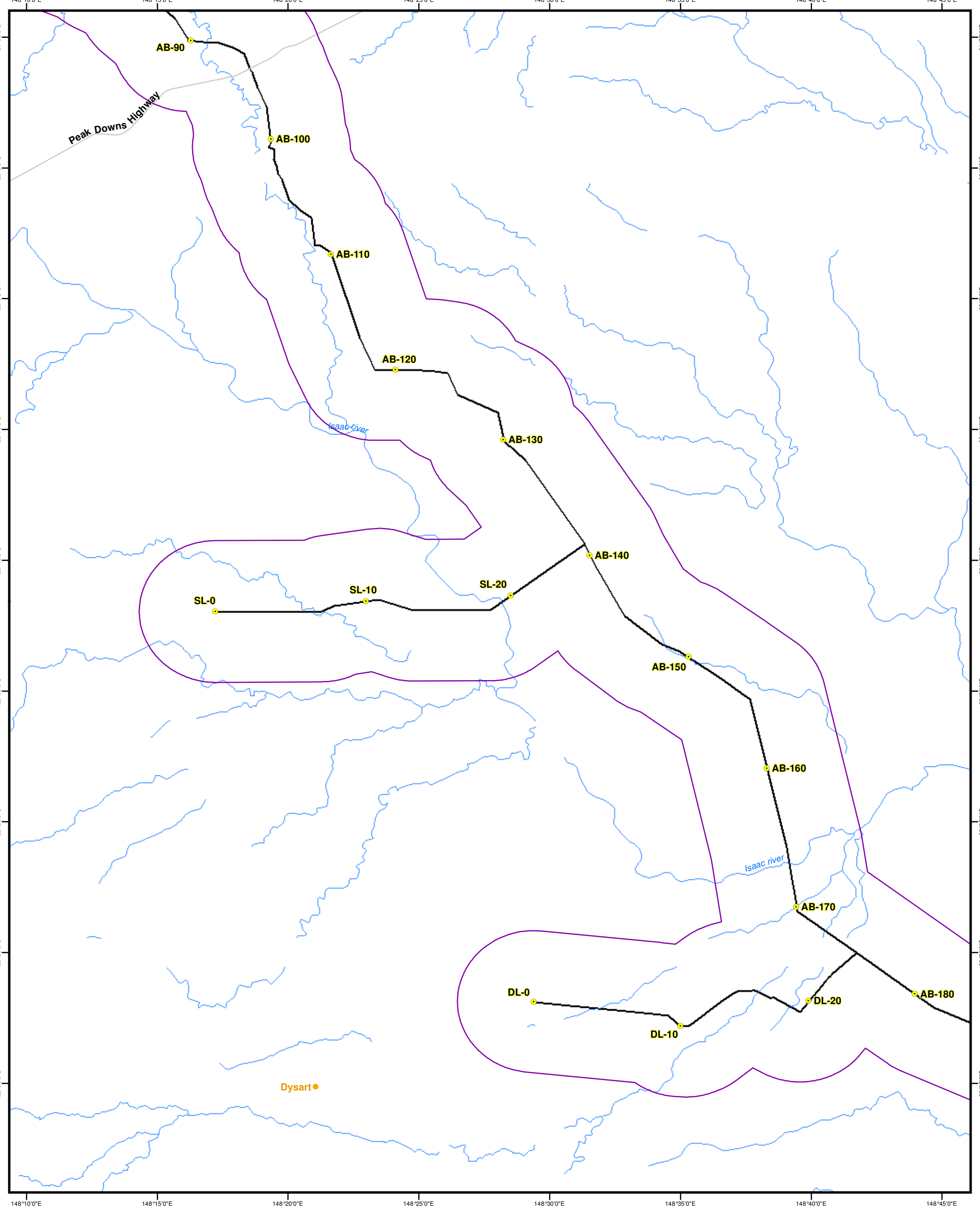

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REV	By	CHK	Description	Date

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Kilometres

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

LEGEND

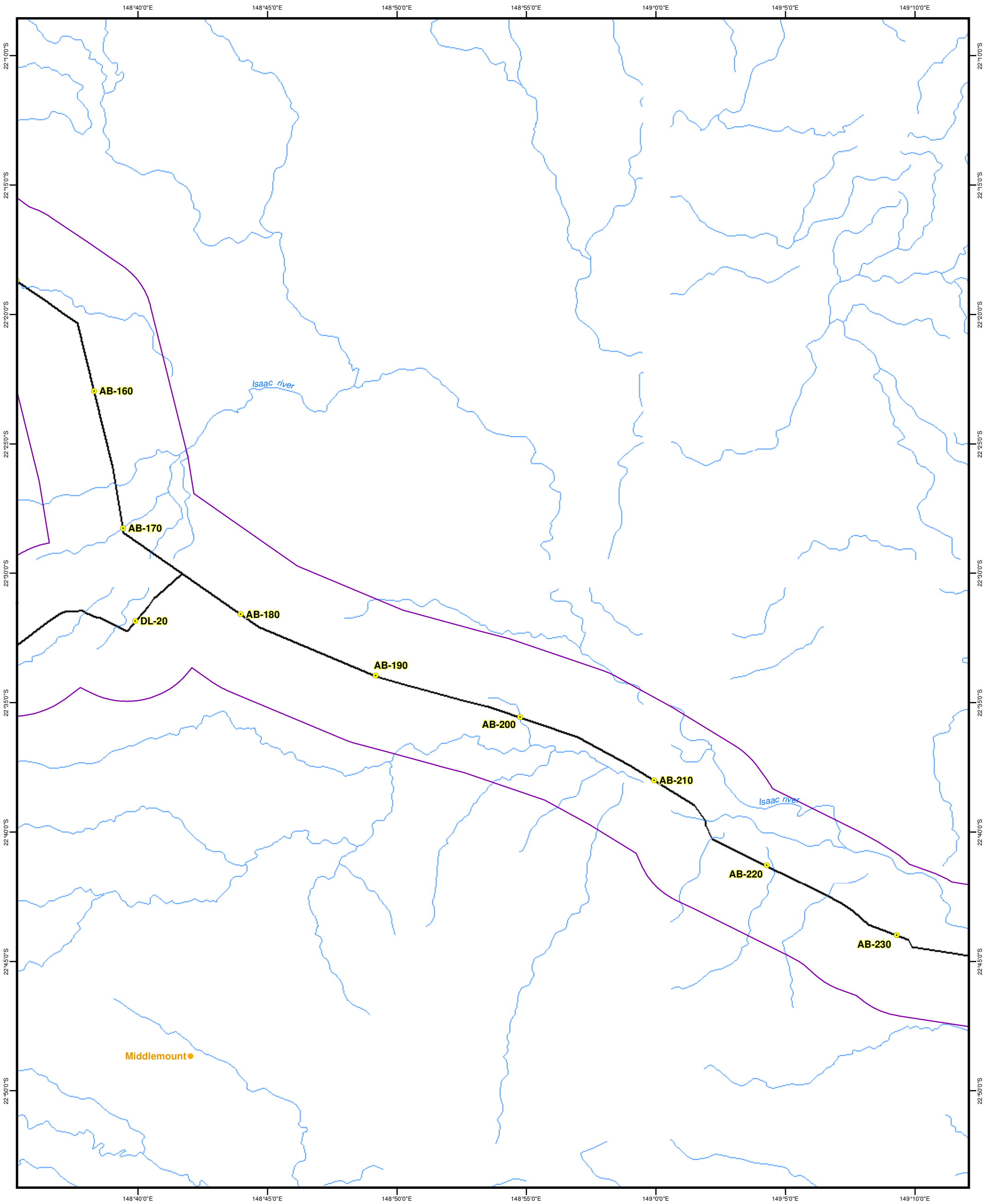
- City or town
- Kilometre Point
- Waterway or Coast Line
- Main roads
- ABP - Rev H1
- Buffer (5 km)

Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

A3



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Document
BE004_MP_006G_Water_Mouse_RevH1

Job Number: BE004

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REV	By	CHK	Description	Date

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GCS GDA 1994
Datum: GDA 1994
Units: Degree

