Napier Downs Irrigation Project

Environmental Assessment and Management Plan

Napier Corporation Pty Ltd

Document control

Version	Prepared by	Authorised by	Signature	Date
V0.1	K. Crews	J. McMahon		6 June 2023

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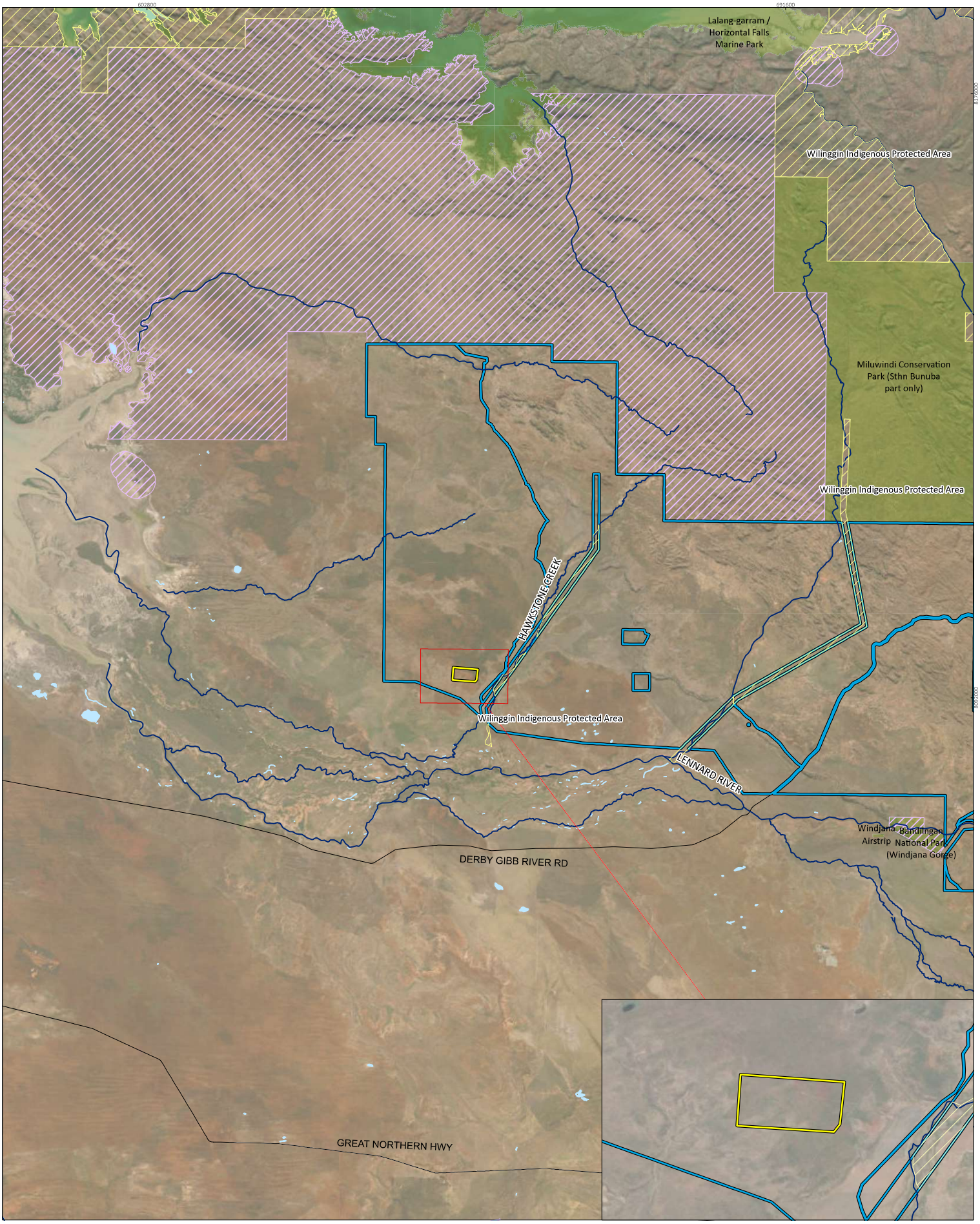
1 INTRODUCTION

Napier Corporation Pty Ltd (Napier Corporation) is proposing to develop the Napier Downs Irrigation Project (the proposal). The proposal is situated within Napier Downs Pastoral lease (LPL N049855), located in the West Kimberley region, 240 km east northeast of Broome, Western Australia (Figure 1-1). The application area for the proposal is located within Scrubby Paddock, towards the southwestern corner of the station (Figure 1-1).

The purpose of this Environmental Assessment and Management Plan (EAMP) is to:

- summarise the environmental values of the application area, based on information collected in several site-specific investigations for the proposal
- assess the potential environmental impacts of the proposal
- document how the mitigation hierarchy has been applied to reduce the potential environmental impacts of the proposal
- outline the environmental management framework for the proposal.

The EAMP is the key supporting document for environmental approval applications for the proposal.



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Project No	1545
Date	18/05/2023
Drawn by	BK
Map author	BQ

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Kilometers

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- Application area
- Indigenous Protected Areas
- Napier Downs Station
- Environmentally sensitive areas
- DBCA managed land
- Lakes
- Rivers

Figure 1-1

Proposal location and application area

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2 EXISTING ENVIRONMENT

2.1 LANDFORM, GEOLOGY AND SOILS

2.1.1 Investigations

Desktop investigations were conducted into land systems, geology and soils as part of an environmental desktop assessment (Phoenix 2019; 2020; Appendix 1) and H3 hydrogeological assessment for the proposal (IGS 2021; Appendix 2). Site-specific topographic, soils and geology data were obtained from drill logs during the hydrogeological assessment and from site descriptions collected in a flora and vegetation survey for the proposal (Phoenix 2023b; Appendix 3).

2.1.2 Topography

The application area occurs in a flat sand plain, with no distinctive landforms present.

2.1.3 Geology and soils

According to the Surface Geology of Australia 1:1,000,000 scale, Western Australia database (Stewart et al. 2008), the application area intersects a single geological formation; Sand plain 38499 (Czs), which is described as 'Sand or gravel plains; quartz sand sheets commonly with ferruginous pisoliths or pebbles.

The application area occurs in 2 land system units according to DPRID mapping (Schoknecht & Payne 2011):

- Sisters system – described as low sandy plateaux, covering ~92% of application area
- Yeeda System – described as red sandplains, covering ~8% of application area.

Soil types recorded at the flora and vegetation survey sites in the application area were primarily described as red-orange loamy sand (Phoenix 2023b; Appendix 3). Drill logs of the monitoring and production bores in the application area, indicated deep red Pindan soils occur to depths of 6–11 m, underlain by fine grained sandstone (IGS 2021; Appendix 2).

The soils in the application area best match Cockatoo Sand, normal phase soils as described in (Smolinski *et al.* 2016). Cockatoo Sand normal phase soils are generally red to dark red, loamy sand to clayey sand, grading to sandy loam or light sandy clay loam subsoils from 1–2 m (Smolinski *et al.* 2016). The loamier subsoils have a massive structure when dry, or a weak crumb and slightly sticky consistency when moderately moist.

2.2 FLORA AND VEGETATION

2.2.1 Investigations

An environmental desktop assessment, including flora and vegetation, was undertaken during early planning for the proposal in 2019, focusing on 2 earlier potential sites, 'Lennard' and Hawkstone' (Phoenix 2019; Appendix 1), with an addendum prepared specifically for the application area in 2020 (Phoenix 2020; Appendix 1). Subsequently, a detailed flora and vegetation survey was undertaken in the application area in October 2021 and May 2022 (Phoenix 2023b; Appendix 3), that included: quadrat and relevé sampling; targeted flora searches; and vegetation type and condition mapping.

A reconnaissance survey was also undertaken within a 15 km buffer of application area to conduct relevé sampling and identify riparian vegetation and potential groundwater dependent indicator species (Phoenix 2022; Appendix 4), particularly for 3 potential groundwater dependent ecosystems identified by the hydrogeological assessment conducted for the proposal (IGS 2021; Appendix 2).

2.2.2 Regional vegetation associations

Regional scale vegetation mapping by Shepherd *et al.* (2002) shows one regional vegetation association present within the application area; association 754, Fitzroy Sandplains. This association is described as *Acacia* thicket with eucalypt woodland over spinifex *Acacia tumida*, *Eucalyptus tectifica*, *Corymbia grandifolia*, *Triodia pungens* and *T. bitextura*.

Only 172 ha of association 754 is protected in DBCA managed land; however, the association has 100% or nearly so of its pre-European extent remaining and therefore is classified as of Least Concern (Government of Western Australia 2019).

2.2.3 Vegetation types

Four vegetation types were mapped in the application area from the flora and vegetation field survey (Table 2-1; Figure 2-1). They comprised *Melaleuca* woodlands over mixed herbs and grasses, tall *Acacia tumida* var. *tumida* mixed shrubland over *Sorghum* and *Chrysopogon* tussock grassland, and low open *Eucalyptus* woodland over open mixed shrublands and mixed tussock grasses.

