

Bunyip North Quarry Project: Aquatic Ecology Existing Conditions



Prepared for: AECOM

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Cover photo: Dam 98 on No Name Creek, south of the Project Site

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ii Acronyms

Abbreviation	Description
%	Percentage
“the Project”	The proposed Bunyip North Quarry Project
AECOM	AECOM Australia Pty Ltd
AHD	Australian Height Datum
ALARA	As Low As Reasonably Achievable
BMO	Bushfire Management Overlay
BNQ	Bunyip North Quarry
BoM	Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DJPR	Department of Jobs, Precincts and Regions
EE Act	<i>Environment Effects Act 1978</i>
EES	Environment Effects Statement
EIIA	Extractive industry interest areas
EMP	Environmental Management Plan
EP Act	<i>Environment Protection Act 1970</i>
EPA	Environment Protection Authority
EPAV	Environment Protection Authority (of Victoria)
EPBC	Environment Protection and Biodiversity Conservation
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERC	Environment Review Committee
ERP	Emergency response plan
ERR	Earth Resources Regulation
ESO	Environmental Significance Overlay
EVC	Ecological Vegetation Classes
FFG Act	<i>Flora and Fauna Guarantee Act 1988</i>
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse gas
GLCC	Global Land Cover Characterisation
GMR	Greater Metropolitan Region
GRZ	Geotechnical Risk Zone
GWZ	Green Wedge Zone
ha	Hectares
Hanson	Hanson Construction Materials Pty Ltd
ITR	Independent Technical review
km	kilometres
km/hr	Kilometres per hour
LGA	Local government authority
LOD	Limit of detection
LOR	Limit of Reporting
LOT	Large old tree
LPPF	Local Planning Policy Framework
m	Metre(s)
MEA	Maximum Extent Achievable
mg/kg	Milligrams per kilograms

Abbreviation	Description
mg/m ³	milligrams per cubic metre
mm	millimetres
MRSD Act	<i>Mineral Resources (Sustainable Development) Act 1990</i>
MSS	Municipal Strategic Statement
Mt	Million tonne
NATA	National Association of Testing Authorities
OMP	Offset Management Plan
P&E Act	<i>Planning and Environment Act 1987</i>
ppm	Parts per million
RL	Relative Level
SEPP	State Environment Protection Policy
SPPF	State Planning Policy Framework
TRG	Technical Reference Group
TRLs	Trigger Response Levels
TSP	Total Suspended Particulates
w/w	Weight by weight
Water Act	<i>Water Act 1989</i>
WA	Work Authority
WP	Work Plan

iii Glossary

Biodiversity	The variety of all life-forms, plants, animals, fungi, protists (including algae) and bacteria, their encoded genes, and the ecosystems of which they form a part
Bioregion	Defined geographical regions of Australia with similar climatic and geophysical characteristics, and which generally contain a suite of distinct ecosystems and species
CaLP Act	Victorian <i>Catchment and Land Protection Act 1994</i>
Conservation status	Categorisation of the threat risk to biological assets (plant and animal species, EVCs or plant communities) at a defined scale (e.g. national, state), as determined by specific criteria
Ecological Vegetation Class (EVC)	A vegetation classification described through a combination of its floristic composition, life form and ecological characteristics, and its association with particular environmental attributes. EVCs may include one or more floristic communities that occur across a biogeographic range, and have similar habitat and ecological processes operating
Endemic	Naturally found only in a defined geographic area
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
Exotic	Plants, animals, fungi and other organisms that have been introduced (deliberately or accidentally) to Australia or a given area after European settlement
Exotic vegetation	Vegetation comprised wholly or substantially of exotic species
FFG Act	Victorian <i>Flora and Fauna Guarantee Act 1988</i>
Floristic	Of or pertaining to plant species, i.e. flora
GIS	Geographic Information System. A digital platform for creating, analysing and viewing maps and other spatially referenced data
High threat weeds	Introduced species (including non-indigenous 'natives') which, as invading species have highly deleterious impacts on indigenous vegetation and faunal habitats
Indigenous	Plant and animal species found naturally in pre-European Australia
Indigenous vegetation	Vegetation native to Australia or native to a specific geographic region
Introduced	Deliberately or accidentally brought to Australia or part of Australia, usually by human agency
Native vegetation	Species occurring naturally in Australia as part of the pre-European flora or fauna

Vegetation community	Term for interacting plant populations forming vegetation. A vegetation community in formal classifications may have characteristic plant species, composition and structure
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1 INTRODUCTION

1.1 Purpose

The proposed Bunyip North Quarry Project (the Project) was referred to the Minister for Planning to seek advice on the need for an Environment Effects Statement (EES) under the Environment Effects Act 1978.

On the 22 November 2015 the Minister issued his decision that an EES is required for the project and issued procedures and requirements that are to apply to the EES.

This technical report provides the assessment of the aquatic ecological values of the site and surrounds.

1.2 Project Description

Hanson proposes to establish a granite quarry on a greenfield site, south of Sanders Road, Bunyip North. The stone reserves at the site are comprised of approximately 130 million tonnes of granite aggregate products over a period of 69 years, depending on demand.

The Project Site covers some 160 hectares and has frontages to Bunyip-Tonimbuk Road and Sanders Road. The pit and overburden stockpile designs have footprints of approximately 68 and 28 hectares respectively. The pit floor is limited to 0 mAHD, thus will be at a depth of between 60 to 140 metres below natural surface.

Development and operation of the Bunyip North Quarry will involve the:

- removal of vegetation, topsoil and overburden to enable stone extraction;
- removal of granite through controlled blasting and mechanical extraction;
- onsite processing of stone;
- mixing of aggregates on site;
- progressive rehabilitation of extracted areas;
- transportation of stone and aggregates from site; and
- final rehabilitation (post resource exhaustion).

1.2.1 Summary of proposed works and activities

On the basis that the Project receives approval, a number of site preparation activities may be required and must be completed before quarry activities can commence. These include the following:

- Relocation of the services;
- Erection of perimeter security fencing;
- Construction of the access road (sealed) to the processing facility via Tonimbuk Road;
- Vegetation clearance of Project Site, including pit, overburden and processing plant footprints;
- Construction weighbridge;
- Preparation of stockpile areas;

- Implementation and construction of drainage channels, sediment and collection dams;
- Decommissioning of the current dwelling and water tanks; and
- Commissioning of workshop and site administrative offices.

1.2.2 Operation

The quarry phase is expected to last approximately 69 years, depending on the future level of resource demand. The following key activities will occur progressively:

Topsoil and Overburden Removal and Storage

Topsoil is progressively removed on an “as needed” basis and stockpiled for later rehabilitation works. Overburden is then progressively removed and either used directly for rehabilitation purposes or stockpiled for future rehabilitation use and/or sold as a general fill or utilised in the production of lower quality processed road base materials.

Quarry Bench Development

Quarry benches will be developed using conventional ripping, excavation, and drill and blast techniques. Bench heights, widths and vertical separation between benches are in accordance with accepted quarry practice and conform to statutory requirements. Bench access haul roads will be of appropriate width and grade for safe passage of dump trucks and are to be well maintained.

Raw Materials Handling

Quarry rock is loaded from quarry benches using a hydraulic excavator or rubber tyred front end loader onto off road quarry haul trucks for haulage to the processing plant.

Processing Plant and Storage of Product

The processing plant is proposed to be located south-east of the pit area. The plant will accept raw product from the quarry and allow for the mixing of aggregate to make road base and wet-mix products. The processing plant is proposed to contain primary, secondary and tertiary processing legs, with stockpiling of material between stages.

Crushing and Screening Plants

Rock will be initially processed through a mobile plant (first 5 years) and then a fixed processing plant comprising a receiving bin, a primary crusher, secondary crushers, tertiary crushers and quaternary, vibrating screens and linking rubber conveyors.

Lower quality material will be initially screened and a transportable screening plant with oversize materials and undersized materials (scalps) will be used to enable these materials to be stockpiled for sale as a select fill or low-grade road material.

Quarry Operational Throughput

The throughput of the Project is proposed to be 0.5 million tonnes per year for the first 5 years, and then increase to 2.0 million tonnes per year to achieve the proposed optimum production rate.

Transport

Transportation of raw material and final product will occur throughout the operation of the quarry. The Project would initially involve the cartage (sales) out of the site of approximately 2,000 tonnes per day, which equates to approximately 108 truck movements per day. Six years into the operation, cartage will increase to 6,000 tonnes per day, which is approximately 216 truck movements per day.

At peak production approximately 6,400 tonnes per day would be carted, which would generate 434 truck movements per day at its peak. This presents an upper limiting number as it is based on every truck being a tandem (unlikely). The average load size is expected to be higher, reducing the expected number of vehicle movements.

Closure

The Project Site will be progressively rehabilitated where possible throughout the Project's life as material is extracted.