LEGEND

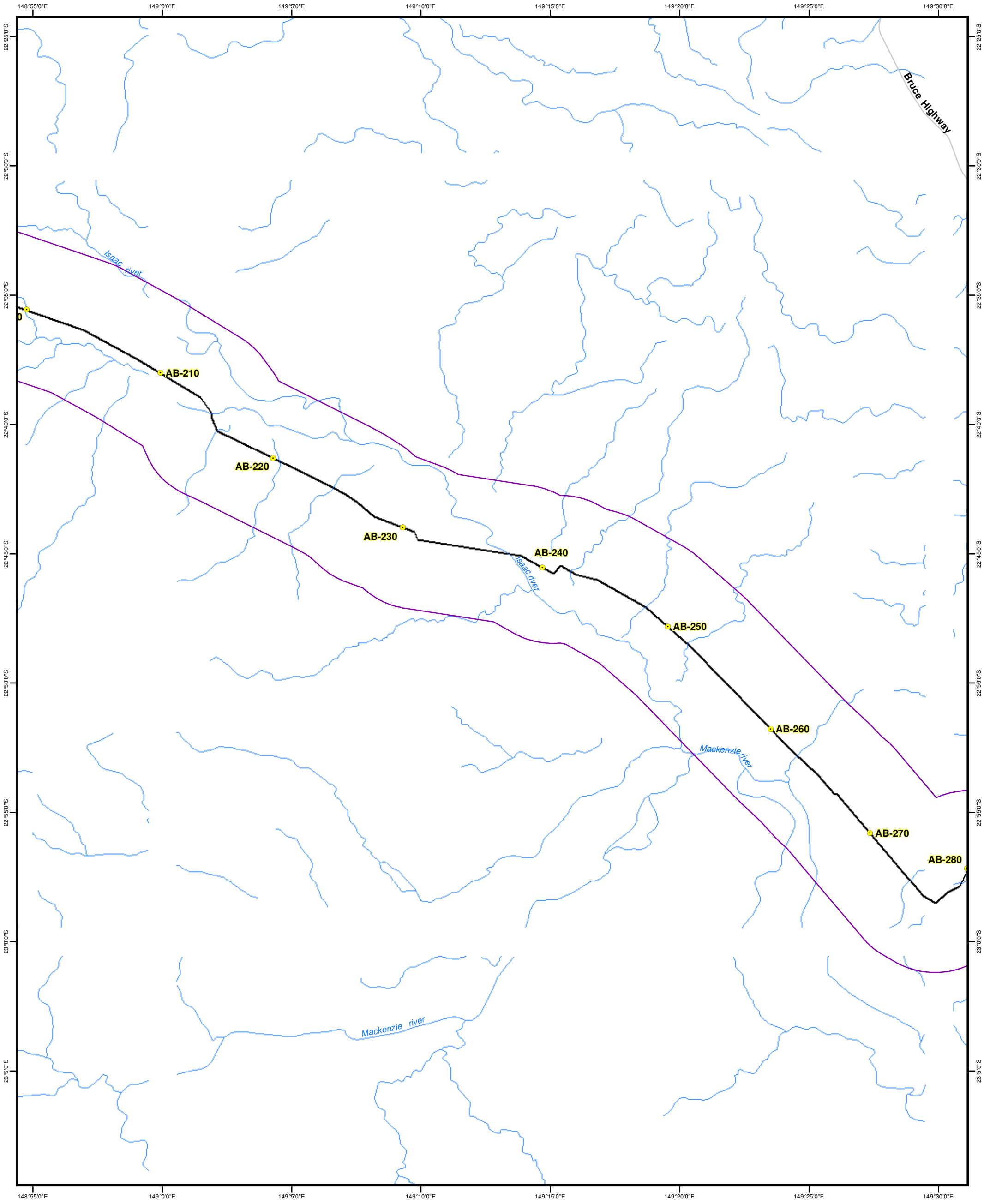
- City or town
- Kilometre Point
- Waterway or Coast Line
- ABP - Rev H1
- Buffer (5 km)

Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

A3



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Job Number: BE004

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Coordinate System:
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Datum: GDA 1994
Units: Degree

