Major Project Canberra

City to Commonwealth Park Light Rail

EPBC Act preliminary documentation

CLR-ARU-C2W-00ENGN01-RPT-000002

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Arup
Level 5
151 Clarence Street
Sydney NSW 2000
Australia
www.arup.com

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		Name	Chani Wheeler	Matt Davis	Chris Fay
		Signature			
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Contents

Appendices

1 Introduction

The ACT Government is proposing an action to extend light rail between Canberra City centre and Commonwealth Park.

This report contains the information (preliminary documentation) requested by the Australian Government Department of Agriculture, Water and Environment (DAWE) to support its assessment of the Proposed Action.

The preliminary documentation has been prepared to respond to the requirements of the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This summary document helps guide the Australian Government and public to the relevant information prepared to respond to the preliminary documentation request made by DAWE on 23 January 2020 in relation to EPBC 2019/8582.

1.1 Background

Major Projects Canberra (MPC) lodged an EPBC referral in December 2019 which was determined to be a Controlled Action as there was determined to be significant impact on a listed species (Golden Sun Moth). The impacts to this are to be assessed via this preliminary documentation report. Table 1.1 summarises how this report is structured against the requirements of the preliminary documentation. The summary report is presented over 12 chapters. Chapters 1 and 2 define the purpose of this report. and the proposed actions. Chapter 3 to Chapter 8 summarise the preliminary documentation requirements for the Golden Sun Moth and the proponent's response. Chapter 9 considers relevant social and economic matters and Chapter 10 describes the proponent (ACT Government's) environmental history. Chapter 11 provides an overall conclusion and Chapter 12 provides references.

Table 1.1: Summary content

Additional information request	Relevant section
Proposed action (Chapter 2)	
Strategic context *Describing the rationale for the Proposed Action along with its need and the options considered.*	Section 2.1
Original referral documentation *Providing an overview of the referral documentation including and corrections and updates.*	Section 2.2
Proposed action *Describing the need for the proposed action the options considered, and the consultation carried out that has resulted in the proposed action.*	Section 2.3
Method (Chapter 3)	
Approach *Describing the previous studies carried out to date and a review of the data gaps that led to defining the assessment scope carried out to prepare the preliminary documentation. Also described are the methods, guidelines and standards that were used to prepare the preliminary documentation.*	Section 3.2.1 and 3.3
Occurrence (Chapter 4)	
Results *Describing the occurrence of golden sun moth in the study area including the associated habitat conditions. Also included is a summary of seasonality and long-term trends.*	Section 4.2
Potential Impacts (Chapter 5)	
Direct impacts *Focussing on the clearing impacts likely to occur during construction*	Section 5.2.1
Indirect impacts *Focussing on the edge effect impacts during construction, operation and maintenance.*	Section 5.2.2
Cumulative impacts *Considering the additive, interactive and compound impacts of the proposed action in combination with other concurrent and expected future developments taking place at the same time locally.*	Section 5.2.3
Avoidance, mitigation and management (Chapter 6)	
Avoidance *Describing the proposed commitments to avoid impacts and their cost effectiveness.*	Section 6.2.1
Mitigation *Describing the proposed commitments to mitigate against unavoidable impacts and their cost effectiveness.*	Section 6.2.2
Management *Describing the proposed commitments to manage unavoidable impacts and their cost effectiveness.*	Section 6.2.3

Additional information request	Relevant section
Proposed offsets (Chapter 7)	
Significant residual impacts *Summarising those impacts that are considered significant after measures to avoid, mitigate and manage impacts have been introduced.*	Section 7.2.1
Offset strategy *Describing the direct and compensatory measures to offset any unavoidable significant residual impacts including their effectiveness, cost and how they comply with policy and conservation, protection and management measures.*	Section 7.2.2
Commonwealth land (Chapter 8)	
Critically endangered habitat Confirming if the proposed action involves an impact on habitat that supports the critically endangered golden sun moth.	Section 8.2.1
Impact significance *Summarising the significance of this impact*	Section 8.2.2
Social and economic matters (Chapter 9)	
Social costs and benefits *Describing the social costs and benefits associated with the proposed action*	Section 9.2.1
Economic benefits *Describing the economic benefits of the project.*	Section 9.3
Environmental history (Chapter 10)	
Proponent details *Describing any legal proceedings*	Section 10.2.1
Environmental policy *Providing the proponent's environmental policy*	Section 10.2.2

1.2 Standards, policies and other guidance material

This Preliminary Documentation was prepared in accordance with the following relevant Commonwealth polies, guidelines and standards:

- Approved conservation advice for *Synemon plana* (golden sun moth) (DoE, 2013)
- Golden Sun Moth Action Plan (ACT Government, 2017)
- SIG for the critically endangered Golden Sun Moth (DEWHA 2009)
- Background Paper to EPBC Act Policy Statement 3.12- Nationally Threatened Species and Ecological Communities: Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*) (DEWHA 2009)
- EPBC Act Environmental Offsets Policy (Department of Sustainability, Environment, Water, Pollution and Communities, 2012) and accompanying Offsets Assessment Guide

1.3 Preparation of preliminary documentation

The following qualified and experienced specialists provided technical and preliminary responses to the preliminary documentation requirements.

Table 1.2: Key authors

Name	Role	Qualifications and experience
Alison Rowell	Golden Sun Moth specialist, field lead and technical review	Alison Rowell is a local consultant with considerable experience in the study of native grassland communities and species in the ACT and surrounding region. She is a local expert in Golden Sun Moth conservation and has contributed to policy documents including the draft *ACT Golden Sun Moth Monitoring Plan* (Rowell, A. and Evans, M. 2014) and the ACT Government's *Golden Sun Moth Action Plan* (ACT Government 2017).
Chani Wheeler	Field support and document author	Chani is a terrestrial ecologist with six years' experience in consulting and the public sector. Chani holds a Bachelor of Science majoring in Ecology and Conservation and a Master of Conservation Biology. She is a Member of the Environment Institute of Australia and New Zealand and an accredited biodiversity assessor in NSW.
Matt Davis	Strategic and approvals support and technical review	Matt is a terrestrial ecologist with 12 years' experience in research, consulting and the public sector. Matt holds a Bachelor of Science majoring in Ecology and Conservation Biology and a Master of Environmental Management (Conservation Biology). Matt is a Certified Environmental Practitioner, a Member of the Environment Institute of Australia and New Zealand, an accredited biodiversity assessor in NSW and an Infrastructure Sustainability Accredited Person.
Sara Golingi	Socioeconomic review	Sara has almost ten years of experience in urban and regional planning. She has been involved in numerous multi-disciplinary projects, including road network planning studies. Sara holds a Bachelor of Built Environment (Urban and Regional Planning) and is a member of the Planning Institute of Australia.
Chris Fay	Technical review	Chris is a Certified Environmental Practitioner in environmental impact assessment with 19 years' experience. He has prepared multiple major-project EIS' and development applications. He also holds a Master's in Environmental Impact Assessment, Auditing and Management Systems, is a Chartered Water and Environmental Engineer and Chartered Environmentalist.

2 Proposed action

This Chapter describes the Proposed Action in relation to the original referral documentation.

2.1 Strategic context

The ACT Government has committed to address the emerging challenges facing many growing cities around the world. This is based on a sustainable future that will create a connected, compact and competitive city recognised for its civic, cultural and recreational amenity. Many of the recent strategies and policies for Canberra realise that an effective integrated transport system is a priority and that light rail has proven to be a solution globally to provide rapid transit between key destinations. The ACT Government published its business case for the Proposed Action in August 2019[1] on the basis of addressing four key challenges:

- Challenge 1: failure to invest in Canberra's livability and economic connections will prevent attracting and retaining people and businesses.
- Challenge 2: inefficient use of existing land and infrastructure will lead to an unproductive and socially dislocated city.
- Challenge 3: the better use of public transport will help meet customer expectations and the needs of a growing population.
- Challenge 4: population growth and high car dependency will lead to road congestion creating negative social, economic and environmental impacts.

Development context

A key focus for the Proposed Action, as described under Challenge 2 and Challenge 4, is to build a functional and liveable city that can cater for 620,000 residents by the mid 2040s[2]. The ACT Government and City Renewal Authority have defined how to develop the City over the coming years to support this growth.

Notably, there are multiple developments planned or under construction in the City, as described in section 3.3 of the business case. These include Section 63 and Section 100 around City Hill, the Acton Waterfront, the University of New South Wales Canberra City Campus, and other smaller mixed-use developments. This is complemented through expected growth at the Australian National University and in New Acton.

[1] https://www.transport.act.gov.au/__data/assets/pdf_file/0003/1412634/Stage-2A-Light-Rail-Business-Case-redacted.pdf
[2] *T Treasury, 'Projections of the resident population 2019', https://apps.treasury.act.gov.au/snapshot/demography/act, 2019*

Light rail is confirmed as a means to help activate and enable these developments by providing a form of mass transit to allow people to move in, out and around the City reliably, cheaply and effectively. The light rail is also expected to help support the future growth in visitor and tourist numbers.

Options and future development

As the basis of design was to build the light rail along the existing road network there were limited options to connect the City and Commonwealth Park. The key decision was taken to route the light rail via the western side of London Circuit, instead of Vernon Circle or the eastern side of London Circuit. This is because it offers the best means to access and support the area's future development. Another key decision was to route light rail down the middle of the to minimise impacts to the broader road network and provide for the most legible public transport system. This was one of the main reasons for including the new intersection between London Circuit and Commonwealth Avenue as part of the Proposed Action as described in the referral.

As one of the first developments in the area, the ACT Government has taken a view to make utility adjustments and carry out earthworks to an extent that it would support future developments by reducing the amount of disruption people would experience over the coming years. The Proposed Action's construction, clearance and disturbance footprints account for this approach, with the impact assessment adopting the ecologically sustainable development precautionary principle.

2.2 Original referral documentation

In late 2019, the ACT Government submitted a referral to DAWE that broadly described the Proposed Action. It contemplated the same route in section 2.3, the provision of two stops (City West and City South) and one terminus (Commonwealth Park). It described the need to build a new intersection between London Circuit and Commonwealth Park; termed as the "raising London Circuit" along with "other minor intersection changes". With respect to the stops and terminus:

- City West was a proposed side stop located on London Circuit between Gordon Street and Edinburgh Avenue.
- City South was a proposed island stop on Commonwealth Avenue just south of the new intersection.
- Commonwealth Park was an island stop on Commonwealth Avenue north of the Albert Street intersection.

A traction power substation was proposed adjacent to the Regatta Place carpark, in Commonwealth Park. This was to supply power to light rail. A new cable was to be installed between the substation and rail track, which was to be under bored.

The referral identified potentially significant impacts on the critically endangered Golden Sun Moth in the referral. The referral contemplated the loss of 6.9ha of GSM habitat as a result of the Proposed Action. The population impacted by the Proposed Action was considered "distinct and isolated from other populations" nearby in Canberra. As such, it was determined to be a significant impact, requiring assessment and approval under the EPBC Act.

The referral also recognised the Proposed Action's potential impact on Commonwealth Land values. These impacts included:

- Temporary and permanent amenity and landscape impacts along Commonwealth Avenue due to construction works, including the new intersection and bridge, and the introduction of new track and stop/ terminus infrastructure.
- Utility relocation works.
- Traffic management control that would be introduced along the route during construction.
- Impacts on the Reserve Bank of Australia and Parliament House Vista.

DAWE agreed with this position in setting its Preliminary Documentation requirements as outlined in Table 1.1.

2.2.1 Updates and clarifications

The following section describes how the Proposed Action's design and footprint have changed from description in the referral.

Updates

The Proposed Action was modified as follows:

- **Update 1**: City West stop was renamed Edinburgh Avenue stop.
- **Update 2**: there is no need to install a traction power substation or connecting power supply.
- **Update 3**: the footprint of the intersection between London Circuit and Commonwealth Avenue was refined to support a defined intersection arrangement.
- **Update 4**: a refined road layout arrangement was developed along the route to define clearer intersection arrangements.

Footprint

- Major Projects Canberra has continued to develop and refine the scope of the Proposed Action since the lodgement of the referral in late 2019. Taking into

consideration specialist engineering and construction advice, the scope of the Proposed Action footprint has been updated since that described in the referral. The updates to the footprint have not expanded to the impact profile of the Proposed Action, and no new matters of National Environmental Significance 9 relative to those canvassed in the referral) are impacted by the footprint update.

- Figure 2.1 shows the difference between the Proposed Action footprint shown in the referral and the Proposed Action footprint presented and assessed in the Preliminary Documentation. Chapter 5 describes the impact of the current Proposed Action footprint. An additional area now included in the footprint would involve works in areas associated with the City Renewal Authority (CRA) Section 63 project, a proposed action that is subject to a separate EPBC assessment process (2019/8449). Without prejudicing the outcome of that process, it is noted that the potential impacts from this project and associated mitigations and offsets discussed in Sections 5 and 7 would have the effect of extinguishing GSM habitat values within the Section 63 development site.
- Note: the green shading shows where the footprint has reduced, and the red shading shows where it has increased.

Corrections

The survey dates presented in the referral were incorrectly cited. They incorrectly cited report publication year over the survey year. Table 2.1 shows the corrections.

Table 2.1: Survey dates

Supporting report	Quoted date	Actual date
Biosis 2016 Golden Sun Moth Survey Report, Commonwealth Avenue ACT (EPBC Referral 2019/8449)	2016	2015
SMEC 2017 Commonwealth Avenue Golden Sun Moth Survey: prepared for Land Development Agency (EPBC Referral 2019/8449)	2017	2016
SMEC 2018 Vegetation, Habitat Assessment and Golden Sun Moth survey at City Hill (EPBC Referral 2019/8449)	2018	2017
Biosis 2019 Title: City to Commonwealth Park Preliminary Environmental Assessment: Biodiversity Draft Report	2019	2017

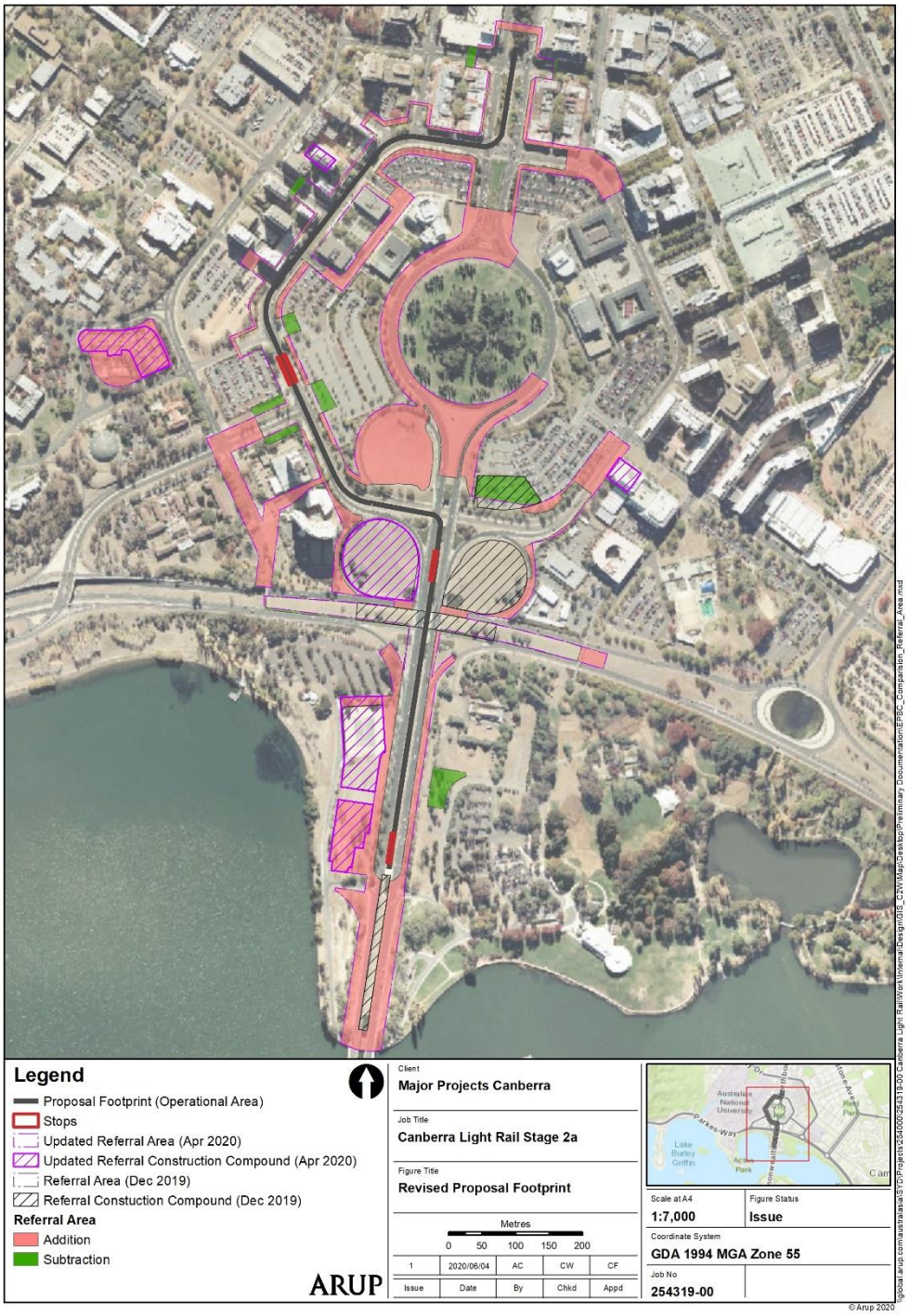

Figure 2.1: Proposal footprint comparison

2.3 Proposed Action

This section describes the Proposed Action.

Overview

The 1.7-kilometre Proposed Action would run between the existing City to Gungahlin light rail terminus at Alinga Street to a new terminus on Commonwealth Avenue opposite Commonwealth Park. It would include two other stops at Edinburgh Avenue and at the northern end of Commonwealth Avenue (City South). The light rail would run down the middle of Northbourne Avenue, the west side of London Circuit and Commonwealth Avenue. Additional work needed to support the light rail would include construction of a new intersection between London Circuit and Commonwealth Avenue and the creation of a new rail bridge over Parkes Way.

Key features

The Proposed Action's key features are described below. These features form part of the preliminary design and will be further developed during the detailed design.

- 1.7-kilometre light rail running from the City to Gungahlin light rail Alinga Street terminus down the middle of London Circuit and Commonwealth Avenue to Commonwealth Park.
- Two light rail stops at Edinburgh Avenue and City South and a terminus at Commonwealth Park.
- One scissor crossover to allow light rail vehicles to reverse direction.
- Wire-free running along the entire alignment to prevent the need to install overhead line equipment and to reduce the Proposed Action's visual impact; especially in areas of cultural value and amenity sensitivity.
- Utility adjustments, relocations and provisions.
- Landscaping features sympathetic with Canberra's design as envisioned by the Griffins' along with requirements set out in other Territory and Australian Government policy.
- 'Green tracks' running along Commonwealth Avenue that involve planting grass or shrubs between and besides the light rail track.
- Intersection layout, traffic signal phasing and road traffic speed changes along the route.
- Pedestrian footpaths and crossing modifications.
- Road widening and verge and kerb line changes.

Construction of the Proposal is expected to start in 2021, with works being carried out in stages and packages to minimise disruption to residents, business and existing transport operations in the local vicinity.

Several temporary construction compounds, stockpile sites and laydown areas would be needed near the Proposed Action footprint to help build the light rail (refer to section 2.3.1). Additional offsite locations would also be needed to help store equipment and machinery.

Stops and terminus

The stops and one terminus have been located at key points along the route where there is expected to be the highest demand. They would comprise the following.

- Edinburgh Avenue would be located on London Circuit between Gordon Street and Edinburgh Avenue. The light rail track would run between two side-platforms.
- City South would be located just south of the London Circuit and Commonwealth Avenue intersection. This stop would comprise an island stop, a single central platform between the rails.
- Commonwealth Park would be an island terminus located on Commonwealth Avenue north of the Albert Street intersection.

The stop and terminus environment have been designed to a common form and architecture where access would be provided via a walkway that would form a shallow ramp up to the stop platform. Customers would join and leave the end of each platform. This would minimise the width of each stop, which is particularly important along London Circuit given the limited space. Raised kerbs are likely to be used around each walkway and ramp to prevent people casually walking onto the tracks. A consistent set of signage would be provided at each stop and the terminus. This would be broadly located in the same place on each platform to help with wayfinding. Each stop and terminus would also include closed-circuit television, smart ticketing, passenger information displays, printed timetables, seating, rubbish bins, and bike racks.

Track

Two tracks would be installed down the middle of the route. One would operate northbound and the other southbound. A crossover would be installed on Commonwealth Avenue to allow light rail vehicles to change direction. The width between the two tracks would vary.

The rail corridor would be separated from the traffic lanes either by being raised or using physical measures such as kerbs, barriers, landscaping or visual markers at intersections. This would reduce the ability for people to cross the road and light rail track outside of designated crossing points (e.g. signalised intersections).

A new bridge would be built between the two road bridges on Commonwealth Avenue over Parkes Way. In appearance, the gap would be infilled to create a single surface. The new ‘infill’ rail bridge would be similar in form and design to

the current road bridges. It would be likely supported on two boxed concrete piers and concrete-walled abutments.

Light rail vehicle design

The new light rail vehicles would be similar in appearance, size and performance to those that operate on the City to Gungahlin light rail. They would carry at least 200 passengers, while providing mobility and bike access. To provide wire-free running, an onboard power supply would be included. This would be charged from the overhead wires on the City to Gungahlin light rail and supplemented through the use of regenerative breaking along the route.

The light rail vehicles would be stabled and maintained at the existing depot at Mitchell.

Operations

It would take about seven minutes to travel between Alinga Street and Commonwealth Park. Services would run between five and 15-minute intervals in both directions depending on the time of day and day of the week.

Ancillary works

Building the light rail down the middle of the route would require supporting ancillary works, mainly in the form of road works and utility adjustments.

Road works

The broad basis of design would restrict right turn movements across the middle of the road by making intersection changes. This means traffic would be prevented from making the following right turns:

- Northbourne Avenue at the Alinga Street intersection
- London Circuit at Hobart Place
- London Circuit at Knowles Place (north)
- London Circuit at Farrell Place
- London Circuit at Gordon Street

The other key changes would be:

- Signalising the intersection at London Circuit at West Row while including/maintaining pedestrian crossing points.
- Signalising the existing pedestrian crossing south of Knowles Place (north).
- Still permitting emergency (police) vehicles to cross the track with their lights on at Knowles Place (south).

- Creating a multi-lane signalised intersection between London Circuit and Commonwealth Avenue at the same level (grade), which would involve 'raising' the southern section of London Circuit.
- Retaining the ability for future right turn bays (filter lane) within the existing median of Commonwealth Avenue to make right turns, into Corkhill Street when travelling southbound and into Albert Street and Commonwealth Park when travelling northbound.

There would be limited changes at University Avenue and Edinburgh Avenue, with all turning movements maintained.

The new intersection between London Circuit and Commonwealth Avenue would see a change to how traffic currently moves through this part of the City. Notably, the footprint of the new intersection would require the eastbound entry ramp from Commonwealth Avenue to be removed (e.g. the southwest cloverleaf). The westbound exit ramp from Parkes Way (e.g. the southeast cloverleaf) would be unaffected. The other key feature of the intersection would be the need to build retaining walls around the intersection. These would be installed along the boundary of Capital Tower, between London Circuit and the southeast cloverleaf ramp, and between London Circuit and the northwest cloverleaf; partly into the land identified for the development of Section 63.

New road signs and signals would be installed, while footpath and cycle adjustments would be made along the route.

Utility adjustments

There are multiple and complex utilities that run along and cross the route. The principal aim is:

- To relocate any existing utilities running along the route from within the rail corridor into the kerb. This would help with future access and maintenance.
- Increase the burial depth or reinforce utilities that cross the route.

New utilities would be installed to support the Proposed Action. This would include a series of conduits and pits for electrical cables and telecommunications and new/upgraded stormwater drains that would connect into the existing regional trunk network that discharges to Lake Burley Griffin.

2.3.1 Construction

It would take about four years to construct the Proposed Action. Broadly, it would involve multiple work stages that could take place at different times in different locations along the route. The exact timing of each stage and work activity in a given location would depend on final the final design, contractor specifications and requirements, consultation feedback, and any restrictions and constraints set

by the ACT and Australian Governments. Construction would be staged and will involve five key phases of work, as detailed in the following sections.

Phase 1: Early works

Early works would involve:

- Site investigations and setting out routes, accesses, and no-go zones.
- Establishment of a compound within the northern section of the carpark at Acton.
- Carrying out utility adjustment, relocation, protection and installation works.

The footprint required for completion of the early works can be seen in Figure 2.2. This phase of works is anticipated to be for nine months in duration. There would be no impacts on Golden Sun Moth habitat during this stage of works as all works within proximity to existing habitat will be limited to the existing road curb.

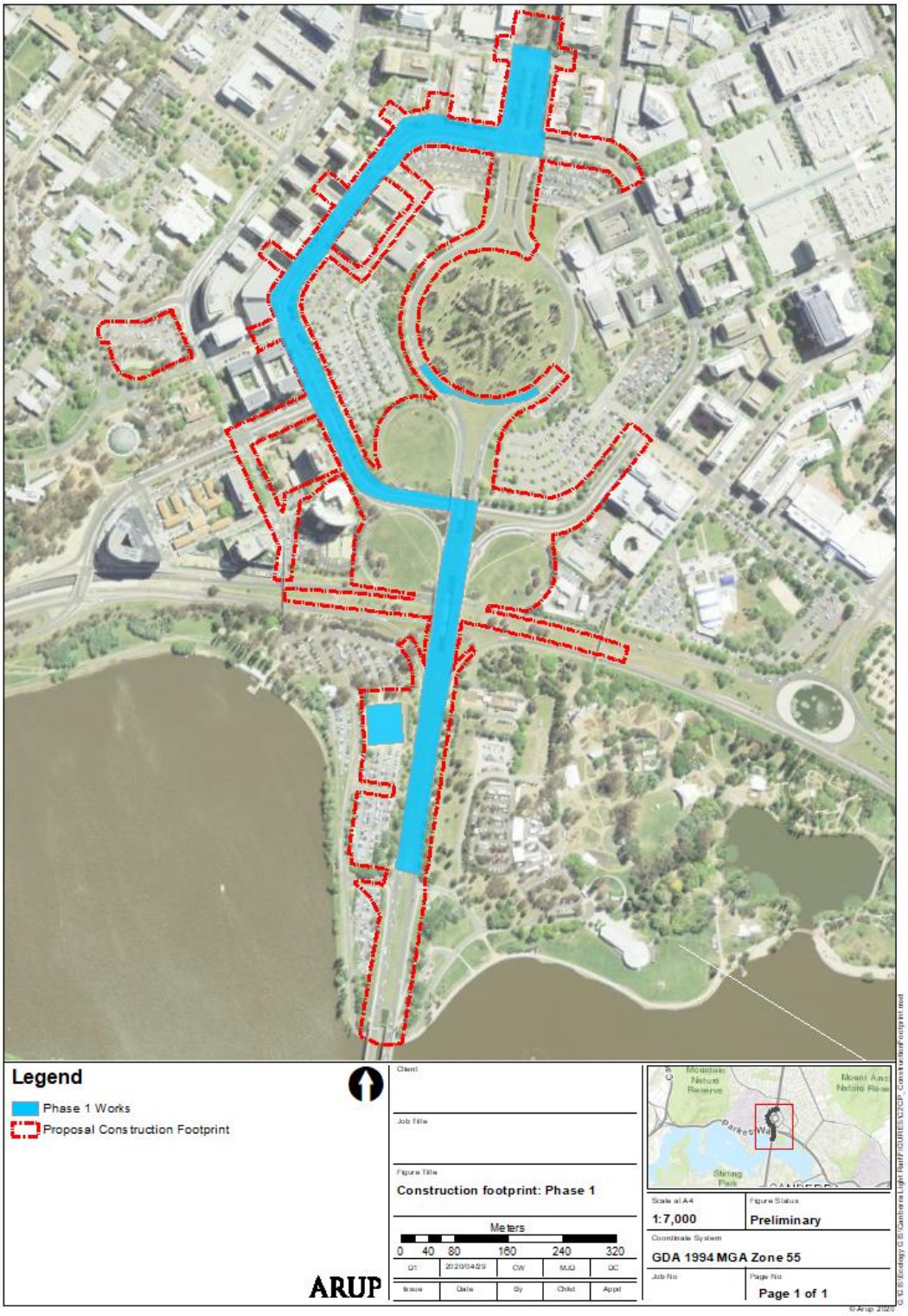

Figure 2.2 Construction footprint for Phase 1

Phase 2: Main Civil works – Raising of London Circuit and associated works

The raising of London Circuit will provide an at-grade signalised intersection at the junction of London Circuit and Commonwealth Avenue. This requires undertaking civil works to remove existing roadway infrastructure prior to filling above London Circuit to achieve design levels approximately in line with Commonwealth Ave existing levels. Removal of the two existing concrete bridges the cross London Circuit will also be required, with traffic moved to a contraflow during the staged removal of each bridge.

The northwest cloverleaf would be entirely cleared during the initial phases of the civil earthwork associated with the raising of the Commonwealth Avenue and London Circuit intersection. This area would be subject to direct permanent impacts from the new intersection, in addition to temporary impacts associated with the use of the area as a construction compound and construction materials storage area for the duration of the project.

A laydown area at Acton would also be required for raising London Circuit with the area continued to be utilised for this purpose for the remainder of the proposed activity.

The clearance works for Raising London Circuit would result in the direct loss of approximately 1.46 ha of Golden Sun Moth Habitat in the north west cloverleaf and the Commonwealth Avenue median south of Vernon Circle. Approximately 2.01 ha of marginal habitat at Vernon Circle will also become isolated from other parts of the population, with works resulting in a distance of more than 200 m to other habitats to the south.

The Staging area required for this component of the works can be seen in Figure 2.3. The area required for construction of this phase finishes north of the Commonwealth Avenue Bridge over Parkes Way. The area shown to the south will be used as a staging area to allow the traffic to return from contraflow over the median of Commonwealth Avenue to the south of the bridge. No works are proposed within the Parkes Way median. This stage of works is anticipated to be approximately 24 months in duration.

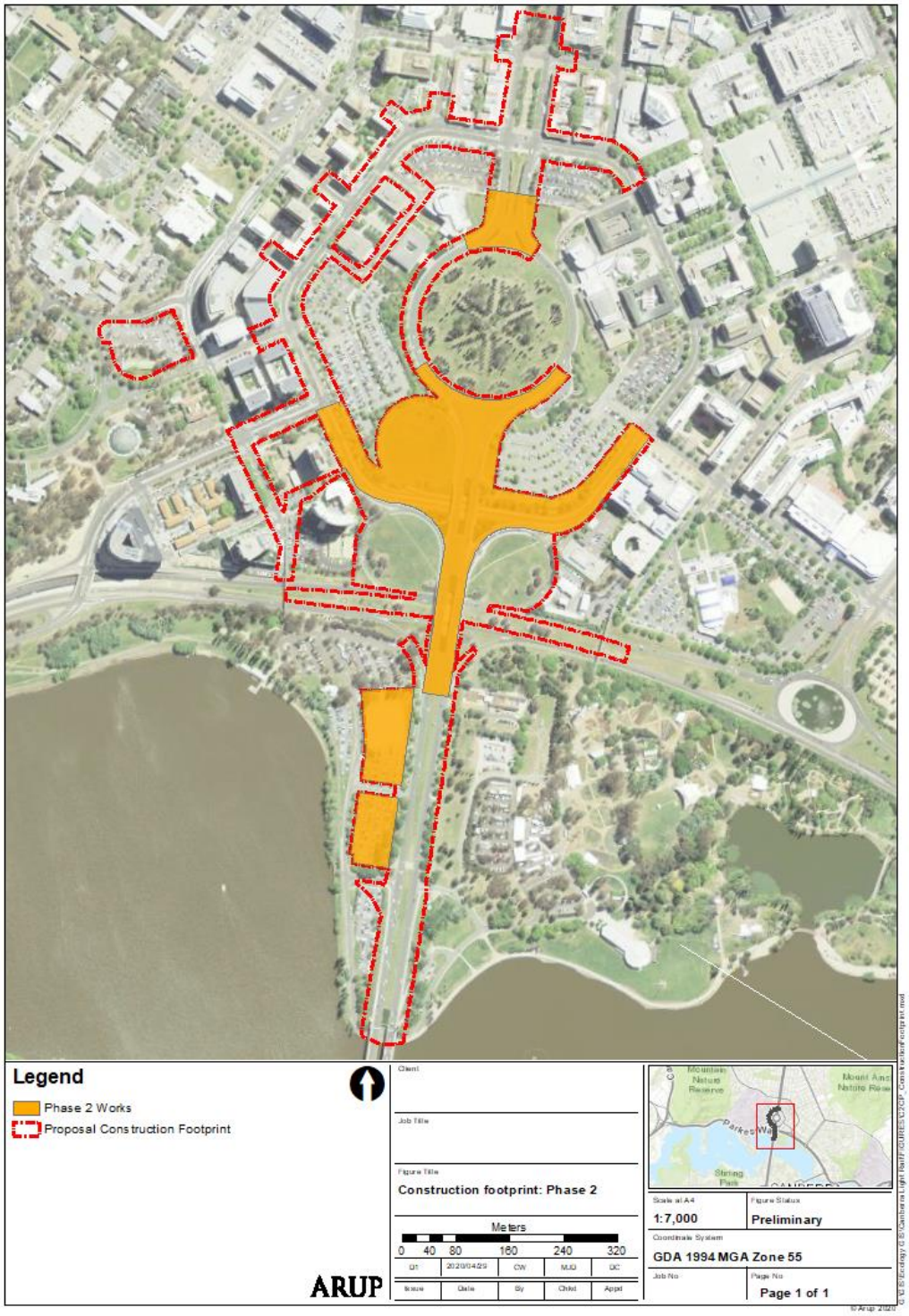

Figure 2.3 Construction footprint for Phase 2

Phase 3: Main Light Rail construction works

This phase would include three key works packages: stop and terminus construction, track works, and road works. All works packages would involve common activities including earthworks and excavations, the use of heavy equipment and machinery, the movement of materials and waste, and general surface and foundational works. The Staging area required for this component of the works can be seen in Figure 2.3.

