Technical Memorandum

24 September 2021

[redacted]

1 Introduction

1.1 Background

The Department of Defence is proposing to upgrade the Cocos (Keeling) Islands (CKI) airfield. The airfield is a Commonwealth of Australia asset falling under the jurisdiction of the Department of Infrastructure, Transport, Regional Development and Communications and managed by Toll Remote Logistics Pty Ltd. Upgrades to the CKI airfield are required to enable the Royal Australian Air Force to support P-8A Poseidon capability on the runway, reduce the safety risks associated with operating Code D aircraft on the airfield and address non-compliances identified by the Civil Aviation Safety Authority.

1.2 Scope of works and purpose of this memorandum

GHD Pty Ltd (GHD) was engaged by Fulton Hogan Construction Pty Ltd (Fulton Hogan) to conduct an inspection of the CKI airfield land-based work areas (as advised by Fulton Hogan) to provide information on the existing terrestrial flora and fauna values present. This memorandum provides a summary of the methods and results from the inspections completed during site visits conducted in September 2020 and June 2021.

1.3 Investigation areas

The CKI airfield is located on West Island with the runway extension (RE) area located to the south of the existing runway and airfield. The investigation areas for the inspections included the CKI airfield, RE area and bore and communications areas within/adjacent to the CKI airfield.

The project locality is shown on Figure 1, with the investigation areas shown in Figure 2, Figure 3 and Figure 4, Attachment 1.

1.4 Limitations and assumptions

This memorandum has been prepared by GHD for Fulton Hogan and may only be used and relied on by Fulton Hogan for the purpose agreed between GHD and Fulton Hogan as set out in Section 1.2 of this memorandum.

GHD otherwise disclaims responsibility to any person other than Fulton Hogan arising in connection with this memorandum. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this memorandum were limited to those specifically detailed in the memorandum and are subject to the scope limitations set out in the memorandum.

The opinions, conclusions and any recommendations in this memorandum are based on conditions encountered and information reviewed at the date of preparation of the memorandum. GHD has no responsibility or obligation to update this memorandum to account for events or changes occurring subsequent to the date that the memorandum was prepared. The opinions, conclusions and any recommendations in this memorandum are based on assumptions made by GHD described in this memorandum. GHD disclaims liability arising from any of the assumptions being incorrect.

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2. Methodology

2.1 Desktop assessment

Prior to the site visits a desktop assessment was undertaken to identify relevant flora and fauna information pertaining to the investigation areas. The desktop assessment involved a review of:

- Previous reports relevant to the investigation areas including:
  - Cocos (Keeling) Islands Airport Runway Refurbishment Project flora, avifauna and intertidal fauna assessment (GHD 2009)
  - Cocos (Keeling) Islands Airfield Upgrade Environmental Report (AECOM 2019)
- The Commonwealth Department of Agriculture, Water and the Environment (DAWE) Protected Matters Search Tool (PMST) to identify communities and species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) potentially occurring within the investigation areas (DAWE 2020a).
- The Department of Biodiversity, Conservation and Attractions (DBCA) *NatureMap* database for Threatened and Priority Ecological Communities (TECs and PECs) and flora and fauna species (including those listed under the Western Australian (WA) *Biodiversity Conservation Act 2016* (BC Act) or as a Priority by the DBCA) previously recorded from the investigation areas (DBCA 2007–).

2.2 Field survey

GHD senior ecologist Jordan Tindiglia (Flora collection licence: FB62000201) completed surveys of the investigation areas on the 8-11 September 2020 and 19-22 June 2021. The surveys were undertaken to identify and describe the dominant vegetation types, fauna habitats and their condition. Inventories of vascular flora and terrestrial vertebrate fauna species were also recorded at the time of survey.

The survey methodology employed by GHD was undertaken with reference to the WA Environmental Protection Authority (EPA) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) and *Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2020).

2.2.1 Vegetation and flora

Field survey methods involved traversing the inspection areas by foot and recording vegetation type and condition as well as taking representative photographs. Vegetation types were identified and boundaries delineated using field data/observations and confirmed by viewing aerial imagery. The vegetation condition was assessed and mapped in accordance with the vegetation condition rating scale for the Eremaean and Northern Botanical Provinces (EPA 2016). A flora inventory was compiled from opportunistic records made throughout the investigation areas. Species were identified in the field and by the use of taxonomic literature and online electronic databases. The conservation status of all recorded flora was compared against the current lists available on *FloraBase* (WA Herbarium 1998–) and the EPBC Act Threatened

species database provided by DAWE (2020b). Nomenclature used in this report follows that used by the WA Herbarium as reported on *FloraBase*.

2.2.2 Fauna

Field survey methods involved traversing the survey area by foot and recording fauna habitat types as well as taking representative photographs. A fauna inventory was compiled from opportunistic records made throughout the investigation areas. This included fauna observed, heard and noted from secondary evidence such as tracks, scats etc. Identification of fauna species was made in the field using available field guides and electronic guides (e.g. Morcombe 2004). Nomenclature used in this report follows that used by the WA Museum and the DBCA *NatureMap* database (DBCA 2007–) with the exception of birds, whereby Christidis and Boles (2008) was used.

3. Results

3.1 CKI Airfield

3.1.1 Site description

The CKI airfield extends in a north-east south-west direction at the southern end of West Island. Areas adjacent to the runway (existing bitumen sealed pavements) are undeveloped with lawn (introduced grasses) and native vegetation. Both the northern and southern ends of the runway-maintained areas are on the edges of intertidal/littoral zones. The CKI airfield investigation area was predominately flat, sloping from west to east.