LEGEND

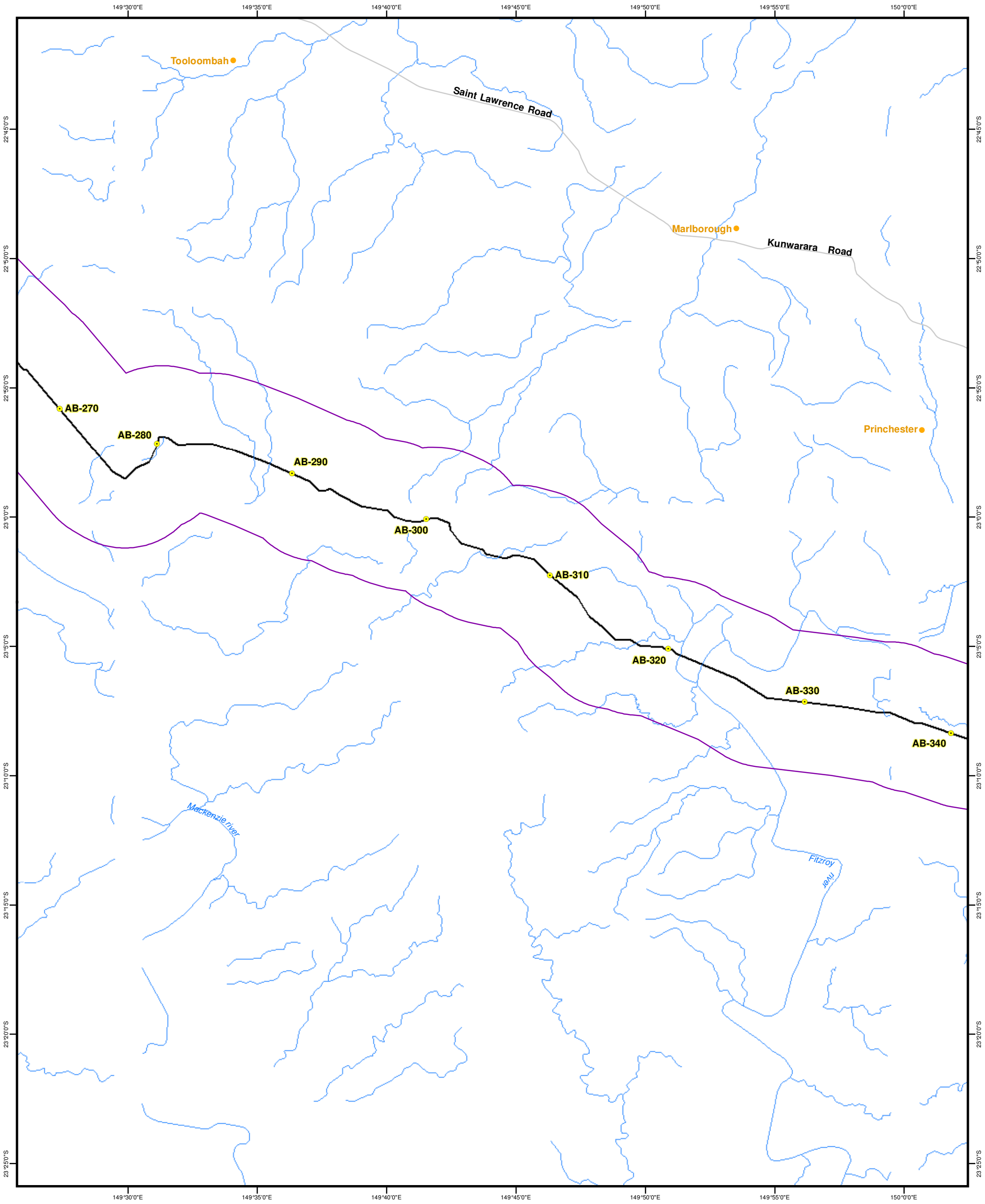
- Kilometre Point
- Waterway or Coast Line
- Main roads
- ABP - Rev H1
- Buffer (5 km)

Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

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
- Buffer (5 km)

Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

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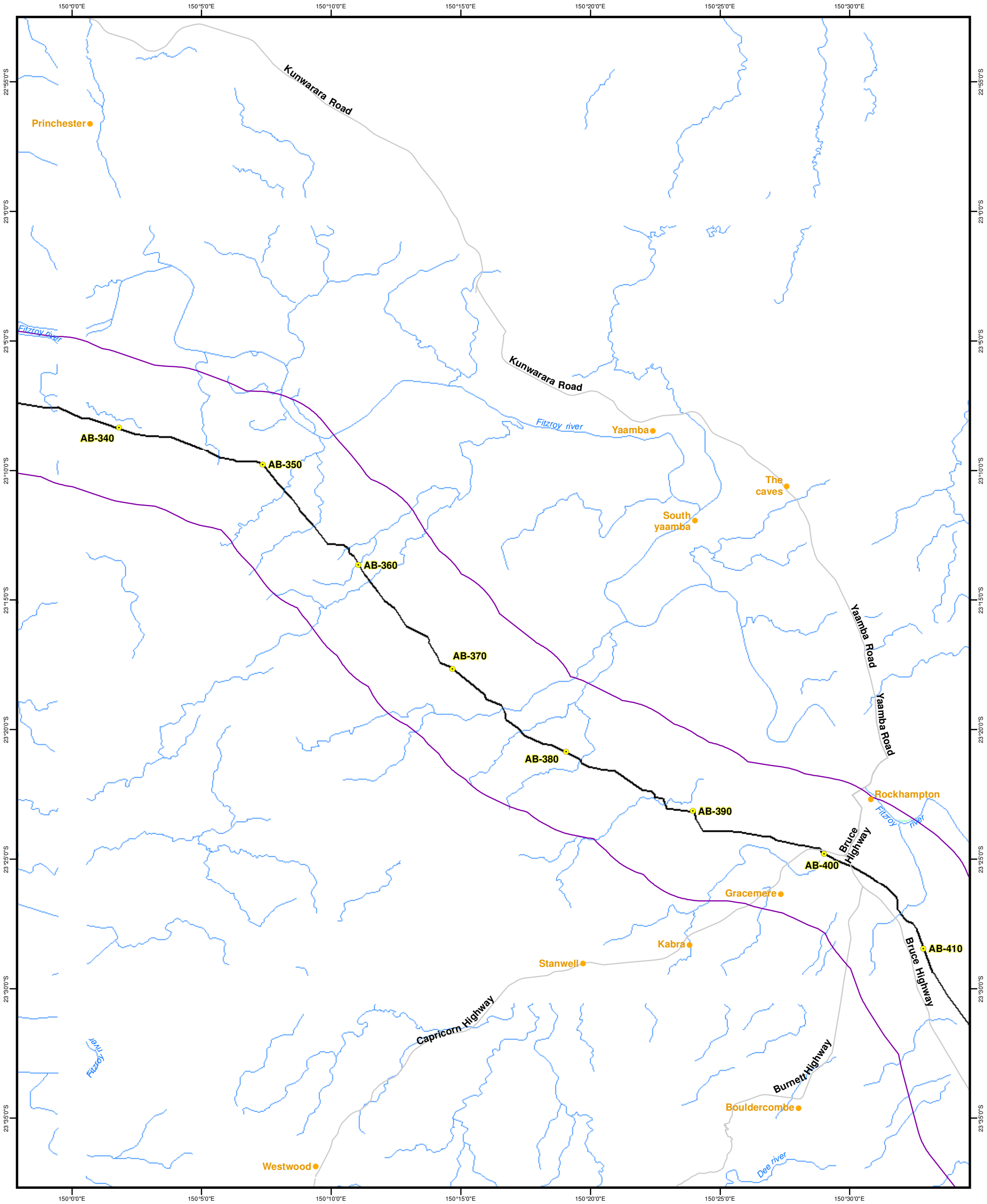
A3



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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