This phase of works would result in a direct loss of an additional 3.3 ha of Golden Sun Moth Habitat. All remaining habitats for Golden Sun Moth would also become fragmented and isolated during this phase of works.

At the completion of the main construction works the site, compounds, laydown areas, and stockpile sites would be cleaned-up and made good. These areas would be resinated to a pre-construction conditions where required. Inspection audits would be carried out to ensure this process is effective. Restoration of areas of Golden Sun Moth habitat would occur as soon as possible after there is confidence that additional construction activities will not be required.

This stage of works is anticipated to be approximately 24 months in duration.

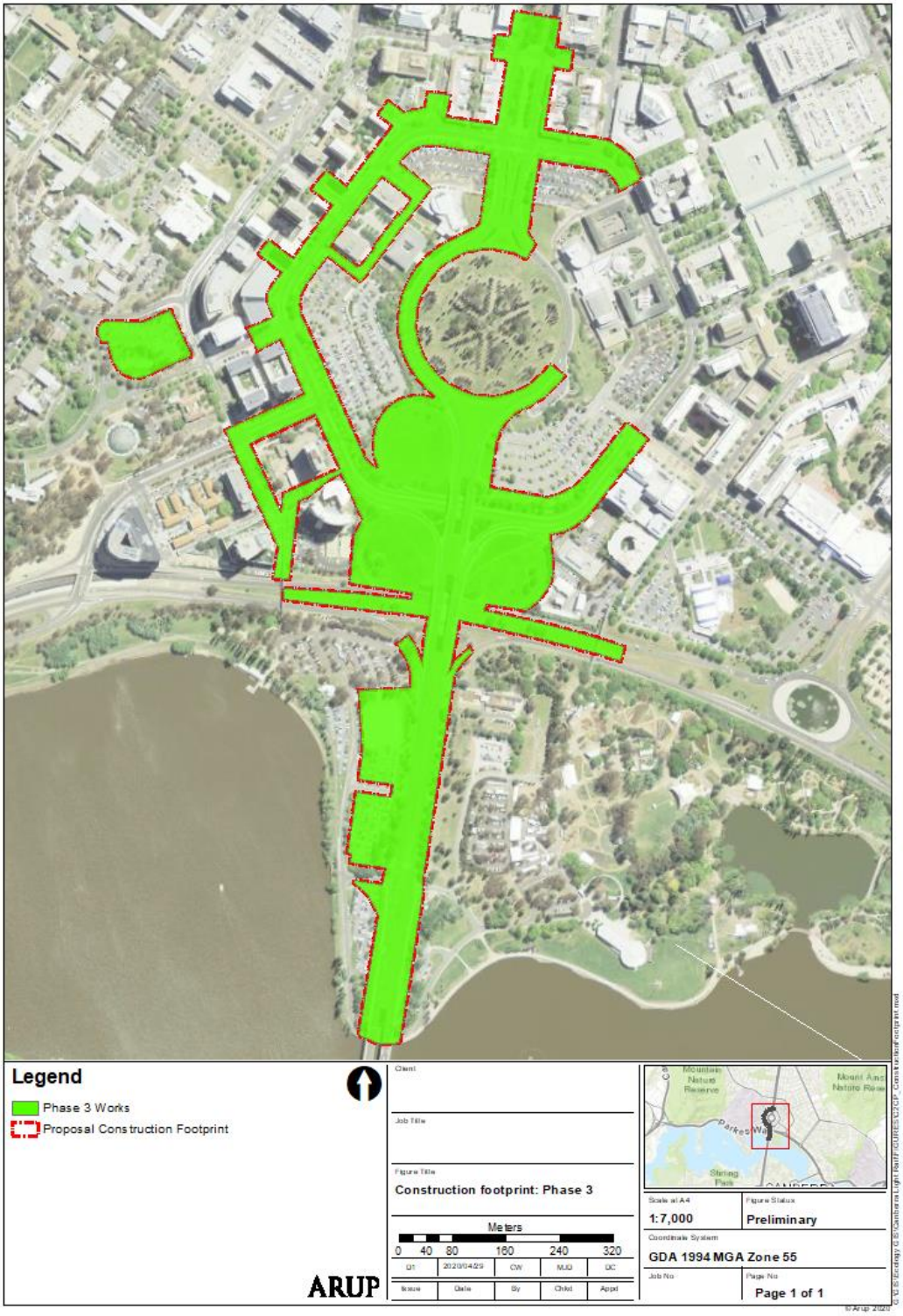

Figure 2.4 Construction footprint for Phase 3

Phase 4: Testing and commissioning

This phase would involve running trials of the light rail vehicles to test the rails, stops, equipment, and service reliability. Post-works management and monitoring of habitat restoration works would also occur.

Phase 5: Handback

An audit inspection would be carried out to address any defects after which the light rail and road would be handed over to the appointed operational and maintenance contractor.

Work program

Construction would be largely carried out Monday to Friday: 7am to 6pm and Saturday: 8am to 6pm. Night and weekend works are also proposed to avoid major disruption to the City and its residents. Standard practices would be used to manage noise impacts such as: limiting certain activities at night and notifying the community before starting work.

Materials requirements

A range of common materials would be used to build the Proposed Action that are available in the local market. They include:

- Topsoil and subsoil, mulch, general and select fill.
- Stone, aggregates and quarried materials.
- Cement, bitumen, asphalt, sand, and binding and spray seals.

Given the limited space in the City, the aim would be to deliver materials to site when they are needed. Waste and spoil would also be removed from site ideally when it is generated and excavated unless it is going to be reused.

Ancillary facilities

As noted in section 2.3, a series of compounds, laydown areas and stockpile sites would be needed near the route to help support construction. These ancillary facilities may be used in full or part at various times to store and stockpile materials, equipment, spoil and waste. They would also be used to house site offices and worker amenities. All facilities would be fenced and gated.

Traffic management and controls

Traffic controls would be implemented at various points depending on location and staging. The final controls would be developed during detailed design and implemented under a construction traffic management plan. The aim would be to allow key roads to remain open to traffic, pedestrians and cyclists during construction. Work would be scheduled to minimise traffic impacts; including weekend and night work where required. Several bus services would be impacted by construction and bus stops may require relocation. Relocation of these services would be undertaken in consultation with the public and relevant Government agencies. Footpaths and cycleways would require closures intermittently throughout. Again, the need for closures would be minimised as much as possible through detailed design. Emergency vehicle access and egress would be maintained throughout construction and operation. Special provisions would also be made to limit traffic impacts during key events in the City.

3 Golden Sun Moth Survey Methodology

3.1 Preliminary documentation requirements

Occurrence of the above species (Golden Sun Moth) at the site of the proposed action should be informed by relevant experts following relevant survey standards. Survey methodology must be described, and results appended to the preliminary documentation.

3.2 Proponent response

Targeted Golden Sun Moth surveys were carried out by suitably qualified ecological specialists as documented in section 1.3. The survey methods were in line with the Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*, DEWHA, 2009). Generally, this included:

- A review of publicly available spatial data and documents including relevant historical survey data.
- Targeted surveys completed for a broad study area on suitable weather days during the flying season.
- Mapping and assessment of confirmed habitats to record and classify dominant features.

Further details regarding study methods are provided in the section 3.3.

3.3 Summary of methods

This section summarises the study methods, including the approach implemented to assess Golden Sun Moth occurrence and the Proposed Action's potential impacts.

3.3.1 Data gathering

The review of publicly available data and documents was used to confirm relevant threatened species and communities in the local area and to identify available existing Golden Sun Moth data. The following data were reviewed:

Previous reports

- Golden Sun Moth Survey Report, Commonwealth Avenue ACT (EPBC Referral 2019/8449, Biosis 2016).
- Commonwealth Avenue Golden Sun Moth Survey: prepared for Land Development Agency (EPBC Referral 2019/8449, SMEC 2017).
- City to Woden Light Rail: Ecological Constraints Assessment (Biosis 2017).

- Vegetation, Habitat Assessment and Golden Sun Moth survey at City Hill (EPBC Referral 2019/8449, SMEC 2018).
- City to Commonwealth Park Preliminary Environmental Assessment: Biodiversity Draft Report (Biosis, 2019).

Accessed 15 November 2019

- Protected Matters Search Tool (PMST) for a 3km radius to the site (Australian Government, 2019).

Accessed 13 January 2020

- ACT wildlife Atlas (ACT Government, 2020).
- Atlas of Living Australia (Atlas of Living Australia, 2020).

Accessed 17 January 2020

- Threatened fauna habitat mapping (ACT Government, 2020).
- Vegetation communities mapping (ACT Government, 2020).
- Grasslands mapping (ACT Government, 2020)
- Threatened woodland mapping (ACT Government, 2020).

3.3.2 Previous studies

Biosis carried out initial field surveys over the local area from 7 December 2017 to 16 January 2018 (Biosis, 2019) to help define preliminary options for the Proposed Action. The survey was completed by five ecologists over 24 days comprising the following activities:

- Vegetation plots and step point transects to classify and map vegetation communities and condition.
- Targeted surveys for the following threatened flora and fauna species with a moderate to high likelihood of occurrence locally:
    - Button Wrinklewort *Rutidosis leptorrhynchoides*
    - Canberra Spider Orchid *Caladenia actensis*
    - Hoary Sunray *Leucochrysum albicans var.tricolor*
    - Snake Orchid *Diuris lanceolata*
    - Ginninderra Pepper-cress *Lepidium ginninderrense*
    - Golden Sun Moth Synemon plana

During the initial field surveys, Biosis carried out a targeted Golden Sun Moth survey in line with the Significant Impact Guidelines (DEWHA, 2009). The survey was limited to 50m either side of the operational footprint. This survey was carried out by two ecologists over six days of suitable weather from 7 December 2017 to 22 December 2017 (Biosis, 2019). Surveys were also completed from 8

January 2018 to 9 January 2018 to confirm the extent and condition of habitats where Golden Sun Moth were recorded.

A more detailed description of field survey methods implemented by Biosis during the preliminary environmental assessment phase is provided in *City to Commonwealth Park Preliminary Environmental Assessment: Biodiversity Draft Report* (Biosis, 2019) (Appendix A).

Additional investigation requirements

Additional investigations were required to address the following gaps associated with previous studies:

- Providing contemporary data relating to Golden Sun Moth occurrence and habitat extent and condition.
- Confirming the full extent of Golden Sun Moth habitat relevant to the proposed action footprint through survey of a broader study area.
- Collecting all necessary data to support an offsets proposal under the EPBC Act, where required.

3.3.3 Additional investigations

Arup completed further additional investigations over four days from 30 October 2019 to 17 January 2020. The surveys were undertaken across the 45.12ha study area shown in Figure 3.1. This covered land within and adjacent to the proposed action footprint and included approximately 9.68ha of Commonwealth Land. Key components of the survey are described in the following sections.

Golden Sun Moth surveys

Targeted surveys for Golden Sun Moth were carried out for the study area in line with the survey guidelines provided in the *Significant impact guidelines for the critically endangered Golden Sun Moth* (*Synemon plana*) (DEWHA, 2009a). Surveys were completed on days of suitable weather during the local flight period of the moth, as determined by species activity within local reference sites. Good weather conditions for Golden Sun Moth emergence are generally between 10am and 2pm in warm sunny weather with little wind, and more than two days since significant rainfall or an unusually cold night.

Each survey event was carried out by two ecologists and involved meandering transects through potential Golden Sun Moth habitat to search for flying males, females and pupal cases. The initial focus of the surveys was to confirm species presence within potential habitats. Once presence was confirmed, the focus of the surveys shifted to defining habitat extent. A total count of all individuals observed during the surveys was recorded for each habitat polygon with the location of sightings recorded using a hand-held GPS.

Habitat assessment

A general traverse of Golden Sun Moth habitat was initially carried out to note dominant vegetation communities and conditions for Golden Sun Moth, including dominant larval food plants. Habitats were mapped using ESRI ArcGIS and the interpretation of field notes, existing spatial datasets and aerial photography. Habitats were then classified and stratified to obtain generally homogeneous habitat patches for further assessment. Assessment of stratified habitats was then carried out using step-point transects, as shown in Figure 3.1.

Transects were 100 m long where the size and shape of the area permitted and where there was a sufficient area of habitat of similar condition. For smaller or dissected habitat areas, 50 m transects were used. A metal tape was laid out in the habitat and the endpoints of the transect were recorded. Reference photographs were taken of each transect from the start point.

A single dominant habitat feature was recorded at each metre for the 100 m transects or each 50 cm mark for the 50 m transects along the tape with a total of 100 observations made per transect. Dominant habitat features recorded were categorised as either plant, cryptogam, bare ground, rock or dead plants/ litter. Where plants where encountered, these were classified as native, exotic, annual, perennial and/ or larval food plant for Golden Sun Moth and identified to genus, or species level where possible. Other relevant site features were noted during the survey including soil type, grazing type and pressure, tussock height, site damage, pupal case locations, presence of trees and shrubs. Other native or invasive exotic species that were observed within 50 cm of the tape were also recorded.

The following criteria for classifying Golden Sun Moth habitat was used in this survey. This approach was developed to be generally consistent the ACT Government's approach to monitoring Golden Sun Moth offsets within the ACT. Four condition classes were defined based on vegetation community, weed cover and habitat characteristics for Golden Sun Moth (Table 3.1)

Table 3.1: Adopted Golden Sun Moth habitat quality classes and criteria

Habitat quality	Criteria
Very high quality habitat	Primary Natural Temperate Grassland or native pasture dominated by native larval food plants (i.e. *Rytidosperma sp.*/ *Austrostipa sp.*) with low weed cover and some bare ground.
High quality habitat	Native-dominated grassland with a high component of *Rytidosperma sp./Austrostipa sp*. but less than very-high quality habitat because of one or more of the following conditions: • On a steep slope or hill top • On a south or east-facing slope • Soil very shallow and/or stony, rock outcrops present • Secondary grassland or contains scattered trees.
Moderate quality habitat	Primary or secondary grassland, with a moderate component of *Rytidosperma sp/ Austrostipa sp*., and moderate weed cover.
Low quality habitat	Larval food plants (*Rytidosperma sp. Austrostipa sp.*/Chilean Needle Grass) are a minor component of the ground layer, growing sparsely or in patches among unsuitable vegetation. **OR** Chilean Needle Grass dominated habitat.

Figure 3.1: Study area and survey locations

4 Golden Sun Moth Occurrence

4.1 Preliminary documentation requirements

Under this controlling provision, any listed threatened species or community is potentially relevant to the assessment. However, based on the information provided in your referral, and other available information, the Department is particularly interested in:

- *Golden Sun Moth (Synemon plana)- Critically endangered.*

Further evidence (e.g. field surveys) and / or a more detailed argument is required to satisfy the Department of claims and conclusions made in your referral documentation in relation to Golden Sun Moth and / or explain how impacts on them will be addressed. Details of information required include:

- *Additional justification (including reference to the approved conservation advice for the Golden Sun Moth) for your assessment that the proposed action area includes 2.6 ha of GSM habitat (based on 2019 survey data) (reduced from 6.9 ha based on 2017 survey data).*

While all relevant species must be addressed, the Department understands that it is appropriate to address different matters at different levels of detail and that some matters can best be addressed in thematic groups.

The following matters should be considered for the Golden Sun Moth:

- *Its occurrence at the site of the proposed action. Consideration must be given to occupancy trends relating to season and time of day. Longer term trends including climate change may also be relevant. In relation to habitat for listed threatened species, the type of habitat (e.g. foraging, breeding, dispersal etc.) must also be considered.*

4.2 Proponent response

The desktop and field investigations (refer to Chapter 3 of this document) confirmed the threatened species and communities relevant to this assessment were limited to the Golden Sun Moth; listed as critically endangered under the EPBC Act.

The proposed action referral discussed project impacts in the context of historical available for the study area, and adopted a potential impact extent of 6.9ha of Golden Sun Moth habitat. Additional investigations were completed in 2019 subsequent to the submission of the proposed action referral. These additional investigations identified approximately 8.09ha of Golden Sun Moth habitat within the study area that may be directly or indirectly impacted by the Proposed Action. The additional investigations considered a broader study area in comparison to

historical surveys carried out by SMEC (2017) and Biosis (2019) during the 2016 and 2017 flying seasons for the moth (refer to Table 4.1).

The results of the additional investigations confirm mapped habitats are likely to represent the full extent of the Golden Sun Moth population locally The possible exception is for sparse/sporadic habitat to extend farther east along Parkes Way connecting with the known Golden Sun Moth population at Reid (St John's Church). However, if this habitat can support Golden Sun Moth, it would be geographically disconnected from the population according to DEWHA (2009).

Although a change in habitat extent and condition has occurred over time (refer to Table 4.1), this was due to the different survey efforts carried out over the years. No reduction or increase in the extent of Golden Sun Moth habitat within the study area can be confirmed by reviewing the available data. However, it is possible that Golden Sun Moth numbers within the study area have declined because of larval food plant dieback following three consecutive years of below average annual rainfall (refer to Table 4.1, pers. comm. A. Rowell, 2020). Although drought impacts on Golden Sun Moth reproductive success are not well understood (ACT Government 2017), it is likely that habitat condition was impacted due to the persistent dry conditions; particularly within sites that were not actively managed (pers. comm. A. Rowell, 2020). Similarly, soil disturbance associated with European Rabbit burrows is known to pose a threat to the species and may have led to some decline in Golden Sun Moth numbers within the northwest cloverleaf (DAWE, 2020).

4.3 Summary of occurrence

This Section summarises the Golden Sun Moth occurrence within the study area.

4.3.1 Analysis of existing data

Confirmed Golden Sun Moth habitat is located within the middle of Parkes Way and the three cloverleaves that form the on and off-ramps between Commonwealth Avenue, Parkes Way and London Circuit (ACTmapi, accessed 17 January 2020)(Figure 4.1).

Historical Golden Sun Moth data was available from the four surveys targeting Golden Sun Moth completed within various parts of the study area between 2015 to 2017 (refer to Table 4.1). This data indicated that Golden Sun Moth habitat was generally limited to the road medians and verges, which was dominated by exotic Chilean Needle Grass *Nassella neesiana* (Biosis, 2016; SMEC, 2017; SMEC, 2018; Biosis, 2019). Chilean Needle Grass is a Weed of National Significance (WONS) and a declared pest plant in the ACT (ACT Government, 2017). Chilean Needle Grass habitats are generally considered low quality for Golden Sun Moth (refer to Table 3.1).

Golden Sun Moth habitat mapping available from all available desktop sources, including historical surveys completed for the study area, is provided in Figure 4.1.

Table 4.1: Targeted Golden Sun Moth survey results comparison

Surveyor	Period	Survey extent	Effort (days)	Estimated habitat Area (ha)	GSM Count	Annual rainfall (mm)*^
2019						
Arup	Oct 2019 to Jan 2020	All lands within the study area	3	8.09	24	351.8
2018						
No survey for this year						432.8
2017-2018						
Biosis	Dec 2017 to Jan 2018	Two southern cloverleaves and Parkes Way only.	6	3.10	52	453.7
2017						
SMEC	Nov to Dec 2017	City Hill and surrounding road verges	4	2.08	13	453.7
2016						
SMEC	Nov to Dec 2016	The study area including lands east of Vernon Circle.	4	6.43**	276	743.7
2015						
Biosis	Nov to Dec 2015	Two western cloverleaves.	4	2.12	40	657.1

* Rainfall data for the Canberra Parliament House weather station (70246, BOM 2020)
^ Average annual rainfall for the Canberra region is approximately 629 mm.
** A much larger area was surveyed by SMEC this season and is likely to account for observed variation.

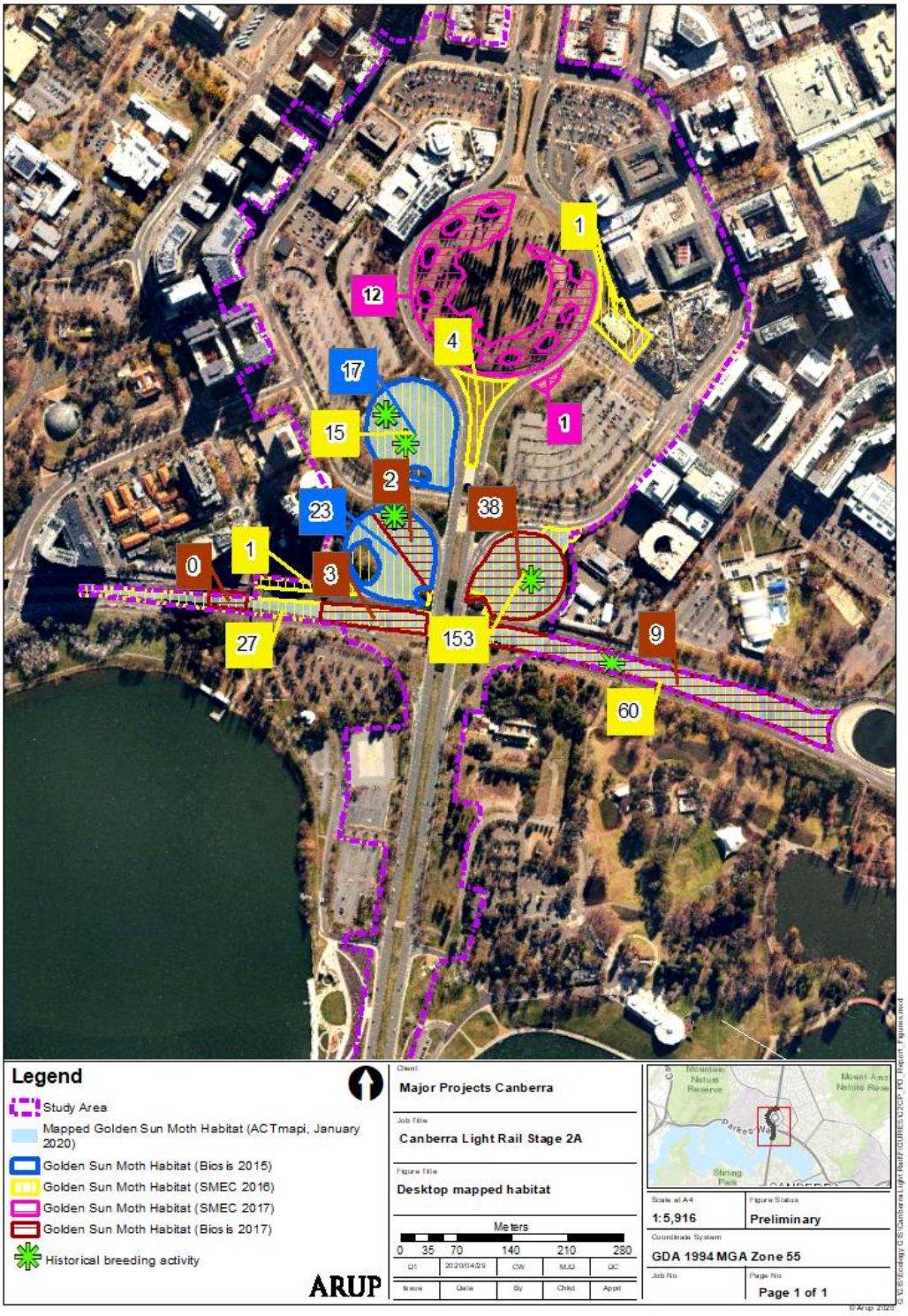

Figure 4.1: Desktop mapped habitat

4.3.2 Additional investigation survey results

This section documents the results of the Arup 2019 targeted surveys, as shown in Table 4.2. The assessment of Golden Sun Moth habitats was also carried out during one day following the flying season (14 January 2020).

Table 4.2: 2019 targeted Golden Sun Moth surveys

Date	Survey time	Temperature (°C)	Wind	Cloud cover	GSM activity local reference sites
30 Oct 2019	11:05-13:10	23-27	None to light	50-80% high thin	Yarralumla, Sutton, Queanbeyan (NSW)
18 Nov 2019	11:00-15:00	19-24	Light	0%	Yarralumla, Mulligans Flat site (NSW)
28 Nov 2019	11:30-16:45	26-30	Light	0%	Commonwealth Park to Woden

Golden Sun Moth habitat within the study area

Approximately 8.09ha of Golden Sun Moth habitat was confirmed in the study area (refer to Table 4.1). Approximately 2.19ha of this habitat is situated within Commonwealth lands (refer to Figure 4.2). Habitats comprised maintained grassland dominated by Chilean Needle Grass offering low value for the species, according to the criteria presented in Table 3.1. Rare (about three percent) Wallaby Grasses *Rytidosperma spp*. were also noted in study areas. These were generally in areas too small to map as discrete patches.

Conditions were dry and there was extensive bare ground; likely due to tussock death associated with drought. Some disturbance of soils due to European rabbit and machinery was also noted. Golden Sun Moth habitat was mapped for all areas where suitable larval food plants were present (refer to Figure 4.2). Marginal habitat (i.e. less than two percent Chilean Needle Grass) was noted within the western-most sections of the Parkes Way median, Vernon Circle and the Commonwealth Avenue median to the south. These areas are unlikely to support breeding activity. However, all other habitat areas were generally considered suitable for breeding (Figure 4.2)

A review of existing data for Golden Sun Moth (refer to section 4.3.1) indicates historically mapped habitats are generally consistent with field survey results.

Vegetation community floristic data is presented in Appendix B.

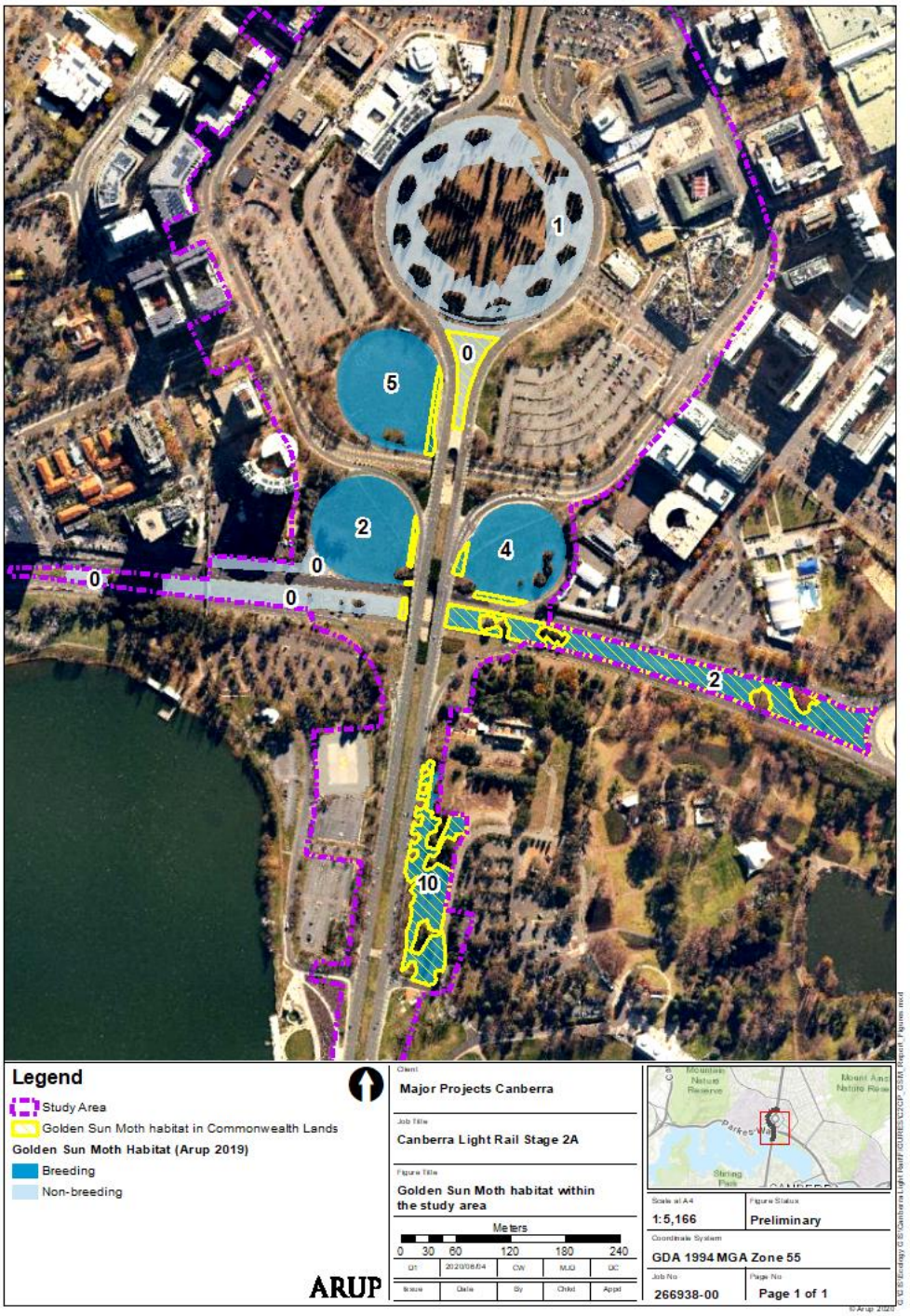

Figure 4.2: Golden Sun Moth habitat within the study area

Golden Sun Moth activity within the survey area

Targeted surveys identified a total of 24 moths in the study area. This indicates generally low moth numbers (according to Hogg, 2010) despite good activity being recorded at local reference sites (refer to Table 4.1). A total of 10 moths were recorded in the eastern verge of Commonwealth Avenue adjacent to Regatta Place, indicating moderate activity levels for this patch (refer to Figure 4.2). No females or pupal cases were recorded in the study area.

Analysis of survey results, in the context of existing data (refer to Table 4.1), indicated Golden Sun Moth numbers recorded in the 2017 and 2019 flying seasons were generally low in comparison to previous results (refer to SMEC, 2017).

This may be the result of seasonal variation in adult emergence; with heavy fluctuation between seasons not uncommon (Richter, *et al.*, 2009; New, 2012; Hogg, 2010). It is also possible that Golden Sun Moth numbers have declined due to the larval food plant dieback following below average annual rainfall. Similarly, soil disturbance associated with European Rabbit burrows is known to pose a threat to the species and may have led to some decline in Golden Sun Moth numbers within the northwest cloverleaf (DAWE, 2020).

Populations and habitat connectivity

Habitats within the study area are largely confined to small patches situated within roadside medians and verges. These patches are subject to considerable fragmentation due to the roads and structures such as bridge abutments and piers, retaining walls, buildings and dense landscape plantings.

According to DEWHA (2009), Golden Sun Moth habitats separated by more than 200m or divided by solid barriers higher than 1m, are effectively isolated and are to be considered separate populations. Desktop analysis indicates the distance between habitat patches within the study area varies from about four to 150 metres. Despite there being some structural barriers, movement between habitat patches is likely to occur to some degree. As such, one Golden Sun Moth population was identified for the study area.

Survey results indicate mapped habitats are likely to represent the full extent of the population, with any habitat farther east on Parkes Way geographically disconnected from the population according to DEWHA (2009).

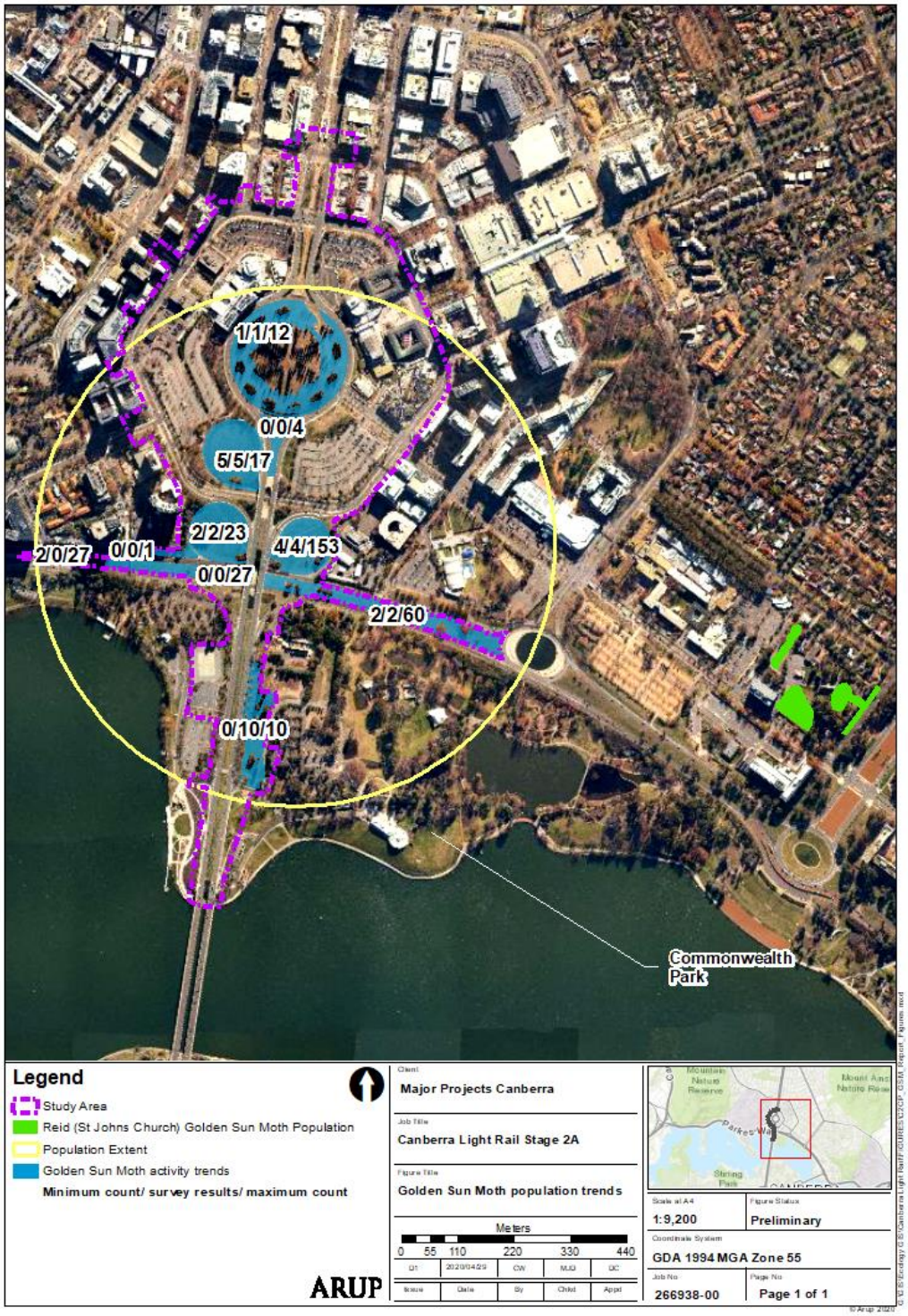

Figure 4.3: Golden Sun Moth population trends

5 Potential Impacts to Golden Sun Moth

5.1 Preliminary documentation requirements

Further evidence (e.g. field surveys) and / or a more detailed argument is required to satisfy the Department of claims and conclusions made in your referral documentation in relation to Golden Sun Moth and / or explain how impacts on them will be addressed. Details of information required include:

- *An assessment of direct and indirect impacts as a result of the proposed action.*

The following matters should be considered for the Golden Sun Moth:

- *Its potential to be impacted by the proposed action.*

Direct and indirect impacts of the proposed action must be considered, in relation to the specific needs and characteristics of Golden Sun Moth. The Department has identified the following types of impacts as being particularly relevant to your proposed action:

Table 5.1: expected impacts

Expected impacts of the proposed action
Clearing (direct impact) associated with development of project related infrastructure
Edge effects (indirect impacts) on retained listed threatened communities or species habitat arising from adjacent activities, including but not necessarily limited to noise and light disturbance, roadkill, trampling, littering, weed invasion, predation by pets, altered fire regime and altered hydrology (in terms of quality and quantity)

Consideration must also be given to cumulative impacts of the proposed action when considered in conjunction with concurrent and expected future developments. Note that cumulative impacts may include interactive and / or compounding impacts as well as additive impacts.