Following extraction of the granite resource, the land will be made safe and stable and rehabilitated in accordance with the rehabilitation plan that will be approved as part of the Work Plan.

1.3 Project Area

The Project is located in Bunyip North, Victoria and is approximately 80 km south-east of Melbourne and 3 km north of the Princes Freeway on land that is currently utilised for grazing purposes.

The Project Site is located within two catchments of the Bunyip River basin: Two Mile Creek West and Cannibal Creek. The Project Site contains the upper first order stream reaches of tributaries of unnamed Two Mile Creek West and Cannibal Creek tributaries and includes a number of online and offline dams. The location of the site is shown in Figure 1.

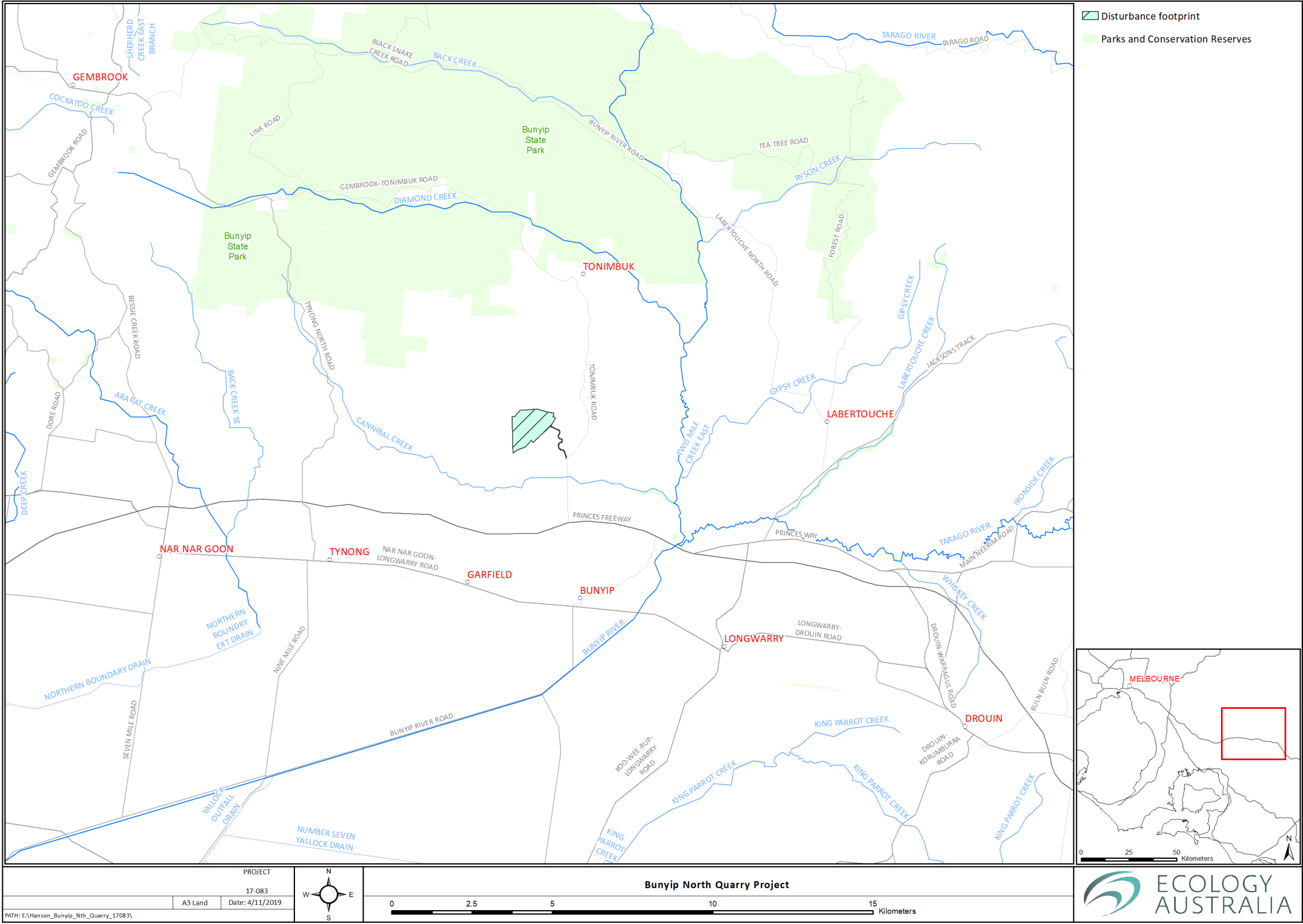


Figure 1 The location of the Project Site relative to major waterways.

2 SCOPING REQUIREMENTS

The Scoping Requirements (September 2017) outline the following key matters that the EES is primarily to focus on:

The EES is to document investigations of potential environmental effects of the proposed project, including the feasibility of associated environmental mitigation and management measures, in particular for:

- a. potential effects on native vegetation and associated biodiversity values, in particular listed threatened species and communities, such as through the loss, degradation or fragmentation of habitat or through other indirect causes, as well as related ecological effects*
- b. potential effects on surface and groundwater environments and related beneficial uses, including as a result of changes to groundwater levels, movement, affected stream flows and discharges*
- c. effects on Indigenous cultural heritage values*
- d. effects arising from the transport from the site onto the public road system*
- e. other effects on amenity, landscape values, land uses and the community*

The Scoping Requirements provide further detail on the specific matters to be investigated in the EES. The following requirements are of particular relevance to the aquatic ecological scope of this investigation.

2.1 EESSR 3.1 General approach

- Potential effects on individual environmental assets – magnitude, extent and duration of change in the values of each asset – having regard to intended avoidance and mitigation measures.
- The likelihood of adverse effects and associated uncertainty of available predictions or estimates.
- Further management measures that are proposed where avoidance and mitigation measures do not adequately address effects on environmental assets including specific details of how the measures address relevant policies.
- Likely residual effects assuming proposed measures are implemented.

2.2 EESSR 3.2 General content and style of the EES

- The main EES report should provide a clear, objective and well-integrated analysis of the potential effects of the proposed project, including proposed mitigation and management measures. Overall, the main report should include:
 - An executive summary of the potential environmental effects of the project, including potential effects on identified MNES outlined in section 4.3
 - Description of the approvals required for the project to proceed, and its relationship to relevant

- Descriptions of the existing environment, to the extent relevant to the assessment of potential effects
- Appropriately detailed assessments of potential effects and risks of the project on environmental assets and values, relative to the 'no project' scenario, together with an estimation of likelihood and degree of uncertainty associated with predictions
- Intended measures for avoiding, minimising, managing and monitoring effects
- Any proposed offset measures where avoidance and mitigation measures will not adequately address effects on environmental values, including the identified MNES, and discussion of how any offset package proposed meets the requirements of the EPBC Act Environmental Offsets Policy as it relates to MNES
- Evaluation of the implications of the project and relevant alternatives for the implementation of applicable legislation and policy, including the principles and objectives of ecologically sustainable development and environmental protection

2.3 EESSR 3.5 Applicable legislation, policies and strategies

- Identify relevant legislation, policies, guidelines and standards, and assess their specific requirements or implications for the project, particularly in relation to required approvals, including but not limited to:
 - Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
 - Catchment and Land Protection Act 1994
 - Environment Protection Act 1970 including the principles of environment protection and relevant State Environment Protection Policies (SEPPs), the Protocol for Environmental Management – Mining and extractive industries (PEM) and other relevant policies and guidelines
 - Flora and Fauna Guarantee Act 1988
 - Mineral Resources (Sustainable Development) Act 1990
 - Planning and Environment Act 1987, and relevant provisions in the Cardinia Planning Scheme
 - Water Act 1989
 - Wildlife Act 1975

2.4 EESSR 3.7 Draft evaluation objectives:

- To avoid or minimise adverse effects on native vegetation, listed threatened species and listed migratory species, other protected flora, fauna and ecological communities, habitat for listed threatened species, listed migratory species and other protected flora and fauna, and address offset requirements for residual environmental effects consistent with relevant Commonwealth and State policies.
 - Key legislation: EPBC Act; MRSD Act; FFG Act; Wildlife Act

2.5 EESSR 4.1 Approach to assessment:

- Key issues or risks that the project poses to the achievement of the draft evaluation objective. In addition to addressing the highlighted issues, the proponent should consider undertaking an environmental risk assessment as appropriate.
- Priorities for characterising the existing environment to underpin predictive impact assessments having regard to the level of risk. Any risk assessment by the proponent could guide the necessary data gathering.
- Design and mitigation measures that could substantially reduce and/or mitigate the risk of significant effects.
- Assessment of likely effects through predictive studies or estimates of effects that are reasonably likely, as well as evaluation of their significance, having regard to their likelihood.
- Approach to manage performance, in terms of further measures that are proposed to manage risks of effects, assuming that identified design and mitigation measures are applied, to achieve appropriate outcomes. This should inform the assessment of likely residual effects (assuming proposed measures are implemented) and consideration of relevant environmental effects where applicable.