Table 2-1 Vegetation types mapped in the application area

Vegetation type	Description	Area (ha)
AttSs	Isolated trees of *Eucalyptus miniata* and *Corymbia greeniana* over a tall shrubland of *Acacia tumida* var. *tumida*, *Grevillea refracta* subsp. *refracta* and *Petalostigma pubescens* over a tall open tussock grassland of *Sorghum stipoideum* and *Chrysopogon latifolius*.	514.2
EmDhaSs	Mid to low open woodland of *Eucalyptus miniata*, *Terminalia canescens* and *Corymbia* spp. over a tall open shrubland of *Dodonaea hispidula* var. *arida*, *Petalostigma pubescens* and *Grevillea refracta* subsp. *refracta* over a mixed open tussock grassland of *Sorghum stipoideum*, *Triodia caelestialis* and *Chrysopogon fallax*.	66.2
MccLggCr	Mid open woodland of *Melaleuca cajuputi* subsp. *cajuputi* and *Eucalyptus tectifica* over a low open forest of *Lophostemon grandiflorus* subsp. *grandiflorus* over a low mixed forbland of *Crotalaria ramosissima*, *Indigofera hirsuta* and *Eriocaulon cinereum* with mixed grasses.	3.5
MvPsp.	Low open forest of resprouting *Melaleuca viridiflora* and *Lophostemon grandiflorus* subsp. *grandiflorus* over low, mixed isolated forbs and grasses including *Phyllanthus* sp. B Kimberley Flora (T.E.G. Aplin et al. 809), *Stemodia lathraia* and *Aristida hygrometrica*.	0.9
Cleared	Areas devoid of vegetation	1.7

2.2.4 Vegetation condition

Native vegetation in the application area was recorded to be in Very Good to Excellent condition in the flora and vegetation field survey, with the vast majority (99.1%) in Excellent condition (Table 2-2; Figure 2-2). Vegetation type MccLggCr was the only unit to record a condition rating other than Excellent, due to the presence of livestock tracks and evidence of grazing.

Table 2-2 Vegetation condition – extent of each condition rating in application area

Condition rating[1]	Area (ha)	Vegetation types
Excellent	581.3	AttSs, EmDhaSs, MvPsp.
Very Good	3.5	MccLggCr
Cleared	1.7	-

1 – no vegetation rated as Good, Poor, Degraded or Completely Degraded.

2.2.5 Threatened and Priority Ecological Communities

The desktop assessment determined that no Threatened Ecological Communities (TECs) listed under the *Biodiversity Conservation Act 2016* (BC Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are present within 40 km of the application area. Seven Priority Ecological Communities (PECs) were identified within the 40 km radius, with the closest buffer zone, of the Kimberley Vegetation Association 759 PEC, approximately 1.3 km east (Table 2-3). Kimberley Vegetation Association 759 PEC is associated with the riparian and floodplain zones of the Lennard River and Hawkstone Creek.

The application area does not intersect any of the PECs or their buffer zones, and the flora and vegetation field survey confirmed none of the vegetation types in the application area were representative of any of the PECs.

Table 2-3 Priority ecological communities occurring within 40 km of the application area

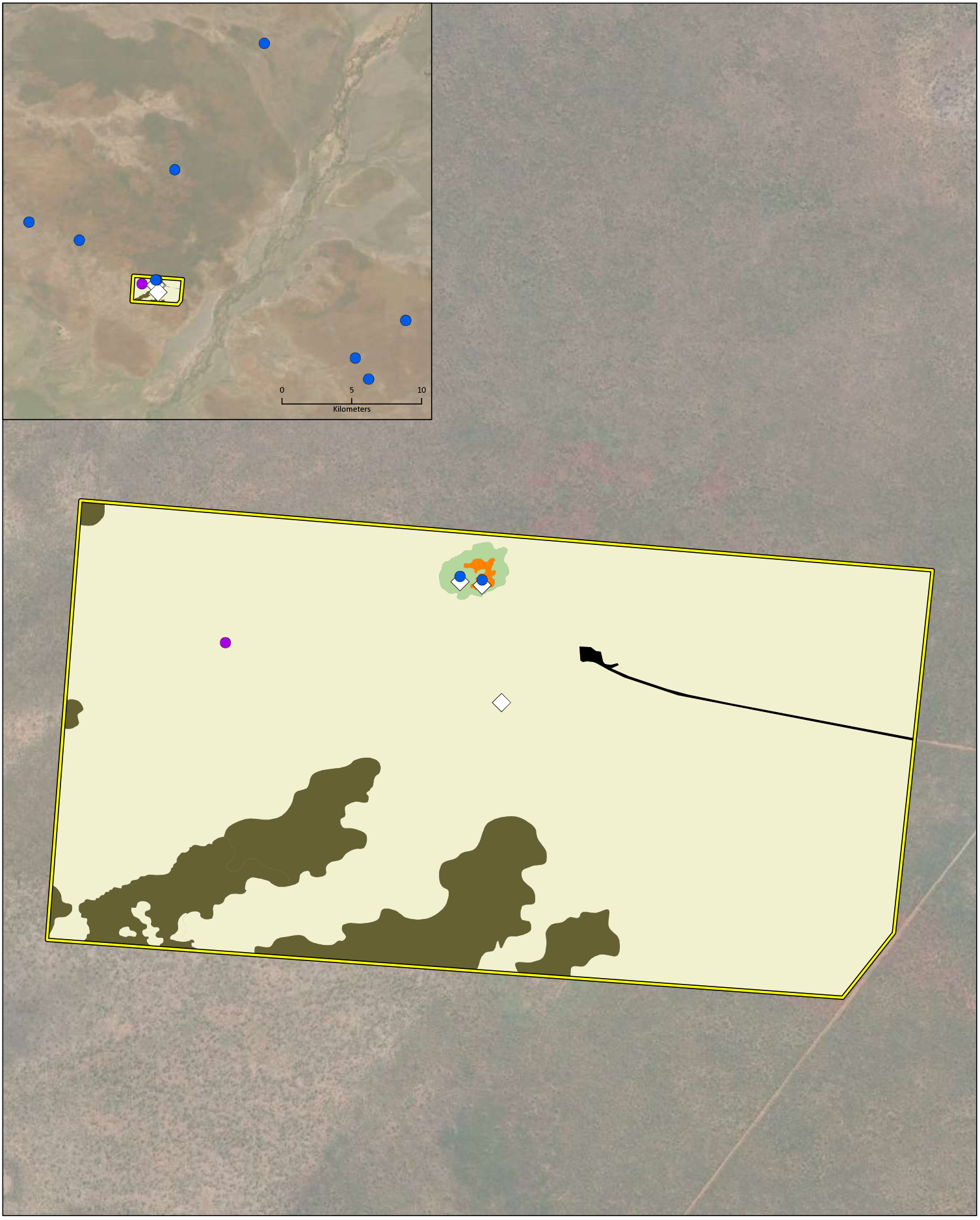
Community ID	Community name	Cons. status	Buffer (km)	Proximity to app. area
Gogo Land System	Gogo Land System.	Priority 3	0.5	25 km south
Leopold Land System	Leopold Land System.	Priority 3	0.5	30.5 km south-east
Napier Range Cave	Invertebrate community of Napier Range Cave.	Priority 1	0.5	51.6 km east
Napier Range	Monsoon vine thickets and Camaenid land snails of limestone ranges (Napier Range).	Priority 1	0.5	21.7 km east
Vegetation Association 33	Kimberley Vegetation Association 33, as defined by Beard (1979). Shrublands, pindan; acacia shrubland with eucalypt medium woodland over curly spinifex.	Priority 1	0.5	22 km north-east
Vegetation Association 759	Kimberley Vegetation Association 759, as defined by Beard (1979). Grasslands, tall bunch grass savanna woodland, coolabah over ribbon/blue grass (*Botriochloa* spp.).	Priority 3	0.5	0.9 km east
Vegetation Association 760	Kimberley Vegetation Association 760, as defined by Beard (1979). Shrublands, pindan; *Acacia tumida* shrubland with scattered low bloodwood & *Eucalyptus setosa* (not current name) over ribbon & curly spinifex.	Priority 1	0.5	24 km south

2.2.6 Significant flora

No Threatened flora listed under the BC Act or the EPBC Act were recorded during the flora and vegetation field survey. Two Priority flora were recorded in the application area (Figure 2-1):

- *Lophostemon grandiflorus* subsp. *grandiflorus* (Priority 3) – recorded at a single location in the application area where it was a dominant overstorey species in a tall shrubland that surrounded a seasonally wet depression. The species was also recorded at 7 locations in the reconnaissance study area, associated with riparian vegetation surrounding small lakes and in seasonally wet depressions.
- *Goodenia sepalosa* var. *glandulosa* (Priority 3) – recorded at a single quadrat site in the application area where it was present in low numbers under isolated *Corymbia* trees over a tall shrubland of *Acacia tumida* var. *tumida*, *Petalostigma pubescens* and *Grevillea refracta* subsp. *refracta*.

