MEMO

METSERVE

Ornamental Snake Habitat in the Vulcan South Impact Area

1 Introduction

The proposed Vulcan South Coal Mine is the subject of referral 2023/09708 under the *Environment Protection of Biodiversity Conservation Act 1999* (EPBC Act). This mine was deemed a controlled action due to impacts to threatened species and ecological communities. A public environment report (PER) is being prepared, which will provide a detailed examination of the impacts of the project on matters of national environmental significance. The current draft PER considers significant impacts to be likely for three threatened species and one threatened ecological community. One species examined by the draft PER but not considered to be significantly impacted by the project is the Ornamental Snake (*Denisonia maculata*). Based on their review of the draft PER, the Department of Climate Change, Energy, the Environment and Water requested that more information be provided to justify the conclusion that habitat on site is unsuitable for the species.

The following are the objectives of this memo:

1. To characterise the habitat present, with respect to the presence of food, shelter, threats and connectivity;
2. To discuss the detectability of the species, the search effort undertaken to date, and adherence of survey methods with published survey guidelines; and
3. To assess whether significant impacts on the species are likely or possible.

2 Habitat Requirements of the Ornamental Snake

The Ornamental Snake is endemic to Queensland, and is found mostly in the Brigalow Belt North and parts of the Brigalow Belt South bioregions. The core of the species' distribution is within the Fitzroy and Dawson River drainages (DCCEEW 2024). The Conservation Advice describes Ornamental Snake habitat is "floodplains, undulating clay pans and along the margins of swamps, lakes and watercourses" (Department of the Environment 2014). DCCEEW's (2023) *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* defines suitable habitat as "*open-forests to woodlands associated with gilgai formations and wetlands. These are commonly mapped as Queensland regional ecosystems 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.5.16 or mapped as cleared but where the above ecosystems formerly occurred*." Similarly, the Species Profile and Threats (SPRAT) database states that the preferred habitat is within or close to habitat favoured by frogs, especially gilgai mounds and depressions in Queensland Regional Ecosystem land zone 4 (clay plains), but also lake margins and wetlands.

Food, shelter and habitat connectivity needs of the species, along with threats, are discussed in the following subsections.

2.1 Food

The Ornamental Snake is a frog specialist (DCCEEW 2024). No published studies have explicitly examined which frog species are primarily eaten; however, the SPRAT database lists the following species as being present where Ornamental Snakes occur:

- Striped Burrowing Frog (*Cyclorana alboguttata*)
- Short-footed Frog (*Cyclorana brevipes*)
- Knife-footed Frog (*Cyclorana cultripes*)
- Wide-mouthed Frog (*Cyclorana novaehollandiae*)
- Water-holding Frog (*Cyclorana platycephala*)

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- Rough Frog (*Cyclorana verrucosa*)
- Spotted Marsh Frog (*Limnodynastes tasmaniensis*)
- Green Tree-frog (*Litoria caerulea*)
- Eastern Sedge Frog (*Litoria fallax*)
- Floodplain Frog (*Litoria inermis*)
- Broad-palmed Rocket-frog (*Litoria latopalmata*)
- Roth's Tree-frog (*Litoria rothii*)
- Desert Tree-frog (*Litoria rubella*)
- Ornate Burrowing-frog (*Platyplectrum ornatum*).

Most of the above species are burrowers that only emerge to feed and breed in ephemeral waterbodies (e.g., gilgais) following rain. An abundance of burrowing frogs (*Cyclorana* species) is listed by the SPRAT database as a characteristic of sites favourable for Ornamental Snakes. Other characteristics listed as important predictors of Ornamental Snake habitat reflect its suitability as a breeding site for frog prey (DCCEEW 2024):

- presence of aquatic vegetation, especially in flooded gilgais where *Monochoria cyanea* grows
- diversity of gilgai size and depth
- soils with high clay content with high water retention capacity
- habitat patches greater than 10 ha in area and are within or connected to larger areas of remnant vegetation.

Not all gilgais are suitable as breeding sites for frogs. Soils with high salt content or gilgais of insufficient depth to facilitate the development of tadpoles are unfavourable as frog breeding sites. Tadpoles of all species known from Ornamental Snake habitat require water for the entirety of the tadpole stage. The length of time water in a gilgai is expected to persist after filling is a useful metric in determining the value of a gilgai to frogs. The length of this period of water retention is primarily driven by gilgai depth and climatic conditions.

Mean rainfall and evaporation rates are available for the Moranbah Airport (Bureau of Meteorology station 034035), 35 km north of the project area. As previous studies have found that most frog period occurs in the early wet season (Francis 2013), weather from November to January is most relevant to frogs. In this period, the mean monthly water deficit (mean rainfall less mean evaporation) is -163.4 mm/month, which is equivalent to 37 mm of evaporation per week. This means that a gilgai that is 111 cm deep will completely dry within three weeks, on average.

Pools of water do not have to dry completely before becoming inhospitable to tadpoles. A study by Francis (2013) found large-scale tadpole mortality, due to heat and increased predation, once pools dry to 68 mm deep in the northern Australian summer. Consequently, the minimum depth a pool must be to support a particular frog species can be estimated using the following formula: $T \times E + M$, where T is the number of weeks required to complete metamorphosis from egg-laying, E is the mean net weekly evaporation rate (37 mm) and M is the minimum depth of water required to sustain tadpoles (68 mm).

Frog species in **Table 2-1** are listed by DCCEEW (2024) as being associated with the habitats known to support the Ornamental Snake. Most species require a depth of at least 253 mm to support breeding, while a depth of 660 mm is required to support a complete frog community.