2.6 EESSR 4.3 Biodiversity

Draft evaluation objective - To avoid or minimise adverse effects on native vegetation, listed threatened species and listed migratory species, other protected flora, fauna and ecological communities, habitat for listed threatened species, listed migratory species and other protected flora and fauna, and address offset requirements for residual environmental effects consistent with relevant Commonwealth and State policies.

2.6.1 Key issues

- Direct loss of native vegetation and associated listed ecological communities.
- Direct loss or degradation of habitat for flora and fauna listed as threatened under the EPBC Act, the FFG Act and/or DELWP Advisory Lists, including, but not limited to:
 - Dwarf Galaxias (*Galaxiella pusilla*)
 - other protected species.
- Disturbance and/or degradation of adjacent habitat that may support listed species or other protected flora or fauna.
- Indirect habitat loss or degradation resulting from other effects of quarrying, such as edge effects, surface hydrological changes, groundwater drawdown, dust deposition or other disturbance impacts such as noise.
- The availability of suitable offsets for the loss of native vegetation and habitat for relevant listed threatened species and migratory species under the EPBC Act.
- Potential for other significant effects on biodiversity values including but not limited to those associated with changes in hydrology, hydrogeology, water quality, dust emissions, weed/pathogen introduction and risk of significantly increased mortality of protected species resulting from quarry related activities such as road traffic and clearing of vegetation or soil.

2.6.2 Priorities for characterising the existing environment

- Characterise the local terrestrial and aquatic environments and any wildlife movement in the broader area that could be directly or indirectly impacted by the project.
- Identify and characterise any groundwater dependant ecosystems that may be affected, in particular by dewatering.
- Describe the specific biodiversity values on or in the vicinity of the project site that could be affected by the project, including:
 - remnant native vegetation and any ecological communities listed under the EPBC Act or the FFG Act
 - presence of, or suitable habitats for, flora and fauna species listed as threatened under the EPBC Act, the FFG Act or DELWP Advisory Lists
 - presence of other protected flora and fauna species
- Describe hazards that the project could present to biodiversity values, including:
 - direct removal of individuals or destruction of habitat
 - disturbance or alteration of habitat conditions or other sources of increased habitat threat, including possible effects on potentially threatening processes listed under the FFG Act and on MNES protected under the EPBC Act
- This characterisation is to be informed by relevant data, literature and appropriate seasonal or targeted surveys, in line with Commonwealth and State survey guidelines as they apply to MNES.

2.6.3 Design and mitigation measures

- Identify potential and proposed design options and measures that could avoid or minimise significant effects on or in the vicinity of the project site on native vegetation and any EPBC Act listed ecological communities or threatened flora or fauna species or listed migratory species or any other listed threatened or protected flora and fauna species and their habitat.
- Develop rehabilitation strategies to enable the return of protected flora and fauna species impacted by project works.

2.6.4 Assessment of likely effects

- Assess the direct and indirect effects of the project and relevant alternatives on native vegetation, and listed ecological communities, listed threatened and other protected flora and fauna and listed migratory species on or in the vicinity of the project site, including any relevant species listed under the EPBC Act or FFG Act.
- Assess the direct and indirect effects of the project and relevant alternatives on protected fauna, especially listed threatened species under the EPBC Act or FFG Act and listed migratory species under the EPBC Act.

2.6.5 Approach to manage performance

- Describe and evaluate proposed measures to manage residual effects of the project on biodiversity values, including an outline of an offset strategy that sets out the offsets that have

been secured or are proposed to satisfy both Commonwealth and State offset policy requirements.

- Describe and evaluate the approach to develop contingency measures to be implemented in the event of adverse residual effects on flora and fauna values requiring further management.
- Identify any further methods proposed to manage risks and effects on other biodiversity values and native vegetation, including as part of the EMF.

3 LEGISLATION, POLICY & GUIDELINES

3.1 Commonwealth legislation

3.1.1 Environment Protection and Biodiversity Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) pertains to matters of national environmental significance, including world heritage properties, national heritage properties, listed threatened flora and fauna species and ecological communities, listed migratory fauna species, Ramsar Wetlands, and Commonwealth marine areas. If a proposed action has the potential to have a significant impact on a Matter of National Environmental Significance, then a referral is required to the Minister for the Environment to determine whether assessment and approval will be required to undertake the activity (i.e. controlled action).

An isolated population of the EPBC listed species, dwarf galaxias *Galaxiella pusilla*, has been found to occur in the immediate vicinity of the study area. The population occurs in a series of online dams and wetlands in No Name Creek (i.e. immediately south of the Project Area). The hydrological regime of No Name Creek will be impacted by the Project, most particularly by groundwater drawdown in the later stages of quarry operation (Stage 3–4). Using the significant impact guidelines (Commonwealth of Australia 2013), the population probably meets one criterion (key source populations either for breeding or dispersal) to be considered for an important population, but may meet a second criterion (populations that are necessary for maintaining genetic diversity). The Project could have a significant impact dwarf galaxias based on the following significant impact criteria:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population; and
- disrupt the breeding cycle of an important population.

A referral for the Project was submitted in 2015 (2015/7574) and the Project was determined in November 2015 to be a controlled action, requiring assessment and approval under the EPBC Act. Impact mitigation and offset approaches will need to be developed to the satisfaction of the Department of Environment and Energy.

3.2 State legislation and policy

3.2.1 Victorian Flora and Fauna Guarantee Act 1988

The Flora and Fauna Guarantee Act 1988 (FFG Act) lists flora and fauna species and ecological communities that are recognised to be rare or threatened in Victoria. It also identifies threatening processes and flora that require protection. Protected flora includes those species listed as rare or threatened under the Act, plant taxa that belong to listed communities and plant taxa that are not threatened, but require protection for other reasons (e.g. over-collection). Authorisation is required to collect, kill, injure or disturb listed fish

An isolated population of the FFG listed fish species, dwarf galaxias *Galaxiella pusilla*, has been found to occur in the immediate vicinity of the study area. The population occurs in a series of online dams and wetlands in No Name Creek (i.e. immediately south of the Project Area). The hydrological regime of No

Name Creek will be impacted by the Project, most particularly by groundwater drawdown in the later stages of quarry operation (Stage 3–4) and an FFG Permit will therefore be required.

3.2.2 Victorian Planning and Environment Act 1987

The Planning and Environment Act 1987 (P & E Act) establishes a framework for planning the use, development and protection of land, including native vegetation retention controls. In particular Clause 52.17 of the planning scheme identifies circumstances where a planning permit is required to remove, destroy or lop native vegetation, including dead native vegetation. Native vegetation clearance may also be managed by zones and overlays.

The Cardinia Shire Planning Scheme is subordinate to the requirements of the P & E Act. The site occurs within an Environmental Significance Overlay (ESO), and a Land Subject to inundation overlay (LSIO) associated with Two Mile Creek West and its unnamed tributary occur in close proximity (north) of the Project area.

Various permits may be required for this project under the P & E Act.

3.2.3 Victorian Catchment and Land Protection Act 1994

The Catchment and Land Protection Act 1994 (CALP Act) contains provisions relating to catchment planning, land management, noxious weeds and pest animals. The Act provides a legislative framework for the management of private and public land. It sets out the responsibilities of landowners declaring that they must take all reasonable steps to:

- avoid causing or contributing to land degradation which causes or could cause damage to land of another landowner;
- protect water resources and conserve soil;
- eradicate regionally prohibited weeds and prevent the growth and spread of regionally controlled weeds; and
- prevent the spread of and eradicate established pest animals (DEPI, 2014).

In essence, the Act establishes a framework for the integrated management and protection of catchments to improve long-term land productivity and conservation of the environment. The Project needs to occur in a manner that is consistent with the responsibilities outlined in this Act.

3.2.4 Wildlife Act 1975

The Wildlife Act 1975 is the primary legislation in Victoria providing for protection and management of wildlife. In particular, it provides the basis for regulation of the handling and use of wildlife, including a requirement for people engaging in wildlife research to obtain a permit in accordance with the Act.

Dams within the construction and pit footprint of the Project will require removal. A permit will be required to salvage and translocate turtles and frogs/tadpoles.

3.2.5 Victorian Fisheries Act 1995

The Fisheries Act 1995 is the primary legislative framework in Victoria for the regulation, management and conservation of fisheries. Syngnathidae (seahorses and pipefish) and any FFG Act listed fish or

aquatic invertebrate are 'protected aquatic biota' under this Act. A fisheries permit is required to take, injure, damage, destroy or release protected aquatic biota.