A significant (212.6 km south-west) range extension was identified for one other species, *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809), which was recorded in 3 survey qudarats. This record may therefore be considered significant in accordance with EPA (2016d). This species is not listed as Threatened or Priority, though currently there are few records in Florabase (WA Herbarium 2023). *Phyllanthus* sp. B Kimberley Flora was recorded within 2 vegetation types, one of which (AttSs) was present across 87.6% (514.2 ha) of the application area. AttSs is representative of pre-European (Beard's) vegetation association 754 (Shepherd *et al.* 2002) and has a current extent of 195,333 ha, with 100% pre-European extent remaining (Government of Western Australia 2019), therefore has a status of least concern. The habitat matches that of the previous records of this species and based on how readily this species was collected and that it was recorded from a widespread vegetation type, it is highly likely that it occurs more widely between the survey records and the nearest records in Florabase.



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Project No	1545
Date	18/05/2023
Drawn by	BK
Map author	GW

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Meters

1:19,600 (at A4) GDA 1994 MGA Zone 51

Application area

Vegetation type

- AttSs
- Cleared
- EmDhaSs
- MccLggCr
- MvPsp.

Significant flora records

- *Goodenia sepalosa var. glandulosa*, P3 (DBCA list)
- *Lophostemon grandiflorus subsp. grandiflorus*, P3 (DBCA list)

Range extension species

- *Phyllanthus sp.* B Kimberley flora

Figure 2-1

Vegetation types and significant flora records

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Map author	KC

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Application area

Vegetation condition

- Excellent
- Very good
- Completely degraded

Figure 2-2

Vegetation condition

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2.3 TERRESTRIAL FAUNA

2.3.1 Investigations

The environmental desktop assessment and addendum undertaken for the proposal (Phoenix 2020; Appendix 1), included a review of terrestrial fauna. Subsequently, a targeted detailed terrestrial fauna survey of the application area was undertaken in June-July and August 2022 (Phoenix 2023a; Appendix 5), which included targeted sampling for significant fauna species, avifauna surveys, short-range endemic (SRE) invertebrate sampling and habitat assessment and mapping (application area plus 1 km buffer).

A reconnaissance fauna survey was also undertaken at potential groundwater dependent ecosystems within a 15 km buffer of the application area (Phoenix 2022; Appendix 4).

2.3.2 Fauna habitats

Three fauna habitat types were identified in the application area (Table 2-4; Figure 2-4). Two of these were also present in the 1 km buffer. The third, open woodland over mixed herbs and grasses surrounding a seasonally inundated depression, represents habitat that has a relatively restricted distribution within the landscape, though other similar seasonal soaks and associated habitat are present in the vicinity of the application area based on the reconnaissance survey, which found several small seasonal wet depressions to the north and south of the application area.

Table 2-4 Fauna habitats in application area and 1 km buffer

Habitat type	Extent in application area (ha)	Extent in habitat mapping area (ha)
Open woodland over open shrubland over grassland Mid *Corymbia, Eucalyptus* and *Acacia* open woodland over mixed open shrubland over *Sorghum stipoideum*, *Chrysopogon* and *Triodia* grassland.	75.9	487.7
Shrubland over grassland Sparse *Corymbia* and *Eucalyptus* open woodland over mixed open shrubland over *Sorghum* grassland.	506.2	1,354.5
Open woodland (shrubby regrowth) over mixed herbs and grasses surrounding a seasonally inundated depression Open *Melaleuca* and *Corymbia* woodland (primarily shrubby regrowth) over mixed herbs and grasses.	4.3	4.3

2.3.3 Significant vertebrate fauna

One significant vertebrate species was recorded in the application area during the terrestrial fauna survey, *Isoodon auratus auratus* Golden Bandicoot (Vulnerable). This species was captured in traps at a site on the southern boundary of the application area (Figure 2-4). One male in breeding condition, and one female with 2 juvenile offspring were recorded on separate days at the same site. *Isoodon sp.* diggings were recorded within the application area and 1 km buffer. The diggings were considered likely to be from both Golden Bandicoot and the similar Northern Brown Bandicoot, which was also captured.

The Golden Bandicoot is likely resident in and surrounding the application area. Records indicate breeding and foraging. The most widely mapped habitat type, shrubland over grassland, appeared to be most used by the species; this provides better protection from predators with typically densest understory, and likely contained an abundance of food. Diggings were also recorded in open woodland over open shrubland over grassland habitat, which was also widespread in the application area and buffer. Both habitats were also observed to be common across the wider region from the reconnaissance survey.

Considering the evidence of presence being readily detected and the wide availability of suitable habitat, the species is likely to occur much more widely than the extent of the survey records.

Several other significant fauna were considered to possibly occur but were not detected in the field survey:

- *Amytornis housei* Black Grasswren (Priority 4) – recorded in the field survey, outside the application area (Figure 2-4)
- *Erythrura gouldiae* Gouldian Finch (Priority 4, Endangered under EPBC Act) – recorded in the field survey, outside the application area (Figure 2-4)
- *Apus pacificus* Fork-tailed Swift (Migratory)
- *Erythrotriorchis radiatus* Red Goshawk (Vulnerable)
- *Falco hypoleucos* Grey Falcon (Vulnerable)
- *Falco peregrinus* Peregrine Falcon (Other Specially Protected)
- *Glareola maldivarum* Oriental Pratincole (Migratory)
- *Hirundo rustica* Barn Swallow (Migratory)
- *Tyto novaehollandiae Kimberli* Masked Owl (Priority 1, Vulnerable under EPBC Act)
- *Dasyurus hallucatus* Northern Quoll (Endangered) Northern Quoll
- *Hipposideros aurantia* Northern Leaf-nosed Bat (Priority 2)
- *Leggadina lakedownensis* Northern Short-tailed Mouse (Priority 4)
- *Macroderma gigas* Ghost Bat (Vulnerable)
- *Macrotis lagotis* Bilby (Vulnerable)
- *Phascogale tapoatafa kimberleyensis* Kimberley Brush-tailed Phascogale (Vulnerable)
- *Rhinonicteris aurantia* Orange Leaf-nosed Bat (Priority 4)
- *Saccolaimus saccolaimus nudicluniatus* Bare-rumped Sheath-tailed Bat (Priority 1, Vulnerable under EPBC Act)
- *Trichosurus vulpecula arnhemensis* Northern Brushtail Possum (Vulnerable).

The habitat of the application area is not considered critical habitat for any of the other significant species. Several of these species are likely to forage only, as denning/roosting/ nesting habitat is not present, with the exceptions of Gouldian Finch, Grey Falcon, Masked Owl, Kimberley Brush-tailed Phascogale, Bare-rumped Sheath-tailed Bat and Northern Brushtail Possum – for which the open woodland habitat is potential breeding/nesting habitat. This habitat type is much more abundant in the surrounds of the application area than within it.

While not detected in the survey, there is a 2013 desktop record of Northern Quoll along the eastern side of Hawkstone Creek, 5.4 km east of the application area, most likely representing a dispersing/foraging individual. No suitable rocky denning habitat is present in the application area or 1 km buffer; however, the habitats within and surrounding it may be used for dispersal and foraging.

2.3.4 SRE invertebrate fauna

The environmental desktop review found 4 terrestrial invertebrates listed as Threatened under the BC Act and 5 Priority species were present within 40 km of the application area. All are molluscs (land snails) in the family Camaenidae and are confirmed SREs. Two PECs are associated with the significant land snails: Invertebrate community of Napier Range Cave, located 27 km east of the application area, and Monsoon vine thickets and Camaenid land snails of limestone ranges, 20 km northeast. An additional 30 confirmed SREs (also all land snails) and 13 potential terrestrial SRE species were identified through the WA Museum database searches.

The SRE land snails are associated with rocky habitats of the surrounding ranges, mainly Napier Range east of the application area. None of the desktop SRE records are from within the application area.