Plate 1 Northern and southern ends of the CKI airfield

3.1.2 Vegetation types and condition

The vegetation surrounding the runway is located between the tidal zone and the maintained introduced grassland areas. Four vegetation types were recorded at the CKI airfield investigation area including beach shrubland, *Scaevola* shrubland, *Cocos* trees and grasslands (Table 1). The majority of the investigation area comprised grasslands and herbfields, mostly of introduced origin. The grasslands include areas both regularly and less frequently maintained. Beach shrubland was located between the maintained runway and the intertidal mudflats at either end of the runway. This vegetation included sparsely spread species on coral sands and shingle. *Scaevola* shrubland was restricted to linear strips on the east side of the runway; at these locations this vegetation formed dense thickets. The final vegetation type, Cocos trees comprised sparsely spread *Cocos nucifera* with occasionally shrubs of *Scaevola taccada*.

The vegetation condition at the CKI airfield investigation area ranged from Completely Degraded to Good. Generally, the *Scaevola* shrubland had structural diversity, but weed incursion was noted. Areas mapped

as mixed trees and beach shrubland were rated as Degraded in condition. Areas mapped as grasslands were rated Completely Degraded.

Table 1 Vegetation types recorded from the CKI airfield investigation area

Vegetation type description	Representative photograph
Beach shrubland *Argusia argentea* and *Cocos nucifera* sparse low woodland over *Pemphis acidula* and **Turnera ulmifolia* mid open shrubland over **Cynodon dactylon*, **Cenchrus ciliaris* and **Eragrostis amabilis* grassland with *Ipomoea* spp. clumps of vines. Represents littoral vegetation. Areas at the northern end of the runway also contained **Melanthera biflora* mid open shrubland.	
Scaevola shrubland *Cocos nucifera, Argusia argentea and Guettarda speciose* tall to mid sparse woodland over *Scaevola taccada* tall closed shrubland over **Euphorbia cyathophora*, **Spermacoce remota* and **Turnera ulmifolia* low sparse herbland. The Scaevola Shrubland is situated alongside the maintained runway lawn and forms a dense thicket. *Pemphis acidula* becomes dominant in this community in areas adjacent to the lagoon.	
Cocos Trees *Cocos nucifera* isolated trees and *Scaevola taccada* isolated shrubs over maintained lawn. Sparsely spread *Cocos nucifera* over grasslands.	
Grasslands **Cynodon radiates*, **Cynodon dactylon* and **Cenchrus ciliaris* low to mid closed grassland with emergent **Boerhavia diffusa*, **Cyanthillium cinereum*, **Tridax procumbens* and **Euphorbia cyathophora* low sparse herbland and **Macroptilium atropurpureum* clumps of vines.	

3.1.3 Flora

Forty-three flora species were recorded from the CKI airfield investigation area (Table 2). This total included 29 introduced (weed) species and 14 native species. One of the introduced species, *Chromolaena odorata is listed as a Declared Pest (Category 1, Prohibited) under the WA *Biosecurity and Agriculture Management Act 2007* (BAM Act).

The CKI airfield investigation area is considered to have low floristic diversity.

No species listed under the EPBC Act or BC Act were recorded at the CKI airfield investigation area. *Lepturus repens*, which is listed as Priority 3 by the DBCA has been previously recorded at the southern end of the runway by GHD (2009); this species was not recorded during the current surveys despite suitable search effort.

GHD (2009) also recorded a single individual of mangrove species, *Rhizophora apiculata* approximately 40 m east of the northern end of the runway on the edge of the littoral zone. It was noted this species was of some significance as it had been previously recorded from Horsburgh Island in the CKI group, but not from West Island (GHD 2009). Seven individuals of *Rhizophora apiculata* were recorded during the current surveys in the intertidal area at the northern end of the runway. The individuals varied from seedlings to mature shrubs with flowering/fruiting material (Plate 2). While not conservation listed the species represents flora of interest due to the range extension The locations of *Rhizophora apiculata* are provided in Table 3.

Table 2 Flora recorded from the CKI airfield investigation area

Family	Taxon	Status
Aizoaceae	*Sesuvium portulacastrum*	
Arecaceae	*Cocos nucifera*	
Asteraceae	*Ageratum conyzoides*	*
Asteraceae	*Chromolaena odorata*	*, DP
Asteraceae	*Cyanthillium cinereum*	*
Asteraceae	*Emilia sonchifolia*	*
Asteraceae	*Melanthera biflora*	
Asteraceae	*Tridax procumbens*	*
Boraginaceae	*Argusia argentea*	
Convolvulaceae	*Ipomoea pes-caprae*	
Convolvulaceae	*Ipomoea violacea*	
Cyperaceae	*Cyperus javanicus*	
Cyperaceae	*Cyperus stolonifera*	
Cyperaceae	*Fimbristylis cymosa*	
Euphorbiaceae	*Euphorbia cyathophora*	*
Euphorbiaceae	*Euphorbia hirta*	*
Fabaceae	*Desmodium triflorum*	*
Fabaceae	*Macroptilium atropurpureum*	*
Fabaceae	*Stylosanthes* sp.	*
Goodeniaceae	*Scaevola taccada*	
Lauraceae	*Cassytha filiformis*	
Lythraceae	*Pemphis acidula*	
Malvaceae	*Triumfetta repens*	*
Nyctaginaceae	*Boerhavia diffusa*	*
Passifloraceae	*Turnera ulmifolia*	*
Plantaginaceae	*Veronia cinerea*	*
Poaceae	*Cenchrus ciliaris*	*
Poaceae	*Cenchrus echinatus*	*
Poaceae	*Chloris barbata*	*
Poaceae	*Cynodon arcuatus*	*