5.2 Proponent response

Potential direct and indirect impacts to Golden Sun Moth within the study area are summarised in Table 5.2. These have been informed by the *Approved conservation advice for Synemon plan (golden sun moth)*(DoE, 2013), where relevant.

Land clearing activities would directly impact the Golden Sun Moth through habitat loss and species mortality. Indirect impacts may occur as a result of construction and light rail operation. These include habitat degradation, fragmentation, isolation and edge effects.

Table 5.2: Summary of impacts to Golden Sun Moth

Impact	Nature	Extent	Duration
Habitat loss	Direct	Direct removal of **3.33ha** of Golden Sun Moth habitat.	Permanent loss
		Direct removal of **1.43ha** of Golden Sun Moth habitat	Short-term subject to proposed restoration
Habitat degradation	Indirect	Indirect impacts to remaining Golden Sun Moth habitat at the interface with the construction area.	Short-term disturbance associated with construction
Habitat fragmentation isolation and edge effects	Indirect	Indirect impacts associated with the fragmentation and isolation of **2.07ha** of remaining Golden Sun Moth habitat.	Permanent loss
		Indirect impacts associated with the fragmentation and isolation of **1.26ha** of remaining Golden Sun Moth habitat.	Short -term loss, subject to proposed restoration
Species mortality	Direct	Direct impact to all individuals within the **4.76ha** clearing footprint	Permanent loss

5.3 Summary of proposed action impacts

The following section summaries potential direct and indirect impacts to Golden Sun Moth as a result of the Proposed Action.

5.3.1 Direct impacts

Direct impacts are generally associated with land clearing during construction and include habitat loss and species mortality.

Habitat loss

Approximately 4.76ha of low quality Golden Sun Moth habitat would be directly impacted as a result of proposed clearing (refer to Figure 5.1). Approximately 3.33ha of cleared habitat would be permanently lost within and adjacent to the operational footprint, including the carriageway, stop/terminus facilities and road infrastructure. Another 1.43ha of cleared habitat would be restored post-construction by means of proposed habitat restoration works. Restored habitats are likely to be recolonised by Golden Sun Moth where connectivity to adjacent remaining habitats is retained. As such, the impacts associated with habitat loss within lands proposed for restoration are considered temporary and reversible.

Species mortality

Golden Sun Moth larvae within the clearing footprint would be directly impacted during construction. However, there are currently no rigorous non-invasive methods for determining the exact number of larvae that would be impacted, as standing populations are poorly represented by seasonal adult emergence (ACT Government, 2017).

It is also likely that adult moths would be impacted during construction through collision with vehicles and construction equipment and potential trampling underfoot during the flying season. However, these impacts would be minimised through the erection of signage or construction fencing which would be designed to preclude unauthorised vehicle or pedestrian access. As this fencing will be required to have hoarding to comply with safety standards there is the potential that this could act as a barrier for GSM movement. Some increased mortality may also occur within the road reserve as a part of proposed operations. However, these impacts are considered negligible.

5.3.2 Indirect impacts

The following indirect impacts may occur during construction and:

- Habitat degradation
- Habitat fragmentation, isolation and edge effects.

Habitat degradation

Approximately 3.33ha of remaining Golden Sun Moth habitat adjacent the construction footprint will likely to subject to disturbance (refer to Figure 5.1). This may occur because of dust, stormwater diversion and soil compaction due to increased foot traffic. Any changes in slashing/ mowing regimes for remaining grassland patches during construction would also impact grassland suitability for Golden Sun Moth. These impacts would be temporary and are unlikely to result in an ongoing disturbance to the habitat beyond construction.

It is also possible that construction activities could facilitate the spread of exotic African Lovegrass throughout the study area. This has the potential to outcompete Chilean Needle Grass in dry nutrient-poor environments. This could impact the suitability of remaining habitats for Golden Sun Moth and could lead to displacement of the species if it is not appropriately managed (Sharp, 2011; pers. comm. A. Rowell, 2020).

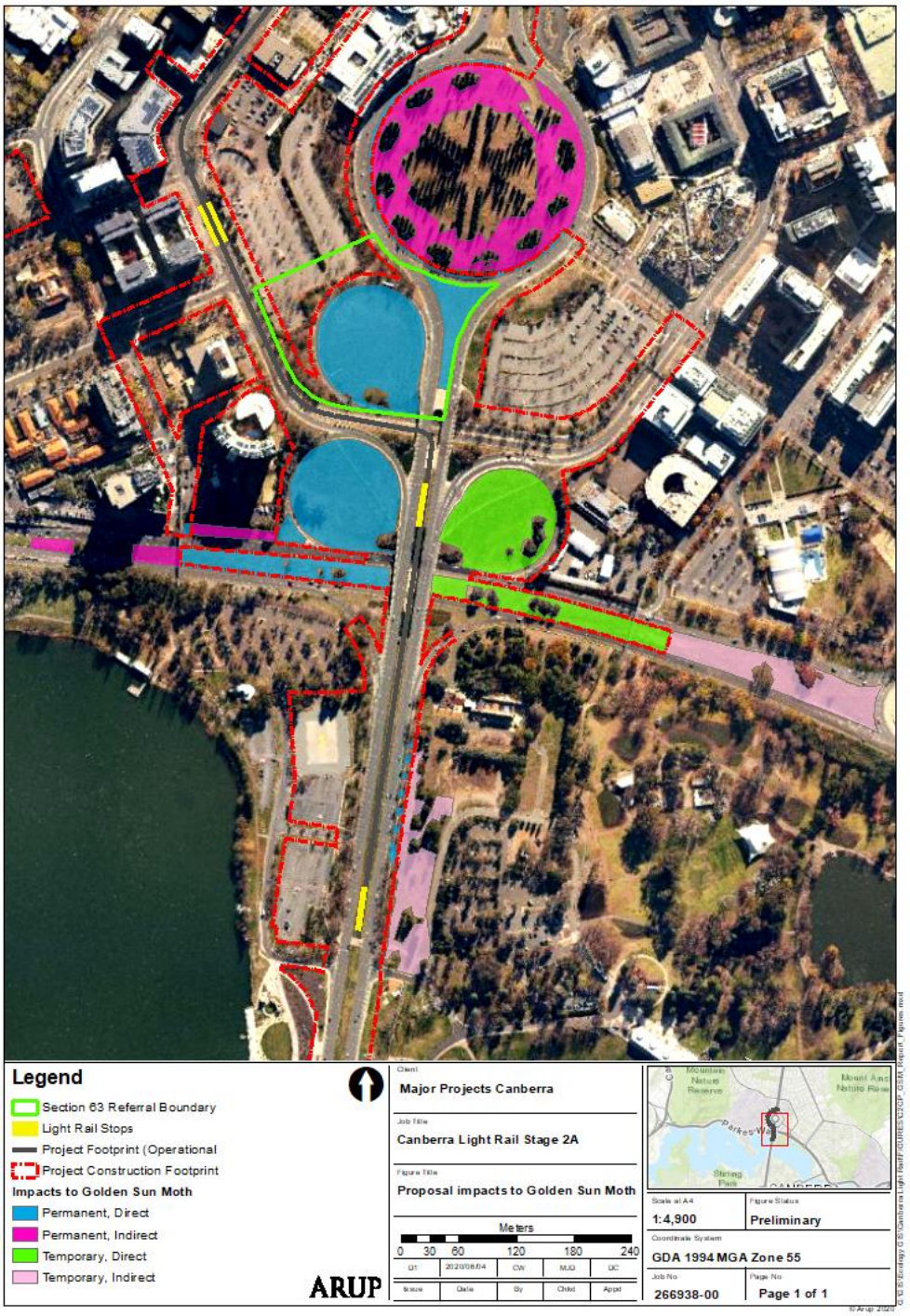

Figure 5.1: Proposal impacts to Golden Sun Moth

Habitat fragmentation isolation and edge effects

Existing Golden Sun Moth habitats within the study area are already subject to considerable edge effects. Any increased risk of edge effects due to the Proposed Action would be negligible, as the shape and size of remaining habitats would not change significantly, and no significant intensification of road use would occur.

Golden Sun Moth habitat within the study area would be subject to habitat fragmentation from the Proposed Action. Approximately 2.07 ha of remaining habitats would be significantly isolated, with distances of more than 200m anticipated between remnants. This includes marginal habitats within Vernon Circle and the Parkes Way median west of Commonwealth Avenue, as shown in Figure 5.1.

Golden Sun Moth populations remaining within isolated fragments are susceptible to loss from localised disturbances and stochastic (random) events and may not be viable in the long-term. As such, a permanent loss of these isolated habitat remnants is considered likely to occur following introduction of the Proposed Action.

An additional 1.26ha of habitat at Commonwealth Park and within the Parkes Way median east of Commonwealth Avenue would also be temporarily fragmentated and isolation. However, connectivity would be restored between these habitats by means of post-works habitat restoration (refer to section 6.3.2).

5.3.3 Cumulative impacts

Concurrent and expected future development

Planned developments that have the potential to interact with and/or compound the Proposed Action's impacts to the Golden Sun Moth during the planned four year construction period are identified in Table 5.2 and shown on Figure 5.2. Any future developments not listed below, and scheduled beyond 2023-24 would be the subject of separate environmental impact assessments and where relevant EPBC assessment and approval process.

Table 5.2: Planned development within proximity to the study area

Project description	Proponent
Section 63 EPBC referral for potential development on site (EPBC 2019/8449). Section 63 is on the Land release program.	City Renewal Authority

Project description	Proponent
Morris Group Development Mixed use development comprising 700 residential dwellings (apartments); 38,500 m2 commercial area; 5,322 m2 retail area.	Morris Property Group
Acton Waterfront Land reclamation to build boardwalk and parks	City Renewal Authority
UNSW Canberra City Campus University Campus. Located at the old Reid CIT	University New South Wales and ACT Government

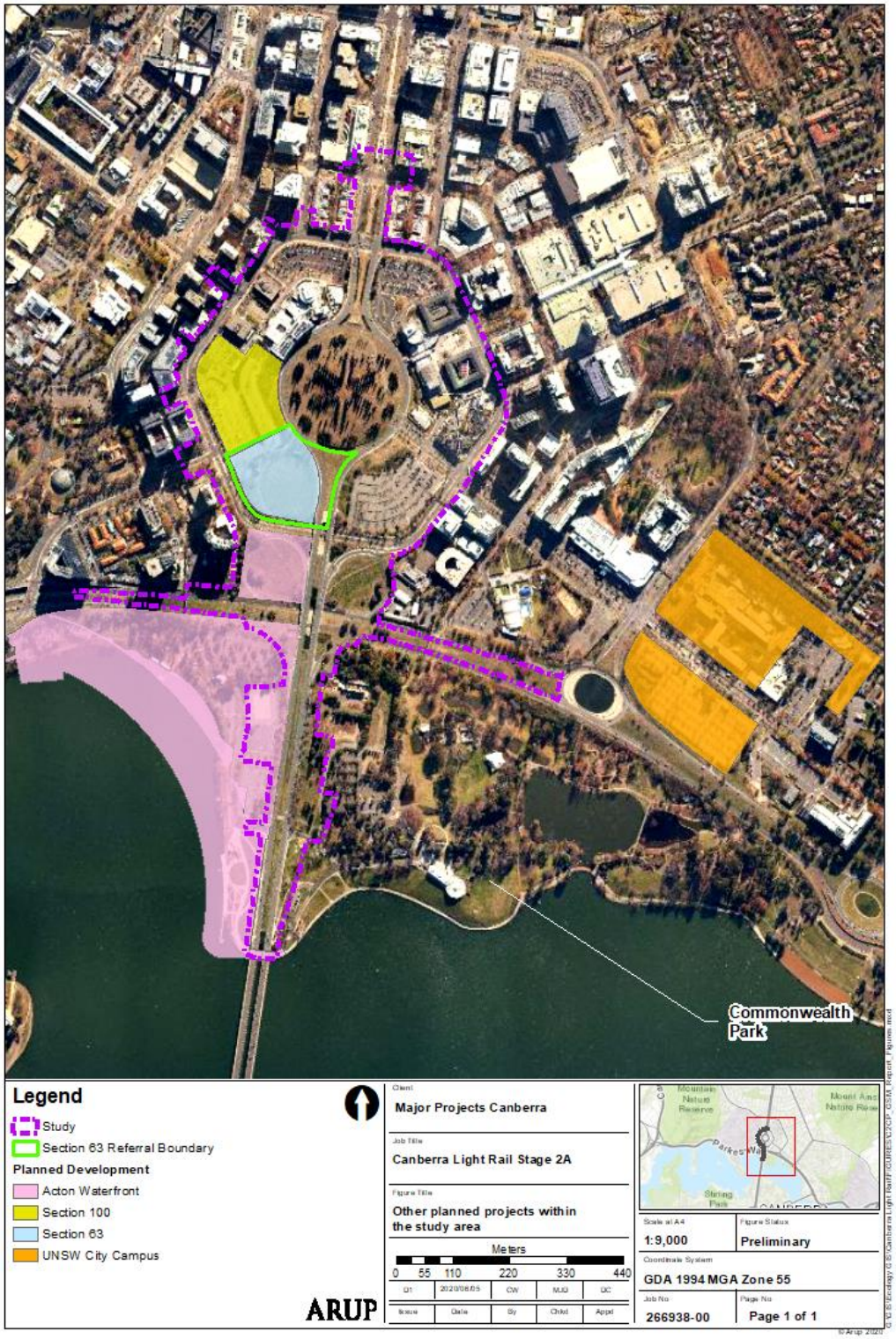

Figure 5.2: Other planned projects within the study area

Expected impacts

Potential cumulative impacts to the Golden Sun Moth include:

- **Section 63:** Approximately 1.46ha of Golden Sun Moth habitat identified within the proposed action study area is located within the Section 63 development site. Restoration of cleared Golden Sun Moth habitat within the Section 63 development site is not considered practicable following construction of the Proposed Action. The project is aware that Section 63 is the subject of a separate EPBC assessment process (2019/8449). Without prejudicing the outcome of that process, it is noted that the potential impacts from this project and associated mitigations and offsets discussed in Sections 5 and 7 would have the effect of extinguishing GSM habitat values within the Section 63 development site.
- **Morris Group Development:** No Golden Sun Moth habitat was identified within the Section 100 site. As such, works associated development are unlikely to directly impact upon Golden Sun Moth. However, some disturbance of remaining habitats within Vernon Circle may occur during construction as a result of dust, changed hydrology and soil compaction from increased traffic and machinery movements.
- **Acton Waterfront:** Works associated with future stages of the Acton Waterfront development, including access options for connecting the City to Lake Burley Griffin over Parkes Way are likely to directly impact on Golden Sun Moth habitats to the west of Commonwealth Avenue at Parkes Way.
- **UNSW Canberra City Campus:** Development activities associated with the proposed UNSW Canberra City Campus would not directly impact Golden Sun Moth habitat within the study area. Some disturbance of habitats within eastern sections of the Parkes Way median may occur during construction as a result of increased traffic and machinery movements. The Reid Golden Sun Moth populations is also located near the planned UNSW development and may be impacted.

As well as assessing potential cumulative impacts to existing Golden Sun Moth habitat from future developments, consideration has also been given to the impacts on the proposed restoration of habitats (refer to chapter 6 for further details of these areas). Based on the known scope of the listed projects with the potential to give rise to cumulative impacts to the Golden Sun Moth population, there is no indication that the any works would need to occur within areas identified for Golden Sun Moth habitat restoration as part of the controlled action. While every effort has been made to consider the potential for impacts in these areas as a result of future projects, there are limits to the degree of confidence that can be placed on these assumptions. Notwithstanding, all projects would be subject to future planning and environmental approval projects. In accordance with EPBC Significant Impact Guidelines, any impacts to Golden Sun Moth habitat in this area (being part of a highly fragmented population is potentially significant, and would therefore be subject to an EPBC Referral process, and potential assessment under the EPBC Act.

6 Avoidance, Mitigation and Management Measures for Golden Sun Moth

6.1 Preliminary documentation requirements

Further evidence (e.g. field surveys) and / or a more detailed argument is required to satisfy the Department of claims and conclusions made in your referral documentation in relation to Golden Sun Moth and / or explain how impacts on them will be addressed. Details of information required include:

- *Consideration of any additional measures that could be implemented to avoid or mitigate potential impacts.*

The following matters should be considered for the Golden Sun Moth:

- *Measures proposed to avoid or mitigate potential impacts.*

Proposed avoidance and mitigation measures must be discussed in terms of their expected effectiveness and cost. Note that in deciding whether to approve the proposed action, the Minister is required to consider whether (as far as possible) any condition is a cost-effective means for achieving its intended objective.

Management commitments by the person proposing to take the action must be clearly distinguished from recommendations or statements of best practice made by the author or other technical expert. It is preferable to provide a consolidated table of management commitments, including details on funding, roles and responsibilities and measurable performance criteria.

6.2 Proponent response

Measures to avoid and mitigate impacts to Golden Sun Moth have been considered as a part of the Proposed Action's planning and designs. Additional measures to further minimise impacts to the species and its habitat will also be implemented during the detailed design phase. A consolidated table of management commitments is provided in Table 6.1.

The following avoidance measures have been implemented as a part of the Proposed Action:

- Alternative delivery strategies and potential route alignments as a part of the Business Case for the light rail (refer to Chapter 2).
- Removal of the proposed traction substation from Commonwealth Park (refer to section 2.2.1).

The following mitigation measures are proposed to address any unavoidable impacts:

- Restoration of 1.43ha of Golden Sun Moth habitat within the southeast cloverleaf and the Parkes Way median, east of Commonwealth Avenue post-construction.
- Re-establishing connectivity between approximately 1.26ha of remaining Golden Sun Moth habitat at Commonwealth Park and in the Parkes Way median, east of Commonwealth Avenue.
- Investigating opportunities to contribute to local research and conservation of the species through:
    - Salvage and preservation of Golden Sun Moth larvae within the clearing footprint.
    - Sharing of monitoring data documenting the success of restoration activities and recolonisation of native grasslands by Golden Sun Moth.

The proposed habitat restoration works are likely to cost approximately $50,000, based on consultation with ACT Parks, and are considered to have a moderate to high likelihood of success. An indicative schedule of maintenance costs will be provided as a part of the Golden Sun Moth Management Plan, prior to construction.

6.3 Summary of avoidance, mitigation and management measures

This section summarises the proposed avoidance and mitigation measures.

6.3.1 Avoidance

Design measures introduced to help avoid and minimise impacts to Golden Sun Moth habitat within the study area included the removal of the proposed traction power substation at Commonwealth Park. Further consolidation and minimisation of the construction footprint will be investigated as a part of the detailed design and early works phases. Strategic measures implemented to minimise impacts during the Business Case phase of the project are summarised in Section 2.1.

Substation removal

To allow for the operation of a wire-free Light Rail network, a dedicated traction power substation was originally proposed as a part of the project referral. The substation was to be located at Commonwealth Park, adjacent to Regatta Place, and would be about 30m long, 10m wide and up to 8m high (refer to Figure 6.1).

However, Golden Sun Moth habitat was identified within the proposed substation site during field surveys completed by Arup in 2019. Subsequent to this, a design

solution was identified that allowed for the delivery of the light rail without the need for the substation, thus avoiding any impacts to Golden Sun Moth that would have otherwise occurred. Charging of the light rail will instead occur by means of the existing City to Gungahlin route with regenerative braking boosting the on-board power supply sufficient to support operation within the proposed light rail route.

6.3.2 Mitigation

Proposed mitigation measures involve habitat restoration activities to be undertaken within the construction footprint. These are summarised further below.

Habitat restoration

Post-works restoration of approximately **1.43 ha** of cleared Golden Sun Moth habitat is proposed within the southeast cloverleaf and in the Parkes Way median east of Commonwealth Avenue (refer to Figure 6.2). The staging of construction impacts to Golden Sun Moth Habitat and the timing for restoration can be seen within Section 2.3.1.

The following commitments will be made as a part of the habitat restoration works:

- Seeding and/or virotube planting of Redleg Grass *Bothriochloa macra* and Wallaby Grasses *Rytidosperma spp.*
- Using clean nutrient-poor soils and implementing ongoing control and suppression activities to minimise weed invasion.
- Managing restored and retained Golden Sun Moth habitats to maintain low biomass and to manage weed invasion.
- Monitoring and auditing works to assess progress towards restoration objectives and to inform requirements for adaptive management.
- Implementing contingency measures such as supplementary plantings or Golden Sun Moth translocation, where restoration objectives are not achieved. In the instance where restoration of Golden Sun Moth habitat is not deemed successful two years after the completion of construction of the proposed activity there will also be the allowance for obtaining additional offsets.

Further details regarding the proposed restoration methodology can be seen within the Draft Golden Sun Moth Habitat Restoration Framework provided in Appendix F.

The proposed restoration strategy balances estimated costs with reasonable predictions regarding the likely effectiveness of proposed measures, by means of the following:

- Minimising likely conflicts with future planned development.
- Prioritising measures to restore habitat connectivity between habitat remnants supporting the highest maximum Golden Sun Moth counts.

- Restoring cleared habitats in closest proximity to remaining Golden Sun Moth habitats to maximise the likelihood of recolonisation by species.

Based on consultation with ACT Parks, we have estimated the proposed restoration works will cost approximately $50,000 to implement. Costs associated with the management of restoration works may vary as much as $5,000 to $40,000 per hectare each year, depending upon the success of planting establishment and weed control measures implemented. This makes it difficult to provide an accurate estimate of management costs at this time. Rather, an indicative schedule of costs will be provided to DAWE as a part of the Golden Sun Moth Management Plan upon finalisation of management and monitoring commitments. At a minimum this would include a defects and liability phase of 2 years in which all restoration treatments will be required to meet necessary performance criteria with contingency measures implemented where necessary.

Restoration for this species is still in its infancy. Within ACT Parks, there is demonstrable knowledge of some food preferences, breeding and life-cycles characteristics. The restoration efforts proposed will build on studies that restore Natural Temperate Grasslands (NTG) in general and assess those previous attempts at GSM translocation.

Given the background knowledge of the species ecology, funding available for restoration and resources for ongoing monitoring by trained ecologists we can be moderately confident that serious restoration attempts would be successful.

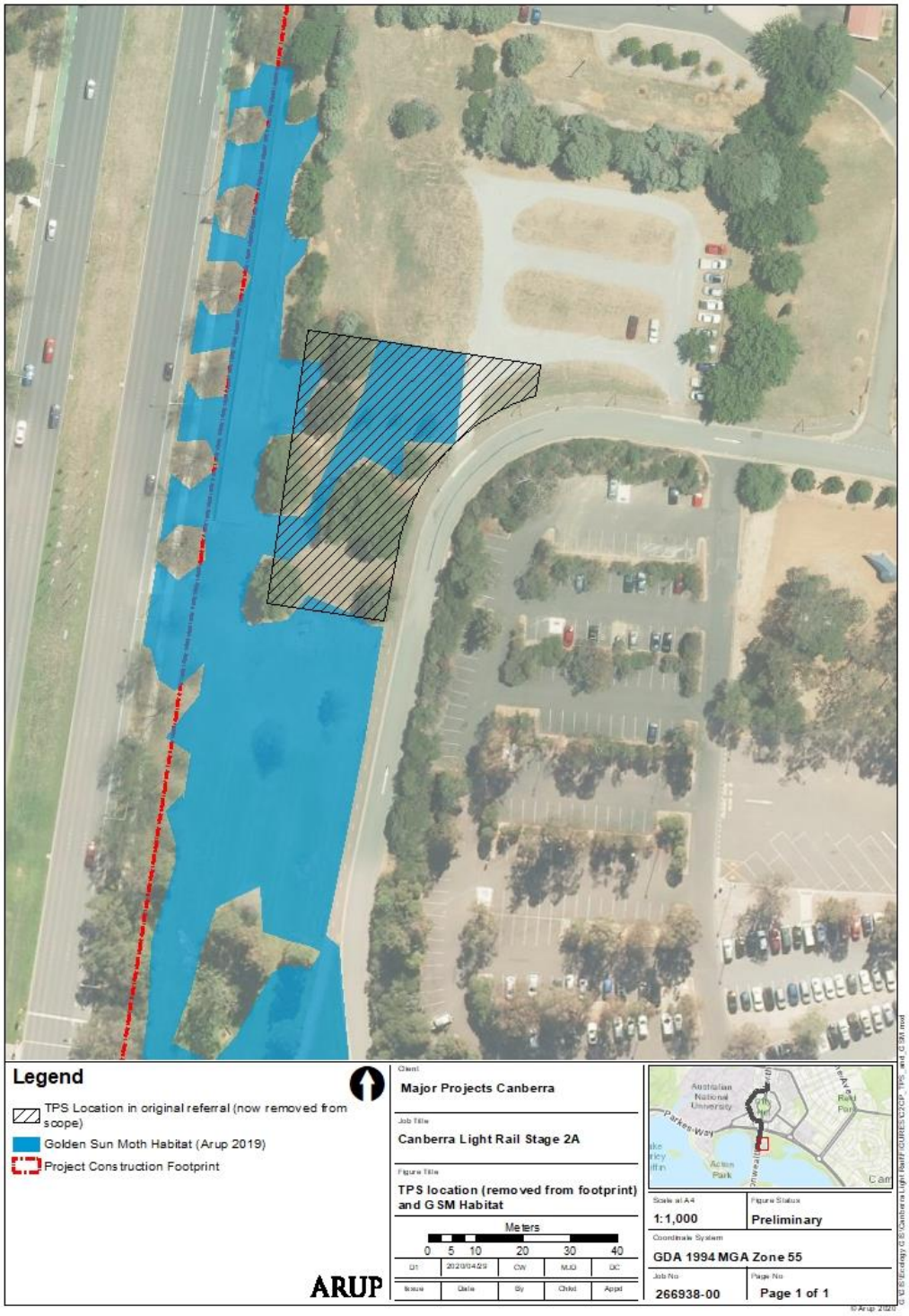

Figure 6.1: Substation removal from Commonwealth Park

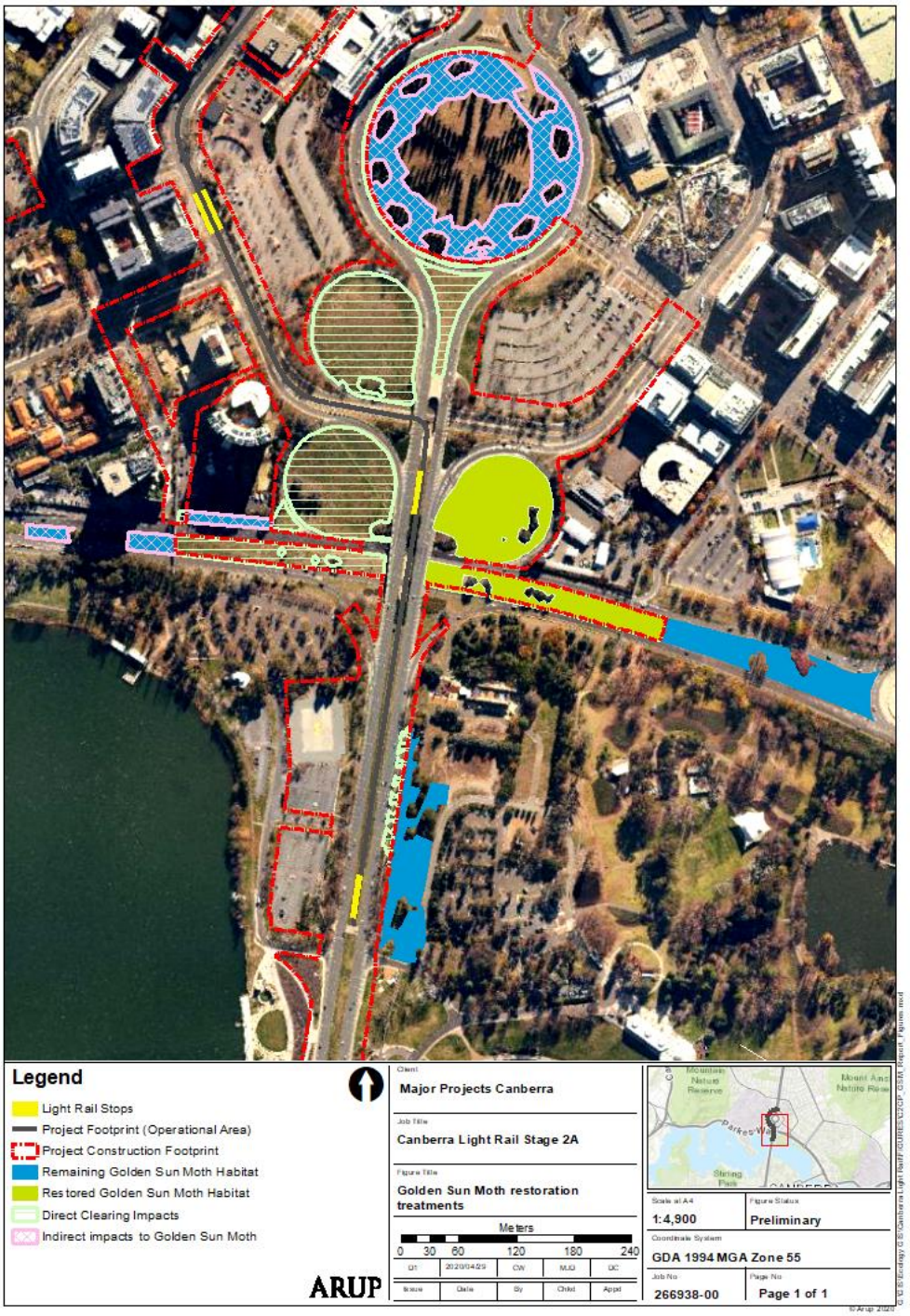

Figure 6.2: Proposed habitat restoration activities

Research opportunities

Opportunities to contribute to local research are also being explored by the ACT Government as a part of the proposal. Where undertaken, the following activities would deliver conservation benefits through supporting local research priorities for the species:

- Salvage and preservation of Golden Sun Moth larvae within clearing footprint.
- Monitoring data documenting success of restoration treatments and Golden Sun Moth colonisation of restored native grasslands.

Where relevant, these opportunities would be explored in consultation with local universities and research centres.

6.3.3 Management

A consolidated table of management strategies for the proposed action is provided in Table 6.1. The following management strategies are proposed to address impacts identified in Chapter 5. These management strategies will be refined as detailed design continues and with stakeholder and regulator engagement through the assessment process, and will be developed to incorporate key performance criteria to measure the success of outcomes, and where required enable effective adaptive management. Key management plans would require approval by DAWE prior to implementation.