An isolated population of the FFG listed fish species, dwarf galaxias *Galaxiella pusilla*, has been found to occur in the immediate vicinity of the study area. The population occurs in a series of online dams and wetlands in No Name Creek (i.e. immediately south of the Project Area). The hydrological regime of No Name Creek will be impacted by the Project, most particularly by groundwater drawdown in the later stages of quarry operation (Stage 3–4) and therefore a fisheries permit could be required. However, obtaining an FFG permit (from DELWP) would likely absolve the need for a Protected Aquatic Biota Permit; clarification should be sought from the Victorian Fisheries Authority.

The Project will require translocation of eels from dams within the Project area and translocation of dwarf galaxias, southern pygmy perch and granular burrowing crayfish from No Name Creek to created habitats. These translocations may require approval under an established process

(<https://vfa.vic.gov.au/operational-policy/moving-and-stocking-live-aquatic-organisms/guidelines-for-assessing-translocations/applying-to-translocate>). Short distance translocations within the same catchment do not always require formal translocation approval, so clarification should be sought from the Victorian Fisheries Authority in this matter.

3.2.6 Victorian Water Act 1989

The Water Act 1989 is the primary legislative framework for the management and allocation of Victorian surface water and groundwater and the maintenance of aquatic ecosystem functions. Relevant Authorities under the Act (i.e. Melbourne Water and Catchment Management Authorities) create By-Laws to regulate works within and in the vicinity of waterways, including any works that may affect water quality and quantity, riparian vegetation or waterway streambed or banks.

Approval would be required from Melbourne Water for the Project for all waterways that are considered Melbourne Water 'Assets'. No Name Creek has a small catchment (<60 ha?) and may or may not be considered a Melbourne Water Asset (i.e. may be a Cardinia Shire Council asset), so clarification should be sought from Melbourne Water in this regard.

3.2.7 Environmental Protection Act 1970: State Environmental Protection Policy (Waters of Victoria) 2018

The State Environmental Protection Policy (SEPP) – Waters of Victoria provides the primary legislative framework for the protection and rehabilitation of Victoria's surface water environments. The beneficial uses and values of waterways are protected by ensuring that impacts to surface water quality do not exceed the background levels or water quality objectives specified in the SEPP.

Beneficial uses include 'Water dependent ecosystems and species', where the intent is to protect the integrity and biodiversity of these systems including the protection of riparian zones, prevention of groundwater quality from adversely affecting surface water quality.

Planning and regulatory authorities must ensure that planning documents and approvals have regard for the objectives and actions set out in this SEPP.

4 METHODOLOGY

4.1 Existing conditions assessment

The existing conditions assessment was undertaken based on:

1. Background review
2. Site visit
3. Survey method development
4. Survey
5. Reporting

4.1.1 Background Review

A background review of all relevant information relating to aquatic ecological values, including but not limited to:

- A catchment based searches of the Victorian Biodiversity Atlas, Melbourne Water Fish database and EPBC Act 1999 Protected Matters Search Tool. The catchments searched were:
 - The Bunyip River catchment above Iona (excluding the Tarago River catchment)
 - The Cannibal Creek catchment
 - The Two Mile Creek catchment
- Review of all aquatic ecological information contained within the previous flora and fauna assessments and targeted surveys undertaken for the Project site
- Review of relevant previous hydrological and water quality reports undertaken for the project
- Relevant of information from any other reports undertaken in the area (e.g. fish survey reports for Melbourne Water)

4.1.2 Survey method development

The survey methods for farm dams/wetlands within the study site and the requirement for offsite surveys to occur were determined on the basis of:

- The background review including the surveys undertaken to date and the potential extent of impacts identified within water quality and hydrology reports;
- A site visit and examination of aerial photography and relevant mapping layers;
- The requirements of state and federal survey guidelines (e.g. DSEPAC 2011);
- A comprehensive and contemporary understanding of dwarf galaxias habitat use and habitat connectivity requirements based the combination of published literature, grey literature and expert opinion and experience; and
- Discussion with Melbourne Water and DELWP.

4.1.3 Site selection

Site selection was based on desktop assessment of available maps and aerial imagery, together with visual inspection during a site visit. The number and location of sites selected was based on professional opinion based on habitat suitability and access, combined with ensuring adequate spatial coverage in the waterways concerned. The sites surveyed are depicted in Figure 2 and are listed in Table 1.

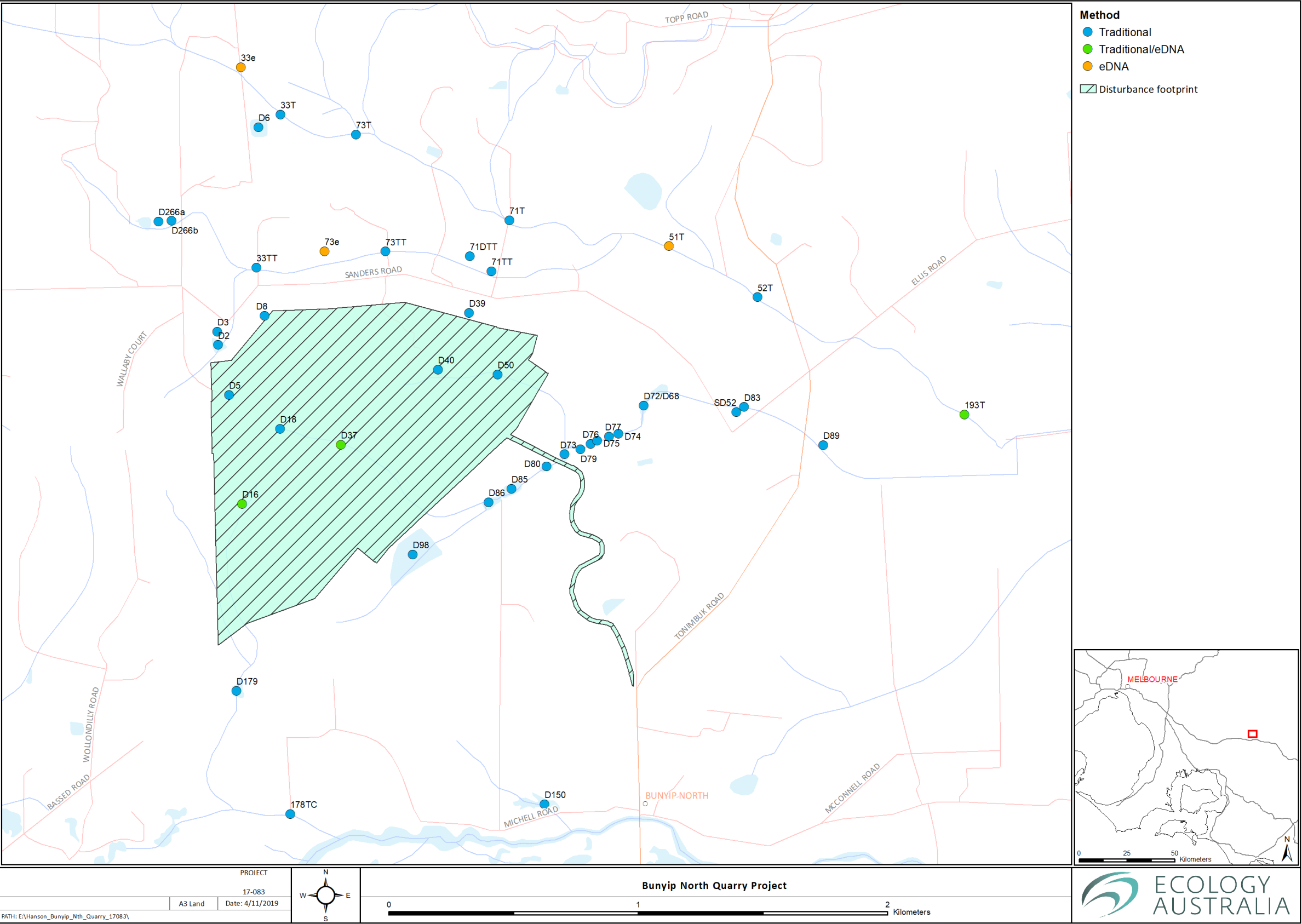


Figure 2 The sites sampled within and around the Project Site using traditional sampling techniques and eDNA.

4.1.4 Habitat assessment

Habitat assessment was a two staged process. Initial visual assessments were conducted as part of the site selection process. More detailed assessments of habitat were undertaken at all sites that were selected for survey. The habitat assessments included a qualitative assessment of a range of physical, biological and water quality characteristics, including assessments of evident and anticipated existing levels of disturbance. Water quality measurements for parameters including pH, temperature, dissolved oxygen and electrical conductivity were made using a calibrated Horiba U53 water quality meter.

4.1.5 Survey

The survey was undertaken using a range of fish and crayfish survey techniques, selected as appropriate on the basis of the physical and water quality characteristics of each of the waterbodies targeted. The techniques used included:

- Dip netting
- Fine-meshed fyke netting
- Bait trapping (with glow sticks)
- Backpack electrofishing
- White bucket larval checks
- eDNA

Dip netting was used as a rapid survey technique for dwarf galaxias. Dip netting typically consisted of 10 minutes of active dip netting using a dip net with a 40 x 40 cm head with a 2 mm mesh net.