Depth of breeding pools is not the only factor influencing frog populations. The total size and abundance of pools is also associated with higher frog abundances. Sarker *et al* (2022) found that the coverage of inundated areas in a given habitat has a direct effect on the density of frogs. This relationship is probably not linear, as a minimum area of dry land is probably required to provide shelter and foraging substrates for frogs.

Table 2-1 Minimum gilgai depths for local frog species

Species	Common name	Time required for metamorphosis	Source	Minimum gilgai depth
Cyclorana alboguttata	Striped Burrowing Frog	Two to eight weeks (6 weeks assumed as average)	FrogID (2020)	290 mm
Cyclorana breviceps	Short-footed Frog	At least one month (assumed to be 5 weeks on average)	FrogID (2020)	253 mm
Cyclorana novaehollandiae	Wide-mouthed Frog	Based on the similar *C australis*, this is assumed to be 9 weeks	Francis (2013)	401 mm
Cyclorana platycephala	Water-holding Frog	5 weeks on average	Francis (2013)	253 mm
Limnodynastes tasmaniensis	Spotted Marsh Frog	At least three and a half months (assumed to be 16 weeks)	FrogID (2020)	660 mm
Litoria caerulea	Green Tree Frog	At least one month (assumed to be 5 weeks)	FrogID (2020)	253 mm
Litoria inermis	Floodplain Frog	Around 6 weeks	Francis (2013)	290 mm
Litoria latopalmata	Broad-palmed Frog	Around two months (assumed to be 8 weeks)	FrogID (2020)	364 mm
Litoria rubella	Desert Tree Frog	5 weeks on average	Francis (2013)	253 mm
Platyplectrum ornatum	Ornate Burrowing Frog	Two weeks	Francis (2013)	142 mm

A final consideration when assessing the value of frog habitats (and Ornamental Snake foraging habitat consequentially) is the presence and abundance of potential predators within breeding pools. Macroinvertebrate predators (predatory diving beetles, beetle larvae, giant water bugs and dragonfly larvae) are the main tadpole predators in temporary pools (Francis 2013). Increasing numbers of macroinvertebrate predators throughout the wet season is a primary reason that most successful frog breeding occurs early in the season (Francis 2013). Fish are largely absent from the temporary pools favoured by breeding frogs (Francis 2013) and are the most likely factor limiting the use by breeding frogs of rivers, permanent waterbodies and pools connected to streams during periods of flood. Pools with fish or a high abundance of macroinvertebrate predators are associated with lower frog abundance and diversity.

2.2 Shelter

The Ornamental Snake is viviparous (live bearing) and therefore does not require specific habitat features for breeding. The species does require shelter during extended dry periods, when it is inactive, as well as during the day in wet conditions (it is primarily nocturnal).

No studies have tracked Ornamental Snakes to determine the key features of dry-season or day-time shelter sites. It is currently thought that the species primarily shelters during the dry season in soil cracks. This is a feature of the heavy clay soils associated with gilgai development, so sites with gilgais typically also exhibit soil cracks, except in situations where a shallow, sandy topsoil layer is present. The SPRAT database states that deep-cracking characteristics important to Ornamental Snakes are a feature of soils with high fine clay particle fraction. Cracking clays with higher sand and more sodic cracking clays have lesser water-retention capacity and hence less propensity to form deep cracks (DCCEEW 2024).

During wet seasons, when cracks disappear, Ornamental Snakes rely on other shelter sites during daytime inactivity. The SPRAT database states that the species likely shelters under coarse woody debris and litter. Burrows made by other animals may also be used occasionally (Royal *et al.* 2022).

No studies have examined whether a minimum density of daytime shelter sites is required for Ornamental Snakes. Benchmark values for the “coarse woody debris” component of BioCondition for regional ecosystems known to be occupied by the Ornamental Snake can be used as a guide to amount of shelter available in high-quality examples of habitat. The published values are presented in **Table 2-2**.

Table 2-2 Coarse woody debris benchmarks for regional ecosystems supporting Ornamental Snakes

Regional Ecosystem	Benchmark for Coarse Woody Debris*
11.3.3	285 m/ha
11.4.3	1,752 m/ha
11.4.6	667 m/ha
11.4.8	813 m/ha
11.4.9	980 m/ha
11.5.16	1,812 m/ha
Mean	1,051 m/ha

*From version 3.4 of the BioCondition Benchmark Database published by the Queensland Herbarium (2023). Coarse woody debris is defined as the total length in metres of woody debris that is >10 cm diameter and >0.5 m in length (and more than 80% in contact with the ground).

2.3 Threats

No studies have examined the extent or causes of population declines in the Ornamental Snake. It is listed as a vulnerable species under the EPBC Act on the basis that it was listed as vulnerable under Schedule 1 of the former *Endangered Species Protection Act 1992* (Cwlth). It is assumed that populations have declined due to large-scale habitat clearance and modification (primarily for agriculture) throughout its distribution, but no population monitoring has taken place. Fauna surveys along a trench between Moranbah and Townsville (north of the project area) in 2004 found that Ornamental Snakes were the second-most abundant species within the trench among 20 species of snake recorded (Swan and Wilson 2012). It was the fourth-most abundant species out of 56 species of reptiles recorded (Swan and Wilson 2012). Given that the northern half of this trench was outside the known distribution of the species, this implies that the species continues to reach high densities in places where it is found.

The Conservation Advice identifies historical broadscale land clearing and habitat degradation as the principal threat to the Ornamental Snake. Habitat destruction due to feral pigs and poisoning from cane toads are additional threats listed.

DCCEEW (2024) lists the following threats to the Ornamental Snake in its SPRAT database:

- Habitat loss through clearing (roads, ploughing, railways, mining-related activities, pipeline constructions)
- Habitat fragmentation
- Habitat degradation by overgrazing by stock, especially cattle, or grazing of gilgais during the wet season leads to soil compaction and compromising of soil structure
- Alteration of landscape hydrology in and around gilgai environments
- Alteration of water quality through chemical and sediment pollution of wet areas
- Contact with the Cane Toad
- Predation by feral species
- Invasive weeds.