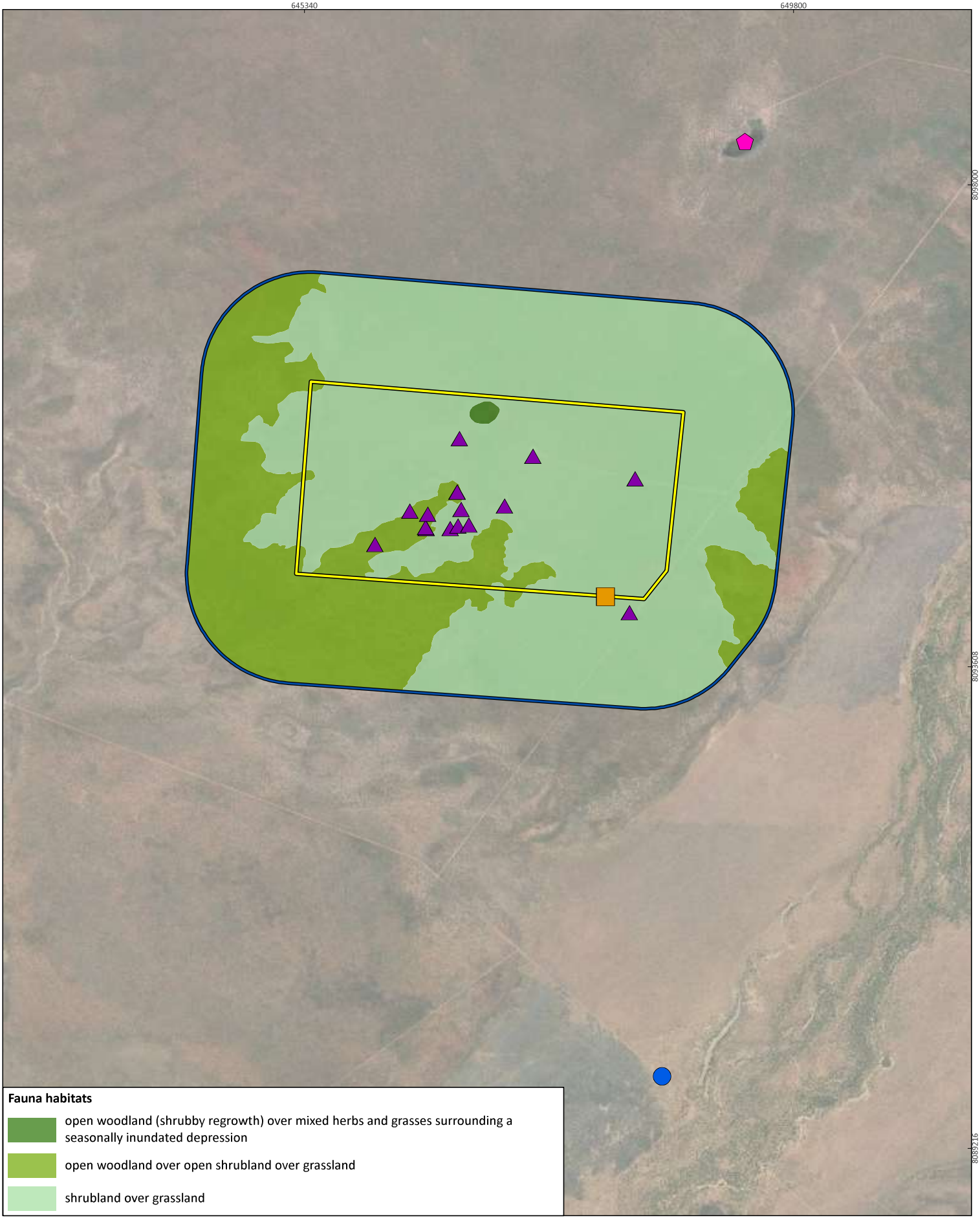
The 3 fauna habitats mapped in the study area were all classified as having low potential to support SRE invertebrates due to a lack of isolating habitat features, such as rocky outbreaks or drainage systems, and no barriers to dispersal. The seasonally inundated depression displayed a higher incidence of moisture/inundation; however, this was not considered sufficient to create a habitat isolate for SREs.

Three potential SRE invertebrates were recorded in the application area in the terrestrial fauna field survey (Figure 2-4):

- *Aname* 'MYG771' – a mygalomorph spider, collected from all 4 SRE survey sites, in and out of the application area, and from all 3 habitat types
- *Cubaris* sp. indet. 'Napier' – an isopod, collected from 3 SRE survey sites, in and out of the application area, and from 2 habitat types
- *Lychas* 'annulatus group' – a scorpion, collected from a single site.

All 3 potential SRE taxa were collected from widespread habitat types and are likely to occur more widely in the vicinity of the application area.

No land snails were collected in the field survey and no rocky habitat features suitable for harbouring members of this group are present in the application area.



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Application area
Habitat mapping area

Species, status

- *Amytornis housei Black Grasswren*, (P4)
- *Erythrura gouldiae*Gouldian Finch, (P4, EN)
- *Isoodon auratus auratus* Golden Bandicoot, (VU)
- *Isoodon auratus auratus* or *macrourus*

Figure 2-3

Fauna habitats and significant fauna records

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2.4 SUBTERRANEAN FAUNA

2.4.1 Investigations

The environmental desktop assessment undertaken for the proposal (Phoenix 2020; Appendix 1) included a review of subterranean fauna. Consideration of habitat suitability for subterranean fauna in the desktop assessment was limited to the application area, as the H3 hydrogeological assessment had not been completed at the time of reporting. A subsequent risk assessment was undertaken that considered habitat suitability within the wider area of modelled groundwater drawdown and potential for impact to subterranean fauna from proposed groundwater abstraction (Phoenix 2023c; Appendix 6). The risk assessment was undertaken for the 6 GL abstraction proposal, not the current 3 GL application.

2.4.2 Subterranean species

The desktop assessment revealed few subterranean fauna records exist within a 100 km radius of the application area, with the only returned records (12 troglofauna species and one stygofauna species) from a single cave within the Napier Range. The desktop review did find however, the stygofauna have been recorded from wells bores, cave pools and springs in the wider West Kimberley region (Humphreys 1995; Karanovic 2005a; Karanovic 2005b).

2.4.3 Subterranean habitat

The desktop assessment for subterranean fauna determined suitable habitat, mainly sandstones, is present for stgofauna within the Grant Group aquifer. Habitat suitability was considered likely to be higher with increasing depth within the aquifer, as the substrate becomes coarser with depth, in particular in the 40 – 70 m bgl range. The risk assessment however, determined negligible impact on stygofauna, if present.

Troglofauna were considered unlikely to occur in subterranean habitats underlying the application area or wider area of modelled groundwater drawdown.

2.5 HYDROLOGY

2.5.1 Investigations

Groundwater investigations were undertaken for the proposal between 2019 and 2021, culminating in a H3 hydrogeological assessment (IGS 2021; Appendix 2), with the modelling conducted for the initial proposed annual abstraction of up to 6 GL/annum. Remodeling was subsequently conducted for the revised 3 GL/annum proposal (4 pivots), including staging for 1 and 2 pivots (Harrington & Laattoe 2022; Appendix 7).

The summary of hydrological features within the proposal area and modelled area of groundwater drawdown is synthesized from the environmental desktop assessment, hydrogeological assessment and biological surveys.

2.5.2 Groundwater

The target aquifer for the Project is the Grant Group within the Canning-Kimberley Groundwater Area (Figure 2-4). The Grant Group aquifer occurs at the northern extremity of the expansive Canning Basin (Paul *et al.* 2013).

The Grant Group aquifer is a thick sedimentary sequence consisting mainly of Carboniferous and Permian sandstones, with minor Devonian sandstone on the northeast margin included within the aquifer (DWER 2020). The aquifer is expansive and, according to the Department of Water and Environmental Regulation (DWER) WRIMS Aquifer dataset (DWER 2020), is mostly unconfined. Poole Sandstone conformably overlies

the Grant Group and is lithologically very similar, with the two formations regularly considered as one connected aquifer system (Taylor *et. al.* 2018, in IGS 2021).

Water chemistry data from the monitoring and production bore in the application area and regional bores indicates the groundwater is fresh, with low concentrations of dissolved metals and nutrients. The data suggests evidence of significant rainfall recharge.

The modelled extent of groundwater drawdown at 3 GL/annum over 10 years (P50) is shown in Figure 2-4.

2.5.3 Surface water

No rivers or mapped drainage lines intersect the application area. There are some minor drainage lines east of the application area that drain into the Hawkstone Creek (Figure 2-4). Hawkstone Creek runs north to south-west adjacent, ~5 km east of, the application area. Its floodplains come within ~1.4 km of the application area. The Lennard River is located south of the application area, with the closest point ~12 km from the southern boundary.

There are no Ramsar or other significant wetlands within the application area or within the area of modelled groundwater drawdown.

No perennial wetlands are present in the application area. A small seasonally inundated depression was mapped in the application area in the biological surveys.

One groundwater fed spring, Ngooderoodyne Spring, is located approximately 10 km west of the application area (Figure 2-4). Some minor seasonally wet depressions were identified within a 15 km radius of the application area in the reconnaissance survey.

2.5.4 Groundwater dependent ecosystems

Two aquatic groundwater dependent ecosystems were identified by the hydrogeological assessment within the modelled area of groundwater drawdown (Figure 2-4): Ngooderoodyne Spring and Lennard River Pool. A third, Hawkstone Creek (Figure 2-4) is a surface water site and any residual pools at the end of each wet season are highly unlikely to be connected to groundwater. The reconnaissance survey (Phoenix 2022) initially identified the following potential values for these sites:

- Ngooderoodyne Spring – likely groundwater fed spring has probable groundwater dependent fringing and aquatic flora species present; potential for SRE invertebrate taxa dependent on the fringing vegetation; habitat for aquatic native fish and a water source for terrestrial fauna in the dry season.
- Lennard River Pool – isolated groundwater fed pool in dry season, potential groundwater dependent fringing flora species, potential refuge for freshwater fish and invertebrates (fish and mussels observed), water source for terrestrial fauna.
- Hawkstone Creek – contains Long Pool, a shallow isolated billabong that persists through part of the dry season, potential groundwater dependent flora species present, potential water source for terrestrial fauna and habitat for aquatic invertebrates (freshwater crabs and mussels observed).

Conceptual groundwater diagrams prepared by IGS (2022; Appendix 8) support the theory of groundwater connection to Ngooderoodyne Spring and Lennard River Pool. At both sites, the end of dry season water table sits above the level of the headwater pool and isolated pools are fed through the dry season by groundwater discharge.