Family	Taxon	Status
Poaceae	*Cynodon dactylon*	*
Poaceae	*Cynodon radiates*	*
Poaceae	*Digitaria mariannensis*	*
Poaceae	*Eleusine indica*	*
Poaceae	*Eragrostis amabilis*	*
Poaceae	*Eragrostis elongata*	*
Poaceae	*Stenotaphrum micranthum*	*
Rhizophoraceae	*Rhizophora apiculata*	
Rubiaceae	*Oldenlandia corymbosa*	*
Rubiaceae	*Spermacoce assurgens*	*
Rubiaceae	*Spermacoce remota*	*
Surianaceae	*Suriana maritima*	
Verbenaceae	*Stachytarpheta jamaicensis*	*

* indicates introduced species, DP= Declared Plant under the *Biosecurity and Agriculture Management Act 2007*

Plate 2 Rhizophora apiculata at the northern end of the CKI airfield

Table 3 Rhizophora apiculata locations

Location	Count	Life form
12° 10' 43" S, 96° 49' 34" E	1	Juvenile
12° 10' 43" S, 96° 49' 37" E	2	Juvenile and seedling
12° 10' 44" S, 96° 49' 39" E	3	Mature shrubs x2 and seedling
12° 10' 45" S, 96° 49' 40" E	1	Mature shrub

3.1.4 Fauna habitats

The CKI airfield investigation area comprised four fauna habitats including palms, beach, shrubland and grasslands (Table 4). The fauna habitats align with the mapped vegetation types.

Table 4 Fauna habitats recorded at the CKI airfield investigation area

Fauna habitat description	Representative photograph
Palms This habitat is highly modified and comprises scattered or isolated stands of palms with minimal to no understorey. Leaf litter and branches may be present at the base of some palm stands. The habitat provides low value to fauna. It may be used by avian species for foraging and may also provide some nest habitat. This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow), *Motacilla flava* (Yellow wagtail) and *Motacilla cinerea* (Grey wagtail).	
Beach This habitat occurs as a narrow strip of sand over mud, with abundant small rock and coral pieces. It lies between the grasslands and intertidal zone. The habitat contains sparsely spread mixed shrubs and palms, with vegetative debris, (e.g. branches coconuts etc.). The habitat provides moderate value to fauna and is heavily utilised by crabs. This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow) and *Motacilla flava* (Yellow wagtail).	
Shrubland This habitat contains areas of shrubland (e.g. *Scaevola* sp.) with isolated/scattered trees (e.g. Coconut Palms). The habitat provides moderate value to fauna as it has structural diversity and provides cover (i.e. leaf litter and understorey vegetation). The habitat may be used by avian and ground dwelling species for foraging and nesting. This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow), *Motacilla flava* (Yellow wagtail) and *Motacilla cinerea* (Grey wagtail).	
Grasslands This habitat has been cleared, is highly modified and comprises introduced grasses and herbs. The habitat provides low value to fauna as no structural diversity and limited cover (i.e. scarce leaf litter and no understorey vegetation). The habitat may be used by avian species for foraging and by avian and ground dwelling species as corridors. This habitat may provide nesting habitat for listed species including *Ardenna pacifica* (Wedge-tailed shearwater). This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow), *Motacilla flava* (Yellow wagtail) and *Motacilla cinerea* (Grey wagtail).	

3.1.5 Fauna

Nine fauna species were observed at the CKI airfield investigation area, this included four bird and five crab species (Table 5). None of the fauna species recorded are conservation listed. White terns were observed overflying over the area, while the Eastern reef egret, Nankeen night heron and Green jungle fowl were observed foraging within the grasslands surrounding the runway. White terns are known to nest in large trees in the nearby beach areas; no nest trees were observed with the CKI airfield investigation area.

Land crabs occupy the intertidal and littoral zones at the top of the high tide mark at both ends of the runway. Numerous burrows were observed in the beach, littoral and intertidal areas during the survey

(Plate 3). Land crabs and Horn-eyed ghost crabs were observed both north and south of the runway area. Several hermit crab individuals were observed at the southern end of the runway and Fiddler crabs observed at the northern end of the runway (Plate 4). GHD (2009) reported that the large areas of sand and silt beds in the lagoon are critical habitats to a variety of crab fauna, in particular the genera *Uca* (Fiddler crabs) and the lagoon is an important nursery to the Land crabs, which spend the juvenile stages of their life cycle in the lagoon before migrating to land.

Table 5 Fauna recorded at the CKI airfield investigation area

Species	Common name
Gygis alba	White tern
Egretta sacra	Eastern reef egret
Nycticorax caledonicus	Nankeen night heron
Gallus varius	Green jungle fowl
Cardisoma carnifex	Land crab
Ocypode ceratophthalma	Horn-eyed ghost crab
Coenobita perlatus	Red hermit crab
Coenobita rugosa	Tawny hermit crab
Uca sp.	Fiddler crab

Plate 3 Land crab and burrows in littoral zone (beach fauna habitat type)

Plate 4 Fiddler crab in littoral zone (beach fauna habitat type)

3.2 Runway Extension

3.2.1 Site description

The RE investigation area extends south of the existing CKI airfield, and includes adjacent to and south east of the runway that are undeveloped with lawn, areas with native vegetation, unsealed roads (i.e. Air Force Road) and cleared areas. The investigation area also includes intertidal/littoral zones that comprise native vegetation, sandy and rocky beaches, and mudflats. The investigation area was predominately flat, sloping both towards the ocean on the west side and the lagoon on the east side.