Two types of fine-meshed fyke nets were used, with the selection depending on the depth of the habitat being surveyed. Single wing standard fine-meshed fyke nets with a mesh size of 4 mm and wing height of 60 cm were used at shallow habitats. Dual wing larval fyke nets (hoop and skirt rather than 'D' entrance) with a mesh size of 2 mm were used at deeper sites because these nets have a wing height of 1.5 m. Fyke nets were set overnight and retrieved the following morning.

Standard accordion style bait traps with a 3.5 cm entrance funnel were used. These traps were constructed of green 2 mm mesh and were set overnight with a yellow glow stick placed inside the trap to serve as an attractant.

Backpack electrofishing was undertaken using a Smith Root LR24 backpack electrofisher. The electrofishing effort was divided into 'shots', each comprising 150 seconds of 'power on' time and the data for each shot was recorded separately. The electrofishing settings (voltage, duty cycle and frequency) were also recorded.

The presence of dwarf galaxias metalarvae and early juveniles was checked by filling a white bucket with water from suitable backwater habitats and checking the bucket contents.

The eDNA samples (two samples per site) were collected using a syringe and the water was pushed through the filter using the syringe until the filter became too clogged to push more water through. Water sampling and sample handling occurred with due care to avoid the potential for cross-contamination. The volume of water pushed through the filter was recorded and samples were kept on ice until received by EnviroDNA for analyses.

The site location details including the sampling technique(s) used and effort deployed is provided in Table 1.

Burrowing crayfish (*Engaeus* spp. burrows) were noted where they were observed. A selection of captured burrowing crayfish specimens were retained, identified using Horwitz (1990) which will be verified by Tarmo Raadik from the Arthur Rylah Institute (ARI – DELWP).

All species were identified and counted. Dwarf galaxias and southern pygmy perch were measured to the nearest millimetre and weighed to the nearest 0.1 gram. The dwarf galaxias and southern pygmy perch catches from individual bait traps were recorded to enhance the future utility of the data (i.e. for baseline monitoring purposes).

Table 1 Aquatic fauna survey site location and sampling technique and effort details. Project Site locations shown in bold.

Site code	Site location	Latitude	Longitude	Dates visited	Sampling type
D2	2nd most north-eastern dam, Project Site	-38.044770	145.695393	4/10/2018	FN fine (2)
D3	Most north-eastern dam, Project Site	-38.044288	145.695357	4/10/2018	FN fine (2)
D5	dam at end of driveway off Wallaby Ct, Project Site	-38.046587	145.695849	4/10/2018	FN fine (2)
D8	dam south of driveway for 205 Sanders Rd, Project Site	-38.043741	145.697525	4/10/2018	FN fine (1)
D16	online dam on tributary of Cannibal Creek, Project Site	-38.050519	145.696393	3/10/2018	eDNA, FN larval (2), BT (5)
D18	Dam 280 m from end of driveway off Wallaby Ct, Project Site	-38.047831	145.698168	3/10/2018	FN fine (2)
D37	Dam in centre of property, Project Site	-38.048433	145.700935	3/10/2018	eDNA, FN larval (2), BT (5)
D39	Dam south of fenceline between 265 and 295 Sanders Rd, Project Site	-38.043737	145.706878	3/10/2018	FN fine (2)
D40	Dam east of end of driveway, Project Site	-38.045773	145.705414	3/10/2018	FN fine (2)
D50	2nd dam east of end of driveway, Project Site	-38.045978	145.708131	3/10/2018	FN fine (2)
D266a	small dam east of D266 on property 24	-38.040285	145.692752	8/08/2018	BT (8)
D266b	2nd small dam east of D266 on property 24	-38.040260	145.693346	8/08/2018	BT (8)
33e	Two Mile Creek West at northern boundary of 205 Sanders Rd	-38.034747	145.696617	9/08/2018	eDNA
33T	Two Mile Creek West where drainage line from dam intersects on 155 Sanders Rd Garfield North (Bridlewood Farm)	-38.036487	145.698381	8/08/2018	BT (10)
33TT	Tributary of Two Mile Creek West upstream of driveway to 205 Sanders Rd Garfield North	-38.041996	145.697182	8/08/2018	BT (5)
D6	Large dam on 155 Sanders Rd Garfield North (Bridlewood Farm)	-38.036929	145.697372	8/08/2018	BT (10)
51T	Two Mile Creek West, 585 m upstream of Tonimbuk Rd	-38.04143	145.71605	28/08/2018	eDNA
52T	Two Mile Creek West downstream of driveway on property 52	-38.043316	145.720059	29/08/2018	EFBP (7)
D83	open dam on 385 Sanders Road Tonimbuk closest to Ellis Rd	-38.047275	145.719379	29/08/2018	BT (10)
SD52	shaded dam on 385 Sanders Road Tonimbuk closest to corner of Sanders and Ellis Roads	-38.047452	145.719008	29/08/2018	BT (10), FN Fine (2)
71DTT	Online dam on southern tributary of Two Mile Creek West upstream of driveway on 295 Sanders Rd Garfield North	-38.041689	145.706938	8/08/2018	BT (10)
71T	Two Mile Creek West at driveway crossing of 295 Sanders Rd Garfield North	-38.040416	145.708770	8/08/2018	BT (10), EFBP (6)
71TT	Tributary of Two Mile Creek West upstream of driveway of 195 Sanders Rd Garfield North	-38.042247	145.707924	8/08/2018	BT (10)
73e	Tributary of Two Mile Creek West at western boundary of 255 Sanders Rd	-38.041440	145.700318	29/08/2018	eDNA
73T	Two Mile Creek on 255 Sanders Rd Garfield North	-38.037239	145.701828	29/08/2018	EFBP (5)
73TT	Tributary of Two Mile Creek West, upstream of driveway on 255 Sanders Rd Garfield North	-38.041481	145.703079	28/08/2018	BT (20)
178TC	Unnamed tributary of Cannibal Creek, 530 m east of end of Michell Rd , 90 Michell Rd, LindenBrook Pastoral	-38.061748	145.698379	9/08/2018	BT (10), WB
D179	online dam on tributary of Cannibal Creek, 90 Michell Rd, LindenBrook Pastoral	-38.057269	145.696001	9/08/2018	BT (10)
D98	Largest online dam on tributary of Two Mile Creek West, 90 Michell Rd, LindenBrook Pastoral	-38.052442	145.704135	22/2/2018; 9/08/2018	DN; BT (20)
D89	Online dam on tributary of Two Mile Creek West on property 187	-38.048691	145.722955	29/08/2018	BT (10)
193T	Two Mile Creek West on property 193	-38.047655	145.729429	3/10/2018	eDNA, EFBP (8)
D73	4th most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.048894	145.711134	3/10/2018; 2/7/2019	BT (10); BT (10)
D80	3rd most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.049321	145.710304	27/03/2018; 3/10/2018; 2/07/2019	DN; BT (10); BT (10)
D85	2nd most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.050118	145.708700	27/03/2018; 3/10/2018; 2/07/2019	DN; BT (10), WB; BT (10), WB
D86	most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.050584	145.707648	27/03/2018; 3/10/2018; 2/07/2019	DN; BT (10), WB; BT (10), WB
D150	online dam on tributary of Cannibal Creek upstream of Michell Rd	-38.061522	145.710001	9/08/2018	BT (20)
D79	5th most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.048718	145.711872	4/10/2018; 2/07/2019	BT (6); BT (6)
D76	6th most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.048528	145.712345	27/03/2018; 4/10/2018; 2/07/2019	DN; BT (6); BT (6)
D75	7th most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.048418	145.712641	4/10/2018; 2/07/2019	BT (6); BT (6)
D77	8th most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.048274	145.713190	4/10/2018; 2/07/2019	BT (6); BT (6)
D74	9th most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.048176	145.713623	4/10/2018; 2/07/2019	BT (8); BT (8)

Site code	Site location	Latitude	Longitude	Dates visited	Sampling type
D72/D68	10th most upstream online dam on tributary of Two Mile Creek West, Tonimbuk Equestrian Centre	-38.047173	145.714786	4/10/2018; 2/07/2019	BT (25); BT (25)
Note: BT = Bait Trap, FN fine = fine-meshed standard fyke net, FN larval = larval fyke net, DN = dip net, EPBP = Backpack electrofishing, WB = white bucket					

4.2 Engagement

Other than meeting with individual landholders as arranged by AECOM and brief discussions with Melbourne Water and DELWP about the intended survey approach, community and stakeholder engagement has not yet been within the current scope of services provided for the aquatic ecological component of the Project.