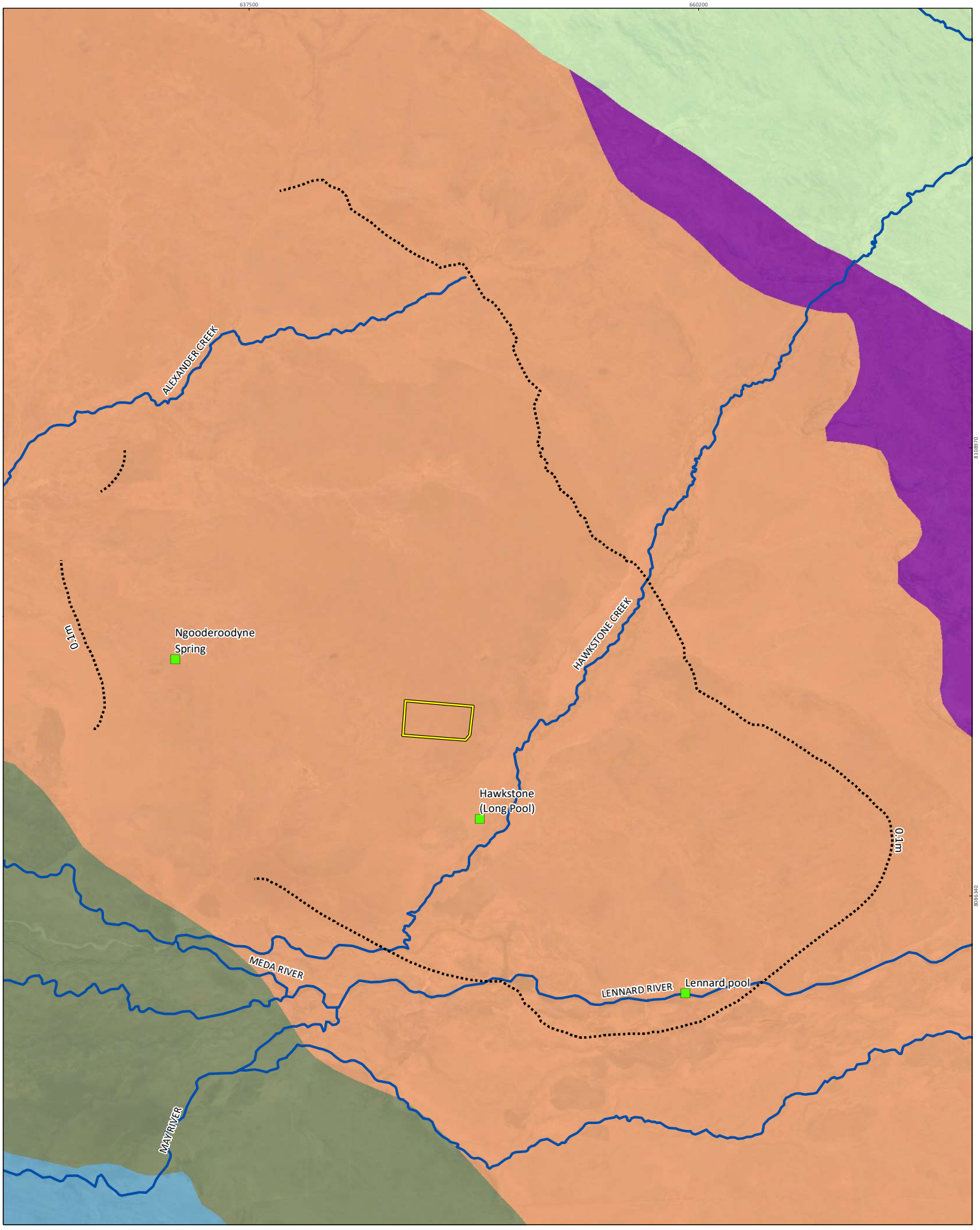
In contrast, the conceptual groundwater diagram for Hawkstone (Appendix 8) does not support the likelihood of groundwater connectivity, with the water table sitting well below the creek in both the wet and dry seasons (approx. 10 m at end of dry season). Long Pool in Hawkstone Creek dries out completely part way through the dry season.

The potential groundwater dependent species recorded at Long Pool were *Eucalyptus camaldulensis*, *Terminalia platyphylla* and *Planchonia careyi. Eucalyptus camaldulensis* has mixed levels of groundwater dependency but is a relatively adaptable species and generally has high variability in physiological traits associated with drought adaption and water stress (Canham *et al.* 2022; Pusey & Kath 2015). *Terminalia platyphylla* is facultatively deciduous in the dry season and as such has low dry season water use, not necessarily relying on groundwater (Canham *et al.* 2022; C. Woods pers. comm). No formal studies exist for *Planchonia careyi*, though it is considered likely to have some groundwater dependency (Phoenix 2022). As some of the riparian vegetation at Hawkstone has the potential to be groundwater dependent, it has been treated under the precautionary principle as a potential terrestrial groundwater dependent ecosystem.

It is possible that the mussels observed in Long Pool enter a period of aestivation to persist through the dry season, by burrowing into the sediment and becoming dormant until water returns. Aestivation is a common survival strategy of freshwater mussels in arid Western Australia (Ponder *et al.* 2002). Alternatively, they may have been transported to the pool during a spawning event.
As the hydrological cycle of Long Pool is not connected to groundwater, the aquatic invertebrates of the pool are not at risk from the proposal.

2.5.5 Groundwater management areas

The application area is in the Canning-Kimberley groundwater subarea of the Canning-Kimberley groundwater area as proclaimed under the *Rights in Water and Irrigation Act 1914* (RIWI Act). There are no public water drinking source areas in within the area of modelled groundwater drawdown. It also does not fall within any specific management zone or area of special licensing rules in the proposed Fitzroy water allocation plan, which the application area falls within (IGS 2021).



Australian Capital Equity
Napier Downs Irrigation Project

Project No	1545-NAP-ACE-ADV
Date	18/05/2023
Drawn by	BK
Map author	KC

0 4 8
Kilometers

1:174,300 (at A3) GDA 1994 MGA Zone 51

Application area

Aquifer name (WRIMS)

- Canning - Erskine, Unconfined
- Canning - Grant, Unconfined
- Canning - Limestone, Unconfined
- Canning - Liveringa, Unconfined
- Combined - Fractured Rock Central, Unconfined
- Modelled area of groundwater drawdown (p50, 3 GL/annum at 10 years)
- Rivers
- GDEs

Figure 2-4

Hydrological features and modelled area of groundwater drawdown

PHOENIX ENVIRONMENTAL SCIENCES

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2.6 HERITAGE

2.6.1 Investigations

An Aboriginal heritage survey was conducted in the application area in 2021 by Fenackling Consult (2021), on behalf of the Warrwa traditional owners, to identify and record any Aboriginal archaeological or ethnographic sites, as defined by Section 5 of the *Aboriginal Heritage Act 1972*.

2.6.2 Heritage values

No sites registered in the Aboriginal Heritage Inquiry System are located in the application area. The nearest Aboriginal cultural site is Hawkstone Peak (Aboriginal Site 14594), 5.3 km east of the application area. This is not at any risk from the proposal.

The heritage survey noted that the application area occurs within a region (known as the Hawkstone area) that may have Aboriginal cultural significance regarding songlines and/or sacred sites. However, the heritage survey did not identify any archaeological or ethnographic Aboriginal sites within the application area and concluded low likelihood of containing any archaeological sites.

Accordingly, no known heritage sites will be impacted by the proposal.

Napier Corporation is committed to the protection of Aboriginal cultural heritage and is aware of its obligations under the *Aboriginal Cultural Heritage Act 2021*. It will continue to consult with the Warrwa traditional owners to agree a framework for the ongoing management of Aboriginal cultural heritage, including the reporting of any potential sites or artefacts of cultural significance should any be discovered during operation of the proposal.

2.7 LAND USE CONSIDERATIONS

The application area falls entirely within the Napier Downs pastoral lease. Adjacent pastoral leases are Meda Station, eastern boundary located 9.6 km west of the application area, and Kimberley Downs, northern boundary located 2.2 km south. To the north of Napier Station is freehold Commonwealth land.

The application area is located within part of the Warrwa Part A Native Title Determination area. The modelled area of drawdown also intersects part of the Wilinggin Native Title Determination area, and a very small part of the Dambimangari Native Title Determination area.

Napier Corporation have maintained ongoing consultation with traditional owner groups Warrwa and Wilinggin throughout the development of the project, including engaging as to preferred location of monitoring and test bores, engagement on the heritage survey and consultation on cultural values of the groundwater dependent ecosystems. There have been no concerns raised in this respect.

The nearest Aboriginal community of Windjingare is located more than 23 km east of application area and has been completely uninhabited for many years (pers. comm. Manager, Napier Downs Station, September 2021). The community overlies Devonian reef and thus any local groundwater supply – if one ever existed – is almost certainly disconnected from the Grant Group aquifer to the south (IGS 2021).