Due to a lack of data, the importance of each of these threats is largely unknown.

2.4 Habitat Connectivity

The home range size or dispersal ability of Ornamental Snakes is not known. The SPRAT database states that the species is recorded in habitat patches that are typically greater than 10 hectares in area and are within, or connected, to larger areas of remnant vegetation (DCCEEW 2024). An Ornamental Snake was been recorded (presumably dispersing) during drought conditions in a paddock dominated by Buffel Grass (*Cenchrus ciliaris*), about one kilometre from a gilgaied patch of Brigalow regrowth (DCCEEW 2024).

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (DCCEEW 2023) states that "habitat connectivity between gilgais and other suitable habitats is important" when deciding whether important habitat occurs on site. However, what constitutes "connected habitat" for a species that can inhabit a broad range of vegetation types, from exotic grassland to native forested habitats, is unclear. Connectivity probably reflects the distance between patches of favourable habitat (cracking clays with gilgais) rather than the nature of the intervening habitat, with the exception of obvious barriers to dispersal such as mine pits, urban environments, or rugged mountain ranges. Other small to medium-sized, nocturnal, Australian snakes tend to move relatively little (50-500 m) (Keogh *et al.* 2007; Dubey *et al.* 2008). These data from other snake species are consistent with the observation reported in the SPRAT database that habitat patches are to be at least 10 ha to support Ornamental Snakes; patches of this size can contain a home range of 315 m × 315 m. For the purposes of this review, habitat patches that are more than 1 km apart are considered poorly connected.

2.5 Important Habitat

Approximately half the criteria for a significant impact on a vulnerable species, as defined by the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*, are based on the effect of an action on "important populations". "Important populations" are defined by these guidelines as "*a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

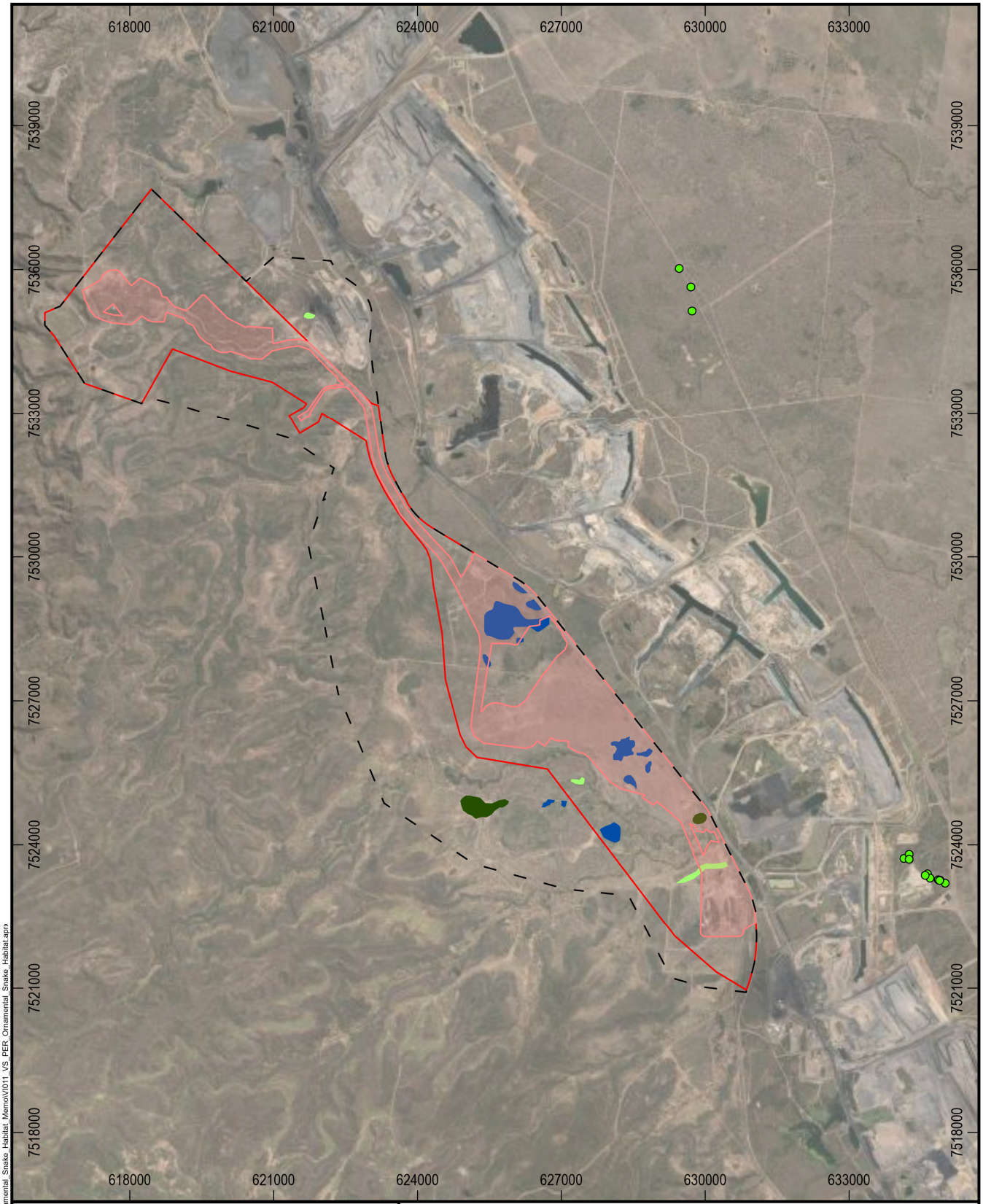
- *key source populations either for breeding or dispersal*
- *populations that are necessary for maintaining genetic diversity, and/or*
- *populations that are near the limit of the species range"* (Department of the Environment 2015).