Plate 5 RE investigation area (lawned and cleared areas)

Plate 6 RE investigation area (coastal and lagoon areas)

3.2.2 Vegetation types and condition

Four vegetation types were recorded at the RE investigation area including beach shrubland, *Scaevola* shrubland, *Cocos* closed forest and grasslands (Table 6). Areas directly adjacent to the runway comprised grasslands and herbfields, mostly of introduced origin. The grasslands include areas both regularly and less frequently maintained. Beach shrubland was located between the maintained runway and the intertidal mudflats on the lagoon side, south of the runway. This vegetation included sparsely spread species on coral sands and shingle. *Scaevola* shrubland dominated western areas of the RE. There was also a small area on the western side of the RE that has been previously disturbed and contains a mix of shrubs and weeds; this area was mapped as Disturbed. The vegetation on the eastern side of the RE was a mix of *Scaevola* shrubland and *Cocos* closed forest.

The vegetation condition at the RE investigation area ranged from Completely Degraded to Good. Generally, the *Scaevola* shrubland and *Cocos* closed forest had structural diversity, but weed incursion was

noted. Areas mapped as beach shrubland were rated as Good or Degraded in condition. Areas mapped as grasslands were rated Completely Degraded.

Table 6 Vegetation types recorded from the RE investigation area

Vegetation type description	Representative photograph
Beach shrubland *Argusia argentea* and *Cocos nucifera* sparse low woodland over *Pemphis acidula* and **Turnera ulmifolia* mid open shrubland over **Cynodon dactylon, *Cenchrus ciliaris* and **Eragrostis amabilis* grassland with *Ipomoea* spp. clumps of vines. Represents littoral vegetation. In lagoon areas further south, *Pemphis acidula* becomes dominant in this community.	
Scaevola shrubland *Argusia argentea and Guettarda speciose* tall to mid sparse woodland with emergent *Cocos nucifera* over *Scaevola taccad*a tall closed shrubland over **Turnera ulmifolia* low sparse herbland and **Eragrostis amabilis* isolated clumps. The *Scaevola* Shrubland can form dense thickets. *Pemphis acidula* can also be present in areas adjacent to rocky/sandy beaches.	
Cocos closed forest *Cocos nucifera* with scattered *Morinda citrifolia, Terminalia catappa* and *Guettarda speciosa* mid forest over *Scaevola taccada, Pemphis acidula* (adjacent to lagoon) and *Turnera ulmifolia* tall shrubland with *Cocos nucifera* (scattered juveniles) over mixed low open herbland/grassland. *Pemphis acidula* becomes dominant in patches adjacent to the lagoon. Representative photograph shows *Cocos* closed forest in background and *Scaevola* shrubland in foreground.	
Grasslands **Cynodon radiates, *Cynodon dactylon* and **Cenchrus ciliaris* low to mid closed grassland with emergent **Boerhavia diffusa, *Cyanthillium cinereum, *Tridax procumbens* and **Macroptilium atropurpureum* low sparse herbland.	

Vegetation type description	Representative photograph
Disturbed Area *Pemphis acidula, Caesalpinia bonduc* tall to mid shrubland over *Fimbristylis cymosa, Ipomoea pes-caprae* and **Stachytarpheta jamaicensis*. This area has been previously disturbed/partially cleared which has allowed several shrub species to dominant.	

3.2.3 Flora

Thirty-three flora species were recorded from the RE investigation area (Table 7). This total included 17 introduced (weed) species and 16 native species. No species listed under the EPBC Act or BC Act were recorded at the RE investigation area. *Lepturus repens*, which is listed as Priority 3 by DBCA has been previously recorded at the southern end of the runway by GHD (2009); this species was not recorded during the 2020 or current survey despite suitable search effort.

The RE investigation area is considered to have low floristic diversity.

Table 7 Flora recorded from the RE investigation area

Family	Taxon	Status
Aizoaceae	*Sesuvium portulacastrum*	
Arecaceae	*Cocos nucifera*	
Asteraceae	*Cyanthillium cinereum*	*
Asteraceae	*Tridax procumbens*	*
Boraginaceae	*Argusia argentea*	
Boraginaceae	*Cordata subcordata*	
Convolvulaceae	*Ipomoea pes-caprae*	
Convolvulaceae	*Ipomoea violacea*	
Cyperaceae	*Cyperus javanicus*	
Cyperaceae	*Cyperus stolonifera*	
Cyperaceae	*Fimbristylis cymosa*	
Fabaceae	*Caesalpinia bonduc*	
Fabaceae	*Desmodium triflorum*	*
Fabaceae	*Macroptilium atropurpureum*	*
Goodeniaceae	*Scaevola taccada*	
Lythraceae	*Pemphis acidula*	
Malvaceae	*Triumfetta repens*	*
Nyctaginaceae	*Boerhavia diffusa*	*
Plantaginaceae	*Veronia cinerea*	*
Poaceae	*Chloris barbata*	*
Poaceae	*Cynodon arcuatus*	*
Poaceae	*Digitaria mariannensis*	*
Poaceae	*Eleusine indica*	*

Family	Taxon	Status
Poaceae	*Eragrostis amabilis*	*
Poaceae	*Eragrostis elongata*	*
Poaceae	*Lepturus repens*	
Poaceae	*Stenotaphrum micranthum*	*
Rubiaceae	*Guettarda speciosa*	
Rubiaceae	*Morinda citrifolia*	
Rubiaceae	*Oldenlandia corymbosa*	*
Rubiaceae	*Spermacoce assurgens*	*
Surianaceae	*Suriana maritima*	
Verbenaceae	*Stachytarpheta jamaicensis*	*

* indicates introduced species.