The current allocation limit for the Grant Group is 100 GL/yr (DOW 2014, in IGS 2021). At the time of preparing the H3 hydrogeological report, the total volume of groundwater allocated from the Grant Group aquifer in the Canning-Kimberley Groundwater Area was 1,175,875 kL/yr. This volume is spread across 23 licences with the nearest licenced allocations to application area being more 20 km away.

3 PROPOSAL

3.1 PROPOSED DEVELOPMENT

The proposal is for a pivot irrigation project to supply fodder crops for pastoral use. The pivots will grow cattle fodder crops (Rhodes grass) for pastoral purposes use on Napier Downs Station, Mount-House Station and other Napier Corporation managed properties, to support sustainable pasture and soil management, particularly during dry conditions, and more effective cattle production.

Up to 4 centre irrigation pivots are proposed to be installed at ~40 ha each. Groundwater will be sourced from the Grant Group Aquifer, at a rate up to 3 GL / annum. Each pivot will have a total water demand of up to 750 megalitres / annum to meet crop water requirements.

The application area is 586.5 ha (Figure 3-1); however, a maximum of 200 ha is proposed to be cleared to allow for the 4 pivots (~160 ha) plus associated infrastructure (up to 40 ha).

The proposal will be staged to enable monitoring of ecological responses to groundwater abstraction. The planned staging for the proposal is outlined in Table 3-1. The indicative pivot locations are shown in Figure 3-1.

Table 3-1 Planned staging of the proposal

Pivot/bore	Planned pumping capacity	Annual abstraction	Commencement
PB01	70 L/s	750,000 kL	2024 dry season
PB02	70 L/s	750,000 kL	2025 dry season
PB03	70 L/s	750,000 kL	2026 dry season
PB04	70 L/s	750,000 kL	2026 dry season

3.2 GROUNDWATER LICENCE APPLICATION

An initial application for a 6 GL / annum water abstraction licence under the *Rights in Water and Irrigation Act 1914* (RIWI Act) was lodged with DWER on 3 Dec 2018 (ref 024277). Following consideration of potential environmental impacts, the application was withdrawn, modified and re- submitted on 23 Jan 2023 for the 3 GL / annum licence (ref 053947), and with the commitment to staging of abstraction.

A detailed water resource operating strategy is currently in preparation, to meet requirements of DWER. This will contain the monitoring and management framework for managing impacts of groundwater abstraction (Table 3-2).

3.3 NATIVE VEGETATION CLEARING PERMIT

A native vegetation clearing permit pursuant to Part V of the *Environmental Protection Act 1986* (EP Act) will be sought from DWER to facilitate construction of the project.

Through the clearing permit process, DWER will assess the proposed clearing in accordance with the ten clearing principles as specified in Schedule 5 of the EP Act and provide a final determination as to the suitability of clearing. This will include any conditions that may be attached to the permit to ensure clearing is undertaken in a manner which minimises impacts to the environment.

It is anticipated that the Part V licence can provide the regulatory mechanism for the management measures outlined in this EAMP (Table 3-2).

3.4 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

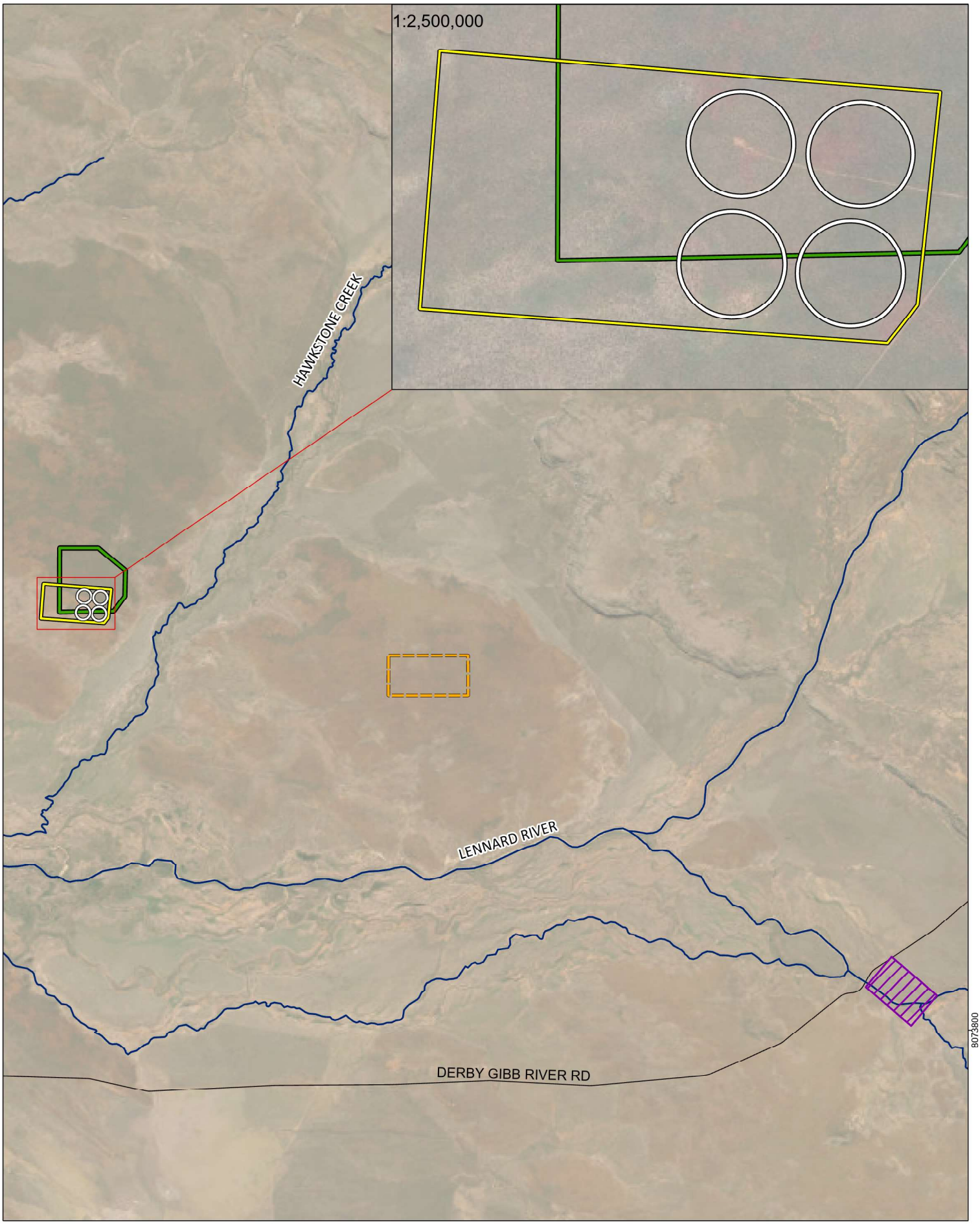
An EPBC Act self-assessment was conducted for the proposal to determine whether referral would be required to the Department of Climate Change, Energy, the Environment and Water (DCCEEW). The assessment found that, with implementation of proposed project staging, controls, and environmental monitoring and management, referral would not be required under the EPBC Act.

3.5 DIVERSIFICATION PERMIT

An application for a diversification permit for the proposal will be submitted to the Pastoral Lands Board under the *Land Administration Act 1997*.

Table 3-2 Other approval instruments for mitigating impacts on the environment

Decision-making authority	Legislation of agreement regulating the activity	Approval required	Whether and how statutory decision-making process can mitigate impacts on the environment?
DWER	*Rights in Water and Irrigation Act 1915*	Groundwater abstraction licence	Impacts to inland waters managed under water resource operating strategy for groundwater licence.
DWER	*Environmental Protection Act 1986* – Part V	Native vegetation clearing permit	Impacts to flora and vegetation and fauna from operations managed via clearing permit and conditions



Australian Capital Equity
Napier Downs Irrigation Project

Project No	1545
Date	6/06/2023
Drawn by	RK
Map author	KC

0 5 10
Kilometers

1:245,800 (at A4) GDA 1994 MGA Zone 51

- Application area

Previous site options

- Option 1
- Hawkstone
- Scrubby (original location)
- Indicative pivot locations.
- Roads

Figure 3–1

Application area, indicative pivot locations and previous sites

PHOENIX ENVIRONMENTAL SCIENCES

4 ENVIRONMENTAL ASSESSMENT AND MANAGEMENT FRAMEWORK

This section outlines how the proposal has accommodated the environmental values associated with the application area and wider area of modelled drawdown and details the proposed environmental management measures.

4.1 CONSIDERATION OF ALTERNATIVES AND APPLICATION OF THE MITIGATION SEQUENCE

Application of the mitigation sequence and consideration of alternatives has been applied to the proposal throughout its development, as summarized below.

Early groundwater investigations exploring groundwater and surface water development opportunities on Napier Downs Station in 2018 (IGS 2018a, b) identified potential groundwater targets in 100–300 m thick sequences of Grant Group extending across the south-western portion of the station, and in Devonian reef limestones. The Devonian reef limestones were later discounted on the basis that they host significant cultural and environmental values.