However, the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (DCCEEW 2023) considers "important habitat" to be a surrogate for "important populations" in the case of the Ornamental Snake. "Important habitat" is defined as "*gilgai depressions and mounds*…[noting] *habitat connectivity between gilgais and other suitable habitats is important*".

3 Habitats Within the Vulcan South Coal Mine Area

Most of the Vulcan South Coal Mine area (the project area) comprises sandstone hills and adjacent sand plains, which do not constitute habitat for the Ornamental Snake. The southern half of the project area contains patches of clay plain (land zone 4) within a sandplain matrix. These patches support remnant and cleared examples of regional ecosystems 11.4.8 and 11.4.9, which constitute "suitable habitat" for the Ornamental Snake where gilgais are present. Gilgais are absent from most of these patches but are present in some (**Figure 3-1**).

All patches with gilgais were relatively small and separated from other patches by sand plain. Only two patches were larger than the 10-ha threshold suggested by the SPRAT database as potentially supporting Ornamental Snakes (**Table 3-1**). Both of these patches were further than 1 km from other habitat patches larger than 10 ha, which means they are effectively isolated.



Legend

ALA Records

- *Denisonia maculata* (Ornamental Snake)
- Survey Area

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Potential Ornamental Snake Habitat

- Clay Soil with Gilgais

Frog Breeding Habitat in Sandy Soils

- High frog abundance (>100 individuals and >5 species)
- Moderate frog abundance (5-100 individuals or 2-5 species)

Source: Atlas of Living Australia 2024, Vulcan South datasets, Ornamental Snake and Frog Habitats - Vitrinite & METServe 2020-2024, Earthstar Geographics 28/09/2023.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Ornamental_Snake_Habitat_Memo\VI011_VS_PER_Ornamental_Snake_Habitat.aprx

Vulcan South

Potential Ornamental Snake Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

2/10/2024

Datum: GDA2020
Projection: MGA55

FIGURE 3-1

VITRINITE BRIGHTER COAL

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Table 3-1 Patches of potential Ornamental Snake habitat within the project's impact area

Size of Patch	Habitat Type	Distance to Nearest Patch	Distance to Nearest Patch >10 ha
58.7 ha	Remnant 11.4.8	110 m	2,748 m
15.7 ha	Cleared land zone 4 with gilgais	59 m	1,276 m
8.8 ha	Regrowth *Eucalyptus populnea* on sandy alluvium where flood waters pool*	860 m	1,492 m
4.4 ha	Remnant 11.4.8	167 m	174 m
4.3 ha	Regrowth *Eucalyptus populnea* on sandy alluvium where flood waters pool*	860 m	1,524 m
4.0 ha	Regrowth 11.4.8	292 m	319 m
3.3 ha	Remnant 11.4.8	167 m	315 m
3.2 ha	Cleared land zone 4 with gilgais	59 m	59 m
2.8 ha	Remnant 11.4.8	392 m	392 m
2.3 ha	Cleared land zone 4 with gilgais	101 m	337 m
1.5 ha	Remnant 11.4.8	110 m	110 m

*These two sites do not contain gilgais or clay soils, so are not "important habitat" as defined by DCCEEW's (2023) *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles.* However, as ephemeral wetlands, they meet the definition of "suitable habitat" and are included in the above table on the basis that numerous frogs were recorded there.

Habitat quality surveys were undertaken across all assessment units within the impact area. These measured the dimensions of all gilgais recorded within 100 m × 50 m sampling plots, as well as abundance of coarse woody debris. Nine out of 55 sampling plots across the proposed impact site were located on land zone 4 (clay plains) and only four of these contained gilgais. In half of the four sites supporting gilgais, these depressions were too shallow to support the breeding of frogs (**Table 3-2**). At the remaining two sites, only one species of frog (the fast-maturing Ornate Burrowing-frog, *Platyplectrum ornatum*) is expected to regularly breed there successfully, based on gilgai depths, local evaporation rates and development times (refer to **Table 2-1** for a summary of the requirements for local frog species). These two sites corresponded to the largest two patches listed in **Table 3-1** (I25 was located in the 58.7 ha patch and I41 was located within the 15.7 ha patch).

The aquatic plant, *Monochoria cyanea*, which is an indicator of suitable Ornamental Snake habitat (DCCEEW 2024), was absent from gilgais.

The habitat quality data strongly accords with the results of fauna surveys within patches of potential Ornamental Snake habitat. Surveys of gilgai habitats immediately after heavy rain in the early wet season (optimal conditions for detecting frogs) recorded only a single frog species calling there: *P. ornatum*. No *Cyclorana* species (an indicator of optimal Ornamental Snake habitat, according to the SPRAT database) were recorded in gilgais, and the depth of the gilgais present is too shallow to support the breeding of these favoured prey species.

A rich diversity of frogs (including ten species that the SPRAT database lists as present where Ornamental Snakes occur) were recorded at sites away from clay soils and gilgais. These were primarily observed in low-lying depressions on sand plains where Poplar Box (*Eucalyptus populnea*) grew. Two such sites are found within the proposed impact site, and these are listed on **Table 3-1**. Despite containing food resources for the Ornamental Snake, these sites were smaller than the 10-ha threshold of patches typically occupied by Ornamental Snakes (DCCEEW 2024). Also, these were 1,313 m and 1,493 m respectively from the nearest patches of cracking clay soil that can provide dry season refuge, which is likely to be an excessive commuting distance for a small, slow-moving snake, based on studies of other species (see **Section 2.4**).