Table 6.1: Project commitments and management measures

ID	Description	Draft Management commitment	Timing
A1	Impacts to nationally listed Golden Sun Moth	A *Golden Sun Moth Management Plan* would be developed, implemented and audited as a part of the proposal. The plan would address the following measures for the protection of Golden Sun Moth within the study area: • Plans identifying clearing footprints, remaining habitats to be protected including associated exclusion zones and areas of proposed habitat restoration. • Clearing protocols, including any specified seasonal limits, pre-clearing inspections, exclusion zones and on-ground identification of specific habitat features to be retained and / or salvaged. • Habitat restoration requirements including suitable restoration treatments and receiving areas, important habitat features and other management actions. • Suitable approaches for the protection and management of retained and restored habitats including a program for the implementation of restoration activities and weed and biomass management. • Monitoring and reporting requirements during and post-construction to assess compliance and progress towards achieving the restoration objectives. • Performance criteria and contingency measures to account for and address any risks associated with habitat establishment, restoration and moth recolonisation. • Marking-out and signing of clearing limits within the construction footprint including clear identification of habitats to be retained and protected using suitable fencing, signage or markings. • Installation of barriers, which are identified on construction drawings and raised to site workers during induction training. • Clearing of areas containing habitat for golden sun moth to be undertaken outside of the breeding season for the species [Oct- Dec]. • Locating all site compounds, vehicle / machinery, material stockpiles, etc. outside of any exclusion zones. • Maintaining surface water quality and hydrology within Golden Sun Moth habitats by ensuring clean water diversions and control of construction site run-off are implemented in accordance with an Environmental Agreement and erosion and sediment control plan that would need to be progressively approved by the Environmental Protection Authority. This will be achieved through a number of measures including temporary drains, lined channels, and the use of site stabilisation measures successfully employed to manage runoff throughout the construction of Light Rail Phase 1. Routine inspections of control measures and water quality will be undertaken throughout construction. • Ensure no permanent shading associated with any structures and tree plantings on Golden Sun Moth Habitat.	Prior to and during construction

ID	Description	Draft Management commitment	Timing
		• Development and implementation of suitable erosion and sediment controls to minimise dust emissions and deposition.	
A2	Golden Sun Moth habitat restoration	Prior to the completion of site works, restore 1.43ha of habitat for Golden Sun Moth within the Parkes Way median and southeast cloverleaf at Commonwealth Avenue. Proposed restoration works are to be carried out in accordance with the strategy presented in Section 5.2.2. The *Golden Sun Moth Management Plan (A1)* would address the following requirements for the restoration works: • Restoration of all cleared Golden Sun Moth habitat within the southeast cloverleaf and Parkes Way median, east of Commonwealth Avenue. • Seeding and/ or virotube planting of Redleg Grass *Bothriochloa macra* and Wallaby Grass *Rytidosperma spp*. such as Short Wallaby Grass *R. carphoides*, Bristly Wallaby Grass *R. setacea* and Clustered Wallaby Grass *R. racemosa*. • Use of clean nutrient-poor soils. • Management of restored native grasslands as separate management unit and ongoing weed control and suppression activities carried out to minimise weed invasion from adjacent lands. • Maintenance of a low open grassland structure supporting low biomass and sufficient bare ground. • Contingency measures to include supplementary planting/ seeding of larval food plants, alternative/ additional weed treatments and/ or translocation of Golden Sun Moth larvae within restored habitats as necessary. • Inspections during both establishment and maintenance periods. • Annual monitoring and reporting of Golden Sun Moth activity and habitat condition within retained and restored habitats following practical completion of restoration works.	During and post construction
A3	Opportunities to further minimise impacts	Opportunities to minimise the proposed construction footprint and/or relocate works to outside areas of Golden Sun Moth habitat where possible will be fully explored as a part of the detailed design.	Pre-construction
A4	Offsets for nationally listed Golden Sun Moth	Prior to the commencement of construction, the ACT Government will retire 82 Golden Sun Moth species credit offset credits.	Pre-construction
A5	Site workers and construction activity impacts	All site workers would be trained to ensure awareness of requirements of the *Golden Sun Moth management plan* (A1) and relevant statutory responsibilities. Site-specific training would be provided when specific work activities were taking place near areas of identified biodiversity value that are to be protected.	Construction

ID	Description	Draft Management commitment	Timing
A6	Minimising construction impacts	Management measures would be implemented to ensure unavoidable vegetation removal minimises biodiversity impacts where possible. As a minimum, this would include: • Not clearing any vegetation beyond limits identified in this environmental assessment and the EBPC Act preliminary documentation. • Avoiding works being carried out in the identified exclusion zones and protected habitat features.	Construction
A7	Spread of weeds, pests and pathogens	Management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include: • Completion of a site weed assessment and development of a *weed management plan*. • Implementation of appropriate weed control and weed disposal in accordance with Weeds of National Significance protocol. • Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. • Disposal of any weed material at an appropriately licensed facility. • Implementation of appropriate hygiene protocols where there are potential or known pathogen risks.	Construction
A8	Effectiveness of mitigation and management measures	Consistent with any specific requirements of the approved *Golden Sun Moth management plan* (A1), a monitoring program would be implemented during construction to assess the effectiveness of mitigation and management measures implemented, to identify any unexpected impacts and appropriate contingency measures necessary for the protection of biodiversity. A register of inspections will be established.	Construction and post-construction
A9	Research opportunities	Explore opportunities for contributing to Golden Sun Moth research with universities and research centres. Measures could include: • Salvage and preservation of Golden Sun Moth larvae within the clearing footprint. • Sharing of monitoring data relating to the success of restoration activities.	Prior to, during and post-construction.

6.3.4 Assessment against recovery actions

No approved recovery plan has been developed for Golden Sun Moth. However, a number of Regional/ Local Priority Actions to address the loss, disturbance and modification of habitat for the species are identified in the approved conservation advice for species (DoE, 2013). Table 7.2 presents an assessment of proposal impacts against relevant Regional/ Local Priority Actions. The assessment indicates proposal activities will not interfere with any regional or local recovery priorities identified for the species.

Table 7.2: Assessment of proposal impacts against Regional/ Local Priority Actions (DoE, 2013)

Regional/ local priority actions	Proposal response
Minimise disturbance in areas where the Golden Sun Moth occurs, excluding necessary actions to manage the conservation of the species. Retain and protect natural grassland remnants within the known distribution of the species.	Measures to avoid and minimise impacts to Golden Sun Moth habitats have been considered as a part of the proposal. Golden Sun Moth habitats are limited to low quality grasslands dominated by exotic Chilean Needle Grass. No impacts to natural grassland remnants will occur as a result of the proposal.
Do not destroy habitat and surrounding areas by ploughing	No ploughing proposed however, habitats will be directly disturbed during construction through proposed vegetation clearing and earthworks. Residual impacts associated with these activities will be addressed through an offset package (Section 7).
Ensure remnant populations remain connected or linked to each other; in cases where remnants have become isolated, consider revegetation to re-establish links and aid dispersal.	Golden Sun Moth habitats are limited to low quality grasslands dominated by exotic Chilean Needle Grass. No impacts to natural grassland remnants will occur as a result of the proposal. Proposed restoration works will restore habitat connectivity between habitat fragments supporting highest Golden Sun Moth activity (Section 5.2.2). Habitat remnants at Vernon Circle and Parkes Way, west of Commonwealth Avenue are considered marginal and restoring connectivity to these is not considered practicable. The loss of these habitats will have a negligible impact on the species.
Manage any changes to hydrology that may result in changes to water table levels and / or increased run-off, salinity or pollution	Measures will be implemented during construction and operation to minimise the diversion of stormwater and changes to hydrology within proximity to remaining habitats (Table 10).
Monitor known populations to determine the species' status	Monitoring of retained and restored Golden Sun Moth habitats is proposed following construction to inform management success and adaptive management requirements
Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.	

7 Proposed offsets

7.1 Preliminary documentation requirements

Further evidence (e.g. field surveys) and / or a more detailed argument is required to satisfy the Department of claims and conclusions made in your referral documentation in relation to Golden Sun Moth and / or explain how impacts on them will be addressed. Details of information required include:

- *An offset proposal for any residual significant impacts (i.e. impacts that cannot be avoided or mitigated including discussion of requirements).*

The following matters should be considered for the Golden Sun Moth:

- *Compensation (offsets) proposed for any residual significant impacts (i.e. impacts that cannot be avoided or mitigated).*

Significant residual (i.e. after any avoidance and mitigation measures have been considered) impacts on any listed threatened species or community must be offset in accordance with the Department's EPBC Environmental Offsets Policy 2012 and offset assessment guide, or other endorsed offset framework (see separate heading below).

Please provide sufficient detail around offsets for any residual significant impacts on listed threatened species and communities, after mitigation and management measures relating to the action have been applied. This information must include proposed specific suitable offset areas and their locations, including existing areas that are available and unlikely to be cleared in the future. Please include:

a) Details of an offset package proposed to be implemented to compensate for the residual significant impacts of the project;

b) Details of how the offset(s) will compensate for the significant residual impact(s) upon listed threatened species and communities resulting from the action;

c) A description of how the offset(s) will ensure the protection, conservation and management of the relevant listed threatened species and communities, for the duration of the impact;

d) A description of how the offset(s) are consistent and comply with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (October 2012) and accompanying Offsets Assessment Guide, accessible from: www.environment.gov.au/epbc/publications/environmental-offsets-policy.html;

e) The anticipated cost (financial and other) of delivery of the offset(s).

The offset package can comprise a combination of direct offsets and other compensatory measures, so long as it meets the requirements of the EPBC Act

Offset Policy. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that is impacted in order to deliver a conservation gain.

Offsets should compensate for an impact for the full duration of the impact.

Offsets must directly contribute to the ongoing viability of the MNES impacted by the project and deliver an overall conservation outcome that improves or maintains the viability of the MNES as compared to what is likely to have occurred under the status quo that is if neither the action not the offset had taken place.

Note offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact.

7.2 Proponent response

Significant impacts due to the Proposed Action consist of 5.4ha of residual impacts to Golden Sun Moth habitat. This is composed of 3.33ha of direct habitat loss through clearing and construction activities, as well as 2.07ha lost through increased fragmentation.

To compensate for residual impacts resulting from the proposal, 82 species credit biodiversity credits will be purchased by the ACT Government and retired in accordance with the NSW Biodiversity Offsets Scheme (BOS). This would occur prior to the commencement of construction.

As a contingency measure where offsets cannot be directly retired from a BioBanking offset site, the offset package will instead be delivered through payment into the Biodiversity Conservation Trust (BCT). Cost of payment into the BCT is $677,578.39.

7.3 Summary of proposed offsets

An offset package is proposed to address all significant residual impacts to Golden Sun Moth as a part of the proposal. The offsets package will be delivered through the NSW Biodiversity Offsets Scheme (BOS). Support was obtained from the DAWE on 8 April 2020, for delivery of the Proposed Action's offsets under the NSW BOS and using the proposed offset calculation methods.

7.3.1 Significant residual impacts

Significant residual impacts to Golden Sun Moth as a result of the project are identified in Table 7.1. The proposal will result in 5.4ha of residual impacts to Golden Sun Moth habitat including 3.33ha of direct impacts and 2.07ha of

indirect impacts. Impacts associated with the proposal would be reassessed before construction to capture any additional avoidance or minimisation of Golden Sun Moth habitat achieved during the detailed design phase.

Table 7.1 provides the Golden Sun Moth habitat quality class, vegetation integrity score and offset obligation for Golden Sun Moth habitats supporting residual impacts as a result of the proposal.

Table 7.1: Significant residual impacts to Golden Sun Moth

Residual impacts	Habitat quality	Extent of impact (ha)	Vegetation integrity score	BAM Offset credits	Cost for payment into BCT
Impacts to Golden Sun Moth habitat	Low	5.4	20	88	$677,578.39

7.3.2 Offset calculation

Offsets were calculated by a NSW-accredited biodiversity ecologist using the Biodiversity Assessment Method (BAM) Offsets Calculator.

As the BAM calculator does not support the calculation of offsets for impacts to exotic vegetation that is habitat for threatened species, an alternative approach was developed in consultation with the NSW Department of Planning, Industry and Environment (DPIE). The adopted approach involved importing manipulated floristic data into the BAM Calculator to generate a vegetation integrity score that corresponded with the observed quality of all impacted Golden Sun Moth habitat as determined by the habitat assessment.

Golden Sun Moth habitat quality classes and associated vegetation integrity scores are provided in Table 7.2. Vegetation integrity scores were assigned to habitat quality classes based on DPIE advice regarding observed BAM calculator trends.

Manipulated floristic data that was input into the BAM Calculator for the purpose of offset calculation is provided in Appendix C. Within the BAM Calculator, a suitable surrogate native Plant Community Type (PCT) was chosen to characterise the exotic Chilean Needle Grass dominated habitats within the study area. The surrogate PCT used for the assessment was PCT1289 Wallaby Grass- Red-grass-Tall Speargrass- Kangaroo Grass dry tussock grasslands of the North-western and Eastern Southern Tablelands in the South Eastern Highlands Bioregion.

Table 7.2: Vegetation integrity score based on Golden Sun Moth habitat quality

Habitat quality	Criteria	Vegetation integrity score
Very high quality habitat	Primary Natural Temperate Grassland or native pasture dominated by native larval food plants (i.e. *Rytidosperma sp.*/ *Austrostipa sp.*) with low weed cover and some bare ground	80 or more

Habitat quality	Criteria	Vegetation integrity score
High quality habitat	Native-dominated grassland with a high component of *Rytidosperma sp./ Austrostipa sp*. but less than Very High quality habitat because of one or more of the following conditions: • On a steep slope or hill top • On a south or east-facing slope • Soil very shallow and/or stony, rock outcrops present • Secondary grassland or contains scattered trees.	60-80
Moderate quality habitat	Primary or secondary grassland, with a moderate component of *Rytidosperma sp/ Austrostipa sp*., and moderate weed cover.	40-60
Low quality habitat	Larval food plants (*Rytidosperma sp. Austrostipa sp*./ Chilean Needle Grass) are a minor component of the ground layer, growing sparsely or in patches among unsuitable vegetation. OR Chilean Needle Grass dominated habitat.	20-30

Table 7.1 provides a summary of impacted Golden Sun Moth habitats and associated offset requirements. All Golden Sun Moth habitats within the study area were dominated by Chilean Needle Grass and were considered low quality. These were assigned a vegetation integrity score of 20 in accordance with the criteria presented Table 7.2. A Biodiversity Credit Report was output from the BAM Calculator and is provided in Appendix D.

7.3.3 Offset package

To compensate for residual impacts resulting from the proposal, 82 species credit biodiversity credits will be purchased by the ACT Government and retired in accordance with the NSW Biodiversity Offsets Scheme (BOS). This would occur prior to the commencement of construction.

A search of the BioBanking public register was carried out to confirm sufficient biodiversity credits for Golden Sun Moth are available for offset delivery. A report from the BioBanking public register is also provided in Appendix E. The ACT Government has commenced engagement with a number of BioBanking offset credit holders in relation to offset delivery and are satisfied that sufficient credits are available and can be retired to address the significant impacts associated with the project. This consultation has factored in the necessary conversion of offset credits from the BioBanking scheme to the BOS.

As a contingency measure where offsets cannot be directly retired from a BioBanking offset site, the offset package will instead be delivered through payment into the Biodiversity Conservation Trust (BCT). Cost of payment into the BCT is $677,578.39.

Retired biodiversity offset credits will be secured for conservation under Part 7A Division 2 of the *Threatened Species Conservation Act 1995* (NSW) through a BioBanking agreement. This agreement will allow for the protection and ongoing management of Golden Sun Moth habitat within site into perpetuity.

7.3.4 Assessment against the EPBC Act Environmental Offsets Policy

Where a proposal is likely to have a significant residual impact on MNES, the EPBC Act allows for the provision of environmental offsets to compensate for such losses. The EPBC Act *Environmental Offsets Policy* (EPBC Offsets Policy) outlines the Australian Government's approach to the use of environmental offsets under the EPBC Act. It is intended to give proponents, the community and stakeholders with greater certainty and guidance on how offsets are determined and when they may be considered under the EPBC Act.

Offsets are proposed under the NSW Biodiversity Offsets Scheme (BOS) to address the significant residual impacts to Golden Sun Moth. The NSW BOS and superseded BioBanking Scheme include provisions that allow for the proposed offset approach to meet the principles of the EPBC Act Environmental Offset Policy (Table 7.3).

Table 7.3: EPBC Act offset policy principles and how they are addressed

EPBC Act Environmental Offset Policy principles	Response
Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action	The quantum of offset credits generated by the impact of the project have been calculated using the NSW Biodiversity Assessment Method (BAM). This method takes into consideration the condition of the habitat impacted and calculates a required number of species credits to be purchased from an offset site. The BioBanking and BAM Offsets calculators include factors to address additionality, time for success and net conservation gain outcomes.
Be built around direct offsets but may include other compensatory measures	By purchasing and retiring BioBanking Golden Sun Moth species credits, the project is providing for 100% of the offset requirement to be delivered through direct offsets. The Golden Sun Moth credits will be purchased and retired from BioBanking sites that have committed to direct, land-based conservation management to improve or

EPBC Act Environmental Offset Policy principles	Response
	create habitat for this species. By purchasing credits that have been generated through an existing BioBanking agreement, offsets will be land-based.
Be in proportion to the level of statutory protection that applies to the protected matter	The calculation of the species offset credit requirement for Golden Sun Moth using the BAM Calculator takes into consideration the conservation status of the species when generating the number of credits.
Be of a size and scale proportionate to the residual impacts on the protected matter	The BAM Calculator was used to generate the number of offset credits required to address the significant residual impact to Golden Sun Moth. The calculator uses the area of impact of Golden Sun Moth habitat to generate the required credit requirement. It also takes into account the conservation status of the species and the condition of the habitat being impacted, where relevant
Effectively account for and manage the risks of the offset not succeeding	The offset credits are proposed to be purchased from a site that has entered into a BioBanking agreement with the NSW Government. For offset credits to be generated at a BioBanking site, the landowner enters into a legal agreement to implement a management plan that directly addresses the conservation and management of Golden Sun Moth.
Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6)	For a site to be registered under a BioBanking agreement, the principle of additionality also must apply. Apart from the BioBanking agreement, there will be no other conservation mechanisms or land use requirements over the site that generates the offset credit.
Be efficient, effective, timely, transparent, scientifically robust and reasonable	Offset credits will be purchased and retired prior to any significant residual impacts to Golden Sun Moth as a result of the project.
Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	BioBanking agreements are legally binding mechanisms that require the area of land used to generate credits to be managed for the purpose of Golden Sun Moth conservation. For the credits to be generated, the landowner enters into a legally binding agreement with the NSW Government that requires the creation or restoration of Golden Sun Moth habitat. This management plan also includes provisions for monitoring and maintenance.

8 Commonwealth land

8.1 Preliminary documentation requirements

Under the EPBC Act, approval is required for:

- *an action taken by any person on Commonwealth land that is likely to have a significant impact on the environment (subsection 26(1) of the EPBC Act) (direct impacts on Commonwealth land);*
- *an action taken by any person outside of Commonwealth land that is likely to have a significant impact on the environment on Commonwealth land (subsection 26(2) of the EPBC Act) (indirect impacts on Commonwealth land).*

The referral documentation states that the proposed action area includes areas of Commonwealth Land along Commonwealth Avenue comprising a section of Commonwealth Avenue and the road verge directly to the south of Capital Hill.

Please assess whether the Commonwealth land in the proposed action area constitutes habitat for the critically endangered Golden Sun Month (Synemon plana) (as a subset of your assessment of impacts to GSM habitat in the section relating to listed threatened species and communities above).

8.2 Proponent response

Approximately 8.09ha of Golden Sun Moth habitat was identified in study area. Approximately 2.19ha of this habitat is situated within Commonwealth lands (Figure 8.1). No other significant biodiversity values were identified within Commonwealth Lands.

Table 8.1 presents a subset of the proposal impacts to Golden Sun Moth relative to Commonwealth Lands within the study area. Only 0.38ha (17%) of Golden Sun Moth habitat occurring within Commonwealth Lands will be impacted permanently by the proposal. Approximately 0.57ha of cleared habitat will be restored within Commonwealth Lands, restoring connectivity to remaining habitats at Commonwealth Park and within the Parkes Way, east of Commonwealth Avenue (refer to Figure 6.2)

Table 8.1: Subset of proposal impacts within Commonwealth Lands

Proposal impacts	Duration	Extent within Commonwealth Land (ha)	% of Golden Sun Moth habitat within Commonwealth Land
Direct loss of Golden Sun Moth habitat	Permanent	0.38	17%
	Short-term, subject to restoration	0.57	26%
Habitat degradation, fragmentation, isolation and edge effects	Short-term, associated with construction	1.24	57%
Total		**2.19**	**100%**

No approved recovery plan has been developed for Golden Sun Moth. However, a number of Regional/ Local Priority Actions to address the loss, disturbance and modification of habitat for the species are identified in the *Approved conservation advice for Synemon plana (golden sun moth)* (DoE, 2013). An assessment of the proposal against Regional/ Local Priority Actions for Golden Sun Moth is presented in Table 7.2. The assessment indicates likely significant residual impacts associated with the project are unlikely to interfere with the conservation of the species.

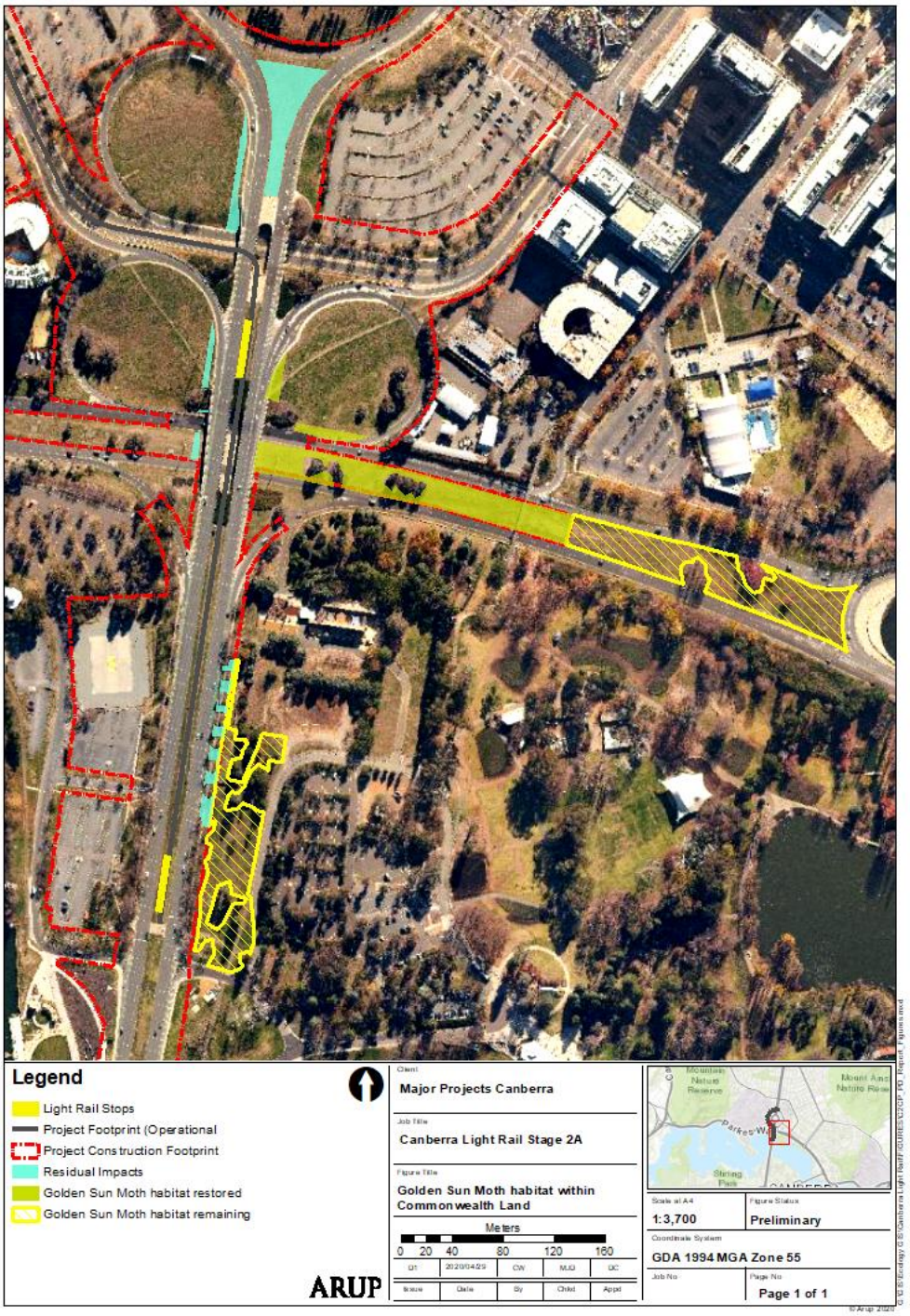

Figure 8.1: Golden Sun Moth habitat within Commonwealth Lands

9 Social and economic matters

The following Chapter describes the social and economic matters relating to the Proposed Action.

9.1 Preliminary documentation requirements

Your preliminary documentation must provide information about the expected economic and social impacts of the proposed action. This should include, but not necessarily be limited to, the following:

- *Consideration of both costs (e.g. disruption to existing community infrastructure or environmental features) and benefits (e.g. increased housing or employment)*
- *Consideration of different scales of impact where relevant (e.g. local versus national)*
- *Specific dollar or other numerical values where relevant*

9.2 Proponent response

9.2.1 Social costs and benefits

Section 2.1 notes the four socioeconomic challenges that resulted in Proposed Action. Key was recognising that a failure to invest in the Canberra's liveability and economic connections would prevent attracting and retaining people and businesses. It would also tend towards an unproductive and socially dislocated City where population growth and high car dependency would lead to road congestion and, in turn, this would create negative social, economic and environmental impacts.

For Canberra to maintain its status as one of Australia's most liveable cities, the ACT Government recognised the need to invest in an effective integrated transport system for the future. The choice to build a light rail in response to this was due to it being a recognised proven solution globally to provide rapid transit between key destinations. While this is the case, there would be some temporary and permanent social costs and benefits and impacts as described below.

Social benefits

The focus of the Proposed Action is to benefit residents, tourists and visitors by improving access to and across the City while creating opportunities for the City to grow and develop. Table 9.1 identifies the key social benefits identified in the business case described in section 2.1.

Table 9.1: Social benefits

Benefit	Scale
Increased economic growth and diversification of employment	
Up to 300 direct jobs would be created across the Proposal's lifecycle mainly within the construction, professional services, and logistics sectors that could be likely supplied from the local and regional labour market. This would be supported by a wide range of indirect jobs across the supply chain. This would include jobs in the design, fabrication, transportation, and fabrication sectors.	**Local and Regional**: local labour market and workforce.
The Proposed Action would help with stimulating the economy, through revitalisation opportunities. It would also help support future development and activation along the route, while reducing reliance on Commonwealth Government employment and expenditure. It would stimulate activity and competition in the private sector through the need to supply goods and services during construction and operation.	**Local, Regional, and to some extent, National:** economy
A key aim of the Proposed Action is to help activate underutilised land along the corridor through providing a reliable, cheap and effective means to travel between key hubs and centres. This would help support the expected increase in the City's population. It would also increase the amount revenue generated through increased land tax.	**Local, Regional, and to some extent, National:** economy
Enhancing tourism opportunities and increasing Canberra's reputation as a desirable city in which to live, visit and invest. This would be achieved by modernising the transport network consistent with other global capitals and helping activate and modernise the City's core to help attract more residents, visitors and tourists.	**Local, Regional, and to some extent, National:** economy
A connected and compact city	
Connecting key residential, cultural, commercial and employment centres across the City using an integrated public transport network.	**Local:** businesses and community facilities **Regional**: residents **National:** tourists and visitors.
Supporting urban renewal, precinct development and activation across the City, and at Acton Waterfront and City Hill by improving public transport accessibility and enhancing urban amenity.	**Local:** businesses and community facilities **Regional**: residents **National:** tourists and visitors
Reducing urban sprawl by the Proposed Action promoting activation of central compact suburbs and improving and increasing land values.	**Regional:** residents **Local, Regional, and to some extent, National:** economy
Improving productivity due to an increase in density and agglomeration through providing the means for a higher number of people to effectively move in, out and around the City.	**Local, Regional, and to some extent, National:** residents, workforce and economy
Improved access to employment and services	
Improving public transport access and cohesion between the City and Lake Burley Griffin and providing improved connectivity for the increasing population, workforce and number of students.	**Regional:** residents **Regional and National**: students and workforce

Benefit	Scale
Improving mobility and access, including for disadvantaged and vulnerable groups. Reducing car dependency, and therefore increasing equity amongst Canberra's residents. Providing a means of reliable transport across the City.	**Local, Regional, and to some extent, National:** residents, including vulnerable groups
Improving employment access for all groups, which may help the overall productivity and economic output.	**Local, Regional, and to some extent, National:** economy
Health and wellbeing	
Encouraging people to walk and cycle as a means to catch the light rail and in turn reducing car dependency. Offering an alternative means of travel that would reduce driver stress and anxiety.	**Local and Regional:** residents.

Social costs

Social costs (impacts) associated with the Proposed Action would mainly occur at a local scale during the construction. Table 8.2 identifies these.

Table 8.2: Social costs

Impact/cost	Scale
Property impacts	
Temporary leasing of land for construction compounds, stockpile sites and laydown areas would affect the area's amenity for up to four years. No property acquisition is needed to carry out the Proposed Action.	**Local:** people that routinely work or travel along the route. **Regional**: reduced attraction and amenity for visitors and tourists.
Demographics	
The construction workforce is likely to be sourced from the local labour market. This means few people would need to relocate to Canberra. Overall, there is not expected to be any downward pressure on the people who live and work in the area as they are unlikely to need to compete for available housing stock and rental properties. Equally, there is unlikely to be any upward pressure on rental costs as the workforce is not expected to relocate to into the centre of Canberra.	Any impact is considered negligible.
Movement and access	
The temporary increase in construction traffic and equipment plus a redistribution of traffic onto diversion routes would inconvenience people that live and travel along these routes. It could lead to travel time delays, potential stress and anxiety. Any delays are not considered to be substantial to the point of affecting regional economic performance as there are alternative routes and accesses available across the City. This means the impacts could be distributed across Canberra with no specific impact on one area or community.	**Local:** people that live and work along traffic diversions routes **Regional**: people who routinely travel through the City.
Amenity impacts	

Impact/cost	Scale
Temporary amenity-related impacts associated potential dust, noise and air quality emissions from the range of construction activities described in Chapter 2. Supplemented by temporary visual amenity impacts for those people that routinely travel into the City, or live or work in the area. Amenity impacts would occur at different scales and over different periods during construction. There is expected to be some temporary disruption for most of the intended four-year construction program, including some limited night-time disruption when carrying out the proposed night works, as described in Chapter 2.	**Local**: people that live and work along traffic diversions routes **Regional:** people who routinely travel through the City.
Economic	
There is expected to be some economic benefit and impact associated with the Proposal. Key is the loss of parking and loading, which would be managed through working with the community to identify agreeable alternatives. Also, there is the agreement to maintain some level of pedestrian and vehicle access to properties and carparks along the route to minimise disruption and economic impacts. There is however the recognition that the reduced access and amenity could affect outdoor café, bar, and restaurant seating areas for periods during construction. People may also actively avoid the construction sites. This could affect businesses that rely on passing trade or rely on the area's amenity, location and setting such as the serviced apartments and hotels.	**Local:** businesses along the route. **Regional:** business associated with the construction, leisure, food, beverage sector. **National:** stimulus through investment in a major project in central Canberra.
Vulnerable and special needs groups	
Young children, the elderly, those with existing health conditions and limited mobility would be the most vulnerable to amenity, health and access impacts. They may find it difficult to access the services and amenity along the route during construction. This would include the various administrative services along London Circuit. It would be managed through and effective pedestrian and access management plan, which would focus on vulnerable groups.	**Local and Regional**: vulnerable groups who rely on access to the businesses and administrative services along the route.
Social infrastructure	
None of the buildings or assets (including parks and public realm) would be directly impacted, but there may be changes in access and amenity of these areas due to the construction works. As above, people may be discouraged from using Commonwealth Park and Acton Waterfront for periods during construction. While this is the case, the works would be timed to avoid impacts to key events such as Floriade. Construction sites would also be actively managed to limit noise and dust, while visual hoardings and screening would be used to help reduce the scale of impact in any location particularly at ground-levels.	**Local and Regional**: recreational users, tourists and visitors to Commonwealth Park and Acton Waterfront.
Community values	
The community values of 'environmental living', 'access to green space', 'liveability', and 'high levels of access and movement 'would be temporarily impacted during construction for the reasons described above.	**Local**: people that live and work locally. **Regional:** people who routinely travel through the City.
Health and wellbeing	

Impact/cost	Scale
The temporary loss of amenity is not predicted to be at a scale that would present any human health impacts, meaning the levels of noise, dust and pollutants would be significantly below health-based guidance. However, as the construction works would affect the City for up to four years it may cause stress and anxiety for vulnerable groups, and for the businesses who rely on passing trade or access along the route.	**Local**: people that live and work locally. **Regional:** people who routinely travel through the City.

9.3 Economic benefits

Table 8.3 below is an extract from the *City to Woden Light Rail: Stage 2A City to Commonwealth Park Business Case* (Major Canberra Projects, 2019) which summarises what kind of investments are required to realise the economic benefits from the Proposed Action.

Table 8.3: Investment required to achieve benefits

Economic Benefit		Need for Investment			
		Economic diversification	Competitive and compact city	Accessibility	Reduced congestion
Transport benefits	Travel time savings	✓		✓	✓
	Reliability benefits	✓		✓	✓
	Vehicle operating costs	✓		✓	✓
	Net externalities	✓		✓	✓
	Accident costs	✓		✓	✓
	Transport revenue	✓		✓	
	Bus operation cost savings			✓	
	Health benefits	✓		✓	
	Light rail amenity benefits			✓	
	Residual value			✓	
	Second round transport benefits		✓	✓	✓
City-shaping benefits	Land value uplift		✓		
	Infrastructure cost savings		✓		
Wider economic benefits	Transport agglomeration	✓			
	Land use agglomeration		✓		

10 Environmental history

10.1 Preliminary documentation requirements

Your preliminary documentation must provide details of any proceedings under a Commonwealth, state or territory law for the protection of the environment, or the conservation and sustainable use of natural resources, against the person proposing to take the action (or if the person is a corporation, its executive officers).

If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must be provided.

10.2 Proponent response

Major Projects Canberra has not had any legal proceedings under a Commonwealth or Territory law for the protection of the environment, or the conservation and sustainable use of natural resources.

While Major Projects Canberra is undertaking the action, the Proposal would be undertaken in accordance with relevant ACT Government policies and guidelines, including the *ACT Planning Strategy 2018*, the *Moving Canberra 2018-2045 Integrated Transport Strategy* and the *ACT Climate Change Strategy 2019*.

11 Conclusion

This report responds the information (preliminary documentation) requested by the Australian Government Department of Agriculture, Water and Environment (DAWE) to support further assessment of the proposed action under the EPBC Act. Threatened species and communities relevant to this assessment were limited to the Golden Sun Moth *Synemon plana*; listed as critically endangered under the EPBC Act.