Surface water options were subsequently ruled out due to the high interannual variability (and therefore reliability) in wet season rainfall, challenges of harvesting and storage, and sub-optimal soil types for irrigation in inundation areas (IGS 2019a, b).

More detailed investigation of groundwater resources, focusing on the Grant Group, was then undertaken at 3 potential sites, denoted as 'Lennard', Hawkstone' and 'Scrubby' in Figure 3-1. The Lennard site was the preferred site on the basis that it had suitable soils, year-round access via the Gibb River Road and was close to existing infrastructure (IGS 2019e, 2021).

Further baseline investigations were undertaken into the Lennard site in 2019, including a preliminary groundwater risk assessment (IGS 2019c), the environmental desktop assessment of the 'Lennard' and Hawkstone' sites (Phoenix 2019), and field investigations into the groundwater connectivity of the Lennard River (IGS 2019d). These found the Lennard River is most likely connected to the regional water table in the Grant Group aquifer, and several environmental values were identified to be associated the river. All plans for the Lennard site were therefore discontinued and the focus changed to Hawkstone and Scrubby sites where there were considerably larger setback distances from Lennard River to avoid potential drawdown impacts to permanent pools.

Drilling at Hawkstone and Scrubby sites in 2020 found the Scrubby site produced far more favourable results compared to the Hawkstone site, therefore, the Scrubby site was chosen as the preferred site for irrigation development, though it was ultimately shifted slightly to the south to become the current application area (Figure 3-1). The environmental desktop review (Phoenix 2020) was then expanded to include the application area and found no major constraints to development.

Hydrogeological modelling was initially conducted for the Scrubby site, based on an initial 8 pivot, 6 GL / annum, with a 360 ha disturbance footprint (IGS 2021). After further analysis of potential impacts, and in discussion with DWER, the project was modified to the current proposal of 4 pivots and 3 GL / annum. This has enabled the area required to be cleared to be reduced from 360 ha to 200 ha.

Napier Corporation is further proposing to avoid significant environmental impacts by staging the development and level of groundwater abstraction, with subsequent stages to be subject to demonstration of no unacceptable impact on groundwater dependent ecosystems. Clearing of the locally restricted vegetation types/fauna habitat type in the application area will also be avoided to reduce impacts to biological values. Further mitigation, including on site management and monitoring is proposed, as outlined for each environmental aspect below.

4.2 FLORA AND VEGETATION

4.2.1 Objective

In the context of environmental impact assessment, the Environmental Protection Authority (EPA) objective for flora and vegetation is 'to protect flora and vegetation so that biological diversity and ecological integrity are maintained (EPA 2016a)'.

4.2.2 Potential impacts and mitigation

As outlined in section 4.1, the extent of native vegetation to be cleared has been reduced from 360 ha to a maximum of 200 ha, following reduction of the proposal from 8 pivots to 4.

The two restricted vegetation types in the application area associated with a seasonal soak, MvPsp (covering 0.9 ha) and MccLggCr (covering 3.5 ha; Figure 2-1) will not be cleared. The vegetation types that will be impacted are:

- AttSs – comprises 87.6% (514.2 ha) of the application area. Allowing maximum flexibility for site layout within the application area (i.e. assuming all clearing takes place in this vegetation type), a maximum of 200 ha, out of 514.2 ha of mapped extent (39%) will be cleared. This vegetation type is likely well represented locally and regionally, being representative of pre-European vegetation association 754 which has a current extent of 195,333 ha and 100% remaining. Impact is therefore not considered significant.
- EmDhaSs – comprises 11.3% (66.2 ha) of the application area. Vegetation type EmDhaSs occurs mainly in the southwestern quadrant of the application area (Figure 2-1) and therefore the majority is unlikely to be impacted by the proposal as the proposed pivot layout is in the eastern half (Figure 3-1). This vegetation type is likely well represented locally and regionally, also being representative of pre-European vegetation association 754 which has a current extent of 195,333 ha and 100% remaining. Impact is therefore not considered significant.

Other potential impacts to flora and vegetation from the proposal are:

- potential impact to one population of *Goodenia sepalosa* var. *glandulosa* (P3)
- potential impact to one population of *Phyllanthus* sp. B Kimberley Flora (T.E.H.Aplin et al. 809) (range extension)
- potential impacts to surrounding vegetation from nutrient enrichment through run-off from irrigated areas, and/or degradation from water erosion
- potential impacts to groundwater dependent vegetation – refer to section 4.4.

One population *of G. s.* var. *glandulosa,* was recorded in the application area with a foliage cover of 0.1% indicating that the species was present in low numbers. The population in the application area is not currently proposed for clearing based on the indicative pivot layout but may be impacted if the pivot placement changes. There are several (16) records on Florabase, of which 2 records are within in a conservation reserve and therefore protected, therefore clearing of the population in the application area is not considered significant.

One population of *Lophostemon grandiflorus* subsp*. grandiflorus* (P3) was recorded in the application area but this population will not be impacted as the vegetation types that this species was recorded in (MvPsp and MccLggCr) will not be cleared.

Under the current pivot design, no direct clearing of any known *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809) populations will occur. Two of three records are in vegetation types that will not be cleared (MvPsp and MccLggCr). The remaining record is ~40 m from pivot 1 in the widespread vegetation type AttSs, therefore some loss of *Phyllanthus* sp. B Kimberley Flora from clearing for this pivot. This species is highly likely to occur

occurs more widely between the records in the application area and the nearest records in Florabase (see section 2.2.6), therefore impact is not considered significant.

No known Threatened or Priority Ecological Communities, or other regionally significant vegetation are present in the application area. The buffer zone of Kimberley Vegetation Association 759 PEC occurs approximately 1.3 km east of application area. The PEC is associated with the riparian and floodplain zones of the Lennard River and Hawkstone Creek (see section 4.4).

The only nutrient treatment proposed which may have a risk of leaching is nitrates. This is only a risk under inappropriate treatment and management regimes. Details of how nutrient application will be managed to minimise risk of leaching are provided in section 4.4.3.

There is low potential for the proposal to result in introduction of weeds to native vegetation surrounding the pivots. No introduced flora species were recorded in the application area during the flora and vegetation survey (Phoenix 2023b) and there will be very limited vectors for introduction as the machinery and equipment to be used for the proposal will be kept onsite. The single crop species proposed, Rhodes grass, has a low risk rating according to the Environmental Weed Strategy (DEC 1999). Previous studies on the invasiveness of Rhodes grass at Kilto Station in the West Kimberley indicated the species has low invasive properties, only establishing and persisting beyond cultivation in highly disturbed areas with high soil moisture, and under a 'no active weed management' regime (Hurter & Naaykens 2012; Rio Tinto 2013).

Some minor changes to vegetation structure and composition may occur in vegetation surrounding pivots from additional water availability. This is likely to be confined to a very small buffer of the pivots and unlikely to generate any significant adverse effects.

4.2.3 Management

Management measures to be implemented for flora and vegetation are:

- demarcation of vegetation to be cleared and restriction of clearing/disturbance to marked areas
- demarcation of vegetation types to be protected (MvPsp and MccLggCr)
- drainage control to avoid erosion/degradation risk to surrounding native vegetation
- monitoring to track potential spread of cultivation crops beyond cultivation areas
- hygiene protocols for machinery and vehicles to minimise the risk of introducing weeds.

With management, the proposal is not anticipated to have a significant impact on flora and vegetation.

4.3 TERRESTRIAL FAUNA

4.3.1 Objective

The EPA objective for terrestrial fauna is 'to protect terrestrial fauna so that biological diversity and ecological integrity are maintained (EPA 2016c)'.

4.3.2 Potential impacts and mitigation

As noted in section 4.1, the proposal has been relocated away from Lennard site (Figure 3-1) which was identified to have several significant fauna values associated with the Lennard River and riparian habitat.

The extent of fauna habitat to be cleared has been reduced from 360 ha to a maximum of 200 ha, following reduction of the proposal from 8 pivots to 4.

The only restricted fauna habitat in the application area, the seasonal soak containing open woodland of shrubby regrowth (Figure 2-3) will not be cleared. The habitat types that will be impacted are:

- Shrubland over grassland – 506.2 ha of this habitat type is present in the application area, 848.3 ha is present in the 1 km buffer (Figure 2-3), and it is extensive beyond the 1 km buffer. Allowing maximum flexibility for site layout within the application area (i.e. assuming all clearing takes place in this habitat type), a maximum of 200 ha, out of 1,354.5 ha of mapped extent (15%) will be cleared.
- Open woodland over open shrubland over grassland – 75.9 ha of this habitat type is present in the application area, 411.8 ha is present in the 1 km buffer (Figure 2-3), and it is extensive beyond the 1 km buffer. Allowing maximum flexibility for site layout within the application area (i.e. assuming all of this habitat type is cleared in the application area), a maximum of 75.9 ha, out of 487.7 ha of mapped extent (16%) will be cleared, although as the pivots are most likely to be located in the eastern half of the application area (see Figure 3-1), clearing is this habitat type is likely to be much lower.

Other potential impacts to terrestrial fauna from the proposal are:

- risk of introduction or promotion of introduced fauna (cats, dogs and cane toads)
- potential for localised displacement and direct mortality of Golden Bandicoot.