Shelter sites for Ornamental Snakes, in the form of coarse woody debris, were in below-average densities at all sites sampled that contained gilgais (**Table 3-1**). At two of the four gilgai sites, coarse woody debris was absent.

Table 3-2 Gilgai depths within the proposed impact site

Sample site	Regional Ecosystem	Number$_{gilgais}$ /ha	Average depth (mm)	Maximum depth (mm)	% of site inundated*	Suitability for frogs	Coarse woody debris
I37	11.4.9	2	100	100	7.5	Gilgai depth is insufficient to support breeding by any frog species.	108 m/ha
I41	Cleared 11.4.8	24	125	200	5.0	*Platyplectrum ornatum* can breed in the deepest gilgai recorded, but most gilgais cannot support any frogs.	0 m/ha
I25	11.4.8	12	183	250	2.7	*Platypletrum ornatum* can breed in most gilgais recorded. The deepest gilgai is only marginally shallower than required by three additional frog species. These species may occasionally breed in this deepest gilgai, but high mortality rates are expected.	641 m/ha
I46	Cleared 11.4.8	4	75	100	0.2	Gilgai depth is insufficient to support breeding by any frog species.	0 m/ha
I23	11.4.8	0					228 m/ha
I26	11.4.8	0					854 m/ha
I29	11.4.8	0					756 m/ha
I42	Cleared 11.4.8	0					73 m/ha
I45	Cleared 11.4.8	0					288 m/ha

*Estimates of maximum inundation extent are highly conservative as they are calculated by multiplying the length by the width of each gilgai (reflecting a rectangle containing each gilgai). As most gilgais are round or irregularly shaped, these estimates could be up to twice as large as the true inundation coverage.

Overall threat levels for the Ornamental Snake at the proposed impact site are high. Approximately half of the potential habitat has been subjected to clearing for agriculture. All habitat patches are exposed to high grazing/trampling pressure from domestic cattle. Feral pigs were also recorded on site, but not in high densities. Cane Toads were the most abundant amphibian recorded across all habitats within the impact area. Finally, the impact site lies adjacent to Saraji Road, a sealed road that receives substantial night-time traffic. As a slow-moving reptile susceptible to collisions with vehicles, this traffic exerts substantial pressure on the viability of small, low-quality habitat patches occurring nearby.

4 Surveys Undertaken

Fauna surveys were undertaken in the Vulcan South impact area over six survey periods, spanning multiple years and seasons:

1. 24 October 2018 to 2 November 2018;
2. 4 February 2019 to 15 February 2019 (spotlighting were undertaken during a flora survey);
3. 25 March 2019 to 29 March 2019 (abandoned prematurely due to heavy rain);
4. 8 April 2019 to 17 April 2019;
5. 1 May 2019 to 9 May 2019; and
6. 23 September to 4 October 2019.

All of the above surveys fell within the two seasons recommended by the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland version 3.0* (Eyre *et al*. 2018) for the Brigalow Belt bioregion. Heavy rain events (>100 mm within 24 h) occurred during the first and third surveys, leading to flash flooding of creeks and the filling of temporary pools and gilgais. This produced optimal conditions for the detection of frogs and Ornamental Snakes. Light rain events (~15 mm) also occurred

during the second and fourth surveys, stimulating moderate frog activity. A light shower (<5 mm) during the sixth survey was the first rain received by the site in many months, stimulating moderate frog activity.

Surveys for the Ornamental Snake at Vulcan South included the following techniques:

- Pitfall traps
- Funnel traps
- Spotlighting.

At each trap site, four pitfall traps and three pairs of funnel traps were positioned along 45 m of 40-cm-high aluminium fly-screen drift fence flush with the ground in a T arrangement. These traps were open for at least four consecutive nights each. Three trap sites were installed in remnant brigalow vegetation on land zone 4 (regional ecosystems 11.4.8 and 11.4.9) and two trap sites were installed in seasonally flooded poplar box woodland (regional ecosystem 11.3.2) that supported high frog densities. Spotlighting was undertaken at each of the five trap sites, in addition to eight other potential Ornamental Snake habitats (three sites in remnant brigalow on land zone 4 and seven sites where water pooled on sandy substrates). All spotlighting events at non-trap sites occurred within one week of heavy rain, which were optimal conditions for detecting Ornamental Snakes.

Overall, the total survey effort for the Ornamental Snake in potential habitats within the project area included 100 pitfall trap-nights, 150 funnel trap-nights and 9 person-hours of spotlighting. This is a subset of the total fauna surveys conducted across all habitat types within the project area.

In addition, habitat quality surveys conducted in 2023 confirmed that the habitat values of the site had not fundamentally changed since the fauna surveys were undertaken, and further quantified what these habitat features were by measuring gilgai dimensions and abundance of shelter sites for the Ornamental Snake.

No Ornamental Snakes were detected within the vicinity of the proposed Vulcan South Coal Mine.

4.1 Detectability of the Species

There is no published data on the detection probability of the species based on various survey techniques. Based on anecdotes reported in the SPRAT database, “the species is relatively easy to detect in suitable habitat, and under the right environmental conditions” (DCCEEW 2024). Optimal conditions are on warm, humid nights following heavy rainfall, when frogs are most active (DCCEEW 2024). High detectability accords with personal observations by METServe ecologists; at sites where the species is known to occur, spotlighting in optimal conditions produced detection rates of around one individual per hour of searching, with multiple individuals observed on each night of spotlighting. Detectability is thought to be low during cool, dry weather or if targeted surveys of shelter locations are conducted during the day (DCCEEW 2024).