Proposed measures for avoiding and minimising impacts to Golden Sun Moth include design refinements to minimise the construction footprint and restoration activities. Approximately 1.43ha of cleared habitat for Golden Sun Moth will be restored within the southeast cloverleaf and Parkes Way median east of Commonwealth Avenue through post-works restoration treatments.

Residual impacts to Golden Sun Moth resulting from the proposed action include a loss of 5.4ha of habitat of habitat resulting from direct and indirect impacts associated with construction and operation. Assessment of residual impacts against conservation advice for the species indicates proposal activities will not interfere with any regional or local recovery conservation priorities for the species.

To compensate for residual impacts resulting from the proposal, 82 species credit biodiversity credits will be purchased by the ACT Government and retired in accordance with the NSW Biodiversity Offsets Scheme (BOS). This would occur prior to the commencement of construction.

12 References

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Appendix A

City to Commonwealth Park Preliminary Biodiversity Assessment: Biodiversity Draft Report (Biosis, 2019)

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CITY TO COMMONWEALTH PARK

PRELIMINARY ENVIRONMENTAL ASSESSMENT: BIODIVERSITY

DRAFT REPORT

PREPARED FOR TRANSPORT CANBERRA AND CITY SERVICES

14 JUNE 2019

Biosis offices

NEW SOUTH WALES

Newcastle
Phone: (02) 4911 4040
Email: newcastle@biosis.com.au

Sydney
Phone: (02) 9101 8700
Email: sydney@biosis.com.au

Wollongong
Phone: (02) 4201 1090
Email: wollongong@biosis.com.au

VICTORIA

Ballarat
Phone: (03) 5304 4250
Email: ballarat@biosis.com.au

Melbourne (Head Office)
Phone: (03) 8686 4800
Fax: (03) 9646 9242
Email: melbourne@biosis.com.au

Wangaratta
Phone: (03) 5721 9453
Email: wangaratta@biosis.com.au

Document information

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Prepared by:	Matthew Hyde, Bianca Klein, Adam Baus, and Tony Cable
Biosis project no.:	30205

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Document control

Version	Internal reviewer	Date issued
Draft version 01	Tony Cable	14/06/2019
Final version 01	TBC	TBC

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- Transport Canberra and City Services: Marcus Sainsbury
- Department of the Environment and Energy for access to the Protected Matters Search Tool of the Australian Government
- ACT Government for access to the ACTmapi database.
- NSW Office of Environment and Heritage for access to the BioNet Atlas of NSW Wildlife.
- NSW Department of Primary Industries for access to the Fisheries Spatial Data Portal.

Contents

Tables

Figures

1 Introduction

Biosis Pty Ltd was commissioned by RPS Pty Ltd (RPS) on behalf of Transport Canberra and City Services (TCCS) to undertake a biodiversity assessment to form part of the Preliminary Environmental Assessment (PEA) for the City to Woden Light Rail (C2W) project. The C2W project is split into two stages; the first part covering the construction of the light rail from City to Commonwealth Park, the second stage covering Commonwealth Park to Woden. The City to Commonwealth Park stage is the subject of this report and is referred to hereafter as 'the study area'. Biosis previously completed desktop and rapid field based ecological assessments for the entire C2W project footprint (Biosis 2017a) to determine the potential impacts to biodiversity from construction activities associated with the project.

The preliminary ecological constraints analysis undertaken by Biosis (2017a) highlighted the key locations of ecological values along the proposed alignment, such as; threatened species, populations and ecological communities (biota), or their habitat, listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and the Australian Capital Territory (ACT) *Nature Conservation Act 2014* (NC Act). The aim of the desktop assessment was to identify constraints within the study area that would require consideration during the design phases.

Following the desktop assessment, the rapid field based preliminary investigations ground-truthed the findings of the desktop assessment within the study area. This included assessment of impacts upon threatened biota that were present or had the potential of occurring within the study area. Investigations were undertaken in accordance with the EPBC Act, the ACT *Planning and Development Act 2007* (P&D Act), and the NC Act. As well as identifying areas of high ecological constraint, the aim of this assessment was to test the accuracy of the desktop assessment in the identification of ecological constraints.

The findings of both the desktop assessment and rapid field investigations guided detailed quantitative assessments, focused on areas identified as ecologically sensitive. This biodiversity assessment describes the findings of the detailed targeted threatened flora and fauna surveys, and vegetation composition and condition assessments undertaken throughout the study area. This report will support the application for the Environmental Impact Statement (EIS) scoping document and referral required to the Commonwealth Minister for the Environment and Energy under the EPBC Act.

2 Background

2.1 The study area

The project is located in Canberra, ACT, and forms part of the proposed C2W project. The project would create a four-stop light rail service between Canberra city and Commonwealth Park that would provide access to educational institutions and key landmarks in the city. The service would also link with the current City to Gungahlin (C2G) light rail in Civic, as well as the second stage of the C2W project (Commonwealth Park to Woden) at its southern terminus. .

The proposed alignment associated with the City to Commonwealth Park stage is approximately 1.7 kilometres in length and approximately 50 metres in width either side of this alignment identified has been identified as the study area. The construction corridors for City to Commonwealth Park are included within the study area in this report and are illustrated in Figure 1.

2.2 The proposed development

This assessment forms part of the larger C2W project, which incorporates a rail corridor connecting the City to surrounding suburbs. The project aims to provide an efficient environmentally responsible public transport option for Canberra's growing population. The City to Commonwealth Park stage of this project would use the existing road network to connect from the C2G terminus at Alinga Street, run down the middle (median) of London Circuit (west) before joining Commonwealth Avenue where it would terminate at the West Basin light rail stop.

Four light rail stops would be indicatively provided as part of the proposed development located at:

- Alinga Street (e.g. the existing terminus of the C2G light rail)
- City West
- Commonwealth Park
- West Basin (forming a temporary terminus).

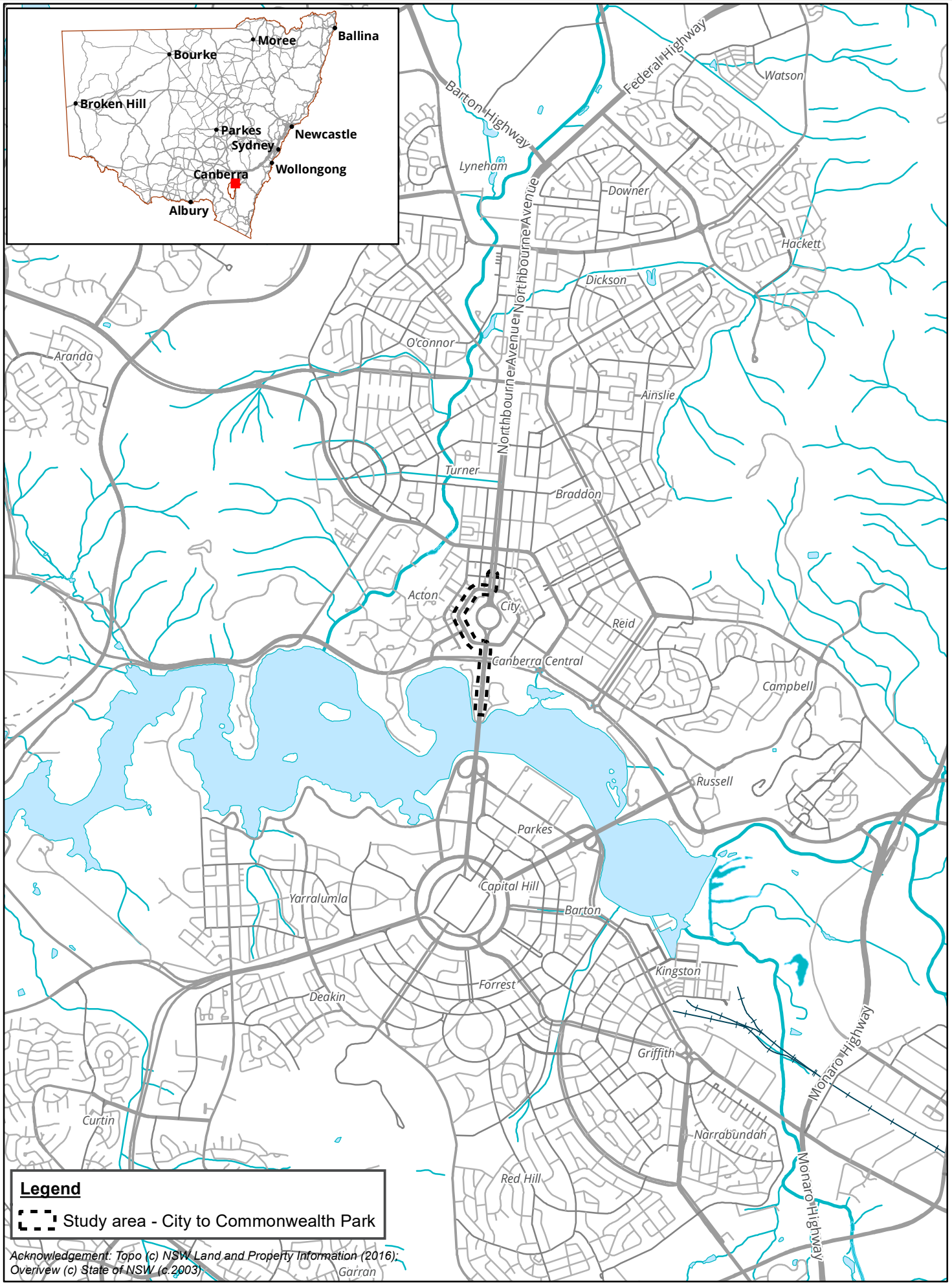


Figure 1 Location of the study area, ACT

Matter: 30205
Date: 14 June 2019,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location:P:\30200s\30205\Mapping\

Scale 1:50,000 @ A4, GDA 1994 MGA Zone 56

Biosis Pty Ltd
Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

3 Legislative context

This section provides an overview of key biodiversity legislation and government policy considered in this assessment. Where available, links to further information are provided. This section does not describe the legislation and policy in detail and guidance provided here does not constitute legal advice.

3.1 Commonwealth

3.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is a Commonwealth mechanism that requires proposed 'actions' to be assessed in terms of their potential impact upon 'Matters of National Environmental Significance' (NES). Matters of NES currently listed under the EPBC Act include:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)
- Water resources, in relation to coal seam gas development and large coal mining development

Matters of NES relevant to the current project include nationally threatened species and ecological communities, and migratory species. Where potential impacts to these Matters of NES may occur as a result of a proposed 'action', the significance of that impact must be assessed. Guideline criteria for determining whether a proposed action is likely to have a significant impact on Matters of NES are provided under the Act and in the *Matters of National Environmental Significance: Significant impact guidelines 1.1* (CoA 2013a). Where a proposed action will, or is likely to, have a significant impact on a Matters of NES, a referral to the Commonwealth Minister for the Environment and Energy must be prepared. The purpose of the referral is to determine whether a proposed action requires approval and/or controls under the EPBC Act.

3.1.2 Actions on, or impacting upon Commonwealth land

In addition to Matters of NES protected under the EPBC Act, any person who proposes to take an action which is either situated on Commonwealth land, or which may impact on Commonwealth land, is required to determine whether the proposed action is likely to have a significant impact on the environment. Guideline criteria for determining whether a proposed action is likely to have a significant impact on the environment are provided under the Act and in the *Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies: Significant impact guidelines 1.2* (CoA 2013b).

If a referral is considered necessary due to a proposed action having a significant impact either on a Matter of NES, or upon the environment on Commonwealth land, only one referral to the Commonwealth Minister for the Environment and Energy including all relevant matters is necessary.

3.2 Territory

3.2.1 Nature Conservation Act 2014

The NC Act is the primary legislation for the protection of native flora and fauna in the ACT, and for the management of the conservation reserve network. It provides the legal underpinning of nature conservation policy, management and action across the ACT.

Where a proposed action has the potential to impact (directly or indirectly) upon NC Act listed threatened species or ecological communities, the NC Act requires that such potential impacts be assessed. An important definition provided in the NC Act is that for 'native vegetation area'. The NC Act defines 'native vegetation area' as:

a) either:
   i) 10% or more of the area is covered with vegetation (whether dead or alive; and
   ii) no more than 60% of the ground layer vegetation cover is exotic annual (at any time of the year); and
   iii) more than 50% of the perennial ground layer vegetation cover is native vegetation; or
b) trees or shrubs indigenous to the area have a canopy cover of 10% or more in any stratum

4 Methodology

Prior to preliminary field investigations, threatened ecological communities and biota identified as having a likelihood of occurring in the study area (Table 2, Biosis 2017a) were reviewed and their likely locations within the study area mapped.

The likelihood of occurrence for threatened flora species and threatened and/or migratory fauna species is a broad categorisation used by Biosis to indicate the potential for a species to occur within the site. It is based on expert opinion, the results of targeted surveys, the findings of the completed desktop and field investigations, and comparison of these findings with the recognised distribution and preferred habitat of each species. The determinations of likelihood are expressed as negligible, low, medium, or high. If a species or ecological community has been identified on site during the field survey, or by other confirmed records, then it is documented here as having been 'recorded'.

4.1 Field surveys

Field survey effort included a total of approximately 24 person days undertaken by five ecologists; Tony Cable (Senior Ecologist), Carl Corden (Zoologist), Bianca Klein (Botanist), Luke Stone (Field Ecologist) and Averill Wilson (Botanist). Surveys were undertaken from 7 December 2017 to 16 January 2017.

The objective of the surveys was to quantitatively assess and categorise vegetation communities within the study area, in accordance with the *Survey guidelines for determining lowland vegetation classification and condition in the ACT* (CPR 2012). Targeted surveys were also undertaken for EPBC Act and NC Act listed biota previously identified as having a medium or greater likelihood to occur within the study area (Biosis 2017a). Targeted flora and fauna surveys were undertaken in accordance with known flowering/emergence times or targeted survey guidelines (CoA 2009).

Field surveys were completed within the study area (Figure 2) as follows:

- Vegetation plots and step-point transects to classify vegetation communities and assess condition.
- Mapping of all identified vegetation communities and fauna habitats using hand held devices operating ArcGIS collector, whilst traversing the entire study area on foot.
- Targeted surveys undertaken in areas identified as having a medium or greater likelihood of supporting threatened species. These included targeted surveys for the following species:
  - Flora:
    - Button Wrinklewort *Rutidosis leptorrhynchoides* (Endangered, EPBC Act and NC Act). Confirmed as flowering at the Australian National Botanic Gardens at time of survey.
    - Canberra Spider Orchid *Caladenia actensis* (Critically Endangered, EPBC Act and Endangered, NC Act).
    - Hoary Sunray *Leucochrysum albicans* var. *tricolor* (Endangered, EPBC Act). Confirmed as flowering at the Australian National Botanic Gardens at time of survey.
    - Snake orchid *Diuris lanceolata* (Endangered, EPBC Act).
    - Erect Pepper-cress *Lepidium pseudopapillosum* (Vulnerable, EPBC Act).
  - Fauna:
    - Golden Sun Moth *Synemon plana* (Critically Endangered, EPBC Act and Endangered, NC Act).

4.1.1 Vegetation classification

Field surveys were completed to provide a quantitative assessment of floristic composition and vegetation condition within the study area. The objectives of the vegetation surveys were to:

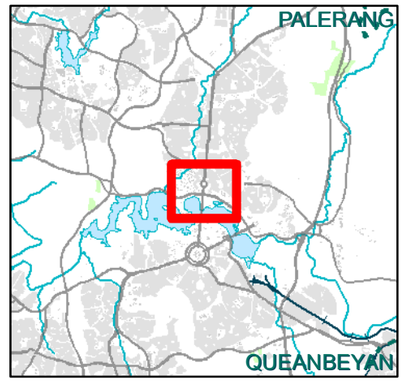
- Determine the vegetation communities present.
- Determine whether vegetation communities met the definition of 'native vegetation', as defined under the NC Act.
- Assess the presence of threatened ecological communities listed under the EPBC Act or NC Act.

Vegetation surveys were undertaken in accordance with the *Survey guidelines for determining lowland vegetation classification and condition in the ACT* (CPR 2012). Two plots and 'step-point' transects were undertaken within the study area. Locations were identified in preliminary assessments as areas supporting native vegetation and/or having the potential to support threatened biota or ecological communities. These were located in areas of grassland (Biosis 2017a).

The structure of the vegetation communities determined the methodology used to assess community floristic composition and condition. For these grassland communities (consisting of less than 10% canopy cover), 20 x 20 metre quadrats were undertaken and an inventory of flora species within each quadrat was created. Species were assigned a cover abundance score using the Braun-Blanquet scale as per *Appendix D - Species cover and abundance* (CPR 2012).

Step-point transects were completed for grassland communities. Transects consisted of a traverse along a minimum length of at least 100 metres through an area most representative of the typical groundcover present in the surrounding area. Data collected included percent cover of native species, annual or perennial exotic species, and bare ground as per *Appendix E – Step point transects* (CPR 2012). A summary of the step-point data is provided in Appendix 1. Geographical locations of plots and transects are illustrated in Figure 2.

Vegetation communities within the study area consisting of native vegetation as defined by the NC Act were classified according to the criteria described in *Appendix B – ACT Vegetation communities* (CPR 2012). The remaining non-native vegetation communities were defined based on community classifications described in ACT's most up to date vegetation mapping dataset (ACT Government 2014). Table 1 describes the vegetation communities, native or otherwise, identified within the study area.



Legend

- Study area
- Vegetation plots and transects

Figure 2 Plot and transect locations

City to Commonwealth Park

0 100 200 300 400

Metres

Scale: 1:8,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 30205
Date: 14 June 2019,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location:P:\30200s\30205\Mapping
30205_Stage2A_F2_PlotandTransects

Acknowledgements: Basemap © Land and Property Information 2016

4.1.2 Targeted threatened flora surveys

Targeted searches for threatened flora were undertaken in conjunction with each plot/transect. Additional areas consisting of vegetation identified with potential to provide suitable habitat for threatened flora were also assessed. This resulted in the majority of the study area being surveyed with the exception of mown lawns and landscaped gardens.

Surveys were undertaken by two botanists using the random meander technique (Cropper 1993), within vegetated areas likely to support threatened species.

4.1.3 Targeted threatened fauna surveys

Golden Sun Moth surveys were undertaken in the entirety of the study area in accordance with *Significant impact guidelines for the critically endangered Golden Sun Moth (Synemon plana)* (CoA 2009). Three survey events were undertaken; six days from 7 December to 22 December 2017 (excluding 20/12/2017), and two days from 8 January to 9 January. Surveys in January were undertaken to characterise habitats where the species was recorded, and allow for quantification of the total Golden Sun Moth habitat present within the study area.

During each survey event, areas within the study area were traversed by two ecologist on warm/hot days where temperatures reached a minimum of 20 degrees Celsius by 10:00 am. Conditions were deemed suitable for Golden Sun Moth surveys during this period (Table 2). GPS coordinates were recorded upon sightings and a count of individuals in the vicinity estimated. Outside of the 10:00 – 14:00 timeframes, incidental sightings were also recorded.

4.1.4 Limitations

Ecological surveys provide a sampling of flora and fauna at a given time and season. There are a number of reasons why not all species will be detected at a site during survey, such as species dormancy, seasonal conditions, and migration and breeding behaviours of some fauna. In many cases these factors do not present a significant limitation to assessing the overall ecological values of a site.

The larger flora and fauna field survey was conducted in summer, which is the optimal time for survey for all of the threatened species targeted in this assessment. It should also be noted that floristic diversity is likely to be reduced when compared with diversity expected in spring, during the peak flowering period for the majority of flora species. Overall survey effort is considered sufficient to assess the presence/absence of all threatened species likely to occur within the study area.

5 Results

5.1 Vegetation community classification

Given the geographical characteristics (elevation, aspect, geology etc.) of the study area, and the floristic composition of the vegetation communities occurring within and adjoining the study area, it can be expected that pre-European settlement the study area would have supported a mosaic of temperate lowland woodland types.

5.1.1 Threatened ecological communities

The majority of the study area is subject to extensive urban and industrial development with the remaining vegetation consisting primarily of manicured lawns and mixed urban plantings. No Threatened Ecological Communities (TECs) listed under the EPBC Act or NC Act were detected in the study area.

5.1.2 Urban vegetation communities

Two vegetation communities were identified within the study area but these did not meet the criteria of any native ACT vegetation communities. Despite many tree species known to grow in the region present throughout the study area, plantings were inconsistent with soil types typically associated with these species. Due to these inconsistencies they are highly unlikely to mature into a climax vegetation community similar to any of the described native communities. Therefore these communities were not included under the native vegetation classification in this assessment.

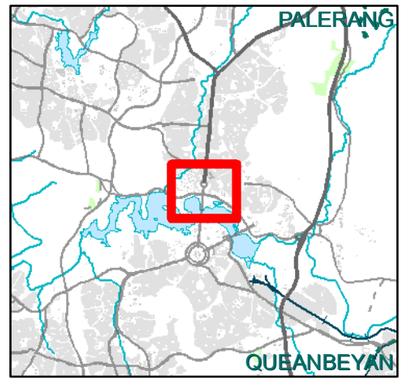
Characteristics of the vegetation communities identified in the study area are described in Table 1 and Figure 3. An inventory of flora species and relative abundance at each plot/transect is provided in Appendix 1.

Six declared pest plant species, listed under the ACT *Pest Plants and Animals (Pest Plants) Declaration 2015 (No 1)*, were identified within the study area and are included in Appendix 1; Table 3.

Table 1 Vegetation communities of the study area

Modified Grassland	
Extent within study area	Approximately 1.28 hectares of modified grassland was recorded throughout the study area. The majority of the median strips and edges of roads consisted of modified grassland vegetation.
Description	Modified grasslands are identified as mown/landscaped areas of mixed native and exotic grasses. The underlying soils are highly modified and disturbed, lacking characteristic properties associated with natural landscapes. Modified grasslands occurred in areas with less than 10% tree canopy cover and an absent or reduced shrub layer. The typical groundcover species included African Lovegrass, Chilean Needle Grass *Nassella neesiana*, and Plantain *Plantago lanceolata*. Golden Sun Moth were recorded throughout areas of modified grassland within the study area (Figure 4).
Condition	The community was recorded in low condition due to the extent of ongoing disturbance and high proportion of exotic groundcover.
Threatened ecological community	This community does not meet the criteria for *Natural Temperate Grassland* based on the high percentage of exotic perennial groundcover.
Modified Grassland	 **Plate 1 Modified grassland located within the study area**

Urban Vegetation – Planted Exotic	
Extent within study area	Approximately 2.42 hectares of urban vegetation – planted exotic was present in the study area. This vegetation community was commonly located in built up areas and along major road verges.
Description	This community was characterised by exotic, deciduous ornamental trees. Common species included Silver Birch *Betula pendula*, Robinia *Robinia pseudoacacia*, Maple *Acer* sp., and Cypress Pine *Cupressus* sp. The midstorey was predominantly absent and the groundcover consisted of mown grassy areas dominated by exotic species, particularly Chilean Needle Grass.
Condition	The community was recorded in low condition and provides marginal habitat for local fauna. Golden Sun Moth was recorded in this vegetation community.
Threatened ecological community	Not applicable.
Urban Vegetation – Planted Exotic	 **Plate 2 Urban vegetation – planted exotics located within the study area**



Legend

Study area

Vegetation communities - Surveyed

Modified grassland

Urban vegetation - Exotics

Figure 3 Vegetation communities

City to Commonwealth Park

0 70 140 210 280 350

Metres

Scale: 1:8,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 29561
Date: 13 June 2019,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location:P:\30200s\30205\Mapping
30205_Stage2A_F3_VegComms

5.2 Threatened flora

Biosis has previously assessed the likelihood of occurrence for EPBC Act and/or NC Act listed threatened flora species likely to occur within the locality based on previous records (2017a). The following species were identified has having a medium or greater likelihood of occurring:

- Button Wrinklewort
- Canberra Spider Orchid
- Hoary Sunray
- Snake Orchid
- Erect Pepper-cress

Targeted surveys for the above species were undertaken along the proposed corridor in areas identified as most suitable to support threatened flora. This included areas with a dominance of native species (remnant and planted) that exhibited minimal recent disturbance and included unmown areas. Scattered records of Button Wrinklewort occur adjacent to the study area and as such resolving the occurrence of this species within the study area was a focus of the targeted surveys.

Targeted surveys were completed at each plot/transect location and in additional areas exhibiting native diversity (Figure 2).

No threatened flora species were identified within the study area. The survey effort and timing of survey is considered adequate to confirm the absence of threatened flora within the study area.

5.3 Threatened fauna

5.3.1 Habitat assessment

The preliminary desktop assessment identified areas of potential habitat for threatened fauna (Biosis 2017a), with Golden Sun Moth and Striped Legless Lizard *Delma impar* both identified as likely to occur within the study area. However, no suitable habitat for Striped Legless Lizard was identified during the field assessments. The study area lacked habitat features commonly utilised by Striped Legless Lizards as shelter including; structurally complex native grasslands dominated by tussock-forming grasses over ground with soil cracks, and lightly embedded rocks or woody debris.

Golden Sun Moth can occur in grassland and grassy woodland with a sparse canopy. The larvae typically feed on tussock grasses including Wallaby Grasses but are also known to feed on introduced grasses including Chilean Needle Grass and Serrated Tussock *Nassella trichotoma* (TSSC 2016). Chilean Needle Grass was particularly dominant throughout the study area, thus targeted surveys for Golden Sun Moth were undertaken over the entirety of the study area.

5.3.2 Golden Sun Moth targeted surveys

A total of 52 individual Golden Sun Moths were encountered during targeted surveys conducted in the City to Commonwealth Park study area, with the highest densities observed within the modified grassland vegetation located in the clover-leaf road network south of London Circuit (Figure 4).

The species was recorded as active within the ACT on 22 November 2017 on local ecological networks (Canberra Nature Map alerts). Weather conditions were optimal for all surveys, with the exception of 9 December 2017 when temperature was 17.2 °C and conditions were overcast when surveys commenced (Table 2).

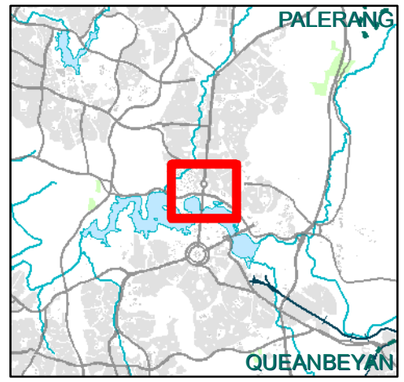
Following the third survey event, geographical assessment of the study area was undertaken to quantify the areas of habitat deemed suitable for Golden Sun Moth. As the larval stage occurs underground for 2 to 3 years it is difficult to assess presence of individuals when in this form. However, it is likely that colonisation of areas containing habitat likely to support larvae is contiguous with sites where adults were successfully identified. This assessment resulted in a total of 2.6 hectares of Golden Sun Moth Habitat identified within the study area (Figure 4).

Populations of the species are considered isolated if they occur greater than 200 metres apart (CoA 2009). Therefore, the study area contains one population identified as Population 1 - Parkes Way and Cloverleafs (Figure 4).

An assessment against Significant Impact Criteria (SIC) outlined in the *Matters of National Environmental Significance: Significant impact guidelines 1.1* (CoA 2013a) has been undertaken and is included in Appendix 2; Table 5. Based on this assessment, referral to the Commonwealth Minister for the Environment and Energy under the EPBC Act is recommended.

Table 2 Temperature and rainfall recorded in Canberra during Golden Sun Moth surveys (Beureau of Meteorology 2018)

Date	8/12/2017	9/12/2017	18/12/2017	19/12/2017	21/12/2017	22/12/2017	8/1/2018	9/1/2018
Maximum temperature (degrees Celsius)	26.7	22.5	32.6	34.3	26.7	29.5	32.8	32.0
Rainfall (mm)	0.2	6.2	1.6	0	2.2	0	0	0.2



Legend

Study area

Golden Sun Moth

Habitat (count annotated)

Populations

Figure 4 Golden Sun Moth habitat and records

City to Commonwealth Park

0 80 160 240 320 400

Metres

Scale: 1:8,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 30205
Date: 14 June 2019,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location:P:\30200s\30205\Mapping
30205_Stage2A_F4_GSM_Habitat

Acknowledgements: Basemap © Land and Property Information 2016

6 Impact assessment

6.1 Potential impacts on threatened ecological communities

No TECs listed under the EPBC Act or NC Act were identified within or adjacent to the study area.

In accordance with the above, referral of the proposed development to the Commonwealth Minister for the Environment and Energy for assessment against the provisions of the EPBC Act is not considered warranted for impacts upon any threatened ecological communities.

6.2 Potential impacts on threatened flora

No threatened plant species were recorded within the study area during any of the field assessments. Given the results of the completed desktop and field assessments, it is considered highly unlikely that any threatened flora species occur within the study area.

In accordance with the above, referral of the proposed development to the Commonwealth Minister for the Environment and Energy for assessment against the provisions of the EPBC Act is not considered warranted for impacts upon any threatened flora species.

6.3 Potential impacts on threatened fauna

The fauna habitats within the study area were very limited owing to the extensive urbanisation of the study area and its surrounds. Fauna habitat in the form of hollow bearing trees or rocky outcrops were absent from the study area, however some tree hollows not visible from the ground may occur. The limited suitable habitat located within the study area consisted of open woodlands and modified grasslands. The habitat provided by the open woodland was not linked to any threatened fauna however, the modified grasslands across the study area were found to support four separate populations of Golden Sun Moth.

As the Golden Sun Moth is listed under the EPBC Act, an SIC assessment against the *Matters of National Environmental Significance: Significant impact guidelines 1.1* (CoA 2013a) for the EPBC Act has been undertaken and is provided in Appendix 2. Based on this assessment, referral to the Commonwealth Minister for the Environment and Energy under the EPBC Act is recommended.

6.4 Potential impacts on migratory fauna

The list of migratory species under the EPBC Act is a compilation of species listed under four international conventions:

- China-Australia Migratory Bird Agreement (CAMBA)
- Japan-Australia Migratory Bird Agreement (JAMBA)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)

Areas of important habitat for a migratory species are defined by the Commonwealth Department of the Environment and Energy as:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species.
- Habitat that is of critical importance to the species at particular lifecycle stages.
- Habitat utilised by a migratory species which is at the limit of the species range.
- Habitat within an area where the species is declining (DEWHA 2009b).

No listed migratory species are considered to have a high potential for occurrence within the study area.

In accordance with the above, referral of the proposed development to the Commonwealth Minister for the Environment and Energy for assessment against the provisions of the EPBC Act is not considered warranted for impacts upon listed migratory fauna species.

6.5 Assessment against the ACT Planning and Development Act and EIS triggers

Pursuant to the P&D Act, the project involves the construction of a light rail corridor and is likely to result in biodiversity impacts listed under Part 4.3 of Schedule 4 of the P&D Act.

The ecological impacts that trigger the requirement to prepare an EIS for the project are detailed below. An assessment of the project against each of these triggers is also provided.

Item 1. *If the proposal is likely to have a significant adverse environmental impact on a species that is endangered, unless the conservator of flora and fauna produces an environmental significance opinion that the proposal is not likely to have a significant adverse environmental impact.*

A Significant adverse environmental impact as defined under the P&D Act occurs when:

a) the environmental function, system, value or entity that might be adversely impacted by a proposed development is significant; or
b) the cumulative or incremental effect of a proposed development might contribute to a substantial adverse impact on an environmental function, system, value or entity.

In deciding whether an adverse environmental impact is significant, the following matters must be taken into account:

a) the kind, size, frequency, intensity, scope and length of time of the impact;
b) the sensitivity, resilience and rarity of the environmental function, system, value or entity likely to be affected.

Given the results of the completed assessment and surveys of the study area, it can be concluded that the project is likely to result in a significant adverse environmental impact upon one threatened fauna species; Golden Sun Moth, listed as Endangered under the NC Act.

Item 2. *If the proposal will result in the clearing of more than 0.5 hectares of native vegetation on land that is not designated as a future urban area under the territory plan, unless the conservator of flora and fauna produces an environmental significance opinion that the clearing is not likely to have a significant adverse environmental impact.*

No more than 0.5 hectares of native vegetation will be cleared. The land within the study area lies within an urban area, located in Canberra, therefore this Item does not apply to the project.

6.6 Assessment against significant impact criteria for proposed actions on, or impacting upon, Commonwealth land

The project includes proposed actions on, or impacting upon Commonwealth land and therefore assessment against the EPBC Act significant impact guidelines '*Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies*' (CoA 2013b) under the EPBC Act is required.

The study area includes habitat and known populations of one EPBC Act listed threatened species, Golden Sun Moth, listed as Critically Endangered and likely to be significantly impacted by the proposed development. As such it is likely that the proposed action will have a significant impact upon environment located within Commonwealth land and referral to the Commonwealth Minster for the Environment and Energy for assessment against the provisions of the EPBC Act is considered warranted.

7 Conclusion

This report assesses the ecological significance of threatened flora and fauna species, and EECs that occur, or have the potential to occur, within the area to be impacted upon by the proposed development, in accordance with the EPBC Act, P&D Act and the NC Act.

Given the results of the completed desktop assessment and targeted surveys of the study area, it is concluded that the proposed development is likely to significantly impact upon one EPBC Act and NC Act listed threatened fauna species; Golden Sun Moth.

No threatened flora species were recorded within the study area. Given the considerable survey effort undertaken within the study area during the optimal survey season for most ACT threatened flora, it is considered highly unlikely that any threatened flora species occur within.

No TECs were recorded within or adjacent to the study area.

Given the likely significant impacts upon the EPBC Act listed fauna species Golden Sun Moth, referral of the proposed development to the Commonwealth Minister for the Environment and Energy for assessment against the provisions of the EPBC Act is considered warranted.

In the context of the P&D Act, the project will result in biodiversity impacts listed under Part 4.3 of Schedule 4 of the P&D Act.