Both main fauna habitats in the study area are suitable for Golden Bandicoot and therefore there will be some loss of habitat for the species (up to 200 ha) from the proposal. The proposed clearing of up to 200 ha represents just 11% of the total mapped extent of suitable habitat for Golden Bandicoot in the application area and 1 km buffer. Suitable habitat for the species is much more widespread beyond this extent. Given the availability of suitable habitat for the species, clearing of 200 ha is unlikely to have a significant impact on the species.

The Golden Bandicoot is known to have multiple breeding events within a year; in the Kimberley, they have previously been recorded with pouch young in autumn and spring (Office of Environment and Heritage 2019), and in July during the terrestrial fauna survey (Phoenix 2023a). Elsewhere they have been recorded breeding continuously throughout the year (Office of Environment and Heritage 2019). Most likely they breed in response to rainfall. It is therefore considered unlikely that clearing for the proposal will significantly disrupt the breeding cycle of the species. There is potential however for localised displacement and direct mortality of individuals during clearing. These risks have been partly mitigated by committing to staged clearing in line with the staging of the proposal (Table 3-1).

Predation by feral cats is listed as a current threat to the Golden Bandicoot (Threatened Species Scientific Committee 2015) and this species was detected in the terrestrial fauna survey. While confirmed as already present, the availability of irrigation water during the dry season may promote an increase in abundance of feral cats. Irrigation and crop production may attract herbivores which may lead to increased abundance of introduced predators (dogs or cats).

The availability of irrigation water during the dry season may also promote an increase in abundance of cane toads. Cane toads are not identified as a threat to Golden Bandicoot, but they are currently considered the main threat to Northern Quoll (Hill & Ward 2010). While not recorded in the fauna survey, the desktop records of Northern Quoll along Hawkstone Creek indicate it is present in the region, therefore an increase in cane toads from the proposal may increase risk of impact on Northern Quoll.

The proposal has low potential to introduce invasive plant species to the surrounding environment and therefore degrade fauna habitat as only crop species with low invasive properties (Rhodes grass) will be used (see section 4.2.2).

Of the 3 potential SRE invertebrates recorded in application area, impacts are unlikely to be significant for any:

- *Aname* 'MYG771' – only one of four sites that this species was recorded from likely to be impacted; collected from widespread habitat.
- *Cubaris* sp. indet. 'Napier' – only one of three sites that this species was recorded from will be impacted; collected from widespread habitat.

- *Lychas* 'annulatus group' – only recorded from southwestern corner of application area, therefore unlikely to be impacted; collected from widespread habitat.

4.3.3 Management

The following management measures are to be implemented in relation to fauna:

- Staging of clearing – clearing will be staged in line with the pivot staging to reduce scale of fauna displacement.
- Feral animal control – feral cat and dog control is already undertaken on Napier Station. The existing management program will be reviewed and refined in response to risks identified in association with the proposal, including adding cane toad control to the existing program.
- Monitoring – annual monitoring of the local Golden Bandicoot population and feral animals will be undertaken to assess population persistence for a sufficient period to demonstrate no significant impact to Golden Bandicoot.

With management, the proposal is not anticipated to have a significant impact on terrestrial fauna.

4.4 HYDROLOGY / INLAND WATERS

4.4.1 Objective

The EPA objective for the environmental factor inland waters is 'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected (EPA 2018)'.

4.4.2 Potential impacts and mitigation

Potential impacts to inland waters from the proposal are:

- potential impact on groundwater dependent ecosystems at Ngooderoodyne Spring, Lennard River Pool and potential GDE at Hawkstone Creek from groundwater drawdown
- potential for nutrient discharge to, and/or herbicide/pesticide contamination of, the floodplain zone of the Hawkstone Creek system (Kimberley Vegetation Association 759 PEC).

As outlined in section 4.1, the proposal has been scaled down by 50% (from 6 GL/annum to 3 GL / annum) to reduce groundwater drawdown impacts on groundwater dependent ecosystems and will be staged within the groundwater licence subject to no unacceptable impact to groundwater dependent ecosystems.

Groundwater abstraction has been modelled for the proposed project stages of 1, 2 and 4 pivots at the two confirmed and one potential groundwater dependent ecosystem (Table 4-1). All three (actual and potential) groundwater dependent ecosystems are predicted to receive small but manageable drawdown over the long term as a result of the proposal.

Table 4-1 Modelled groundwater drawdown at groundwater dependent ecosystems

Staged volume and timeline	Predicted drawdown (m, P50)		
	Ngooderoodyne Spring	Lennard River Pool	Hawkstone Creek (precautionary GDE)
0.6 GL/a (1 pivot bore – low water use)			
1 year	0.02	0.00	0.08
10 years	0.11	0.04	0.30
30 years	0.12	0.05	0.33
0.75 GL/a (1 pivot bore)			
1 year	0.02	0.00	0.10
10 years	0.13	0.05	0.38
30 years	0.15	0.07	0.42
1.5 GL/a (2 pivot bores)			
1 year	0.03	0.00	0.16
10 years	0.25	0.11	0.78
30 years	0.29	0.14	0.90
3.0 GL/a (4 pivot bores)			
1 year	0.05	0.00	0.44
10 years	0.52	0.22	1.67
30 years	0.59	0.32	1.93

The only nutrient treatment proposed which may have a risk of leaching is nitrates, which are highly soluble and may leach through the soil under high rainfall conditions. However, research conducted by the Department of Primary Industries and Regional Development (DPIRD) at Skuthorpe horticultural area near Broome shows that nitrate leaching under Rhodes grass that is irrigated appropriately is negligible (Carla Milazzo, Development Officer, DPIRD, *pers. comm.* email to J. McMahon 11 May 2023).

4.4.3 Management

Monitoring and management of impacts to the groundwater dependent ecosystems will be undertaken under the groundwater licence via a water resource operating strategy (currently in preparation). Monitoring will include:

- groundwater monitoring of water level and water quality impacts within and beyond the irrigation area, at Ngooderoodyne Spring and Lennard River pool, and at Hawkstone Creek (precautionary)
- vegetation health monitoring where drawdown levels are greater than predicted at Ngooderoodyne Spring, Lennard River pool or Hawkstone Creek; baseline vegetation health monitoring sites (control and impact) to be established prior to drawdown
- adaptive management plan which includes a requirement to reduce, move or cease abstraction if monitoring identifies that vegetation is stressed.

The risk of nitrate leaching will be minimised by using an appropriate rate of nitrogen fertiliser (i.e. not over-applying), and minimising the use of urea when there is a high risk of large rainfall events. The proposed nutrient application regime for Rhodes grass production is provided in Table 4-1, and is based on guidance from DPIRD. It adopts a rate that optimises fodder yield and quality without creating a build-up of nitrate in

the soil profile. Therefore, with appropriate management of nutrient applications, the risk of nitrate leaching to offsite inland waters (i.e. Hawkstone Creek and it's floodplains) is extremely low.

Any application of pesticides/insecticides, if required, will be undertaken with guidance from DPIRD and with consideration to trial outcomes at Skuthorpe. Drainage controls will be implemented to manage water runoff from pivots.

Table 4-2 Proposed nutrient application regime for Rhodes grass

Establishment		**kg/ha**	
Element	N	18	
	P	18	
	K	20	
Trace element	Ca	38	
	Cu	1.2	
	Zn	0.6	
	Mo	0.1	
Product	Urea (46% N)	40	
	Super Cu Zn Mo	200	
	Muriate of Potash	40	
Per cut		**kg/ha/cut***	**kg/ha/day***
Element	N	105	3.0
	P	18	0.5
	K	64	1.8
Product	Urea (46% N)	228	6.5
	3:2 PK blend (5.5% P, 19.8% K)	325	9.3
*Assuming approx. 35 day cut cycle length			
Per year		kg/ha	
Trace element	Cu	4	
	Zn	10	
	Mg	20	
Product	CuSO4	16	
	ZnSO4	30	
	MgSO4	204	

4.5 SOIL MANAGEMENT

4.5.1 Objective

The EPA objective for the terrestrial environmental quality is 'to maintain the quality of land and soils so that environmental values are protected (EPA 2016b)'.

4.5.2 Potential impacts and mitigation

The proposal is unlikely to cause significant erosion or impacts to soil structure or quality. The Pindan soils of the application area are fast draining. In addition, the proposed crop, Rhodes grass is recognized as a useful crop for erosion control because of its spreading growth habitat (Pastures Australia 2007). It is therefore likely to have a stabilizing, rather than degrading effect on the pindan soils of the application area.

4.5.3 Management

While not considered a significant risk to surrounding soils, drainage controls will be implemented to manage water runoff and avoid erosion risk.

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APPENDICES

Appendix 1 Environmental desktop assessment and addendum

Appendix 2 H3 hydrogeological assessment

Appendix 3 Flora and vegetation survey

Appendix 4 Reconnaissance survey of potential groundwater associated values

Appendix 5 Terrestrial fauna survey

Appendix 6 Subterranean fauna risk assessment

Appendix 7 Model simulation of alternative pumping scenarios

Appendix 8 Conceptual groundwater diagrams of GDEs