3.2.4 Fauna habitats

The CKI airfield investigation area comprised four fauna habitats, mixed shrubland and trees, beach, shrubland and grasslands (Table 8). The fauna habitats align with the mapped vegetation types.

Table 8 Fauna habitats recorded from the RE investigation area

Fauna habitat description	Representative photograph
Mixed shrubland and trees This habitat contains areas of shrubland and trees (e.g. Coconut Palms). This habitat is varied and can range from monocultures of Coconut Palms to closed forest with increased structural layers and diversity. Canopy cover is generally high and this habitat tends to open up beneath the canopy, comprising a tangle of branches and trunks. Abundant leaf litter is present, with fallen branches and occasional small hollows. The habitat provides moderate value to fauna. The habitat may be used by avian and ground dwelling species for foraging and nesting. This habitat may provide nesting habitat for listed species including Lesser frigatebird (*Fregata ariel*), Great frigatebird (*Fregata minor*), Oriental cuckoo (*Cuculus saturatus*). This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow), *Motacilla flava* (Yellow wagtail) and *Motacilla cinerea* (Grey wagtail).	
Beach This habitat occurs as a narrow strip of sand over mud, with abundant small rock and coral pieces. It lies between the grasslands and intertidal zone. The habitat contains sparsely spread mixed shrubs and palms, with vegetative debris, (e.g. branches coconuts etc.). The habitat provides moderate value to fauna and is heavily utilised by crabs. This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow) and *Motacilla flava* (Yellow wagtail).	

Fauna habitat description	Representative photograph
Shrubland This habitat contains areas of shrubland (e.g. *Scaevola* sp.) with isolated/scattered trees (e.g. Coconut Palms and *Guettarda speciose*). The habitat provides moderate value to fauna as it has structural diversity and provides cover (i.e. leaf litter and understorey vegetation). The habitat may be used by avian and ground dwelling species for foraging and nesting. This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow), *Motacilla flava* (Yellow wagtail) and *Motacilla cinerea* (Grey wagtail).	
Grasslands This habitat has been cleared, is highly modified and comprises introduced grasses and herbs. The habitat provides low value to fauna as no structural diversity and limited cover (i.e. scarce leaf litter and no understorey vegetation). The habitat may be used by avian species for foraging and by avian and ground dwelling species as corridors. This habitat may provide nesting habitat for listed species including *Ardenna pacifica* (Wedge-tailed shearwater). This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow), *Motacilla flava* (Yellow wagtail) and *Motacilla cinerea* (Grey wagtail).	

3.2.5 Fauna

Nine fauna species were observed at the RE investigation area, including three birds and six crab species (Table 9). None of the fauna species recorded are conservation listed. White terns were observed overflying over the area, the Nankeen night heron foraging in grassed areas, and the Eastern reef egret foraging in coastal areas both west and east (in the lagoon). White terns are known to nest in large trees in nearby beach areas; no nest trees were observed with the RE investigation area.

Land crabs occupy the intertidal and littoral zones at the top of the high tide mark in coastal areas both the west and east. Numerous burrows and individuals were observed throughout the RE investigation area. Numerous Red hermit crabs and several Tawny hermit crabs and Horn-eyed ghost crabs were observed in coastal areas (west and east). Rock crabs (Yellow nipper and Thin-shelled rock crab) were observed in the western coastal area. Example photographs of burrows and crabs are shown in Plate 7.

Table 9 Fauna recorded at the RE investigation area

Species	Common name
Gygis alba	White tern
Egretta sacra	Eastern reef egret
Nycticorax caledonicus	Nankeen night heron
Cardisoma carnifex	Land crab
Ocypode ceratophthalma	Horn-eyed ghost crab
Coenobita perlatus	Red hermit crab
Coenobita rugosa	Tawny hermit crab
Geograpsus crinipes	Yellow nipper
Grapsus tenuicrustatis	Thin-shelled rock crab / Natal lightfoot crab


Plate 7 *Horn-eyed ghost crab and crab burrows (likely Land crabs) in the lagoon area*

3.3 Bore and Communications Area

3.3.1 Site description

The bore and communications investigation area comprises a bore area which is within/adjacent to the western side of the CKI airfield. The communications area spans the CKI airfield from west to east across the southern part of the runway.

3.3.2 Vegetation types and condition

One vegetation type was recorded at the bore and communications investigation area, grasslands (Table 10). The vegetation comprised introduced species only and was rated Completely Degraded in condition.

Table 10 *Vegetation type recorded from the bore and communications investigation area*

Vegetation type description	Representative photograph
Grasslands **Cynodon radiates, *Cynodon dactylon* and **Chloris barbata* low to mid closed grassland with emergent **Cyanthillium cinereum and* **Tridax procumbens* low sparse herbland.	