4.2 Adherence to Survey Guidelines

Three Australian Government documents make recommendations about minimum survey effort when surveying for the Ornamental Snake. How the Vulcan South survey adhered to each of these is discussed in **Table 4-1**. The surveys undertaken at Vulcan South utilised all methods recommended by all guidelines. Furthermore, surveys were undertaken under optimal environmental conditions, which detectability of the species is expected to be high. The survey effort expended was expected to be sufficient for detecting Ornamental Snakes if they were to occur on site.

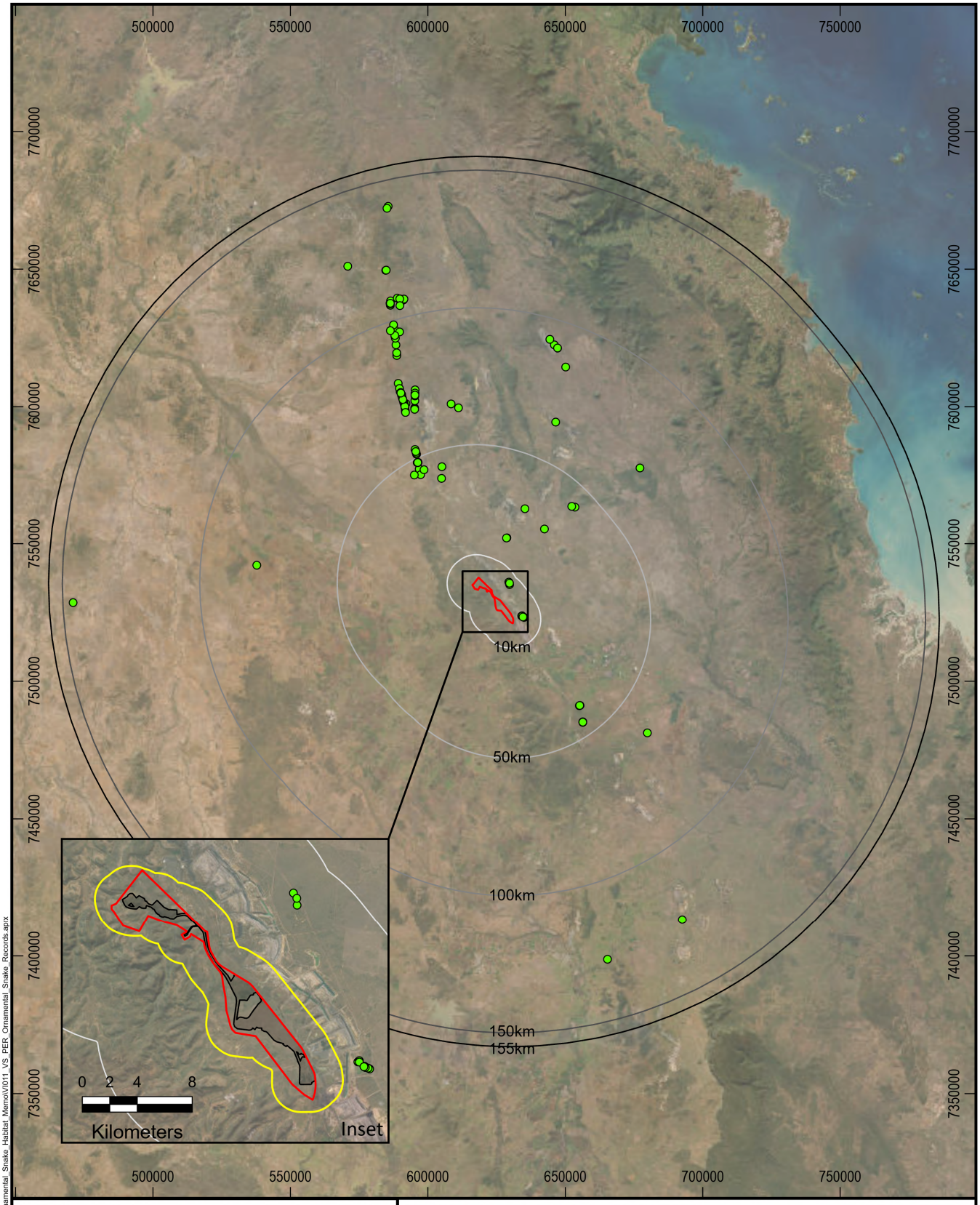
Table 4-1 Accordance of survey methods with published guidelines