5 EXISTING CONDITIONS

5.1 Background

5.1.1 Database reviews

Victorian Biodiversity Atlas

The Victorian Biodiversity Atlas (VBA) contains records of two threatened aquatic fauna species in the areas searched. Both species are FFG listed and are listed as vulnerable under the EPBC Act:

- Dwarf galaxias *Galaxiella pusilla*
- Australian grayling *Prototroces maraena*

Australian grayling records only exist from the Bunyip River itself and, based on habitat requirements/preferences for faster flowing streams, they have a very low likelihood of occurrence within the Cannibal Creek or Two Mile Creek catchments.

Dwarf galaxias records exist from:

- Bunyip River
- Dingo Creek
- Cannibal Creek
- Tea Tree Creek
- Two Mile Creek west (i.e. the 2009 record from dam 98)

The search area was expanded to include the Tarago River catchment so that the distribution and proximity of FFG listed Warragul burrowing crayfish *Engaeus sternalis* records could be examined. The known distributional range of the species is from Labertouche extends south east through Drouin and Warragul. The species is considered unlikely to occur in the vicinity or downstream of the Project Site and is not considered further.

Melbourne Water Fish database

A search of the Melbourne Water Fish database revealed no additional records of conservation interest.

Groundwater Dependent Ecosystems Atlas

All of the surveyed waterways and waterbodies are considered to be intermittent in their hydrology and most are expected to be reliant on groundwater inputs to varying degrees, and thus can be referred to as Aquatic Groundwater Dependent Ecosystems (GDE). The Bunyip River is considered to be a known GDE, while Cannibal Creek and Two Mile Creek West are considered to have high potential to be GDE (<http://www.bom.gov.au/water/groundwater/gde/map.shtml>). For the purposes of this report, this classification is considered to serve little purpose other than to highlight the obvious importance of groundwater discharge in provision of baseflow and the likely contribution it makes to the persistence of refuge pools during periods of no flow. As this contribution is neither unique nor unexpected, repetitive use of the term GDE will be avoided throughout the report.

5.1.2 Relevant previous reports – Project Site and immediate surrounds

Aquatic habitats within and adjacent to the Project Site were specifically assessed in 2009 (Ecology Australia 2009) and 2017 (Ecology and Heritage Partners 2017), during the precursor studies for this project. Survey of aquatic fauna during these investigations was limited to a backpack electrofishing and dip-netting based survey of seven sites in August 2008 and one additional site in January 2009. These sites included one on Two Mile Creek West, one on a Two Mile Creek West tributary, two sites on No Name Creek, three sites on an unnamed tributary (and connected dam) of Cannibal Creek, and one site on Cannibal Creek itself.

The survey found no fish within the Project Site, but did record dwarf galaxias and southern pygmy perch at one site, the large dam on No Name Creek immediately south of the Project Site (referred to as Dam 98 in this study). No fish were detected at any other site except Cannibal Creek itself, where Southern Pygmy Perch was recorded. The continued presence of the southern pygmy perch and dwarf galaxias population at Dam 98 was confirmed by ANGFA volunteers in January 2017 (https://angfa.org.au/index.php?option=com_attachments&task=download&id=98).

Dwarf galaxias

Dwarf galaxias are listed as ‘vulnerable’ under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999, threatened under the Victorian Flora and Fauna Guarantee (FFG) Act 1988, and endangered under the Advisory List of Threatened Vertebrate Fauna in Victoria (DELWP 2013).

Dwarf galaxias was considered to be one species until genetic and taxonomic revision in 2015 described a second species, little galaxias *Galaxiella toourtkoourt* (Coleman et al. 2015) and revealed no distributional overlap between them. Little galaxias occurs from western Victoria to South Australia. Dwarf galaxias *Galaxiella pusilla* occurs from eastern Victoria (east of Melbourne to around Bairnsdale), Flinders Island and Tasmania. This splitting of the species means that the newly defined distribution of dwarf galaxias is now around 40% of what it was previously considered to be, and that a reassessment of dwarf galaxias threatened species status under the EPBC Act will need to occur. On the basis of the collective populations of little galaxias and dwarf galaxias having previously resulted in a listing category of vulnerable, and dwarf galaxias found to have much lower genetic diversity than little galaxias, it is likely that reassessment would result in dwarf galaxias being reassessed as ‘endangered’, a category also arrived at using IUCN criteria (Coleman et al 2015).

Dwarf galaxias habitat preferences include shallow depths, low flow velocity, higher coverage of aquatic macrophytes, and often a degree of hydrological intermittency. Occasional connectivity with waterbodies within the broader landscape is important to recolonise sites where extended periods of drying have resulted in extirpation (Saddler et al. 2010). Most dwarf galaxias habitats have a seasonal hydrologic regime, entailing substantial contraction during dry periods and expansion during wet periods (Coleman 2014). The presence of leaf litter, detritus, aquatic macrophytes and freshwater crayfish burrows (e.g. *Engaeus* spp.) appears to enhance survival under dry conditions (Coleman 2014).

Major threats to dwarf galaxias include habitat loss through wetland drainage, altered hydrological regimes, habitat degradation, and invasive species, particularly the noxious eastern gambusia *Gambusia holbrooki* (Saddler et al 2010). The importance of hydrologic intermittency/seasonality is elevated by confirmation that dwarf galaxias have greater capacity to endure drying habitats and desiccation than eastern gambusia (Coleman 2014).

Many aspects of dwarf galaxias habitat requirements and use remain poorly understood. Coleman (2014) outlined the importance of refuge pools during times of drought, the importance of flooding and drying and consequent zooplankton blooms, the competitive advantage that dwarf galaxias can have over eastern gambusia under specific hydrological conditions (i.e. brief loss of surface water), and that the persistence of populations as a whole being likely facilitated by multiple interconnected habitats across the landscape. However, increased drying severity as a result of climate change/drought, combined with the effects of eastern gambusia proliferation and dominance, mean that fewer refuge habitats are likely to exist in the landscape over time, and that only some of those refuge habitats may have attributes required to support dwarf galaxias for sustained periods (i.e. until the next re-colonisation opportunity arises). As a short lived species, dwarf galaxias extirpation across a landscape can demonstrably occur over a relatively short period of time (i.e. <5 years), particularly under unfavourable hydrological conditions.

The refuge pool habitat attributes that enable dwarf galaxias to persist in the long term presence of eastern gambusia are poorly understood. Anecdotally, shade, water temperature and particularly intra and inter annual hydrological events are thought likely to have a substantial influence. Deeper and heavily shaded habitats with lower temperatures are typically avoided by eastern gambusia and are thought to offer some degree of protection to dwarf galaxias and may suppress eastern gambusia population size (Biosis 2012b). The timing of rainfall events and corresponding habitat inundation/expansion is also likely to be of particular importance due to the contrasting water temperature breeding tolerances/preferences of dwarf galaxias and eastern gambusia. Eastern gambusia generally will not breed over winter. Habitat inundation during colder months of the year where water temperature is below the temporal spawning limits of eastern gambusia are likely to provide dwarf galaxias with a spawning and recruitment 'head start' on eastern gambusia, enhancing recruitment success via increased access to food resources (lower competition) and reduced predation pressure. Conversely, inundation occurring too early or late in the season when water temperatures are higher may be detrimental to dwarf galaxias due to the enhanced conditions for spawning and recruitment of eastern gambusia. The persistence of dwarf galaxias over periods of unfavourable hydrological conditions may require specific types of refuge habitats and/or secure populations (e.g. eastern gambusia free due to barriers to upstream movement) in addition to expansive areas of connected ephemeral habitat.

5.1.3 Relevant previous reports – Cannibal Creek dwarf galaxias distribution

Dwarf galaxias *Galaxiella pusilla* are known to be present in Cannibal Creek and associated habitats including tributaries and wetlands (Saddler et al 2010), although additional populations have been documented in Cannibal Creek tributaries (e.g. Hamilton Creek, Biosis 2012) since the publication of the 2010 Recovery Plan (Saddler et al 2010). There have been attempts to better document the distribution within the Cannibal Creek catchment in recent years, primarily to determine the potential influences that discontinuation of flow inputs from the Bunyip Main Race (Jacobs 2018). A small number of sites were surveyed using traditional methods (e.g. dip netting and bait trapping)(Ecology Australia 2017) and a much larger number of sites were subsequently surveyed using eDNA (Jacobs 2018). The results of the eDNA investigation (Jacobs 2018) revealed positive detections for dwarf galaxias at Dam 98 and in Cannibal Creek at former sites in the vicinity of Garfield Road, Bunyip-Tonimbuk Road, and Wimpole Road. Despite the known limitations of eDNA (Roussel et al 2015), the eDNA results (Jacobs 2018) are indicative of dwarf galaxias distribution in the Cannibal Creek catchment being typically disjunct and

patchy. There were ten eDNA detections from the 38 sites sampled, including four from Cannibal Creek itself, three detections from tributaries (Tea Tree Creek and two unnamed tributaries) and three from Cannibal Creek floodplain dams/wetlands. There were no positive detections from Hamilton Creek, indicating that the population discovered at multiple sites there in 2011 (Biosis 2012) may have since been lost, or that eDNA (Jacobs 2018) may have simply failed to detect them.