7.1 Recommendations

The primary means of minimising the impacts of the project on ecological values will be to minimise the clearing of existing vegetation. The vegetation within the study area still provides suitable habitat for a suite of common native flora and fauna species which remain important to natural ecological processes of the region. The following recommendations are made to reduce direct and indirect impact upon ecological values:

- Undertake detailed design and route planning in consideration of Golden Sun Moth habitat within the study area. Once confirmation of the route and a likely construction footprint can be defined, a referral to the Commonwealth Minister for the Environment and Energy in accordance with the EPBC Act should be prepared.
- Establish no-go zones around areas of Golden Sun Moth habitat immediately adjacent to the construction footprint, to ensure vehicles, machinery and heavy foot traffic does not impact on these areas.
- Tree felling is to be undertaken by an appropriately trained and qualified arborists.
- Any branch trimming within the study area is to be undertaken by accredited and experienced arborists using cleaned and sterilised equipment to prevent the transmission of plant pathogens.
- All green waste resulting from vegetation removal is to be mulched and disposed of appropriately.
- Tree Protection Zones (TPZs), including root protection zones and canopy protection zones, should be established around remnant trees in accordance with *Australian Standard (AS4970-2009) Protection of Trees on Development Sites* (Australian Standard 2009). These protection zones should be fenced off with signage installed designating them as environmental exclusion zones.
- Construction staff should be inducted to an appropriate level and made aware of the location and extent of vegetation designated as to be retained.

- Any construction compounds associated with the proposal should be located in areas where impacts to retained native vegetation are minimised. The removal of native or mature canopy species for compound purposes should be avoided.
- Six plant species are declared pest plant species in the ACT listed under the *Pest Plants and Animals (Pest Plants) Declaration 2015 (No 1)* (Appendix 1; Table 3). Therefore it is important to prevent the dispersal of weed seed or soil-borne pathogens into native vegetation through the implementation of vegetation hygiene protocols for footwear, vehicles, heavy plant and machinery.
- Appropriately designed sediment and erosion controls should be installed and maintained during excavation works to prevent any potential sediment runoff entering nearby stormwater drains.
- An independent environmental auditor should be engaged to assess environmental management procedures and delivery of the project. The environmental auditor should ensure procedures are in place for stakeholders and community to provide feedback on environmental management measures.

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Appendix 1 Vegetation community floristic composition and condition

Table 3 Quadrat and plot data (Braun-Blanquet scale)

D: Dominant, S: Subdominant, C: Codominant, r: rare

Scientific name	Common name	CLR5	CLR6
Native			
Bothriochloa macra	Red leg Grass	1	
Chloris truncata	Windmill Grass	1	
Cotula australis	Carrot Weed		1
Einadia nutans	Saltbush	1	
Eucalyptus bridgesiana	Apple Box	D	D
Geranium solanderi		1	
Oxalis perennans		1	
Rytidosperma laeve		1	1
Exotic			
**Acacia baileyana*	Cootamundra Wattle	1	
Bromus catharticus	Prairie Grass	1	
Cynodon dactylon	Couch Grass	1	2
Dactylis glomerata	Cocks-foot Grass	1	1
**Eragrostis curvula*	African Lovegrass		1
Erodium cicutarium	Common Storksbill	1	
Gazania sp.		1	1r
Hirschfeldia incana	Brassica	1	
Hordeum sp.	Barley		1
Lepidium africanum	Common Peppercress		1
Lolium perenne	Perennial Ryegrass	1	1
Malva neglecta	Dwarf Mallow		1
Modiola caroliniana	Mallow	1	
**Nassella neesiana*	Chilean Needle Grass	2	2
**Nassella trichotoma*	Serrated Tussock	1	
Paronychia brasiliana	Brazilian Whitlow	1	1
Paspalum dilatatum	Paspalum	2	1
Plantago lanceolate	Plantain		2
Poa annua		1	1
Prunus sp.			1r
Robinia pseudoacacia			1
Salvia verbenaca	Wild Sage		1
Trifolium arvense	Hares-foot Clover	1	
Vicia sp.	Vetch		1
**Cotoneaster* sp.		1	

Scientific name	Common name	CLR5	CLR6
**Robinia pseudoacacia*	Robinia		1r

* - denotes species Declared pest plant species in the ACT listed under the Pest Plants and Animals (Pest Plants) Declaration 2015 (No 1).

Table 4 Step-point data

Groundcover	Plot	
	CLR5	CLR6
Bare Earth	13	10
Litter/Dead Vegetation	8	11
Perennial Exotic Grass	85	135
Exotic Broadleaf	27	33
Perennial Native Grass	35	4
Other Native	10	5
Total	**178**	**198**
% Native	29	5
% Native (of all grasses)	29	5
% Native perennial vegetation	29	5

Appendix 2 Significant Impact Criteria – Golden Sun Moth

Table 5 Assessment of the project against significant impact criteria for Commonwealth listed endangered species (DOE 2013)

Significant Impact Criteria for endangered species (DoE 2013).	Likelihood of the project triggering criteria for Golden Sun Moth	Response to criteria
1. Lead to a long-term decrease in the size of a population	High	One population, identified as Population 1, occupying a total area of 2.6 hectares occurs within the vicinity of the study area. This population will be impacted by the project and it is highly likely that a long-term decrease in its size will occur.
2. Reduce the area of occupancy of the species	High	Construction of the project will impact on areas of occupied Golden Sun Moth habitat and will therefore reduce the area of occupancy of the species.
3. Fragment an existing population into two or more populations	High	Proposed works will disrupt continuity of habitat in the medium to long-term to the extent that the existing population will be fragmented into two or more populations. However, the current level of fragmentation in the surrounding landscape is already high, given the extent of urbanisation. Golden Sun Moths are able to persist in highly fragmented landscapes.
4. Adversely affect habitat critical to the survival of a species	High	Habitat critical to the survival of a species is defined by DoE (2013) as areas that are *necessary* for essential activities (e.g. foraging, breeding, roosting, or dispersal), for the long-term maintenance of the species, maintaining genetic diversity and long term evolutionary development, and/or the recovery of the species. All populations of Golden Sun Moth are considered to be important for the long-term survival and recovery of the species (Commonwealth of Australia 2009). By extension, it is therefore assumed that the project will adversely affect habitat critical to the survival of the species by permanently removing occupied habitat.
5. Disrupt the breeding cycle of a population	High	The proposed works may affect an unknown number of breeding individuals within and in close proximity to the construction footprint through direct mortality and disturbance during construction works. This is likely to result in a disruption to the breeding cycle within the local population identified within the study area.
6. Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	High	The proposed works will result in the destruction and removal of habitat for the species. While vegetation outside of the direct construction footprint can be re-established following works through sod-salvage and planting, vegetation is unlikely to represent original structure and quality and will therefore be modified.
7. Result in invasive species that are harmful to a critically endangered or	Unlikely	The population of Golden Sun Moth within and adjacent to the project area occurs in exotic grassland dominated by the invasive Chilean Needle-grass. The proposed works are highly unlikely to result in new

Significant Impact Criteria for endangered species (DoE 2013).	Likelihood of the project triggering criteria for Golden Sun Moth	Response to criteria
endangered species becoming established in the endangered or critically endangered species' habitat		weeds or pests becoming established within the study area. It is recommended that a suitable weed management protocol is implemented to ensure that no transfer of weeds or pests occur as a result of the proposed works.
8. Introduce disease that may cause the species to decline	Unlikely	There are no known diseases that have been transmitted to this species as a result of human activity.
9. Interfere with the recovery of the species.	High	There is no approved recovery plan for Golden Sun Moth, however the Commonwealth of Australia (2009) consider all populations to be important for the long-term survival and recovery of the species. It is likely that the proposed works will substantially interfere with the recovery of the species as a whole.
Significant impact guidelines for the critically endangered Golden Sun Moth (Synemon plana; Commonwealth of Australia 2009)		
Habitat loss, degradation or fragmentation >0.5 ha of a large or contiguous habitat area (>10 ha)	Not applicable	The area of Golden Sun Moth habitat within the study area does not form part of a large or contiguous habitat area consisting of greater than 10 hectares.
Any habitat loss, degradation or fragmentation of a small or fragmented habitat area (<10 ha).	High	The project will impact 2.6 hectares of Golden Sun Moth habitat consisting of one population, resulting in further fragmentation to the existing population.
Fragmentation of a population through the introduction of a barrier to dispersal	High	The project involves the construction of a linear light rail corridor of approximately 50 metres in width through all part of the existing Golden Sun Moth population. The corridor will likely form an obstructive barrier to dispersal, thereby fragmenting existing populations within the study area.

Appendix B

Vegetation community floristic data

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Table B.1: Flora species schedule

Scientific name	Common name	Status	T1	T2
Arctotheca calendula	Capeweed	I		x
Austrostipa bigeniculata	Tall Speargrass	N		
Bromus catharticus	Prairie Grass	I		
Bromus hordeaceus	Soft Brome	I		x
Chloris truncata	Windmill Grass	N	x	
Cynodon dactylon	Couch Grass	I	x	x
Eleusine tristachya	Goose Grass	I	x	
Eragrostis curvula	African Lovegrass	I	x	x
Erodium sp.	Storksbill	I		
Eucalyptus cinerea (planted)	Argyle Apple	N		
Festuca arundinacea	Tall Fescue	I	x	
Gazania sp.	Treasure Flower	I		x
Hordeum leporinum	Barley Grass	I		
Liquidambar styraciflua	Sweet Gum	I		
Lolium perenne	Perennial Ryegrass	I		
Malva parviflora	Small-flowered Mallow	I		
Nassella neesiana	Chilean Needlegrass	I		x
Paspalum dilatatum	Paspalum	I		x
Plantago lanceolata	Ribwort Plantain	I		
Prunus sp. (planted)	Flowering Plum	I		
Quercus sp.	Oak	I		
Rytidosperma sp.	Wallaby Grass	N	x	
Trifolium glomeratum	Clustered Clover	I		
Trifolium subterraneum	Subterranean Clover	I		x
Ulmus sp. (planted)	Elm	I		
Vulpia sp.	Annual fescue	I		x
Wahlenbergia communis	Tufted Bluebell	N		

* N: denotes native species; I: denotes introduced/ exotic species

Table B.2: Step-point transect data

Habitat feature		Transect	
		T1	**T2**
Bare Earth		21	5
Rock		0	0
Cryptogams (Moss/ Lichen)		0	0
Litter / Dead Vegetation		17	23
Perennial Native Grass (GSM food)	*Austrostipa*	0	0
	Austrodanthonia	3	0
Other native grass (non-GSM food)		11	0
Native forb		0	0
Exotic GSM food plants	Chilean Needle Grass	0	17
	Serrated Tussock	0	0
Perennial Exotic Grass (non-GSM food)		48	38
Annual Exotic Grass		0	12
Exotic Forb		0	5
Total		100	100

Appendix C

BAM Calculator Floristic Data

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BAM calculator floristic data

Manipulated floristic data that was input into the BAM calculator to determine the vegetation integrity and associated offsets for impacted Golden Sun Moth habitat within the study area is presented in Table C.1. A suitable surrogate native Plant Community Type (PCT) was chosen to characterise the exotic Chilean Needle Grass dominated habitats within the study area. The surrogate PCT used for the assessment was PCT1289 Wallaby Grass- Red-grass- Tall Speargrass- Kangaroo Grass dry tussock grasslands of the North-western and Eastern Southern Tablelands in the South Eastern Highlands Bioregion.

Table C.1: Manipulated floristic data input into the BAM Calculator

Vegetation floristic data		Plot 1	Plot 2
Composition attributes	Tree species	2	2
	Shrub species	0	0
	Grass species	2	2
	Forb species	0	0
	Fern species	0	0
	Other species	0	0
Structural attributes	Tree cover	3	3
	Shrub cover	0	0
	Grass cover	38	38
	Forb cover	0	0
	Fern cover	0	0
	Other cover	0	0

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Appendix D

Biodiversity Credit Report

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BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00019593/BAAS19077/20/00019594

Proposal Name
Canberra Light Rail Stage 2A

BAM data last updated *
26/11/2019

Assessor Name

Assessor Number

BAM Data version *
22

Proponent Names

Report Created
24/04/2020

BAM Case Status
Open

Assessment Revision
0

Assessment Type
Major Projects

Date Finalised
To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Nil

Species
Synemon plana / Golden Sun Moth

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

BAM Biodiversity Credit Report (Like for like)

Predicted Threatened Species Not On Site

Name
Artamus cyanopterus cyanopterus / Dusky Woodswallow
Dasyurus maculatus / Spotted-tailed Quoll
Melanodryas cucullata cucullata / Hooded Robin (south-eastern form)
Miniopterus orianae oceanensis / Large Bent-winged Bat
Chthonicola sagittata / Speckled Warbler
Stagonopleura guttata / Diamond Firetail
Petroica phoenicea / Flame Robin
Petroica boodang / Scarlet Robin
Epthianura albifrons / White-fronted Chat

~~Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)~~

~~Name of Plant Community Type/ID~~	~~Name of threatened ecological community~~	~~Area of impact~~	~~Number of credits to be retired~~
~~1289-Wallaby Grass - Red-grass - Tall Speargrass - Kangaroo Grass dry tussock grassland of the North-western and Eastern Southern Tablelands in the South Eastern Highlands Bioregion~~	~~Not a TEC~~	~~5.4~~	~~34.00~~

ECOSYSTEM CREDIT OFFSETS NOT APPLICABLE TO THE PROJECT.

BAM Biodiversity Credit Report (Like for like)

1289-Wallaby Grass - Red-grass - Tall Speargrass - Kangaroo Grass dry tussock grassland of the North-western and Eastern Southern Tablelands in the South Eastern Highlands Bioregion	Like-for-like credit retirement options			
	Class	Trading group	HBT	IBRA region
	Temperate Montane Grasslands This includes PCT's: 586, 894, 895, 896, 1110, 1185, 1186, 1187, 1202, 1288, 1289, 1298	Temperate Montane Grasslands >=50% and <70%	No	Murrumbateman, Bondo, Crookwell, Inland Slopes, Monaro, Murrumbateman and Snowy Mountains. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

ECOSYSTEM CREDIT OFFSETS NOT APPLICABLE TO THE PROJECT.

Species Credit Summary

Species	Area	Credits
Synemon plana / Golden Sun Moth	5.4	82.00

Synemon plana/ Golden Sun Moth	1289_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Synemon plana/Golden Sun Moth	Any in NSW

Synemon plana/ Golden Sun Moth	1289_Moderate

Appendix E

BioBanking public register offset credit report

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Search results for species credits

Species scientific name - *Synemon plana*
Species common name - Golden Sun Moth
Credit status - Issued/Pending

matched 6 records

Credit owner(s)	Email	Agreement ID	Scientific name	Common name	Credit status	Credits
Robin Pty Ltd	environa@bigpond.net.au	See note	*Synemon plana*	Golden Sun Moth	Issued	322
Robin Pty Ltd	wandiyali.restoration@gmail.com	See note	*Synemon plana*	Golden Sun Moth	Issued	247
Robin Pty Ltd	wandiyali.restoration@gmail.com	See note	*Synemon plana*	Golden Sun Moth	Issued	232
Robin Pty Ltd	environa@bigpond.net.au	See note	*Synemon plana*	Golden Sun Moth	Issued	174
Lakeview Holdings (ACT) Pty Ltd	sam@domagroup.com.au	See note	*Synemon plana*	Golden Sun Moth	Issued	62
Canberra Brickworks Developments Pty Ltd	sam@domagroup.com.au	See note	*Synemon plana*	Golden Sun Moth	Issued	35

- End -

Note: Details on sensitive species covered by Department of Environment & Climate Change's (DECC) Threatened Species Information Disclosure Policy will not be included within the biobanking agreement available from the public register. Credit details relating to these species are provided without links to the biobanking agreement.

N/A - Credits with the status of pending are attached to a draft biobanking agreement. A biobanking agreement is only available on the BioBanking public register once it has been finalised and reached agreement issued status.

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Appendix F

Draft Golden Sun Moth Habitat Restoration Framework

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City to Commonwealth Park Light Rail

November 2020 - Golden Sun Moth Habitat Restoration Framework

Version Control

Version	Issue Date	Details
0	June 2020	Draft Framework
1	November 2020	Framework updated following responses from public exhibition of Preliminary Documentation and further input from EPSDD

Table of Contents

PREAMBLE

This is a framework document only, to accompany the Preliminary Documentation for the Light Rail Stage 2A (the Project). The purpose of this document is to outline the management activities that will support restoration activities required to reinstate Golden Sun Moth habitat following construction of the Project. The content of this Framework would be updated to reflect ongoing discussions with relevant stakeholders, and any relevant conditions that may be identified during the determination of the Proposal (through either of the Development Application or Works Approval processes, or the determination of the EPBC Act assessment via Preliminary Documentation. Ultimately this Framework would include actions and management strategies that would ensure all relevant conditions of any environmental approvals issued for the project are implemented to enable effective restoration of Golden Sun Moth habitat.

1.0 Introduction

1.1 Purpose

The purpose of this **Golden Sun Moth Habitat Restoration Framework** is to specify management actions that will support the restoration of Golden Sun Moth habitat as a result of temporary impacts from the Light Rail Stage 2A construction (the Project) in the "**south east cloverleaf**", and the **eastern median of Parkes Way** (see **Figure 1**). As part of the broader environmental management for the Project, a comprehensive Construction Environmental Management Plan (CEMP) will operate throughout the construction phase, with a key objective relating to Golden Sun Moth management being the avoidance of unnecessary clearing of existing Golden Sun Moth habitat within the south east cloverleaf, and the eastern median of Parkes Way.

1.2 Timing for restoration works

Restoration activities are planned to occur as soon as practically feasible following disturbance activities within the south east cloverleaf and the eastern Parkes Way median. The Proposed Action would take approximately four years to construct. Broadly, it would involve multiple work stages that could take place at different times in different locations along the route. The exact timing of each stage and work activity in a given location would depend on the final design, contractor specifications and requirements, consultation feedback, and any restrictions and constraints set by the ACT and Australian Governments. Construction would be staged and will likely involve five key phases of work, as detailed in the following sections.

1.2.1 Phase 1: Early works

Early works would involve:

- Site investigations and setting out access routes and no-go zones.
- Establishment of a compound within the northern section of the carpark at Acton.
- Carrying out utility adjustment, relocation, protection and installation works.

This phase of works is anticipated to be for nine to twelve months in duration.

Restoration Activities: Disturbance in the south east cloverleaf would occur during this stage of construction after which restoration activities would commence. As detailed in Section 5.1 and Section 5.2 several adaptive management techniques will be trialled in this area which, if successful, will be implemented in the restoration of the eastern side of Parkes Way.

1.2.2 Phase 2: Main Civil works – Raising of London Circuit and associated works

The raising of London Circuit will provide an at-grade signalised intersection at the junction of London Circuit and Commonwealth Avenue. This requires undertaking civil works to remove existing roadway infrastructure prior to filling above London Circuit to achieve design levels approximately in line with Commonwealth Avenue existing levels. Removal of the two existing concrete bridges that cross London Circuit will also be required, with traffic moved to a contraflow around the active worksite during the staged removal of each bridge.

This stage of works is anticipated to be approximately 24 months in duration. It is not anticipated that there will be any additional disturbance to the GSM restoration areas during this stage of works. Through this period there will be the continuation of restoration activities in the south east cloverleaf.

1.2.3 Phase 3: Main Light Rail construction works

This phase would include three key works packages: stop and terminus construction, track works, and road works. All works packages would involve common activities including earthworks and excavations, the use of heavy equipment and machinery, the movement of materials and waste, and general surface and foundational works. This stage of works is anticipated to be approximately 24 months in duration.

Restoration Activities: Construction of the additional bridge over Parkes Way will require disturbance of the eastern median of Parkes Way. Restoration of this area of Golden Sun Moth habitat would occur as soon as possible after there is confidence that additional construction activities will not be required

1.2.4 Phase 4: Testing and commissioning

This phase would involve running trials of the light rail vehicles to test the rails, stops, equipment, and service reliability. Post-works management and monitoring of habitat restoration works would also occur during this phase.

1.2.5 Phase 5: Handback

An audit inspection would be carried out to address any defects after which the light rail and road would be handed over to the appointed operational and maintenance entity. Habitat restoration works are expected to occur for a three year period in each area after habitat disturbance is complete.

2.0 Description of the Project

The Project involves the construction and operation of a 1.7-kilometre light rail extension between the existing City to Gungahlin light rail terminus at Alinga Street to a new terminus on Commonwealth Avenue opposite Commonwealth Park. It would include two other stops at Edinburgh Avenue and at the northern end of Commonwealth Avenue (City South). The light rail would run down the middle of Northbourne Avenue, the west side of London Circuit and then the median of Commonwealth Avenue. Additional work needed to support the light rail would include construction of a new intersection between London Circuit and Commonwealth Avenue and the creation of a new rail bridge over Parkes Way.

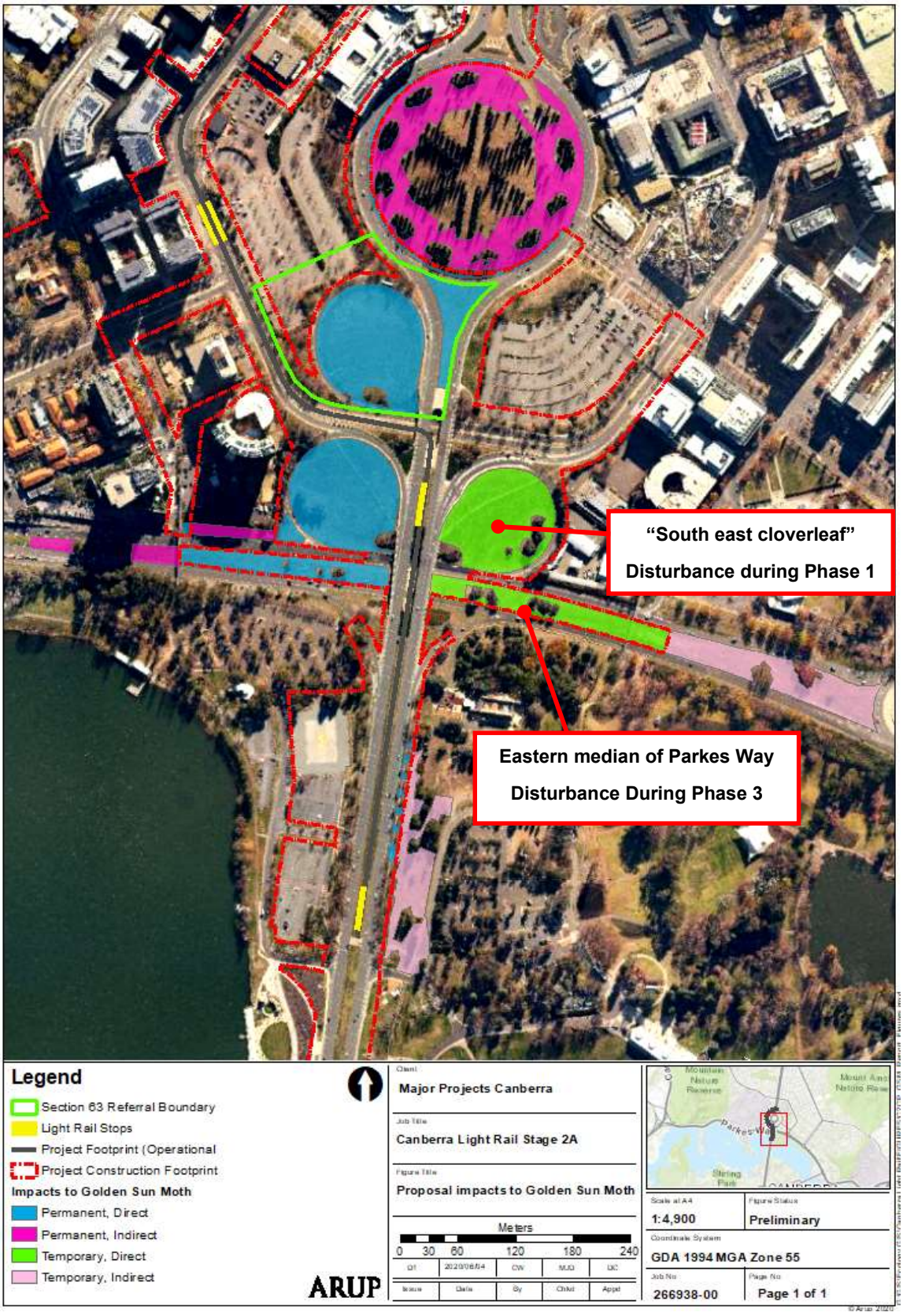


Figure 1: Project area, including areas of proposed Golden Sun Moth habitat restoration activities, that are the subject of this Framework (South east cloverleaf and eastern median of Parkes Way).

2.1 Matters of National Environmental Significance

The Project is undergoing assessment in accordance with the EPBC Act through Preliminary Documentation. The matters of national environmental significance likely to be affected by the Project are restricted to low-moderate quality Golden Sun Moth habitat.

3.0 Training

The Project Environmental Manager is responsible for ensuring that personnel and subcontractors under their control have the requisite competencies, skills and training to carry out their assigned tasks and for identifying additional training and competency requirements. The Project Environmental Manager is responsible for ensuring training records are maintained.

Prior to the commencement of restoration activities the Project Environmental Manager, in conjunction with other staff, will approve an induction program to be delivered to all personnel and subcontractors' personnel involved in the project prior to, or as soon as practical after commencement. The program will address environmental safeguards, safety, emergency procedures and incident reporting and management. The Project Environmental Manager is responsible for ensuring that records are maintained of all Project related training.

4.0 Auditing and Reporting

Audits provide lead indicators for potential incidents and provide important information for corrective action and review of management arrangements and procedures. Audits by an external party will be conducted for this Project at the frequencies set out in **Table 1**. Issues identified during audits will be recorded and corrective action implemented. Compliance monitoring will be undertaken routinely to measure the success of restoration activities. Details of compliance activities can be seen within **Table 2**.

Table 1 Audit schedule

No.	Audit / Reporting	Timing
1	Framework Compliance	Within four weeks of commencement of restoration activities
2	Framework Compliance and review of corrective actions from Audit 1	Four months after restoration activities complete
3	Annual Reporting, detailing progress on all Actions identified in Section 6, including details on monitoring, performance, non-conformances and corrective actions.	March every year

4.1 Incident management

Incident reporting will be implemented to record any safety or environmental non-conformances or incidents. Incidents will be investigated and followed up and, where relevant, corrective actions nominated.

5.0 Restoration Activities

This section outlines the key activities relating to the restoration of Golden Sun Moth habitat following construction disturbance. The following activities identified in **Table 2** have been developed having regard to the outcomes of the ecological assessment completed for the EPBC Preliminary documentation and through discussions with experienced grassland ecologists within ACT Government.

The timing and method of restoration activities have been further developed following input from government bodies and environmental groups following the exhibition of the draft Preliminary Documentation. The impact to the SE Cloverleaf will now be one of the first activities of the project which will allow restoration activities to occur during the first Stage of the project. This will allow a number of adaptive restoration techniques to be trialled which, if successful, will be utilised in the restoration of Parkes Way which will be impacted at that latter stage of the Project for the installation of a bridge over Parkes Way. Specific measures which are to be applied to the restoration of the south east cloverleaf are described in Section 5.1 and Section 5.2.

The majority of food grasses for GSM are C3 grasses which indicates that restoration attempts should be implemented in the cooler months so planting of seedlings should commence in Autumn to give these plants the best chance at establishment. Studies show that seedlings (or tube stock) resulted in faster restoration of GSM habitat then seeding did (O'Dwyer and Attiwill 2001[1]). Tube stock should be planted to a density of between 40-80% of the available area and should be augmented with seeding. No bark or other materials will be placed around plantings with areas between seedlings left as bare earth.

[1] O'Dwyer, C., Attiwill, P.M. 2001. Restoration of a Native Grassland as Habitat for the Golden Sun Moth *Synemon plana* Walker (Lepidoptera; Castniidae) at Mount Piper, Australia. Restoration Ecology.

Table 2: Key restoration activities

#	Action	Timing	Monitoring Requirements	Monitoring Timing	Performance Indicators	Responsibility	Corrective Action
1	**Native seed collection** To the extent possible, collect native seed stock prior to clearing, for use in the revegetation of disturbed areas	Prior to construction	N/A	N/A	Seed collected of native larval food plants identified in previous ecological surveys	Rehabilitation contractor to ensure native seeds are available prior to commencement of works.	N/A
2	**Population lift from disturbed areas within project area** **Prior to disturbing areas to the west of Commonwealth Avenue (s63, SW Cloverleaf etc)** translocate GSM larvae to areas for restoration in the SE cloverleaf. Translocation methods will be based on successful techniques which have been used in a pilot program on the Majura Parkway Program and refined during the recent Dudley St Golden Sun Moth Translocation (Umwelt, 2020[2]). This would involve using a mattock or backhoe plough, the soil will be churned and searched for the larvae by hand. These will then be deposited into the "non-impact area" of the SE Cloverleaf. The source sites within the western cloverleafs will be selected on the basis of previous GSM larvae detections and/ or the presence of good quality habitat.	Prior to construction activities on the western side of Commonwealth Avenue. The larvae must be translocated in spring when they become active.	Specialist ecologist to monitor GSM populations in the restoration areas after relocation has occurred.	Annually during GSM flying period between November and January	Discussion with GSM specialists from Parks indicated that it is impossible to develop performance indicators to measure the success of translocation due to the likelihood of a large proportion of the relocated larvae remaining dormant and also that the survival rate is approximately 10% (SMEC, 2014[3]).	MPC will be responsible for managing specialist ecologists undertaking translocation of GSM. ACT Government Environmental Offsets/Parks – Responsible for overseeing and guiding translocation of GSM.	NA
3	**Protection during establishment** Establish a 'no-go' zone using fencing outside the site boundary and communicate to all staff. Ensure territory maintenance crews do not mow area 2 years after initial restoration activities are completed or when directed in the instance where the area is restored prior to the 2-year period and the grass is becoming overgrown.	Immediately following completion of restoration activities	Conduct regular audits to ensure 'no-go' areas are being adhered to.	Weekly until active construction within 50m of the site is complete	No evidence of construction access within 'no-go' areas. Fencing integrity Induction records	MPC Project Manager and Construction Contractor Project Manager are responsible for implementing measures	- Training - Non-Conformance Reporting - Option to cease work for repeated breaches.
4	**Photo monitoring** Collect representative photos from designated photo points. Photo points will be located approximately 20m apart indicative locations for photo points in the SE cloverleaf and eastern median of Parkes Way can be seen in **Figure 2**.	Prior to construction, during construction and post construction for two years	A minimum of eight points to be established at the north-west corner of each vegetation monitoring plot	Once planting of native plants has occurred monitoring will be completed twice a year	Photo records indicate an increase in native grass populations and decrease in exotic species.	MPC will be responsible for managing biannual monitoring. ACT Government Environmental Offsets/Park – Responsible for overseeing results of photo monitoring and providing advice and direction.	- To be determined through audit process

[2] Umwelt 2020 Briefing Note: Dudley Street Golden Sun Moth Translocation
[3] SMEC 2014 Arboreteum Golden Sun Moth Larvae Retrieval

#	Action	Timing	Monitoring Requirements	Monitoring Timing	Performance Indicators	Responsibility	Corrective Action
5	**Erosion and sediment control** Implement erosion and sediment control plans in accordance with the EPA approved plans. Ensure storage of equipment/stockpile areas in proximity to worksite are within shaded areas that have less potential to be GSM habitat.	During construction	Monitor compliance with erosion and sediment control plans weekly. Conduct periodic inspections with the EPA.	Weekly during construction	Compliance with EPA approved plans	MPC Project Manager and Construction Contractor Project Manager are responsible for implementing measures	- Training - Non-Conformance Reporting - Potential for construction ceasing in accordance with disciplinary measures under *Environment Protection Act* 1997
6	**Native re-planting** As soon as practicable after disturbance complete as necessary: - Soil testing - Soil preparation - Restoration with appropriate tubestock *Rytidosperma sp*. to 40% density augmented with seeding	Progressively following construction activities Preferably in autumn	Wallaby grasses; *Rytidosperma carphoides*, *R. auriculata*, *R. setacea*, and *R. eriantha* to 40% densities and other NTG components that GSM show preference for or are suspected of using (Austrostipa for example)	After establishment of restoration native planning the specialist rehabilitation contractor will complete quarterly inspections involving additional planting, watering and weeding for at least one year.	Develop performance indicators around: - % C3 Cover - % native grass cover - Grass biomass - % bare ground - % exotics	MPC will be responsible managing rehabilitation contractor. Specialist rehabilitation contractor: responsible for preparation of land and planting of preferred grasses in disturbance areas. Responsible for providing reports after monitoring events of success/failure. ACT Government Environmental Offsets/Park – Responsible for overseeing results of quarterly inspections and providing advice and direction.	- Replanting native seeds if required. - Weed management if exotics spread into rehabilitation area
7	**Landscape establishment** Maintain plantings for not less than twelve months post planting	Up to 12 months post construction disturbance	Monitor to ensure plantings are adequately maintained and that maintenance is continuing for at least two years and until 85% of plants are established.	Post plantings for 2+ years	Plantings are adequately maintained and 85% of plants are established within 12 months post disturbance	Specialist rehabilitation contractor is responsible for preparation of land and planting of preferred grasses in disturbance areas. Responsible for providing reports after monitoring events of success/failure.	- If plantings are not adequately maintained, and suffer from attrition, replant, and review establishment care. - Non-Conformance Reporting
8	**Weed management** Undertake ongoing management of weed invasion (other than Chilean Needle Grass) within the restored areas. Focus towards known weeds that have the potential to invade including African Love Grass, Witch Grass and Madagascan Fireweed	Up to 3 years post construction disturbance	Monitor for weed invasion within the restored areas: - Establish two monitoring points in each of the two restoration areas - Monitor monthly for changes in weed status (compare to baseline surveys)	Quarterly.	No increase in weed abundance or number of weed species compared with baseline measurements.	MPC E&A will be responsible managing rehabilitation contractor. Specialist rehabilitation contractor: responsible for management of weeds. Responsible for providing reports after monitoring events of success/failure. ACT Government Environmental Offsets/Park – Responsible for overseeing results of quarterly inspections and providing advice and direction.	- Non-Conformance Reporting - Increase in weed management efforts

#	Action	Timing	Monitoring Requirements	Monitoring Timing	Performance Indicators	Responsibility	Corrective Action
9	**GSM and GSM habitat monitoring**	For 3 years post construction disturbance	The *Conservation Effectiveness Monitoring Program* (an overarching ecosystem condition monitoring framework) will be used to inform the specific monitoring requirements	Annually during GSM flying period between November and January Biannually after planting for first years then annually if native re-planting establishes	In addition to Action #5, consider further indicators utilised by the *Conservation Effectiveness Monitoring Program* (see Appendix A)	MPC E&A will be responsible managing specialist ecologists monitoring GSM population and habitat. Act Government Environmental Offsets/Park – Responsible for providing advice on monitoring findings	- Failure for GSM to recolonise restored areas will necessitate the procurement of additional offsets
10	**Population lift** Should GSM show no emergence after 3 years, consider translocation of ovipositing females from adjacent sites to the restored sites. Ensure any species translocated are within proximity to the project site to reduce the risks of disease or parasites.	Only to be considered 3 years post construction disturbance	Specialist ecologist to monitor GSM populations in the restoration areas.	Annually	Develop performance indicators around: - % C3 Cover - % native grass cover - Grass biomass - % bare ground - % exotics Which would indicate improved habitat for GSM.	MPC will be responsible managing specialist ecologists for translocation of GSM. ACT Government Environmental Offsets/Park – Responsible for overseeing and guiding translocation of GSM.	- Failure for GSM to recolonise restored areas will necessitate the procurement of additional offsets

5.1 Restoration Activities specific to the South East Clover Leaf

The disturbance area for the south east cloverleaf has been refined to ensure that the existing population of GSM will be maintained as much as possible. The area to be maintained is the north western section of the cloverleaf which can be seen in Figure 1 and is displayed as the no impact area. This area has been targeted to be retained as it has a higher proportion of Chilean Grass in comparison to the southern section adjacent to the disturbed area which has broad leaf grasses which are not a food source for the Golden Sun Moth. This will allow maintenance of the existing GSM population in this area where the remainder of the SE cloverleaf is being restored. At the conclusion of the disturbance the area impacted with be restored in line with the activities detailed in **Table 2.**

5.2 GSM Habitat restoration trial area

At the commencement of works Major Projects Canberra, in co-ordination with the Offset section of Parks, will implement a number of initiatives to target broad leaf exotic grasses, which are not favoured by GSM, and then re-instate native grasses which will promote GSM. As the impacts to the to the SE Cloverleaf will be the first activity of this project, to allow the relocation of utilities prior to the conducting civil works, this will be the area where initiatives are trialled. Measures which are deemed to be successful will then be implemented to restore impacted areas in Parkes Way where construction works will not happen until the final stage of the project. Identified trial areas can be seen in **Figure 1**.