Recommended Survey Effort	Vulcan South Survey Effort
SPRAT Database: **Targeted surveys to confirm the presence/absence of the Ornamental Snake are done by actively searching suitable habitats, especially during warm evenings.** **Actively looking whilst driving along roads, especially following heavy rainfall events and/or on warm evenings, is recommended.** **Sufficient time is required to thoroughly search the area by day and to spotlight by night. The minimum survey effort required includes:** • **a minimum of three survey days and nights** • **at least one replicate survey if the species has not already been detected.**	Spotlighting targeting the Ornamental Snake took place on warm, wet evenings following rain. Night-time targeted surveys for the Ornamental Snake were undertaken over 9 person-hours spread across ten separate nights. There are no roads through the project area apart from grassy tracks, on which it was difficult to spot reptiles at night. However, Saraji Road runs immediately east of the project area and this was driven at night on numerous occasions (20+ nights) in order to access sampling sites to the north. All fauna observed on the road (dead or alive) was recorded. The 10 nights of survey exceeded the six nights recommended for completing the initial and replicate rounds of survey.
***Survey Guidelines for Australia's Threatened Reptiles*:** **Search around suitable gilgai habitat while frogs are active. Driving roads at night, particularly after wet weather when frogs are active, may be necessary if wet weather precludes access to suitable (gilgai) habitat. Diurnal searches under sheltering sites (rocks, logs or other large objects on the ground) could also be employed. Pitfall and funnel trap arrays could be trialled. These methods are all likely to yield low returns.** **The recommended pitfall trapping methodology for reptiles in general is six 10 L buckets spread along a 15 m drift fence.** **Minimum survey effort is not prescribed.**	Surveys for the Ornamental Snake included 100 pitfall trap-nights, 150 funnel trap-nights and 9 person-hours of spotlighting, which were conducted immediately after rain and targeted places where water pooled (gilgais and other ephemeral depressions). 5.3 person-hours of diurnal searches under shelter sites were conducted at eight sites in potential Ornamental Snake habitat. The pitfall trapping method used four rather than six buckets per site, which were 20 L rather than 10 L. The drift fence was three times longer than recommended. Drift fence length is expected to have a much larger effect on capture rates than number of buckets.
***Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*:** **Diurnal searches are to involve searching microhabitats, such as carefully turning woody debris, rocks and artificial debris, raking the soil surface or leaf litter beneath trees. Optimal survey time is during the coolest parts of the day. Survey over a minimum of 1.5 person-hours per hectare for habitats of average complexity per targeted species. Survey over a minimum of 3 days.** **Spotlighting is to target water-inundated gilgais, wetlands, riparian habitats and the surrounding environment (e.g., roads) and large logs between dusk and early morning hours. More effective on warm, humid evenings. Survey over a minimum of 1.5 person-hours per hectare for habitats of average complexity per targeted species. Survey over a minimum of 3 nights.** **The guidelines offer no guidance on scaling surveys from 1 ha to larger sites. However, the Survey Guidelines for Australia's Threatened Reptiles advises that "a project site of 500 hectares with uniform landform and vegetation composition might only require the same survey effort as a 50 ha site". Sampling effort should be informed by diversity of habitat types present, and should be increased and stratified to give adequate coverage and representation.** **Opportunistic surveys of roads should involve actively looking for reptiles whilst driving along roadways in your study area, especially following heavy rainfall events and during warm evenings.** **Pitfall and funnel trapping is to include six 20 L (500 mm deep) buckets evenly distributed under a 30 m drift fence where optimal microhabitats occur. Place a funnel at each end of a pitfall line. At least 2 replicates are to be sampled per habitat type. Check every morning and early evening (after the optimal foraging periods) over four days.**	5.3 person-hours of diurnal searches under shelter sites were conducted at 8 sites in potential Ornamental Snake habitat. Each site was checked on a different day. 9 person-hours of spotlighting, spread across 10 warm, wet nights following rain, targeted Ornamental Snake habitat (flooded gilgais and wetlands). There are no roads through the project area apart from grassy tracks, on which it was difficult to spot reptiles at night. However, Saraji Road runs immediately east of the project area and this was driven at night on numerous occasions (20+ nights) in order to access sampling sites to the north. All fauna observed on the road (dead or alive) was recorded. 100 pitfall trap-nights and 150 funnel trap-nights of trapping were undertaken in potential Ornamental Snake habitat under optimal weather conditions. The survey used six rather than two funnel traps per site. It also used four rather than the recommended six buckets per site, but the drift fence was 45 m instead of 30 m long. Drift fence length is expected to have a much larger effect on capture rates than number of buckets. Three replicate sites were installed in brigalow woodland on land zone 4, and two replicate sites were installed in seasonally flooded poplar box woodland on land zone 3. Potential Ornamental Snake habitat comprised 109 ha within the impact area. This was primarily made up of only two habitat types: brigalow woodland on clay plains and poplar box woodland on sandy flats with ephemeral pools. Both habitat types were evenly sampled. Species accumulation curves fitted to fauna data gathered across the Vulcan South area predicted that 100% of reptiles were detected during surveys. While there remains a possibility that some species were missed (especially species that aren't readily detected using the methods adopted), this statistical test suggests this number is very small. Furthermore, the methods used are known to successfully detect Ornamental Snakes elsewhere.

4.3 Nearest Known Populations

There are many public Ornamental Snake records within 150 km radius of the proposed Vulcan South Coal Mine (**Figure 4-1**). The closest of these are just 4 km east of the project, where the species was recorded in the WildNet database as recently as 2010. There are 14 published records from the extensive clay plains immediately east of Peak Downs Mine and Saraji Mine, and this constitutes the nearest known population to the proposed Vulcan South Coal Mine. Despite this proximity, significant dispersal barriers occur between known populations and the project area. Between known populations and the project area lies a 58-km-long chain of open-cut mine pits and waste rock dumps. This likely represents an important barrier to dispersal for a small snake incapable of climbing. Adjacent to these mines run Saraji Road and the Goonyella Rail, which represent hazards to westward-dispersing Ornamental Snakes.

The extensive and rugged Harrow Range is located immediately west of the project area, and no eastward dispersal of Ornamental Snakes is likely from populations west of this range to the project area.



Legend

ALA Records

Denisonia maculata (Ornamental Snake)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Impact Area Search Radius (km)

2

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Ornamental Snake Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

2/10/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Ornamental_Snake_Habitat_Memo\VI011_VS_PER_Ornamental_Snake_Records.aprx

5 Summary of Habitat Importance

Potentially suitable habitat for the Ornamental Snake occurs in small, isolated patches of remnant and cleared brigalow woodland on clay plains. All but two of these patches were smaller than the 10 ha suggested by the SPRAT database as suitable for Ornamental Snakes. These two larger habitat patches contained gilgais, but based on evaporation rates and development times of local frog species, these gilgais were too shallow to support frog-breeding by all but a single species (*Platyplectrum ornatum*). Field surveys confirmed that *P. ornatum* was the only frog species breeding in these gilgais. Burrowing frogs in the genus *Cyclorana*, which the SPRAT database lists as indicators of Ornamental Snake habitat, were absent from gilgais. These habitat patches contained dry season refuges in the form of soil cracks, but wet season refuges (coarse woody debris) were absent from one patch and in below-average density in the other. Overall, patches of gilgai habitat on clay soil provided negligible foraging opportunities for Ornamental Snakes, contained below-average amounts of shelter, and were isolated from other patches by more than 1 km. No Ornamental Snakes were observed in these patches, despite the species being relatively detectable, and surveys were undertaken under optimal environmental conditions using methods recommended by guidelines.