3.3.3 Flora

Seven flora species were recorded from the bore and communications investigation area (Table 11). This total included five introduced (weed) species and two native species. The two native species occurred as single individuals planted at the western and eastern ends of the communications location. No species listed under the EPBC Act, BC Act or as Priority by DBCA were recorded at the bore and communications investigation area. The bore and communications investigation area is considered to have low floristic diversity.

Table 11 Flora species recorded from the other investigation area

Family	Taxon	Status
Arecaceae	*Cocos nucifera*	
Asteraceae	*Tridax procumbens*	*
Asteraceae	*Cyanthillium cinereum*	*
Poaceae	*Chloris barbata*	*
Poaceae	*Cynodon dactylon*	*
Poaceae	*Cynodon radiates*	*
Verbenaceae	*Premna serratifolia*	

* indicates introduced species.

3.3.4 Fauna habitats

One fauna habitat was recorded from the bore and communications investigation area (Table 12). The fauna habitats align with the mapped vegetation type. The habitat provided low value to fauna.

Table 12 Fauna habitat recorded at other investigation area

Fauna habitat description	Representative photograph
Grasslands This habitat has been cleared, is highly modified and comprises introduced grasses and herbs. The habitat provides low value to fauna as no structural diversity and limited/no cover (i.e. no understorey vegetation). The habitat may be used by avian species for foraging and by avian and ground dwelling species as corridors. This habitat may provide nesting habitat for listed species including *Ardenna pacifica* (Wedge-tailed Shearwater). This habitat may provide foraging habitat for listed species including *Hirundo rustica* (Barn swallow), *Motacilla flava* (Yellow wagtail) and *Motacilla cinerea* (Grey wagtail).	

3.3.5 Fauna

No fauna species were observed in the bore and communications investigation area.

4. Discussion and Conclusions

Five vegetation types were identified during the flora and fauna survey as well as disturbed areas. These vegetation types align with those previously identified and described by AECOM (2019) and GHD (2009). Overall, the vegetation types recorded from the investigation areas are representative of the vegetation across West Island. Woodroffe and Berry (1994) state that the 'human impact on the CKI has been most devastating on the South Keeling Islands (the southern atoll), where the vegetation has been almost totally altered to coconut plantation.' This is also supported by Williams (1994) who stated that CKI 'pre-settlement vegetation has been extensively modified for coconut plantations, except for certain parts of North Keeling'. Based on these statements, it could be suggested that much of the vegetation recorded during the survey is representative of highly modified vegetation as *Cocos nucifera* was a common species, recorded from both investigation areas.

Vegetation condition across the investigation areas ranged from Good to Completely Degraded. The vegetation largely lacked structural diversity and weed incursion was noted at most locations. Other

disturbances included tracks, partial clearing, rubbish and debris; historical storm and swell events are also likely to impact vegetation in coastal locations.

Overall, species diversity on CKI is considered low and the isolated location of CKI is likely to contribute to reduced diversity. Renvoize (1979) noted that low habitat diversity of CKI has led to a flora characterised by very low endemicity with indigenous taxa of pantropical or Indo-Pacific distribution dominating. Only one endemic species of flora is recorded from CKI, *Pandanus tectorius* var. *cocosensis*; this species has not been recorded during any of the surveys. No listed flora species were recorded within the investigation areas during the survey. *Lepturus repens*, which is listed as Priority 3 by the DBCA has been previously recorded at the southern end of the runway by GHD (2009); this species was not recorded during the current survey.

One species recorded during the survey is likely to be considered significant flora, although is not legislative protected. Mangrove species, *Rhizophora apiculata* was recorded in the intertidal area at the northern end of the runway. This species has been previously recorded from Horsburgh Island in the CKI group, but not from West Island. This record represents a range extension. The remainder of species recorded during the survey are common and widespread over West Island.

Five fauna habitat types were identified during the flora and fauna survey. The fauna habitats recorded during the survey align closely with the vegetation types described, as well as those previously identified and described by AECOM (2019) and GHD (2009). Overall, the fauna habitat types recorded from the investigation areas are representative of the habitats across West Island.

The diversity of terrestrial fauna on CKI is limited, largely due to the lack of diversity in habitats as well as human impact. While there was a lack of habitat diversity recorded from the investigation areas, the habitats present likely provide nesting and foraging habitat for the fauna species recorded during the survey. Fauna recorded during the survey included avian species as well as crabs. Crab species were conspicuous in the intertidal and littoral zones throughout the investigation areas. No significant fauna species were recorded within the investigation areas during the survey. However, the habitats present within the investigation areas may provide nesting and foraging habitat for a number of listed species.

Regards

pp

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Senior Environmental Scientist

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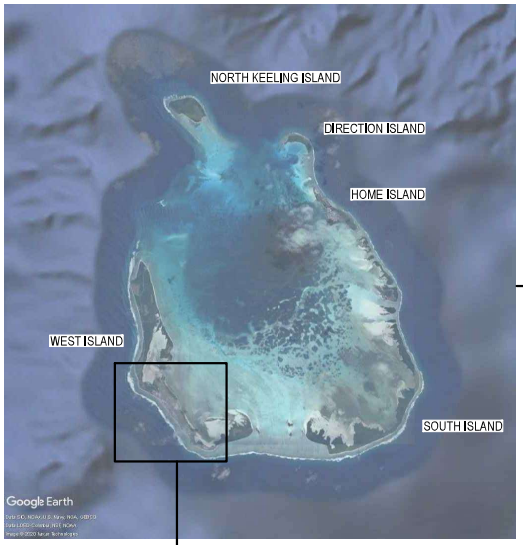
Attachment 1

Figures

DEPARTMENT OF DEFENCE

R8129 COCOS KEELING ISLAND AIRFIELD UPGRADE



LOCALITY PLAN

EXTRACTED FROM GOOGLE EARTH PRO 2020

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D P.MGR	APP'D P.DIR	AMENDMENT
A	25.09.20	CS	JL	MB	CO	ISSUED FOR REVIEW - 30%

CAUTION UNDERGROUND CABLES and PIPES

The data supplied within this plan should be used as general guidance only.