Possible adaptive approaches within the trial area:

The trail area is small and only suitable for trailing one or two factors that could be manipulated. Two possible adaptive management approaches could be having different cover/heterogeneity amounts within the trial area and different irrigation treatments of the grasses.

An adaptive management approach to the heterogeneity/density of plants within plots could be undertaken to determine if GSM prefer different levels of heterogeneity of grasses. For example, at patchy arrangement of 80% grasses could be done in a proportion of the site and a more heterogenous arrangement of 50% cover of native GSM grasses / 50% bare ground. Depending on findings the cover variation or density of cover could increase. These two levels of heterogeneity/density levels will be trialled in Area A and B after targeted removal of broadleaf grasses as mentioned above.

An adaptive management approach to irrigation frequency and the effect on root extension in grasses could also be undertaken. GSM spend most of their life cycle underground feeding on grass roots. Having frequent and high amounts of irrigation and deficit irrigation (i.e. 13mm of water per week – enough to ensure survival) in half of the trial area. Differences in irrigation has been demonstrated to impact root extension. Depending on the method of watering the trial of this method could be dependent on gaining Works Approval from the National Capital Authority as there is not an existing water supply to the SE Cloverleaf. This approach is proposed to be trialed within the disturbance area with this section being broken up into two sections (north and south) after restoration activities have been undertaken in this area for a 12-month period and native grasses have returned.

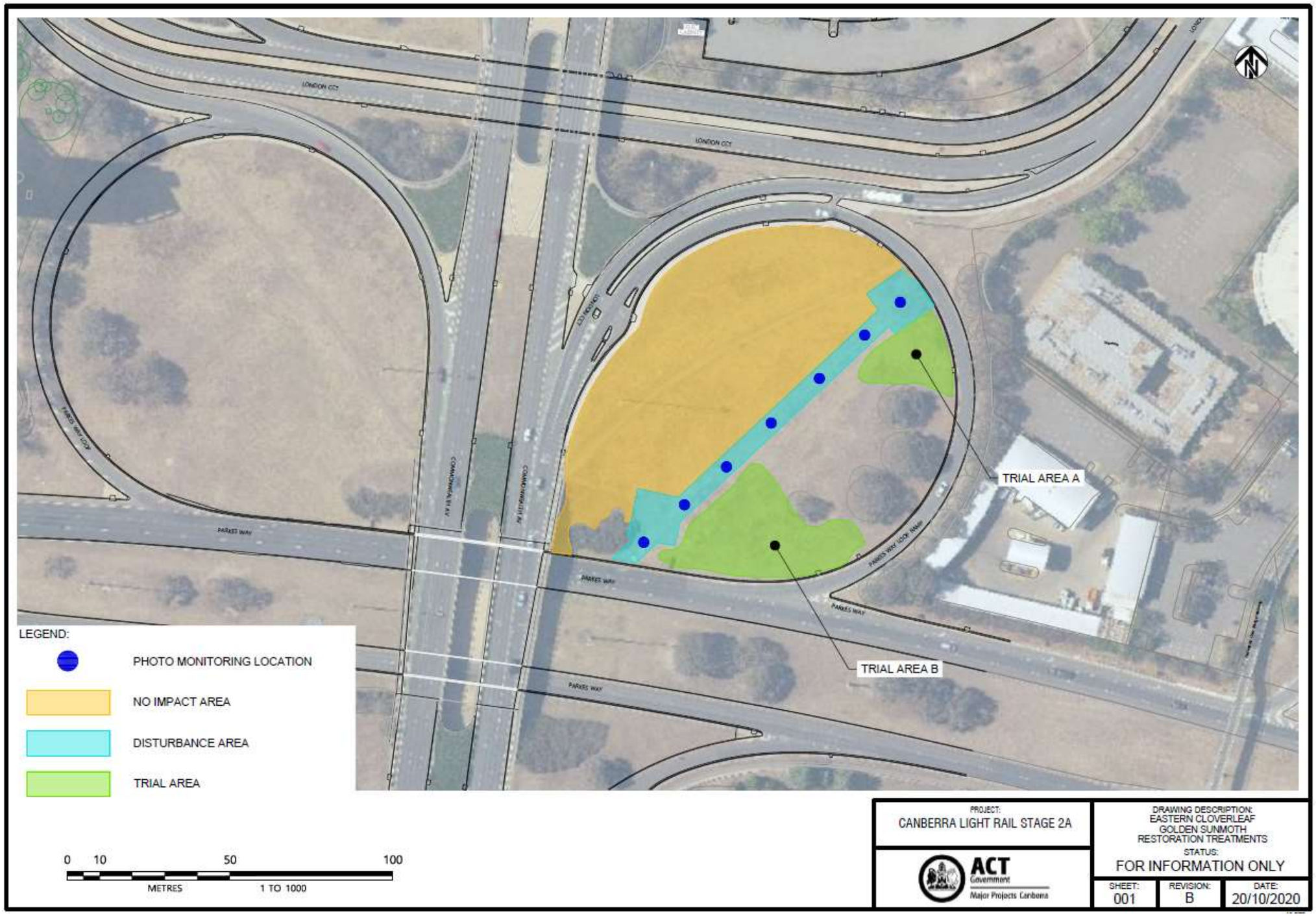


Figure 1: South East Cloverleaf

Appendix A

Conservation Effectiveness Monitoring Program (ACT Government, 2017)

ACT Government

CONSERVATION EFFECTIVENESS MONITORING PROGRAM: AN OVERVIEW

RENEE BRAWATA, BEN STEVENSON AND JULIAN SEDDON

Environment Division

Technical Report
April 2017

ACT Government
Environment, Planning and Sustainable Development

Title:

Conservation Effectiveness Monitoring Program: an overview

Environment Division

EPSDD

This document should be cited as: Brawata, R., Stevenson, B., and Seddon, J. 2017. Conservation Effectiveness Monitoring Program: an overview. Technical Report. Environment, Planning and Sustainable Development Directorate, ACT Government, Canberra.

http://www.environment.act.gov.au

Telephone: Access Canberra 13 22 81

Disclaimer

The views and opinions expressed in this report are those of the authors and do not necessarily represent the views, opinions or policy of funding bodies or participating member agencies or organisations.

Front cover (clockwise from left): Monitoring woodland flora; backpack electro fishing and strategic burning for grassland restoration. All Photographs: Conservation Research

CONTENTS

SUMMARY

The Conservation Effectiveness Monitoring Program (CEMP) is an overarching ecosystem condition monitoring framework for the ACT conservation estate. Monitoring is an integral part of evaluating the effectiveness of management actions in achieving nature conservation objectives. There are also many legislative, policy and management requirements for the ACT Government to monitor condition of biodiversity in nature reserves.

CEMP aims to create a coordinated, systematic, and robust biodiversity monitoring program that will allow us to detect changes in ecosystem condition within reserves, evaluate the effectiveness of management actions in achieving conservation outcomes and provide evidence to support land management decisions. A key component of the program is to develop monitoring plans for the eight identified ecosystem units within the ACT reserve system.

This document gives a brief summary of the purpose of CEMP and the rationale behind the adaptive management approach central to the CEMP framework. Its intent is to provide a background as to how and why the CEMP framework was developed including the choice to use ecosystem units to monitor changes in condition over time. Within this document the selection of indicators and metrics within an ecosystem is explained, in addition to a detailed summary of the symbology and classification used to report condition of indicators within ecosystem monitoring plans. The aim is to provide managers, contributors and other users with an easy to use resource that enables interpretation of symbology and summaries found in each of the CEMP ecosystem monitoring plans.

The CEMP reporting framework enables an assessment of the efficacy of management actions, identification of knowledge gaps and the prioritisation of future research. Through consolidating information on ecosystem condition and increasing accessibility of this information across ACT Government, CEMP aims to provide a data-rich decision support tool to inform strategic planning and assist management in conserving ecological values within the ACT reserve system.

1. INTRODUCTION

1.1 BACKGROUND

In Australia and internationally, natural resource agencies are increasingly embedding monitoring programs into reserve management to enable efficient evaluation of enhancement programs and actions (Parks Victoria, 2014b; Parks Victoria 2014a; Parks and Wildlife Service Tasmania 2014; WWF 2005; Hockings et al. 2013; Metsahallitus 2012; Gilliagan et al. 2005). Efficient and correctly established monitoring programs may also be used as a strong decision support tool (Lindenmayer and Likens 2010; Westgate et al. 2012), assist with ensuring effective resource allocation to programs (Hockings et al. 2006; Fancy et al. 2009), help improve park management planning (Vos et al. 1999; Hockings et al. 2006; Fancy et al. 2009) and may provide information suitable for engagement and education of stakeholders, thereby promoting appreciation of biodiversity values and fostering a conservation ethos in the broader community (Stevenson and Seddon, 2014).

Nature reserves, encompassing over half of the land area in the Australian Capital Territory (ACT), were established to protect the rich biodiversity values of the region and are managed by the ACT Government's Parks and Conservation Service (PCS). A 2011 investigation by the Commissioner for Sustainability and Environment into the Canberra Nature Park recommended that a nature reserve monitoring strategy be developed to ensure that threats to reserves were quickly identified, and that information was readily available to ensure better decision making in reserve management. For the purpose of this document, reserve areas refer to areas listed under the Territory Plan as national park, nature reserve, or wilderness area. They include Bimberi Wilderness Area, Canberra Nature Park (CNP), Googong Foreshores (GF), Jerrabomberra Wetlands (JW), Lower Cotter Catchment (LCC), Molonglo River Nature Park (MRNP), Mulligan's Flat Nature Reserve (MF), the Murrumbidgee River Corridor (MRC), Namadgi National Park (NNP), Tidbinbilla Nature Reserve (TNR) and all biodiversity offsets areas.

Stevenson and Seddon (2014) reviewed the extent and type of current monitoring programs across ACT reserves, and provided recommendations to improve the quality and sharing of information collected from these programs so that data may contribute meaningfully to reserve management. Stevenson and Seddon (2014) showed that while monitoring was taking place in ACT reserves, much of the data from these programs was not being collated and presented to reserve managers in a suitable format to inform decision making (Hockings et al. 2004). Additionally, monitoring of conservation outcomes and management actions were rarely linked; most management programs were evaluated by reporting on management actions as opposed to reporting changes in reserve condition or conservation outcomes. Other issues included a lack of coordination across monitoring programs (including the absence of formalised data collection, storage protocols and procedures), leading to an inconsistency of sampling methods between agencies; little integration of management actions and monitoring programs (including volunteer programs) and a large focus on mandated monitoring (such as threatened species monitoring conducted to meet legislative requirements) often providing little insight into the status of biodiversity more broadly. Such mandated monitoring is rarely driven by specific well formulated questions relevant to management with rigorous experimental design, therefore is usually ineffective for informing any meaningful management action (Lindenmayer & Likens, 2010).

Noting the presence of these issues in current monitoring, Stevenson and Seddon (2014) summarised the following important principles of effective monitoring and evaluation programs:

1. Management questions should inform research and monitoring. These questions need to be adaptive and may change over time;
2. Monitoring programs must include or be linked to evaluating conservation outcomes;
3. Conceptual models should be developed to build an understanding of ecosystem processes and relationships and to define critical assumptions;
4. All stakeholders must be engaged in the monitoring program to ensure acceptance;
5. Dedicated, on-going funding is required for biodiversity monitoring and evaluation;
6. Consistent and explicit monitoring protocols need to be developed and a program leader needs to oversee their implementation to maintain data integrity;
7. The monitoring program should use data from current monitoring programs where appropriate;
8. Systems must be developed to ensure the monitoring program is embedded as a land management decision support tool.

Adoption of these principles into a holistic monitoring program would enable a strong paradigm shift from mandate and reactive monitoring into an active adaptive management framework. In response to these findings, the ACT Government commenced the development of an overarching condition monitoring program for ACT nature reserves. The Conservation Effectiveness Monitoring Program (CEMP) was initiated to address the recommendations by the Commissioner for Sustainability and Environment (2011) and to incorporate improvements highlighted in the review by Stevenson & Seddon (2014). The overarching goals of the CEMP program were to:

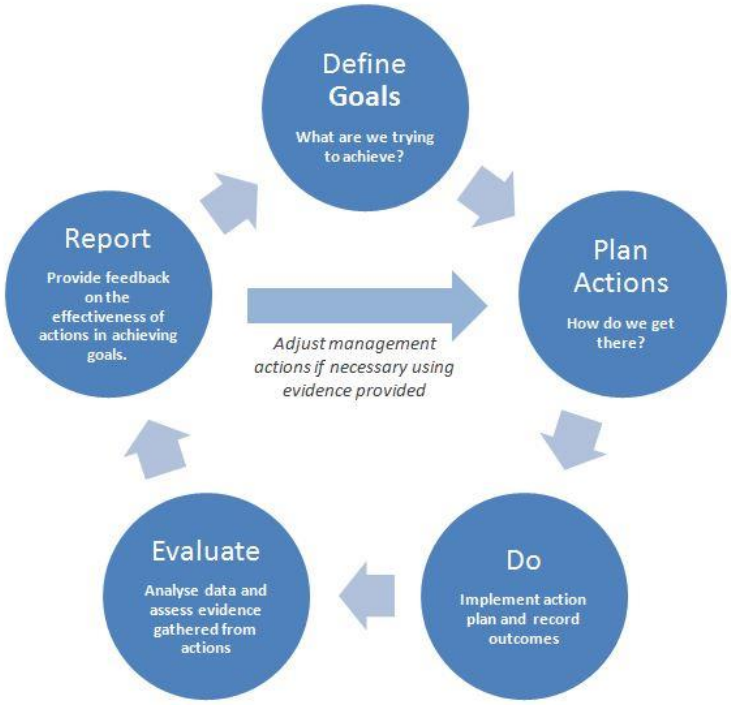
- Detect and report change in the condition of reserve ecosystems and the level of stress imposed by threatening processes;
- Evaluate the effectiveness of management actions at protecting and enhancing ecological values and reducing the impact of threats;
- Provide information to support evidence-based decision making;
- Identify knowledge gaps and areas requiring further targeted research and monitoring;
- Encourage ACT Government staff, community groups and research institutions to contribute towards biodiversity monitoring and research in nature reserves in the ACT.

The program would act as an important tool for evaluating the effectiveness of management actions in achieving conservation outcomes (Possingham et al. 2012); provide information to support land management decisions through evidence based assessment (Lindenmayer and Gibbons 2012) and help address the monitoring requirements of policy and management. A further desired outcome of the program was to develop a coordinated, systematic, and robust biodiversity monitoring program that enabled detection of early signs of change to reserve condition. In this way, the CEMP framework could provide the vital feedback linkages currently absent between management programs and monitoring to generate positive conservation outcomes (Reid et al. 2013).

1.2 THE ADAPTIVE MANAGEMENT CYCLE

An active adaptive management approach ensures management actions are constantly improved through an ongoing learning cycle that encourages research and investigation into best management practice (Allen, 2007; Hockings, et al., 2006). The stages of a typical adaptive management cycle involve recognition of what the desired achievement is (**Goal**), a plan on how this goal may be achieved (**Plan**), actions to carry out the plan (**Do**), a review or assessment on whether the actions achieved the goal (**Evaluate**), communication of this review to other stakeholders (**Report**) and then a decision to either adjust management actions (make a new **Plan**) or even adjust primary goals if necessary (Figure 1).

Figure 1. The stages of the adaptive management cycle as applicable to CEMP



Monitoring the effectiveness of management actions in achieving the stated **goals** is a key component of any adaptive management process (Hockings, et al., 2006). Protecting and conserving natural and ecological values, as defined in management and operational plans for ACT reserves, is the core business of the Environment Division of the ACT Government, Environment and Sustainable Development Directorate. While the Parks and Conservation Service (PCS) is the land management agency, the overarching **goals** are driven by statutory obligations that align with legislative requirements. Action **plans** (for example, action plans for a threatened species or the boarder Reserve Operational Plans (ROPs)) align with these **goals** and form the basis of reserve Plans of Management (POM).

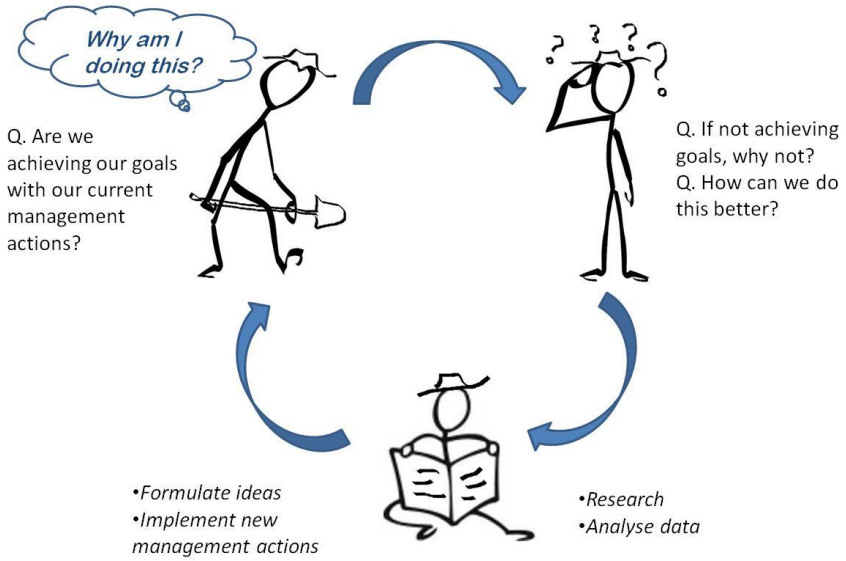
During the first stage of the CEMP program, a framework was developed to enable the systematic evaluation of the effectiveness of reserve management in the ACT. The framework was based on the adaptive management framework, where qualitative and quantitative information drawn from

current monitoring programs (the **Do** phase of the cycle) could be used to track progress toward achieving conservation **goals**. Using monitoring data, the framework could evaluate ecosystem condition and the effectiveness of reserve management programs in maintaining and/or enhancing natural values (the **Evaluate** phase). The outcomes of this process would then provide information, recommendations and feedback (the **Report** phase) to support adaptive, evidence-based decision making into the future (completion of the cycle back to the **Plan** phase) (Figure 1).

In this way CEMP aims to provided the **evaluation** and **reporting** capability for adaptive management by filling the currently missing links between the on the ground actions (the **Do** phase) and the **goal** setting and planning phases, for example by feeding into ROPs (the **Plan** phase) or helping to redefine strategic objectives. The review by Stevenson and Seddon (2014) showed that in the **Do** phase of the cycle, many current monitoring programs in ACT reserves only monitor trends in values of interest over time, with little or no data collected on possible causal agents and response to variations in management. There was also a lack of research questions and appropriate frameworks to focus monitoring efforts. CEMP aims to initiate the progression towards a more experimental approach to monitoring in the ACT through encouraging the simultaneous monitoring of probable causal agents, selecting monitoring sites that represent the variation in different management regimes and monitoring control sites in addition to sites where management actions are implemented (i.e. "active" adaptive management).

The information provided by the CEMP allows adaptation of management objectives and actions as the knowledge base increases, assisting in identifying research priorities and knowledge gaps and may assist in improving budgeting allocations over time to ensure resources are directed to priority programs and in ways that lead to improvements in the conservation values (Figure 2).

Figure 2. On-the-ground management and learning through doing in an adaptive management framework.



Biodiversity condition ↔ management and monitoring

How effective are our management programs in conserving our ecosystems?

2. AN ECOSYSTEM APPROACH

2.1 USING ECOSYSTEM UNITS IN THE CEMP FRAMEWORK

The review by Stevenson and Seddon (2014) highlighted the need to coordinate monitoring programs around explicit management questions derived from a conceptual understanding of the ecology of ACT ecosystems. The review recommended a framework for collecting and collating monitoring information using ecosystem units. The ecosystem units were broadly based on native vegetation formations identified by Keith (2004) in addition to management context. The combination of a management and ecosystems approach has the benefit of linking reserves with the broader landscape to promote a nil-tenure approach to natural resource monitoring, in addition to enabling a more targeted assessment of values, threats and processes specific to each ecosystem. Furthermore, this method provides increased synergies with statutory reporting requirements such as threatened species action plans (Stevenson and Seddon 2014).

Stevenson and Seddon (2014) identified eight ecosystems that were represented in ACT nature reserves. Most ecosystems were separated into either 'lowland' or 'upland' monitoring units to recognise the differing management needs and threats to the fragmented lowland communities of Canberra Nature Park compared to the more intact upland communities of Namadgi National Park, the Lower Cotter Catchment and Tidbinbilla Nature reserve. The following eight ecosystems are used in the CEMP program:

1. Lowland native grasslands
2. Lowland woodlands
3. Lowland forests
4. Aquatic and riparian ecosystems
5. Upland native grasslands
6. Upland woodlands
7. Upland forests
8. Upland bogs and fens

The CEMP project aims to development individual monitoring plans for these eight ecosystem monitoring units.

2.2 UNDERSTANDING ECOSYSTEM INTERACTIONS

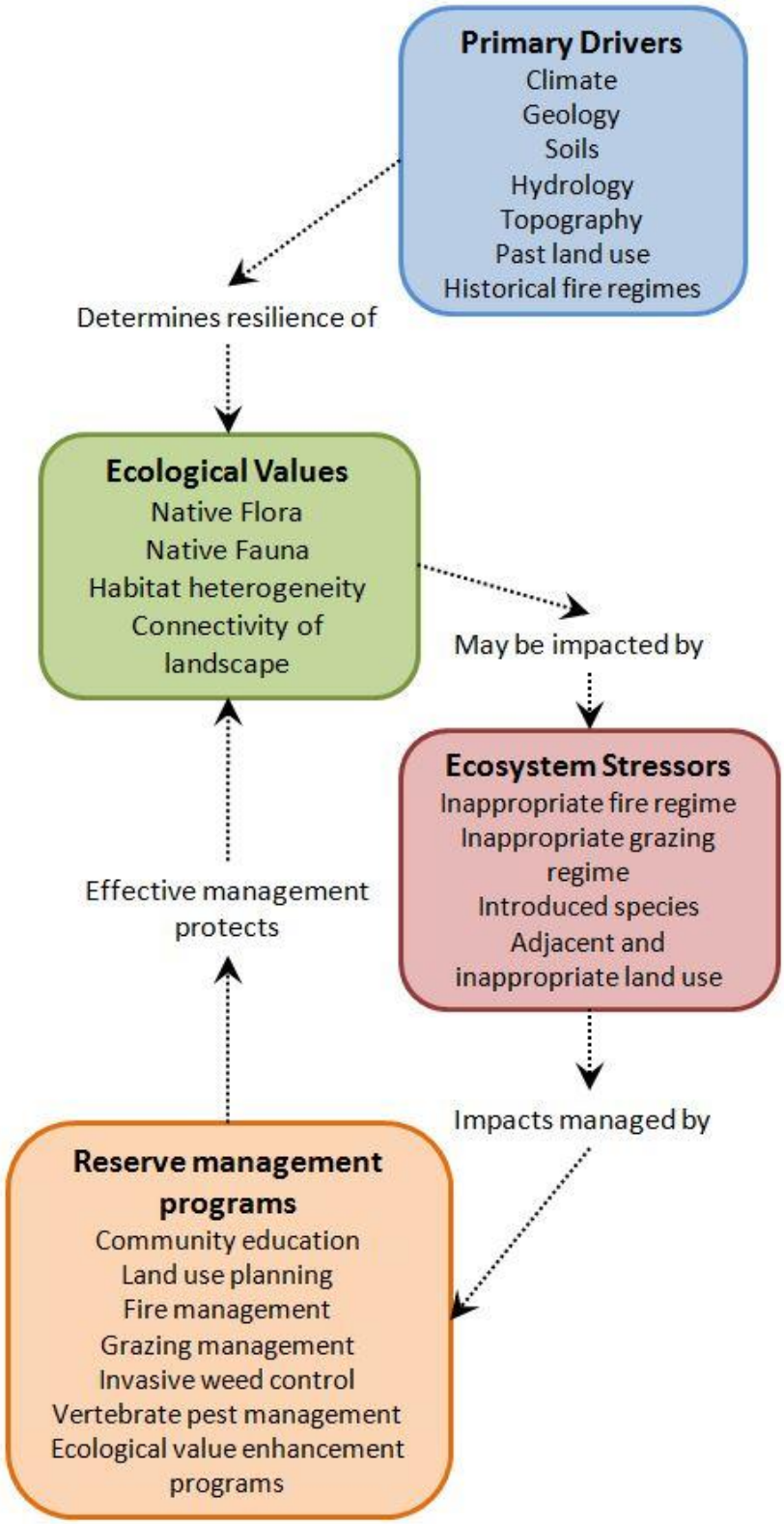
Monitoring ecosystem condition requires an understanding of the complex relationships and interactions between organisms and their environment. For each ecosystem, a conceptual model is created using an expert reference group. The conceptual model aims to demonstrate the current understanding of how the ecosystem functions and to identify the key influences that can potentially drive change in reserve condition. This includes defining key values, threats and interactions within each ecosystem.

For each ecosystem unit, CEMP incorporates a conceptual model of how primary drivers, ecological values, stressors and management programs interact and influence ecosystem condition within ACT nature reserves.

Key ecosystem influences, as derived from expert discussions, could be grouped into one of four categories: primary drivers, ecological values, ecosystem stressors and reserve management programs (Figure 3).

1. **Primary drivers:** These are the natural ecological drivers or historical processes that determine the distribution, composition and structure of ecosystems. In many cases they are the processes maintaining ecosystems in their natural states. Measures of primary drivers may include elements of landscape dynamics or climatic variation.
2. **Ecological values:** These are the biological and physical environmental characteristics contained within ACT nature reserves that the ACT Government identifies as core values for conservation and key for healthy ecosystem function. In the CEMP reporting, ecological values are used to derive the ecosystem condition indicators and metrics. Ecological values typically include native flora and fauna, habitat and connectivity of the landscape.
3. **Ecosystem stressors:** These are the threatening processes in ecosystems that are suspected to elicit change in the condition of the ecological values of the ecosystem. Protection and conservation of ecological values requires the identification and management of threat agents and processes that may impact and stress ecological values. Most management actions aim at reducing the level of stress posed by threatening processes. Specific ecosystem stressors may include pressures such as weeds, pest animals, inappropriate fire regimes, grazing, urban development, recreation, disease, and climate change.
4. **Reserve management programs:** These are the land management actions that aim to eliminate or reduce the impact of ecosystem stressors on ecological values. They can be reactive, such as pest management, or proactive, such as land use planning and community education programs.

Figure 3. A cyclic model showing the interactions between primary drivers, ecological values, ecosystem stressors and reserve management programs in a CEMP ecosystem unit.



3. MONITORING ECOSYSTEM CONDITION

3.1 SELECTING INDICATORS TO MONITOR ECOSYSTEM CONDITION

Indicators are being increasingly used by management agencies to provide information about changes in condition of protected areas. Measurement and monitoring of all ecosystem components is impossible, therefore indicators are often used as "measurable surrogates", providing a low cost and time efficient method for monitoring ecosystem health and the influence of disturbance over time (Carignan and Villard 2002; Fancy et al. 2009; Lindenmayer 1999; Niemi and McDonald 2004; Noss 1990; Noss 1999). Given the limited resources available for a detailed monitoring program in the ACT, the use of indicators is a resource efficient method of monitoring ecosystem condition over the longer term.

Within CEMP ecosystem monitoring plans, indicators are used to capture current knowledge about the relevant ecosystem and to provide a measurement of ecosystem condition. In biodiversity assessment, indicators may take many forms, and include entities such as species, ecosystems or processes. Two types of indicators are used in the CEMP monitoring plans; ecosystem condition indicators and ecosystem stressors. Ecosystem condition indicators report on the state of ecological values within an ecosystem, while ecosystem stressor indicators identify threats and effectiveness of management programs at reducing these threats. The combined use of these two types of indicators enables assessment of effectiveness of management actions aimed at reducing threatening processes and maintaining or enhancing reserve condition.

Ensuring indicators used in monitoring programs are representative of ecosystem condition is challenging (Dale and Beyeler 2001; Fancy et al. 2009; Noss 1999). In selecting indicators, the ecological values, threatening processes and what ecosystem functions play a key role in ecosystem health need to be identified for each ecosystem unit (see section 2.1). Indicator selection can then be informed and validated by expert opinion, peer-review literature or management experience. The indicators used in the CEMP monitoring plans are selected by members of an expert reference group associated with each ecosystem. Expert reference groups comprise of researchers, ecologists, land managers and community group representatives.

During a workshop, the expert reference group for each ecosystem unit propose a list of indicators which are then assessed for suitability against the following criteria:

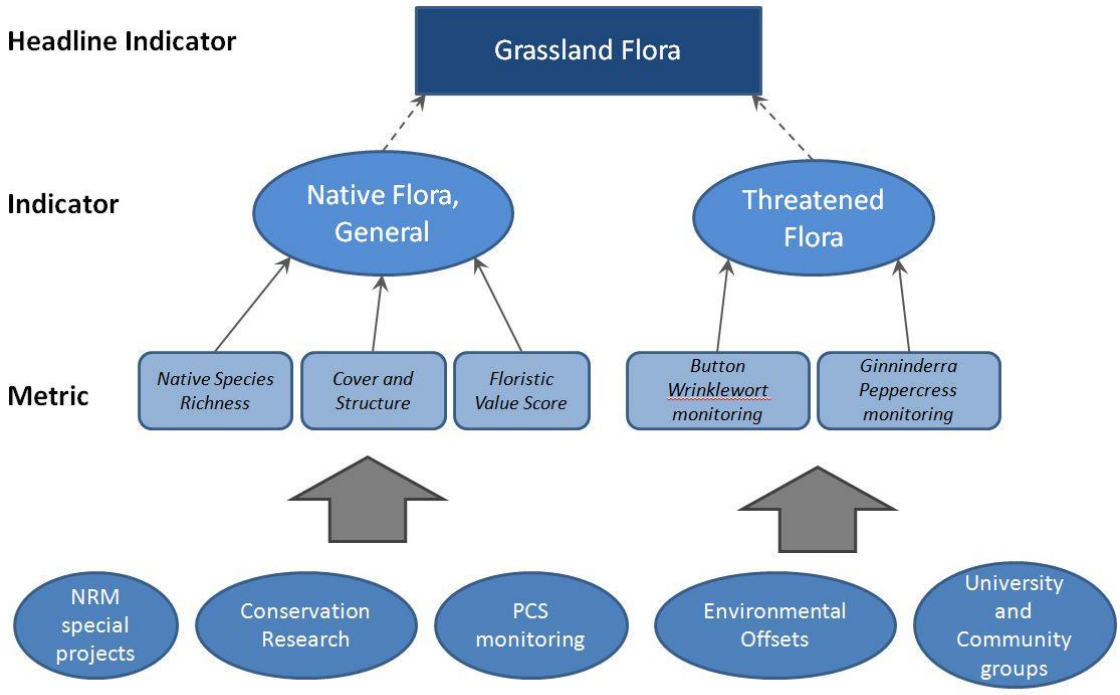
1. Can the indicator be accurately measured quantitatively?
2. Is the indicator ecologically responsive and sensitive to change?
3. Can the influence of natural processes on the indicator be separated from that of management actions (i.e. Can we determine the mechanism of change)?
4. Is the indicator informative to land managers, so that changes to management actions may affect desired conservation outcomes?
5. Is measuring the indicator logistically feasible, cost effective and within current resource availability?
6. Does the indicator meet a management need to capture current knowledge and/or fulfil statutory monitoring requirements?