Higher-quality (frog-rich) foraging habitat was available outside favoured clay soil where water pooled temporarily within sandy plains. Despite containing food resources for the Ornamental Snake, these sites were smaller than the 10-ha threshold of patches typically occupied by Ornamental Snakes. Also, these were 1,313 m and 1,493 m respectively from the nearest patches of cracking clay soil that can provide dry season refuge, which is likely to be an excessive commuting distance for a small, slow-moving snake, based on studies of other species. No Ornamental Snakes were recorded during surveys of this foraging habitat.

Habitats of poor quality that are unable to sustain Ornamental Snake populations may be occasionally utilised by dispersing individuals from nearby source populations. However, poor-quality habitat patches at Vulcan South are isolated from known populations by mountain ranges, mine pits and other physical barriers to dispersal. It is therefore unlikely to be utilised in any capacity by Ornamental Snakes.

6 Significance of Impacts

Significant impacts to matters of national environmental significance must be approved by the Australian Government and are typically conditional on environmental offsets. Two documents advise how the significance of impacts is to be assessed for the Ornamental Snake. These are discussed below.

6.1 Matters of National Environmental Significance Significant Impact Guidelines 1.1

According to this guideline, "*an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:*

- *lead to a long-term decrease in the size of an important population of a species*
- *reduce the area of occupancy of an important population*
- *fragment an existing important population into two or more populations*
- *adversely affect habitat critical to the survival of a species*
- *disrupt the breeding cycle of an important population*
- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*
- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*
- *introduce disease that may cause the species to decline, or*
- *interfere substantially with the recovery of the species.*"

"Important populations" are defined by the guideline as "*a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

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

Habitat at Vulcan South is not likely to contain an important population of Ornamental Snakes. The project is not near the limit of the species' range and does not support a source population. It does not qualify as habitat critical to the survival of the species, as it does not provide areas favourable for foraging, shelter or dispersal. The species is unlikely to decline as a result of the habitat removal, as this habitat is unoccupied and isolated from occupied habitats. The project will not move pathogens or potentially infected animals, so will not introduce disease. The project will not introduce feral predators. The Cane Toad, the principal invasive species thought to threatened the Ornamental Snake, is already widespread at the site. New weeds may become established during mining operations, but it is unlikely that these would be harmful to Ornamental Snakes, given that the species is unlikely to occur on site, and foraging and shelter resources are unlikely to be affected by weeds.

The proposed Vulcan South Coal Mine does not trigger any of the criteria for a significant impact on the Ornamental Snake based on definitions in the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*.

6.2 Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles

Definitions of significant impacts provided this guideline are based on the nine criteria listed in the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*, but with the following variations:

- Important habitat is defined as habitat (a) where the species has been identified during a survey, (b) near the limit of the species' known range, (c) in large, contiguous patches and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations), or (d) of a type where the species is identified during a survey, but which was previously thought not to support the species.

- Important habitat for the Ornamental Snake is further described as "*gilgai depressions and mounds*…[noting] *habitat connectivity between gilgais and other suitable habitats is important*".

Despite the presence of gilgais on site, these do not meet the definition of important habitat as they are not connected to other suitable habitats and are too shallow to support large frog populations and hence Ornamental Snakes. The species was not recorded on site, and the site is not located in large, connected patches of suitable habitat.

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* also lists examples of actions that have a high or uncertain risk to the Ornamental Snake (**Table 6-1**). The proposed Vulcan South Coal Mine will not cause any of these impacts and is therefore a low risk of causing a significant impact to the Ornamental Snake.

Table 6-1 Examples of high-risk significant impacts listed by the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*

Examples of high-risk significant impacts	Vulcan South Coal Mine
The loss, fragmentation or change in the ecological character or function of important habitat which is likely to adversely affect the recovery of one or more Brigalow Belt reptile species	Important habitat will not be affected by the project.
The fragmentation of important habitat or landscape corridors through the introduction of a barrier to dispersal	No barriers will be introduced within or between important habitats.
The introduction of invasive weeds, including the deliberate or accidental sowing of pasture grasses, within 30 m of important reptile habitat without appropriate and ongoing control measures	The project does not lie within 30 m of important habitat. Sites with gilgais already have a high weed cover (57.6% of groundcover vegetation is non-native). The project will not introduce pasture grasses not already occurring at the site.
Enabling the access of animal pests, including cats, pigs and cane toads, to important reptile habitat without appropriate and ongoing control measures	No important habitat is present in the disturbance footprint. The site already contains cats, pigs and cane toads. The project will not increase populations of these species.
Cattle grazing activities resulting in the degradation of microhabitat features within important habitat patches (for important gilgai habitats, this only applies when gilgais contain surface water)	The site is already grazed by cattle. The project will not introduce cattle to any important habitats.
Alteration of water quality or quantity affecting four or more hectares of important gilgai or riparian habitat	No important habitat is present in the disturbance footprint. Important habitats downstream will be unaffected as (a) these comprise gilgais that do not receive flood waters from creeks that receive water from the project area, and (b) water modelling suggests there will be negligible impacts of the project on water quality within receiving watercourses.
Clearing two or more hectares of important habitat has a high risk of significant impacts, while clearing of between one and two hectares has an uncertain risk.	No important habitat will be cleared.

7 References

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