5.1.4 Climate and hydrology

Flow gauge data does not exist for the Two Mile Creek or Cannibal Creek catchment. During an investigation into the effects of decommissioning the Bunyip Main Race (BMR), Jacobs (2018) undertook flow gauging of Cannibal Creek at 13 locations for nine months and used this data together with nearby flow gauge data (i.e. Bunyip River) and rainfall data to extrapolate a 13 year flow series for Cannibal Creek. Additionally they used water balance models to characterise water levels at three potentially important refuge pools to determine the number of days the pools would take to dry under three surface water/groundwater and climate change scenarios. For the last 15 years, a flow diversion from the Bunyip River, via the BMR and Cannibal Creek and back to the Bunyip River is thought to contributed flows of 4–5 ML/day in dry conditions (Jacobs 2018), essentially turning a naturally intermittent creek into a perennial one. The results of the hydrological assessment were that without the contribution from the BMR, Cannibal Creek would cease to flow in dry years under all three scenarios and that refuge pools dried out much more frequently without the input of groundwater. The refuge pool in the vicinity of Wimpole Road, an area where three of the ten positive eDNA detections were recorded, is a site considered to lose surface water to groundwater and was modelled to be dry for extended periods particularly under the scenario that includes surface water, groundwater and climate change.

5.2 Aquatic habitats within the Project Site

The Project site includes four offline dams and eight online dams. Of the online dams, two are situated on the unnamed tributary of Cannibal Creek, two are situated on an unnamed tributary of Two Mile Creek West, and four are situated on unnamed tributaries of No Name Creek (itself a tributary of Two Mile Creek West).

The size and habitat quality of the dams varies considerably. Some were so devoid of habitat such as aquatic vegetation, and were too shallow and/or heavily impacted by cattle access (high levels of turbidity and algae), that they did not warrant survey. The degree of longitudinal connectivity with downstream waterways was limited by the position in the catchment and by corresponding factors such as stream slope and the cumulative effects of online dams and associated dam walls.

The dams surveyed within the project site were D2, D3, D5, D8, D16, D18, D37, D39, D40, and D50 (see Plate 1). The site was stocked with cattle at the time of assessment, resulting in pugging and increased turbidity at many of the dams. Aquatic vegetation and filamentous algae were essentially the only forms of cover available to aquatic fauna. The main species and genera noted were *Eleocharis sphacelata*, *Typha* spp., *Myriophyllum* spp., and *Nymphaea* spp.



D40



D50



D5



D2



D3



D18



D16



D37

Plate 1 The dams surveyed within the Project Site.

5.3 Offsite Aquatic habitats

The offsite aquatic habitats include Two Mile Creek West and tributaries, No Name Creek (a tributary of Two Mile Creek West), unnamed tributaries of Cannibal Creek, and the online, connected or immediately adjacent dams of the aforementioned waterways. The habitats are discussed below.

5.3.1 Two Mile Creek West and tributaries

Two Mile Creek West is largely a shallow creek with patchy riparian vegetation and instream cover including emergent vegetation (particularly *Paspalum* spp. and *Juncus* spp.), CPOM and coarse woody debris.



Site 73T - Two Mile Creek West



Site 73T - Two Mile Creek West



Site 73T - Two Mile Creek West



Site 71T - Two Mile Creek West

Plate 2 Examples of habitat in Two Mile Creek West.

The tributary of Two Mile Creek West that was sampled runs south of Two Mile Creek West, through pasture. For the most part, there is negligible riparian vegetation and it is accessible by cattle. There is some emergent and submergent aquatic vegetation including *Juncus* spp. and *Callitriche stagnalis*.



135 Sanders Rd – Tributary of Two Mile Creek West



Site 71DTT – Tributary of Two Mile Creek West and online dam

Plate 3 Examples of habitat on the tributary of Two Mile Creek West.



Site 71 DDT – Tributary of Two Mile Creek West



Site 71 DDT – Tributary of Two Mile Creek West

Plate 4 Examples of habitat on the tributary of Two Mile Creek West.

5.3.2 No Name Creek

No Name Creek consists of a series of online dams, with D98 being the most upstream and largest of these dams (approximately 250 m by 130 m). Instream cover consisted of <5% coarse particulate organic matter (CPOM), and 75% aquatic vegetation. It was densely fringed on most sides by *Eleocharis sphacelata*, *Eleocharis acuta*, *Chara* spp., *Goodenia humilis*, and *Myriophyllum crispatum*, *Myriophyllum simulans*, with some *Juncus* spp., *Triglochin striata* s.l., *Isolepis* spp., *Ranunculus inundatus*, *Potamogeton cheesemanii*, *Centella cordifolia*, and *Persicaria decipiens*. The riparian zone was dominated by swamp paperbark *Melaleuca ericifolia*. In situ water quality measurements indicated that salinity was elevated (1.71 mS/cm). The substrate was predominantly silt/clay, with some sand. Burrowing crayfish (*Engaeus* spp.) burrows were noted around D98. The dam is estimated to be approximately 90 years old, and has been desilted at least once (Geri Fargas, pers. comm. 22 February 2018). Eastern long-necked turtles *Chelodina longicollis* have been noted in the dam (G. Fargas, pers. comm. 22 February 2018). Local sources of disturbance at this site included bank erosion, riparian vegetation clearance, and sedimentation. D98 has previously been pumped and stock was allowed access, but these activities have ceased.

The other downstream dams surveyed on No Name Creek were D86, 85, 80, 73, 79, 76, 75, 77, 74, 72 and 68. D86 is the most upstream of the series, and all 11 of these pools are within Hanson land. Similarly to D98, the riparian zone was dominated by *Melaleuca ericifolia*. Instream habitat within dams D86–D68 was reduced compared with D98, with low amounts of CPOM, some overhanging terrestrial vegetation and rubbish, and typically less than 15% cover of aquatic vegetation. In situ water quality measurements indicated that salinity was elevated (1.33–2.22 mS/cm). Existing sources of disturbance include clearance of riparian vegetation, sedimentation, and mild infestations of blackberry *Rubus fruticosus* spp. agg., and fish barriers (such as ‘perched’ culverts). A number of areas have been modified for horse jumps and crossings, and works on waterway were conducted during the survey period. Deer were also noted onsite.



Plate 5 Dam 98 on No Name Creek.



D86



D85



D73



'Perched culvert' between online dams on No Name Creek – a barrier to fish passage



Waterway modifications – horse jump



Waterway modifications – recent works on waterway (27/3/2018)

Plate 6 No Name Creek habitat and disturbance examples.

5.3.3 Unnamed tributaries of Cannibal Creek

Site D179 is an online dam on a tributary of Cannibal Creek. There is limited riparian vegetation and water is pumped from this dam. Livestock (cattle) have access to this dam, resulting in pugging and increased turbidity. The main aquatic vegetation includes *Eleocharis sphacelata*, *Juncus* spp. and *Myriophyllum* spp.



Plate 7 Tributary of Cannibal Creek – online dam (D179).

Site 178TC was located downstream of the junction of two unnamed tributaries of Cannibal Creek. The site was very shallow and densely vegetated with emergent vegetation including a large amount of organic matter (e.g. dead leaves of *Typha* spp.). The main species and genera of aquatic vegetation noted were *Typha* spp., *Eleocharis sphacelata*, *Juncus* spp. and *Paspalum* spp.



Plate 8 Tributary of Cannibal Creek – Site 178TC.

5.4 Aquatic fauna survey results

The results of the aquatic fauna surveys are provided in **Error! Reference source not found.** Table 2. In summary, no fish other than shortfin eel *Anguilla australis* were found within the Project Site. Eels were only found within dams 2 and 3, but may be present in low abundance in a significant proportion of the dams within the project site. The surveys detected a number of common frog species (adults and tadpoles), eastern snake-necked turtle *Chelodina longicollis* and common yabby *Cherax destructor* at most dams within the Project Site.

Outside of the Project Site, the non-migratory southern pygmy perch *nannoperca australis* was widespread, being found in Two Mile Creek West and its tributary, No Name Creek, together with online dam 178 (south of the Project Site) and the unnamed tributary of Cannibal Creek (Site 178TC). The granular burrowing crayfish *Engaeus cunicularius* shared a similar distribution, being found (or burrows observed) at most of the sites where southern pygmy perch were detected.

The threatened dwarf galaxias was less widespread than other native aquatic fauna species, being found only within No Name Creek and at the unnamed tributary of Cannibal Creek (Site 178TC)(see Figure 3). Dwarf galaxias distribution within No Name Creek included dam 98 where it was previously detected, and almost every online dam downstream between there and dam 72/68 within the equestrian centre; although Dwarf galaxias abundance was notably higher in dams where eastern gambusia appeared to be absent (dams 98 to 80).