The sensitivity of an indicator is not always known prior to monitoring; knowledge of how well an indicator detects change in ecosystem condition often emerges over time. In light of this, CEMP evaluates and reviews the contribution of both indicators and metrics each reporting cycle.

Following the expert reference group workshop and choice of indicators for each ecosystem, a four-tiered structure is used to help further define selected indicators and determine how they can be measured to assess ecosystem condition. The four components of the indicator structure developed (Figure 4) are:

1. **Indicator type**: Two types of indicators are used – ecosystem condition indicators and ecosystem stressor indicators.
2. **Headline Indicator**: Each indicator belongs to a headline indicator, which enables the grouping of indicators into broad categories. Examples of a headline indicator may be flora or fauna.
3. **Indicators:** Indicators are monitored and assessed in each ecosystem to provide an indication of change in condition. Examples of indicators might be a threatened ecological community or introduced predators.
4. **Metrics**: Metrics are used as the data sources to measure the condition of each indicator. There may be more than one metric contributing to each indicator.

Figure 4. A diagram showing the upwards flow of information from monitoring and research programs that contribute data to metrics, which in turn inform indicators for ecosystem condition assessment. The example shown is for two ecosystem condition indicators in the Lowland Native Grassland Ecosystem unit; Native Flora (General) and Threatened Flora, which are grouped together under the Grassland Flora headline indicator.



3.2 CLASSIFICATION OF METRIC ATTRIBUTES

Metrics are the 'measurable entities' that are used to provide data to inform indicator condition in CEMP. For example, the condition of the indicator 'Native Flora (general)' in the Lowland Native Grassland Ecosystem Monitoring Plan may be measured in various ways, such as by assessing native species richness, cover and structure of major functional groups or the floristic value score of grasslands. These are just some of the ways to 'measure' grassland flora health. Similarly, the indicator of 'Threatened Flora' may be measured by choosing some representative species and assessing changes in abundance and distribution in response to management actions (Figure 4).

For each ecosystem unit, CEMP initially used information from pre-existing monitoring programs that had data on metrics which could be aligned with chosen indicators. The use of existing monitoring programs enabled an assessment of the amount and quality of pre-existing quantitative data, in addition to a preliminary assessment as to where current knowledge gaps and data deficiencies were. For each ecosystem unit plan, additional, new metrics were suggested where data gaps were strongly apparent.

Once indicators and associated metrics were decided upon for each ecosystem unit, CEMP conducted an analysis of available data for each metric to determine its' condition within the ecosystem. In order to provide accurate information with repeatable measurements so that metric condition (and therefore indicator and ecosystem condition) could be tracked over time and compared between reporting cycles, metrics were required to have a clear, concise and repeatable method for measurement and analysis of data. To ensure this, metrics were defined using a number of different attributes (Table 1).

The first step was to define in detail what data populated each metric and how they would be assessed. This was termed the 'metric assessment' (Table 1) and examples included changes in abundance, richness or area or distribution.

To capture how important each metric was to informing the relevant indicator and thus ecosystem condition, metrics were ranked against five criteria and given a rating or "class" associated with its ranking; either "core", "mandate" or "minor" (Table 1). To determine the metric rating we considered whether:

1. There is a large risk to the ecological value represented by the metric, indicator and/or ecosystem function associated with incorrect /absent management strategies;
2. The cost of managing and monitoring the metric is acceptable and achievable;
3. There exists a long term data set that forms solid baseline data from which future research questions can be effectively derived;
4. There is uncertainty surrounding the best management practice for the ecological value represented by the metric;
5. The species or community impacted is threatened (therefore must be monitored under statutory obligations) or is little known.

Table 1. Metric attributes and associated definitions.

Metric Attribute	Definition
Metric name and associated indicator or stressor	The metric name and number. The metric number indicates whether the metric contributes data towards a condition (C) indicator or a stressor (S).
Summary and condition report	A summary of the findings for the condition, trend and data confidence for the metric applicable to the current CEMP report.
Metric Assessment	The method by which the metric is assessed, such as increase in area, richness, abundance or diversity over time.
Class	The three classes include core (usually long-term monitoring programs or key ecosystem function), mandate (usually a threatened species monitored through statutory requirements) or a minor metric.
Category	The ACT monitoring category; whether the indicator or stressor is monitored under a statutory obligations under the *Nature Conservation Act 2014* or the *Environment Protection and Biodiversity Conservation Act 1999* or is a non-statutory monitoring program.
Primary Drivers	Primary natural drivers such as climate and land use history, which are identified as interacting with the indicator as shown in the conceptual model relevant to the ecosystem.
Associated condition indicators	Related ecosystem condition indicators identified as interacting with the metric as shown in the conceptual model relevant to the ecosystem.
Associated stressors	Related ecosystem stressors identified as interacting with the metric as found by the conceptual model relevant to the ecosystem.
Rationale	An explanation of the rationale behind the inclusion of the metric e.g. statutory monitoring, high priority for management.
Projects contributing to metric	Which projects and/or organisations (within ACT government or otherwise) have monitoring programs that contribute data to inform the metric.
Periodicity	How often the data will contribute to CEMP reporting.
Baseline	The data used as the reference or baseline condition of the indicator or stressor e.g. the first survey or control plots.
Reference Condition	The original (modelled or data-derived) condition of the indicator prior to large scale modern anthropogenic disturbance. A detailed description is given section 3.3 of this document.
Target Condition	When maintenance or restoration of reference condition cannot be feasibly achieved, the target condition is used to provide a meaningful goal for management actions to aim towards over the medium term (10+ years).
Trigger point(s) for management	A pre-defined point for management intervention. For example, if population decline of a threatened species is found to be greater than 30% over two years, then a particular response may be triggered.
Qualitative input	Identified any expert opinion, observational data or other qualitative input that informs the metric. Source of expertise is identified.
Future research questions, management directions, knowledge gaps and recommendations:	A practical outcome of the assessment including data gaps, priorities for management or information/data needs relating to the indicator or stressor.

Metrics meeting three or more of the first four criteria are classed as “core” metrics. Most metrics that are placed in the “core” category included those with consistent methods and long-term datasets. Metrics that meet condition five are classed as “mandate” while all others are placed in the “minor” category.

Each metric was assigned an ACT monitoring category to indicate whether it was monitored under statutory requirements. The primary drivers associated with each metric were identified, as were other condition indicators and stressors that would interact with each metric and associated indicator. The rationale behind the inclusion of the metric was explained, contributing projects (including the use of expert advice) were identified and how often the metric would be assessed (periodicity) was listed (Table 1). Four important metric attributes were the baseline, reference condition, target condition and trigger points, and these are explained in more detail in section 3.3 below. The final attribute for each metric was the recommendations on future research priorities and management directions as an outcome of the metric condition assessment (see section 4).

3.3 WHO PROVIDES DATA TO INFORM CEMP METRICS?

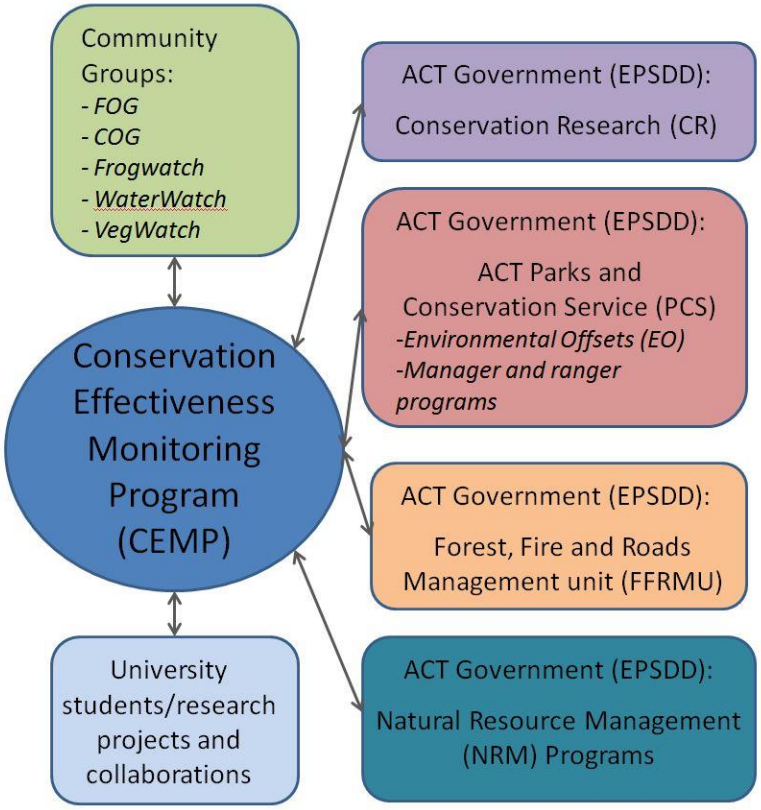
As metrics may be informed by a number of different monitoring programs or research projects, for the purpose of assessing the quality and relevance of data, monitoring and research programs contributing to each metric are defined by different attributes (Table 2). These include location of study sites, duration of program, methods used and sampling design as well as information including the program name, primary contact position, data storage, reporting schedules and specific research questions to inform users of CEMP reports of the origins of data informing the metrics. These data appear in the appendix of each ecosystem monitoring plan.

Information to inform CEMP metrics and associated indicators is collected from Government and non-Government monitoring programs, research projects and surveys. CEMP draws on data collected during monitoring and research programs conducted by ACT Government as well as relevant external research and monitoring conducted by universities and community groups (Figure 5). This provides an opportunity to coordinate and integrate monitoring efforts across government, research institutions and community groups, and to capture the best information available to support adaptive, evidence-based decision making.

Table 2: Attributes of contributing programs and corresponding definitions.

Program Attribute	Definition
Program name and affiliated projects	The name of the monitoring program/research project and the organisation or group from which it is run, in addition to any affiliated projects.
Sites	Locations from which data is collected.
Measured attributes	The variables within the metric that are measured representing numerical or categorical data that could be used in analyses.
Monitors action or asset	Whether or not the monitoring is focused on recording only changes in the entity that is directly managed (action) and/or monitors the ecological asset or value to be conserved.
Management/research questions (project specific)	Specified management questions that the research project or monitoring is aimed at answering.
Type of monitoring:	Defined as one or more of four types of monitoring: opportunistic/ad-hoc, qualitative surveys, mandate monitoring or research project.
Temporal scale:	The length of time the monitoring or research program has run, or is intended to run, defined as one of three categories: long (> 10 years), medium (5-10 years) or short (<5 years) term.
Monitoring period:	The period of time over which the monitoring has taken place (for example from 2008-current day), with any missed sampling periods identified.
Sampling intervals	How often the monitoring takes place, for example, annually during October, or biannually during summer and spring.
Sampling methods:	What sampling methods are used, and if sampling methods have changed over the monitoring period. For example transects, spotlighting, trapping, point observation.
Data type	The data that is collected, for example presence/absence, number of individuals, qualitative.
Spatial data available	Spatial locations of research and monitoring plots should be available on ArcGIS Online "Research and Monitoring plots" file (CR administration), where applicable.
Confidence in data	A three-tiered system (Low, Moderate or High; see section 4.1 of this document) measuring the rigour of data collected by the monitoring program or research project.
Data storage and availability	The location that the data is stored in (either ACT Government or external), when data becomes available (if cyclic) and any prior agreements with external parties to access the data.
Reporting schedule	When reports/up-to-date data are to be available from the project or monitoring program, including if not immediately available or if cyclic.
Contact	The primary contact for the monitoring program or project, including ACT Government department, external organisation and position.

Figure 5: Framework to show contributors to data sources collated by CEMP. Information from programs feed into CEMP, which in turn provides feedback on management actions and future research priorities.



3.4 BASELINES, REFERENCE CONDITION, TARGET CONDITION AND TRIGGER POINTS

Key attributes of metrics are the **baseline, reference condition** and where applicable, **target condition** and associated **trigger points**.

The **baseline** refers to the initial condition from which any change in condition, including an increasing, stable or declining trend, can be measured. For many metrics the results from the first survey are used as a baseline, or alternatively the first data contributing to CEMP are used. This is particularly the case where large changes in methods used have taken place that compromised the ability to use historical data to compare changes over time. For research projects with a robust experimental design, data from control plots were are as a baseline.

The **reference condition** is defined as the ideal condition of the metric reflecting a relatively intact ecosystem. Reference conditions are sometimes called 'benchmarks' and relate to the natural range of variability of an ecosystem. Depending on the scale at which data was collected for the metric, reference condition is defined in one of three ways. The three data scales identified in CEMP are:

1) **Spatial data collected at the landscape scale (e.g. extent, connectivity):** To establish the reference condition for spatial metrics assessed at a landscape scale CEMP used the known or estimated (modelled) distribution prior to recent modern anthropogenic changes to the landscape. For example, the reference condition for Natural Temperate Grassland (NTG) extent would be the distribution of NTG prior to clearing and development of the area associated with European settlement. The connectivity of the metric at a landscape scale could also be assessed and compared to the level of connectivity in the intact or pre-modified condition.

2) **Data collected at the plot or site scale (e.g. species assemblage or structural attributes): F**or metrics sampled at the plot or site scale, such as species assemblages, richness, or biodiversity surrogates such as habitat and vegetation structural attributes. For these metrics we selected local sites which were most representative of an "intact" community (i.e. minimal disturbance by recent modern anthropogenic changes) and measured the metric at those sites (Gibbons & Freudenberger 2006). We then took either the average measurement or create a range (typically $\pm$ 1 SE) to establish reference condition for that metric. The use of a range rather than an absolute value for the reference condition allowed for natural variability between sites in addition to accommodating climatic and seasonal variations.

3) **Data collected on single species populations (e.g. threatened species):** The third and final way of establishing reference condition is for single species data, which usually applies to mandate monitoring of threatened species or monitoring of vertebrate pests. For native species data CEMP uses the IUCN Red List category for the species in the ACT as the current condition compared to the reference condition. IUCN ratings take into account abundance, geographic extent and number of populations of the species. (IUCN 2008). For vertebrate pests and introduced species, the reference condition is zero.

The **target condition** is established for metrics where the reference condition is, in all practical terms, beyond the ability of management to achieve, and represents medium-term goals for management to work towards. For example, the return of NTG to its pre-modern anthropogenic change extent of 15,000 ha may be the reference condition for a metric measuring NTG extent, but is an unrealistic target for management. A more achievable goal may be to increase the quality of 5% of native pasture to NTG status over 10 years and avoid any net loss of extent from current levels. The target condition for metrics are established with extensive consultation with managers, and can be adjusted over time as increased knowledge of the ecosystem is available and better adaptive management outcomes are obtained.

Trigger points are used in some metrics to define recognisable points (thresholds) above or below which a change in management should be triggered. For example, when the estimated population density of a threatened species falls below a certain number (e.g. <500 animals) a pre-determined management response may be initiated. Trigger points enable adjustment to management actions prior to poor condition being reached, with an upper or lower trigger point used where appropriate. For metrics without substantial data sets or expert knowledge, the definition of a meaningful trigger point is difficult to allocate. In the first CEMP report for each ecosystem unit, the trigger points for some metrics are defined as 'To Be Advised' (TBA) until further knowledge is gained that can assist in the establishment of meaningful trigger points and associated management response.

4. ASSESSING ECOSYSTEM CONDITION

4.1 DEFINING 'CONDITION'

For the purpose of the CEMP program, monitoring ecological condition refers to the measuring of the biodiversity values within the ecosystem (Keith and Gorrod 2006). This may include metrics that measure structure, function or composition of the ecosystem at various scales (Noss 1990). To monitor ecosystem condition CEMP measures changes in select indicators and associated metrics within an ecosystem. The first step of assessing the condition of metrics (and consequently related indicators) involves the review of information from current monitoring programs as per each metric assessment definition (Table 1). The condition of each metric/indicator is a relative state; it is assessed and defined relative to the 'baseline' and against the 'reference condition' and 'target condition' over time (see section 3.3 of this document).

Three elements of condition are assessed to determine the overall condition grading for each metric. **Condition/state** is the current condition of the metric relative to the prescribed reference condition; **condition trend** is the current condition compared to the baseline condition (i.e. whether condition is improving, stable or declining over time) and **data confidence** refers to how confident we are in the accuracy of the data informing condition/state and trend. These three elements of overall condition are defined as follows:

1) **Condition/state**: In this assessment the term 'condition' refers to the health of ecological values, while the term 'state' refers to the status of ecological stressors. The condition or state of a metric is assessed relative to an identified acceptable condition or state (the reference condition or target condition).

   Specific criteria for ranking condition or state have been established for different data types. The scaling of condition for spatial metrics was adapted from McIvor and McIntyre (2002) and condition assessments for population metrics used listing categories in the IUCN Red List (IUCN 2008).

   Condition/state of a metric or indicator may be one of four levels as follows:

   a. Good condition refers to a situation where the condition of ecosystem values and processes are close to or above the reference condition and where the negative impacts of threatening processes are limited or successfully controlled by management actions. The quantitative assessment of 'good' condition in CEMP reporting is defined as equal to or above 75% of reference condition for spatial data, equal to or above reference condition for plot data, and for individual species data the population meets criteria for not being listed in the IUCN Red List and is stable.

   b. Good with some concerns indicates overall condition of the metric/indicator is good, but there are some sites or attributes that need improvement or do not meet the 'good condition' criteria and condition is therefore below reference condition. The quantitative assessment of 'good with some concerns' condition in CEMP reporting is defined as being

greater than 60% but less than 75% of reference condition for spatial data, within one statistical range of variability (e.g. standard deviation or standard error) from reference condition (defined for each metric) for plot data, and for individual species data the population meets criteria for not being listed in the IUCN Red List, but is declining and/or is uncommon and data deficient.

c. Moderate condition indicates that values within the ecosystem are showing signs of degradation and management actions need to be implemented as a priority to restore condition and to prevent further loss of condition. The quantitative assessment of 'moderate' condition in CEMP reporting is defined as being between greater than 45% but less than 60% of reference condition for spatial data, within two statistical ranges of variability from reference condition for plot data, and for individual species data the population meets criteria for being listed as Vulnerable in the IUCN Red List.

d. Poor condition indicates the indicator is not managed or management has been ineffective, placing a significant threat on the ecosystem values. Changes to management should be of high priority; in some cases data deficiency on threatening process will lead to a poor rating. The quantitative assessment of 'poor' condition in CEMP reporting is defined as being between less than 45% of reference condition for spatial data, outside of two statistical ranges of variability from reference condition for plot data, and for individual species data the population meets criteria for being listed as Endangered or Critically Endangered in the IUCN Red List.

The scaling system used for condition assessment of metrics and associated indicators in CEMP is based on a "traffic -light" system adapted from the US State of the Parks Report (see https://www.nps.gov/stateoftheparks), and the Queensland National Parks key park values rating system (http://www.npsr.qld.gov.au). The Queensland National Parks key park values rating system identifies a four tiered colour-coded indicator system adapted from the IUCN World Heritage Outlook (2014) (see http://www.worldheritageoutlook.iucn.org). In this system, 'good' condition/state is denoted using dark green, light green denotes generally good condition with some concerns, amber denotes moderate condition while red is used to show very poor condition of metrics/indicators (Figure 6).

2) **Condition trend:** Condition trend is the direction of change in condition over time, which may be one of three states: positive, negative or stable. Current condition of an ecosystem is assessed and compared to a previously determined state ('baseline'). In the CEMP program condition trend is indicated by a directional arrow located within the colour-coded symbol. Up arrows indicate an increase in condition over time as shown by the data, while a downwards arrow indicates a decrease in condition. A sideways arrow is used to indicate that the condition of the metric/indicator is stable (Figure 6).

3) **Data confidence**: The data confidence rating evaluates the ability to draw both statistical and causal inference from the data, reflecting the robustness of sampling methods used and therefore is an indication of the accuracy of and ability to be confident in the condition/state and trend rating given to each metric. The data confidence rating may be one of four ratings:

a. High: This confidence level is given when data is sourced from monitoring and/or research that used proven field methods and robust sampling designs, such as the use of many sites (replication), randomisation of site locations and the use of control plots.

b. Medium: This rating is given where monitoring has taken place over a long period of time, but may have inconsistencies in methods over this period, a change of study sites or minimum experimental design underpinning the methods used (e.g. many mandate monitoring programs) and with some, but limited, replication and randomisation.

c. Low: This rating was given where study sites are severely limited (minimal replication), no experimental design was used, there may have been large changes to the field methods used or study sites (inconsistency of methods), no randomisation and/or unproven sampling methods were used.

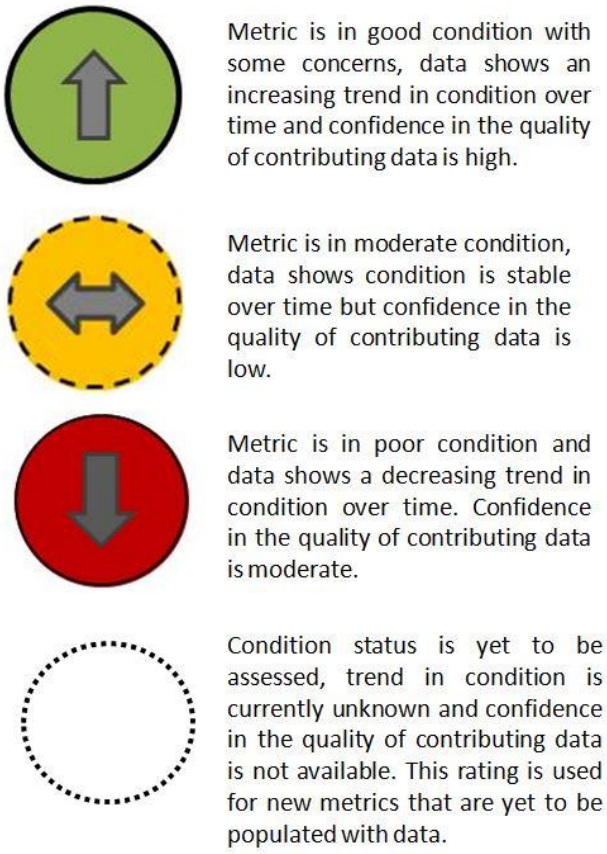
d. Unknown: Data confidence is unknown due to no information on data type. This category is often used for new metrics, where a data confidence rating will be assigned in the next reporting cycle. (Figure 6).

Figure 6. Levels and corresponding symbology for condition/state, condition trend and data confidence used in the CEMP program.

Condition/State		Condition Trend		Data Confidence	
	Indicator is in good condition		Condition of the indicator is improving		Confidence in condition assessment is high
	Indicator is in good condition with some concerns		Condition of the indicator is stable		Confidence in condition assessment is moderate
	Indicator is in moderate condition with a number of concerns		Condition of the indicator is declining		Confidence in condition assessment is low
	Indicator is in poor condition with many significant concerns		(Blank) Trend in the condition of the indicator is unknown		Confidence in condition assessment is not available

Examples of combinations of symbols used for reporting overall condition are shown in Figure 7. These represent the combined assessment of condition/state, condition trend and data confidence.

Figure 7. Examples of overall condition assessment symbology for metrics and indicators used in the CEMP reporting framework.



When each contributing metric has been assessed for condition/state, the outcomes are 'rolled-up' to inform the condition/state of the relevant indicator. The process of 'rolling-up' of metric data to get the overall condition/state grading follows an averaging process. Each condition/state is given a numeric value as follows: 'Good'=4, 'Good with some concerns'=3, 'Moderate'=2 and 'Poor'=1. As the number of metrics informing indicator condition/state varies between indicators, the total sum of all the metric conditions is calculated then averaged by the number of contributing metrics. For example, an indicator with four metrics with conditions 'Good' (4), 'Good with some concerns' (3), 'Moderate' (2) and 'Good with some concerns' (3) respectively, would lead to an indicator condition/state of 4+3+2+3=12/4=3, which gives an indicator condition assessment of 'Good with some concerns'. In a case of the final value containing a half (e.g. 2.5), a conservative approach is taken and the indicator condition/state is rounded down to the lower grading (e.g. 2.5 is lowered to 2= 'Moderate'). Examples of metric condition/state combinations and the 'rolled-up' overall indicator condition/state are shown in Figure 8.

Figure 8. 'Rolling-up' the data - table showing various combinations of metric conditions and outcomes for the condition of the relevant indication they inform, following an averaging process.

	Metric 1	Metric 2	Metric 3	Metric 4	Overall Indicator Grading
1	Good	Good with some concerns	Moderate	Good with some concerns	Good with some concerns
2	Good with some concerns	Poor	Moderate	Good	Moderate
3	Moderate	Good with some concerns	Poor		Moderate
4	Poor	Moderate	Moderate	Poor	Poor
5	Good	Good with some concerns			Good with some concerns
6	Good	Good	Moderate		Good with some concerns
7	Moderate	Moderate	Good with some concerns		Moderate

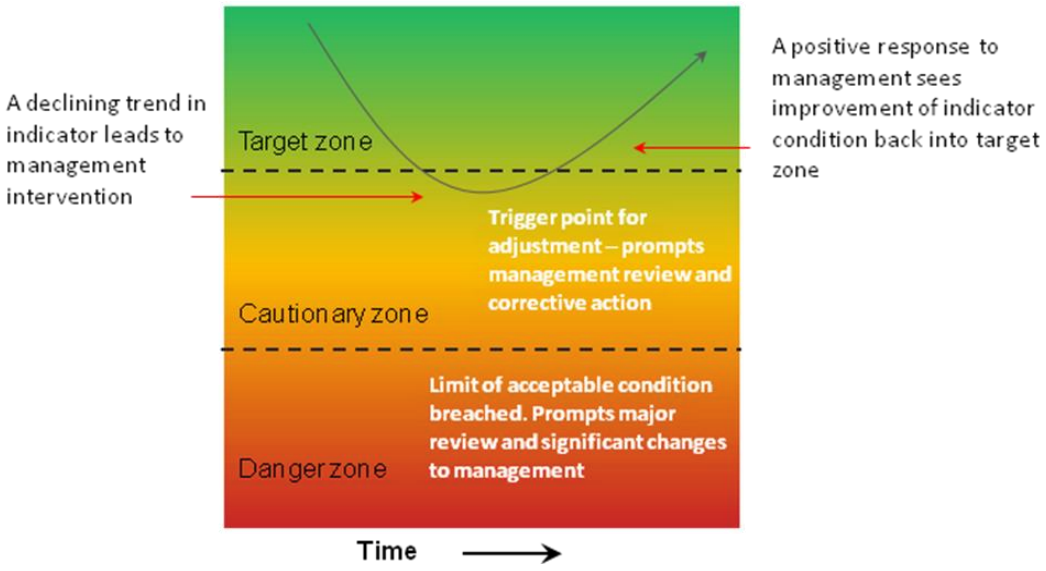
The same process of averaging used to assess indicator condition/state is repeated for condition trend ('Improving'=3, 'Stable'=2 or 'Declining'=1) and data confidence ('High'=3, 'Moderate'=2 and 'Low'=1). These two assessments are then combined with the condition/state of the indicator to inform the overall indicator condition.

4.2 COMBINING CONDITION ASSESSMENT WITH REFERENCE CONDITION AND TARGET CONDITION

CEMP modified the principles of 'Target zones', 'Cautionary zones' and unacceptable 'Danger zones' presented in Jones (2009) to tie together results of condition assessment with reference/target condition and trigger points. This method provides the ability to identify quantifiable thresholds in condition that 'trigger' a review of management actions when breached, thus enabling management to act prior to poor condition being reached (Figure 9).

For example, if indicator condition is within the target zone defined for that indicator (such as 'good' condition/state with a stable or improving trend – see section 4.1 of this document), management actions are adequate and the desired outcomes are being achieved. However, if the condition of the indicator is declining, its condition may soon pass a defined trigger point into the 'Cautionary zone'. Such an outcome would initiate changes to management actions (Figure 9) that may be reviewed in the next CEMP reporting cycle. For example, for a particular species, a trigger point may be a population that is a given amount above the minimum viable population for that species. The actual minimum viable population represents the limit of acceptable condition beyond which the indicator enters the 'Danger zone' and requires immediate review and significant changes to be made to management (Figure 9). One current issue is that trigger points for many metrics are either unknown or based on expert opinion due to lack of data. Part of the CEMP process is to highlight research and knowledge gaps so that trigger points for each metric can eventually be derived from data and sound knowledge of the ecosystem.

Figure 9. The conceptual relationship between the condition/state of an indicator, its reference condition or target condition and trigger points that lead to a change in management actions. Adapted from Jones (2009).



5. REPORTING OUTCOMES, EVALUATION AND OTHER CONSIDERATIONS

The CEMP's primary role is to consolidate information on ecosystem condition, thereby providing a data-rich decision support tool to inform management actions. It is important therefore, that a reporting mechanism relevant to the temporal scale of both the indicators and current management programs be established. To meet this need, the CEMP program aims to hold annual update workshops with reserve managers in addition to formal reporting cycles, with ecosystem condition reports for each ecosystem unit produced once every three years. The purpose of CEMP ecosystem reports will be primarily to help inform management actions in conserving ecological values within the ACT reserve system, however, this timeframe will also compliment other existing ACT Government commitments for reporting on biodiversity conservation outcomes that inform strategic planning and policy development such as State of the Environment reporting (SOE), Reserve Operational Plans (ROP), State of the Forests reporting (SOF), the Biodiversity Research and Monitoring Program (BRAMP) and ACT Government Nature Conservation Strategy reporting (NCS).

The structure of the CEMP reporting framework, including the use of assessment summaries and symbology to represent indicator condition (see Section 4 of this document), aims to be both informative and user-friendly. The CEMP ecosystem reports also include graphs and relevant summaries of the data behind each condition assessment for transparency of reporting and providing access to data (including links to data sets) for those readers that require more detailed information. Publishing ecosystem reports online via an intranet Hub would allow an increase in accessibility to general staff and should be considered. It is hoped that through such a reporting structure, the CEMP program will achieve higher visibility generally and encourage greater collaboration between ecologists, planners and managers through linking research prioritisation, strategic planning and management actions. The CEMP reports may also be used to recognise and promote partnerships with citizen science and external organisations that have contributed monitoring data, or may wish to contribute in the future.

A review of monitoring in ACT reserves by Stevenson and Seddon (2014) revealed that monitoring generally did not record conservation gains in response to management actions, and that consequently many current monitoring programs were "data rich but information poor" (Lindenmayer and Likens, 2010). Monitoring programs that fail to provide useful information that links management and conservation outcomes will be highlighted in the CEMP report for each ecosystem unit, with the view to re-evaluating and/or re-designing such monitoring programs through the addition of question driven monitoring with robust experimental design. In many cases this may mean adding value to current "mandate" monitoring through supplementary research projects in order to address specific management questions. By addressing such limitations, there will be a shift towards monitoring uncertainty around management efficacy and a greater focus on ensuring monitoring remains relevant to conservation goals (including overarching policy requirements) and management priorities.

A further aim of CEMP is to identify gaps in our current knowledge pertaining to the management of ecosystem units, therefore it is important that the CEMP reporting framework contains a section

that highlights these gaps and prioritises future research that addresses them. In addition to providing a mechanism for feeding in new projects to address knowledge gaps, a future research section within each ecosystem report aids in adjusting priority questions as new information emerges (adaptive management) and incorporating new conservation ideas that may have strong community and political support. This includes the ability to accommodate short term research projects, often associated with opportunistic funding, into the reporting framework.

Another issue with current monitoring programs, as identified by Stevenson and Seddon (2014), is that data is not always collected in a consistent manner over time or across organisations. Changes to study sites, field methods or the scale of data collection poses difficulties for latter data analysis and undermines confidence in results. Turnover in personnel responsible for monitoring programs and rapid changes in technology may result in inconsistent sampling methods over time, threatening data quality and consistency. The systematic approach of the CEMP framework enables the standardisation of protocols that are important for maintaining data integrity. CEMP project officers have liaised extensively to assist with achieving consistency between projects in monitoring of metrics, field methods used for data collection and to ensure management implications are considered in new programs.

CEMP also requires an ability to adapt as our knowledge base increases and new technologies become available (e.g. LIDAR, remote sensing, Collector app.). The ability of the CEMP program to incorporate multiple research projects into metrics provides a mechanism for bringing in new data collection techniques. Additional methods can be incorporated into the CEMP program to compliment standardised data whilst ensuring consistency between reporting cycles. The need to ensure data integrity across the CEMP program, in addition to promoting increased accessibility of information across agencies, has led to the idea of a centralised database for maintaining integrity of data for contributing metrics.

Other protected area management agencies in Australia have found a key element to ensure the long-term accessibility and participation in monitoring programs is the involvement of rangers and field staff (Parks and Wildlife Service, 2013). It is critically important that staff managing reserves feel involved, are able to contribute knowledge to the CEMP program (e.g. suggest areas of management uncertainty or future monitoring sites), understand its value in assisting management and consequently maintain a vested interest in collecting accurate monitoring records. Funding and logistical requirements for the CEMP program need to consider existing time demands on field staff, in addition to establishing robust protocols for the transfer of relevant skills in order to manage the high turnover of field personnel and to ensure information flow is retained on monitoring programs.

Finally, the efficacy of management actions, in terms of both achieving management goals and cost effectiveness, needs to be established. The CEMP assessment of ecosystem condition may be combined with budgeting to generate an assessment of the cost-effectiveness of management actions. A cost/benefit analysis (CBA) could consider the ecological risk vs. management cost when there is uncertainty of best practice and to assist in the prioritisation of management actions. Where monitoring data shows no measurable improvement in the ecosystem values and/or a CBA indicates management is not cost effective at achieving conservation goals, alternate management options should be considered.

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