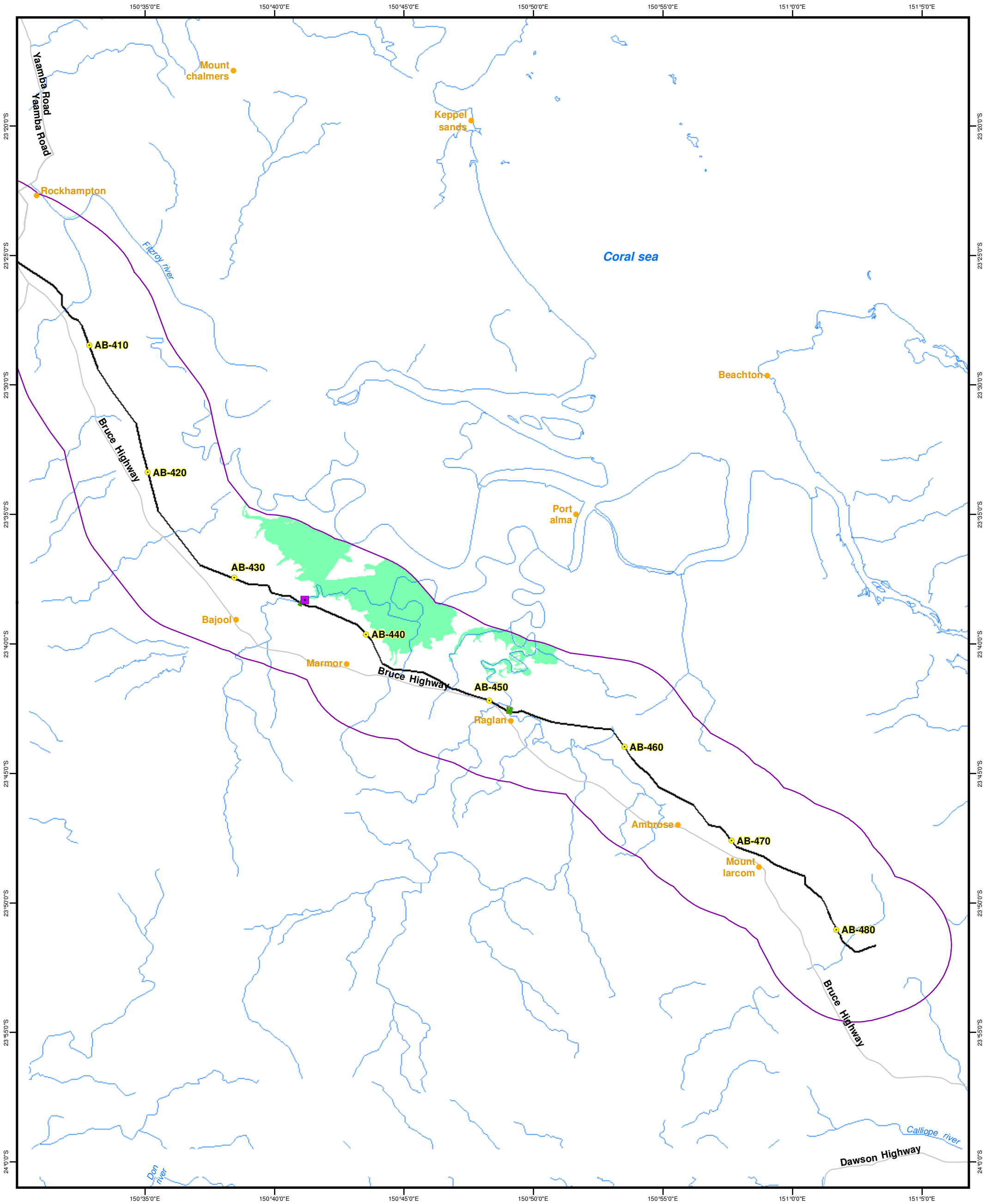
- City or town
- Kilometre Point
- Waterway or Coast Line
- Main roads
- ABP - Rev H1
- Potential Habitat in Buffer (from State RE Mapping)
- Buffer (5 km)

Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

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

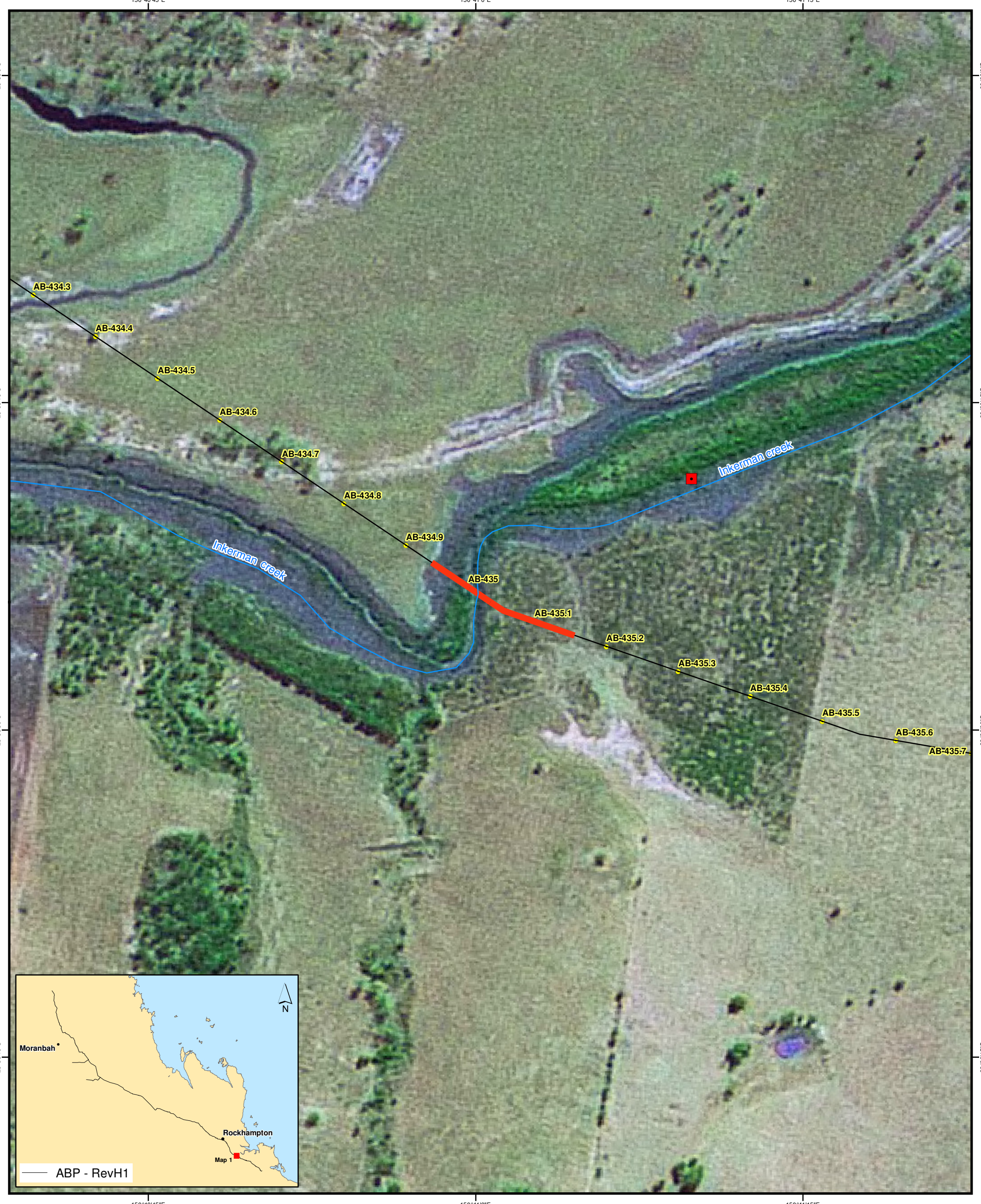
- City or town
- Kilometre Point
- Waterway or Coast Line
- Main roads
- ABP - Rev H1
- Water Mouse Survey Records
- Critical Habitat for Water Mouse
- Potential Habitat in ROW (Field Verified)
- Potential Habitat in Buffer (from State RE Mapping)
- Buffer (5 km)

Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

A3



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Document
BE004_MP_002_Critical_habitat_for_Water_Mouse

Job Number: BE004

REV	By	CHK	Description	Date
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Metres

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

LEGEND

- Water Mouse Record
- Critical Habitat for Water Mouse
- ABP Route - Rev H1
- Waterway