Where shown, Underground Service Lines have been determined by Field Survey or through information supplied by External Agencies/Contractors.

It is the responsibility of the recipient to assess whether the supplied data is accurate or fit for purpose especially if associated with critical activities (ie: measurements, excavations, permits, etc).

Defence does not warrant that the data is free of errors and shall not accept any liability for any loss or damaged incurred as a result of the user's reliance in this information.

Fulton Hogan

GHD

Australian Government
Department of Defence
Defence Support Group

DRAWING No	R8129_CKIAF_SWD_GC_DR_CD_0001
PROJECT	R8129 COCOS KEELING ISLAND AIRFIELD UPGRADE
BLD Class	Ext Area
SURVEY DATE	JULY 2020
SCALE	NOT TO SCALE
Int Area	AMDT A

TITLE

FIGURE 1

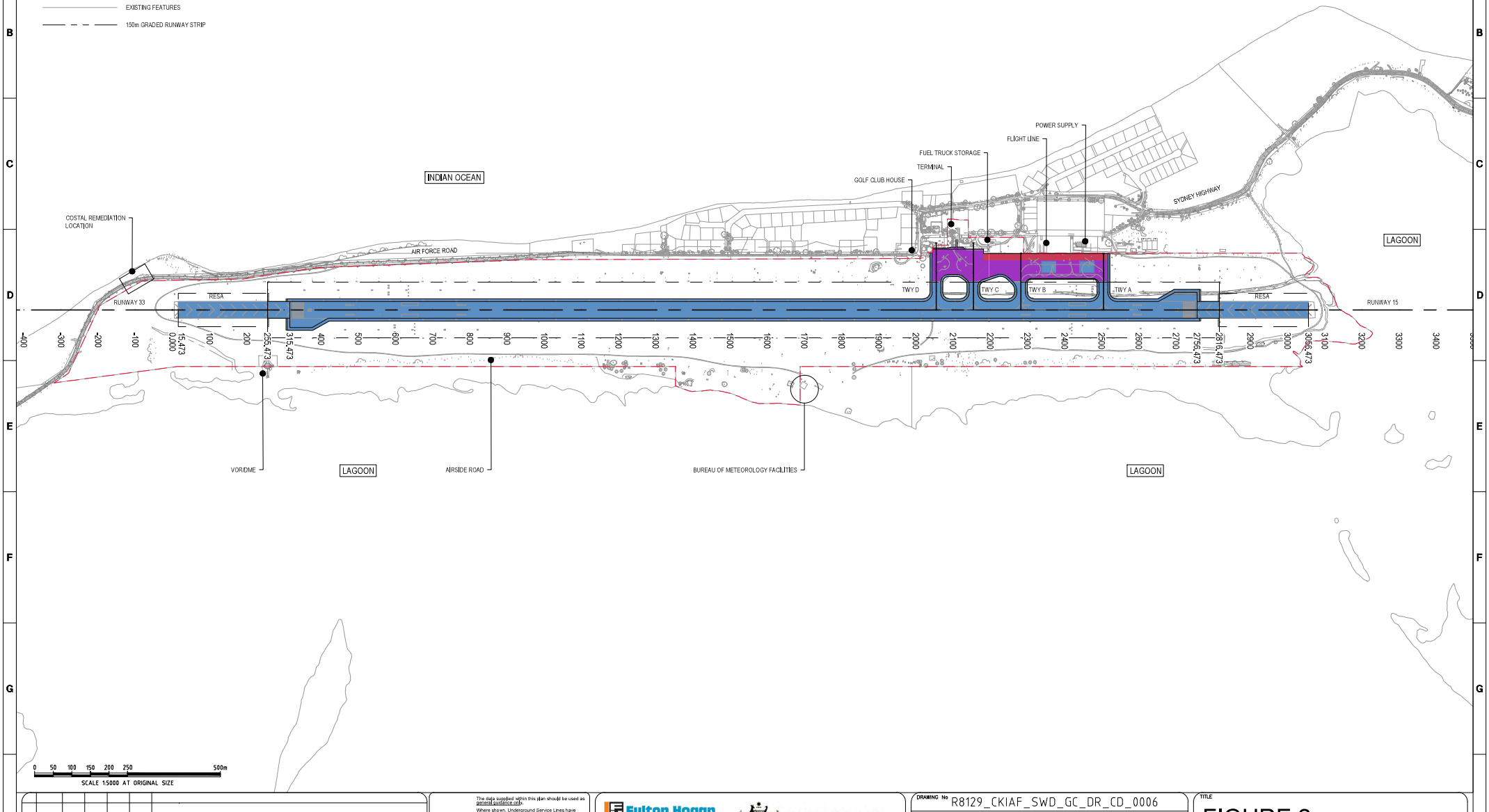
LEGEND:

SCOPE OF PAVEMENT WORKS

AIRPORT BOUNDARY

EXISTING FEATURES

150m GRADED RUNWAY STRIP



0 50 100 150 200 250 500m

SCALE 1:5000 AT ORIGINAL SIZE

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D P.MGR	APP'D P.DIR	AMENDMENT
A	25.09.20	CS	JL	MB	CO	ISSUED FOR REVIEW - 30%

CAUTION UNDERGROUND CABLES and PIPES

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Defence Support Group

DRAWING No	R8129_CKIAF_SWD_GC_DR_CD_0006
PROJECT	R8129 COCOS KEELING ISLAND AIRFIELD UPGRADE
BLD Class	Ext Area
SURVEY DATE	JULY 2020
SCALE	1:5000
Int Area	
AMDT	A

TITLE

FIGURE 2

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D P.MGR	APP'D P.DIR	AMENDMENT
A	23.04.21	MG	DB	MB	CO	ISSUED FOR REVIEW - 5%

CAUTION
UNDERGROUND CABLES and PIPES

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Defence does not warrant that the data is free of errors and shall not accept any liability for any loss or damaged incurred as a result of the user's reliance in this information.

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GHD

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Defence Support Group

DRAWING No	R8129_CKIAF_RWY_EQ_SK_MP_3010	
PROJECT	R8129 COCOS KEELING ISLAND AIRFIELD UPGRADE	
BLD Class	Ext Area	SURVEY DATE JULY 2020
SCALE 1:1000	Int Area	AMDT A

TITLE

FIGURE 3

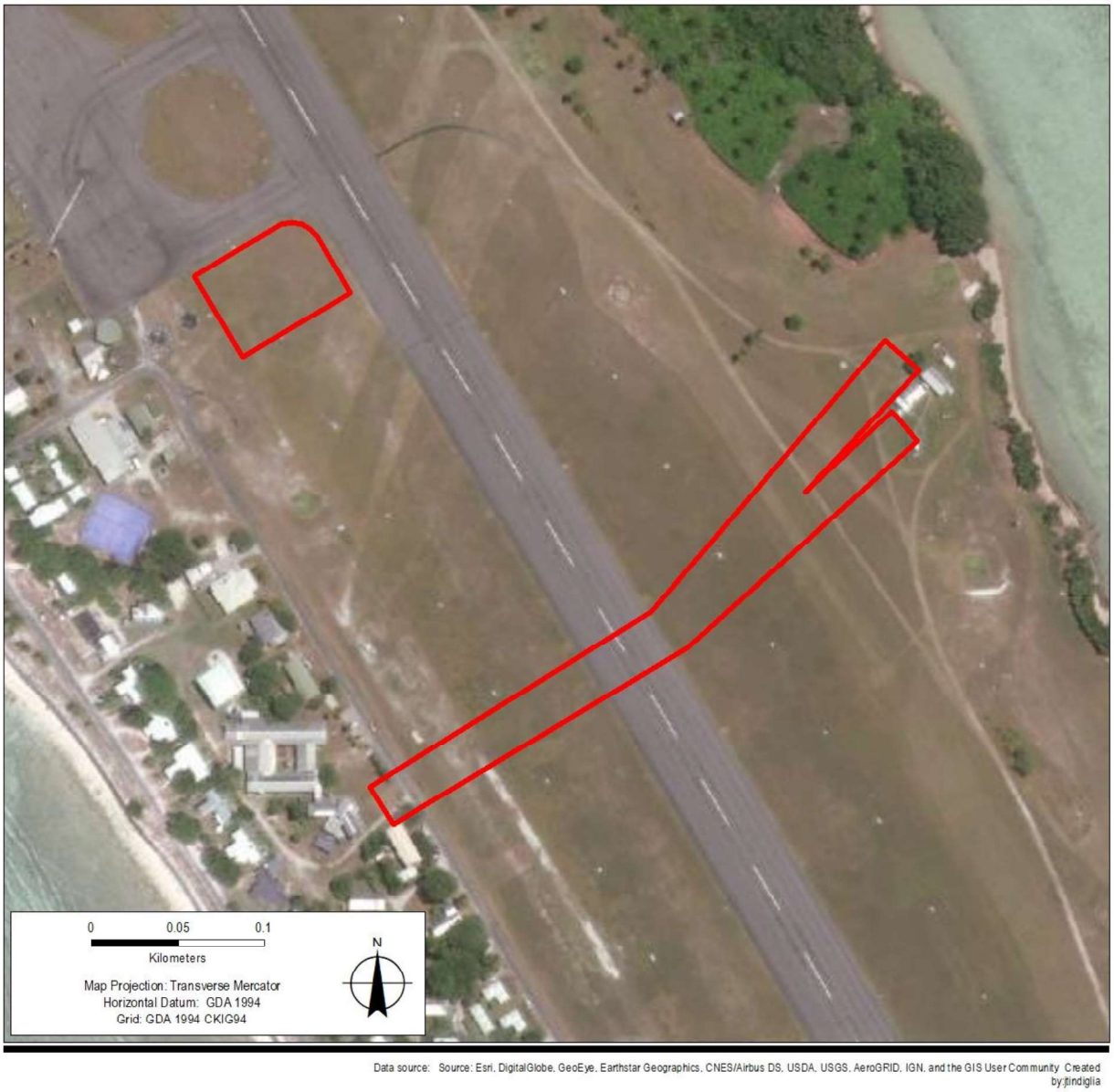

Figure 4 *Bore and Communications Investigation Area*