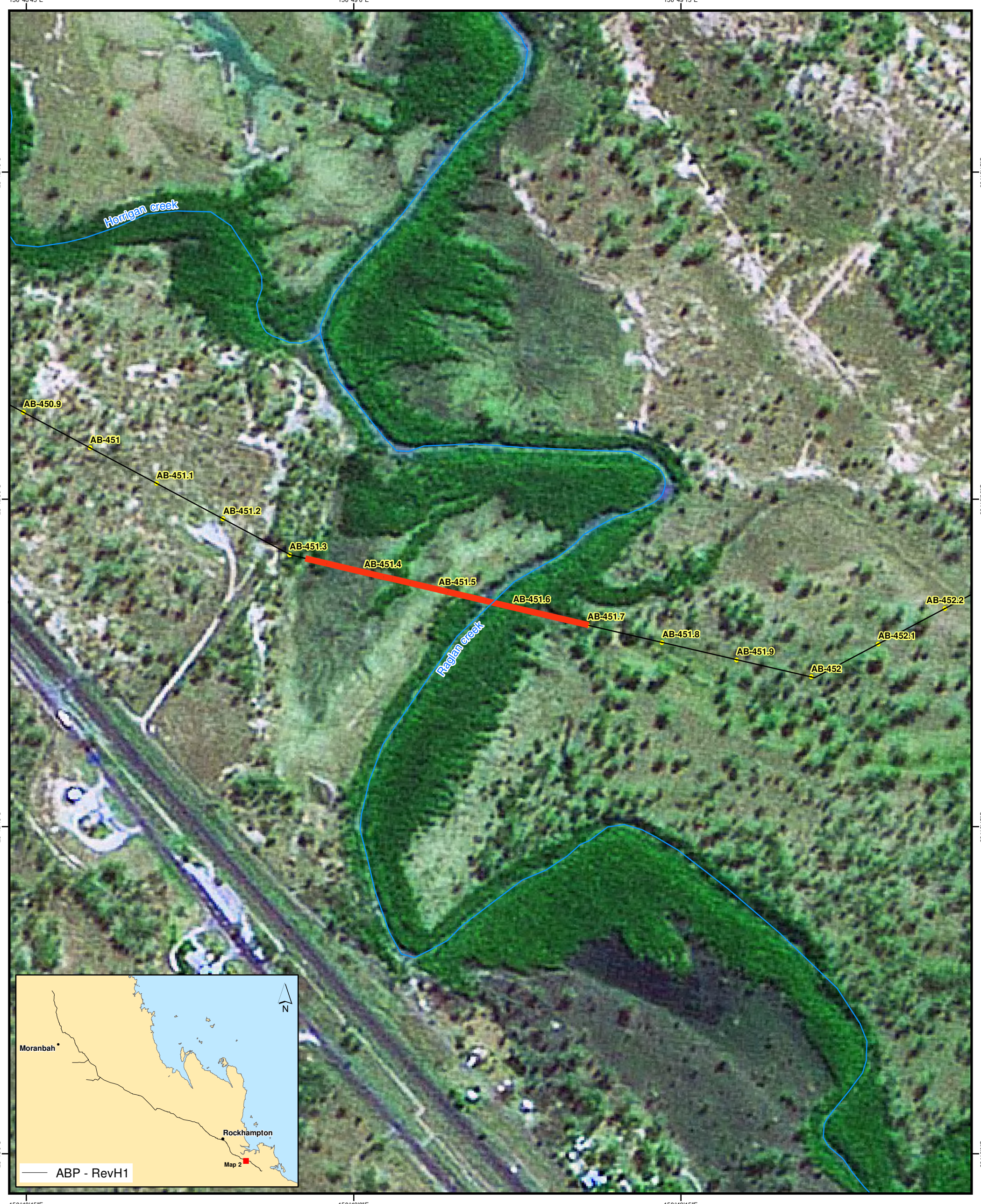
Critical habitat for Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Map 1 of 2 - Inkerman creek - AB-434.3 to AB-435.6

A3



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Document
BE004_MP_002_Critical_habitat_for_Water_Mouse

Job Number: BE004

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

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Metres

Scale: 1:5,000 when printed at A3

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

LEGEND

- Critical Habitat for Water Mouse
- ABP Route - Rev H1
- Waterway

Critical habitat for Water Mouse

Arrow Energy Pty Ltd

Arrow Bowen Pipeline
Revision H1

Map 2 of 2 - Raglan creek - AB-450.9 to AB-452.2

A3

3 Rehabilitation

Table 37 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 37: 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.

ABP Project

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

ABP Project

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 38 identifies proposed measures and performance indicators for each habitat.

Table 38: 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

ABP Project

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 37 and Table 38 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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