Supplementary eDNA sampling at two of the dams within the project site, one site on the Two Mile Creek West tributary, and three sites on Two Mile Creek West failed to detect the species.

The highest dwarf galaxias densities based on Catch Per Unit Effort (CPUE) were from the tributary of Cannibal Creek (Site 178TC). Within No Name Creek, dwarf galaxias CPUE varied between sampling events and between sites (See Table 4). On both occasions CPUE in No Name Creek was highest in dam 86 (i.e. the second most upstream dam).

Migratory native fish species such as shortfin eel and common galaxias *Galaxias maculatus* were recorded in low abundance in Two Mile Creek West.

Table 2 Aquatic fauna survey summary results for sites located within the Project Site (in bold) and in the surrounding area

	shortfin eel	common yabby	eastern snake-neck turtle	common froglet	burrowing crayfish	common galaxias	dwarf galaxias	eastern gambusia	pobblebonk frog	striped marsh frog	marsh frog tadpoles	tree frog tadpoles	southern pygmy perch	common shrimp	Unknown Tadpoles
Site Code	Ang aus	Che des	Che lon	Cri sig	Eng sp	Gal mac	Gal pus	Gam hol	Lim dum	Lim per	Lim sp	Lit sp	Nan aus	Par aus	
178TC							56						86		
193T					5								1	2	
33T													37		
51T	2				2	8							1	1	
71D TT													8		
71T					1	3							6	5	
71TT													3		
73T	1				1	1							31		
73TT													65		
D150								8					102	20	
D16										2		1			
D179													126	42	
D18		2								2	1	77			
D2	34		3											1	
D266a												50			
D266b												20			
D3	8													500	
D37		4		2						1	2	79			
D39												35			
D40		11	2						1	1		3			
D5			4	1						1		320			
D50		7							2			32			
D6														13	
D72/D68				2			2	82					275	100	
D73		1											537	102	
D74		3						10					65	253	
D75								2					59	235	
D76		2					2						90	167	
D77				2				6					67	180	
D79					1		1						78	44	
D80					1		37						340	275	
D83								150					112		2
D85		12					27						332	11	
D86		5					68						528	31	
D89				1	1					1					30
D98					1		5				1		443	11	
SD52								50					49	90	
Totals	45	47	9	8	13	12	198	308	3	8	4	617	3441	2083	32

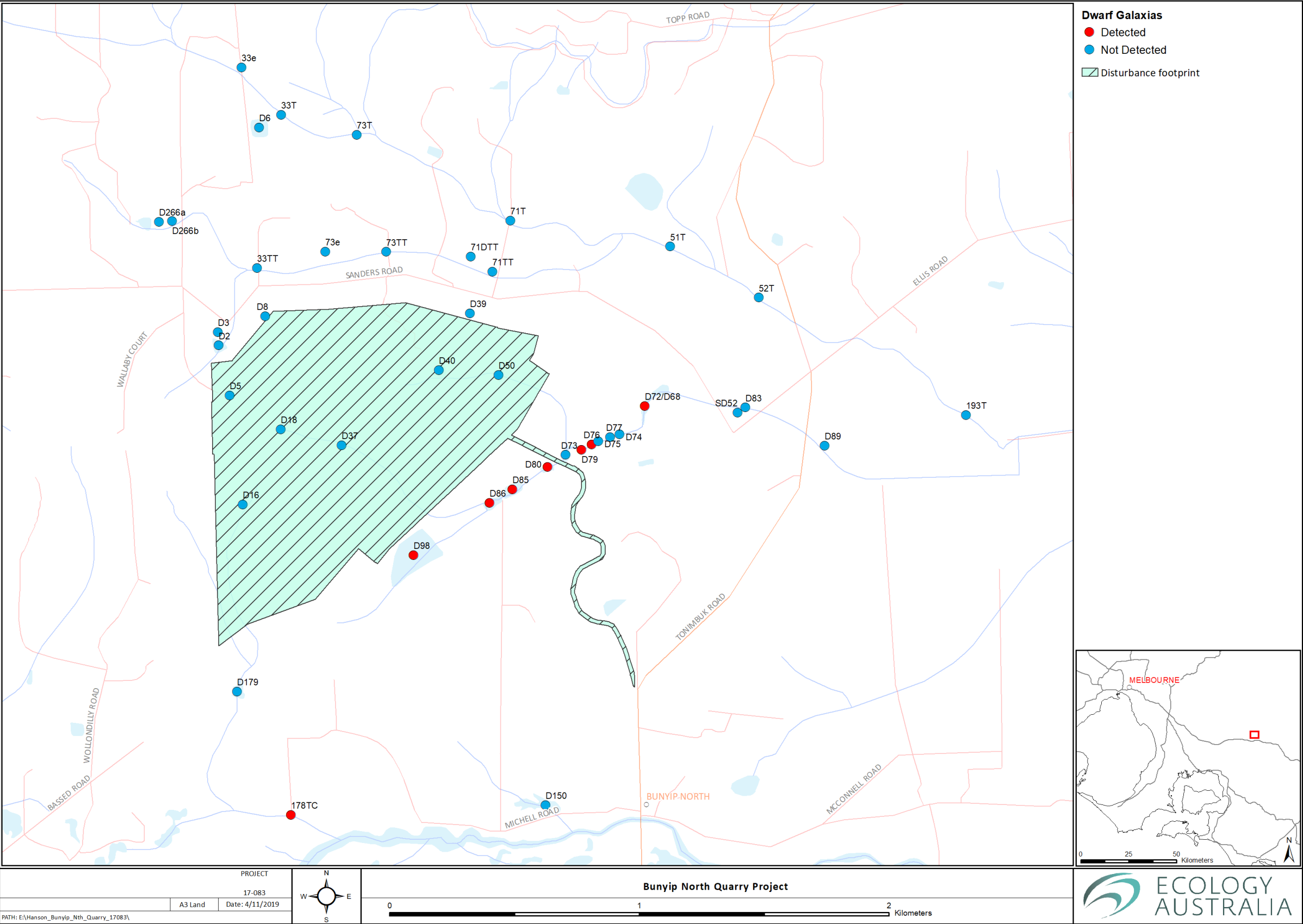


Figure 3 Dwarf galaxias survey detection results

Table 3 Dwarf galaxias eDNA sample results

Site Code	Waterway or waterbody	qPCRs +ve (out of 6)	Test result
D16	Online dam on tributary of Cannibal Creek, Project Site	0	Negative
D37	Dam in centre of property, Project Site	0	Negative
33e	Two Mile Creek West at northern boundary of 205 Sanders Rd	0	Negative
51T	Two Mile Creek West, 585 m upstream of Tonimbuk Rd	0	Negative
73e	Tributary of Two Mile Creek West at eastern boundary of 255 Sanders Rd	0	Negative
193T	Two Mile Creek West on property 193	0	Negative

Table 4 Dwarf Galaxias bait trap CPUE results (fish/hr), white bucket metalarvae/early juvenile presence, and eastern gambusia presence

Site Code	Eastern gambusia present	Date 1	DG CPUE (fish/hr)	Metalarvae / early juveniles present	Date 2	DG CPUE (fish/hr)	Metalarvae / early juveniles present
178TC		10/08/2018	0.2800	✓			
D98		10/08/2018	0.0102				
D86		4/10/2018	0.2081	✓	3/07/2019	0.1176	✓
D85		4/10/2018	0.0094	✓	3/07/2019	0.0833	✓
D80		4/10/2018	0.1182		3/07/2019	0.0441	✓
D79		3/07/2019	0.0082				
D72/D68	✓	5/10/2018	0.0042		3/07/2019	0.0049	

5.5 Dwarf Galaxias current distribution in the Cannibal Creek catchment

The results of this investigation together with previous studies are indicative of dwarf galaxias having a patchy and disjunct distribution within the Cannibal Creek catchment. The population in No Name Creek is currently the only known population from the Two Mile Creek catchment. It is partially secure in terms of the existence of eastern gambusia free habitat in some of the more upstream dams (dams 98 to 80), however further upstream incursion into some of the dwarf galaxias habitat is expected to occur in the absence of management intervention; if this occurs, the dwarf galaxias populations in the affected dams would no longer be considered 'secure'.

Eastern gambusia free habitat (e.g. online dams/wetlands) above artificial barriers are likely to be of particular importance to dwarf galaxias persistence at the Cannibal Creek catchment scale. These secure populations or 'source' populations are likely to be critical for periodic replenishment of downstream populations, particularly following periods of drought or successive years of poor recruitment. Other

potentially secure populations in the catchment include the unnamed tributary of Cannibal Creek at Wimpole Road (as detected by eDNA) and another in Hamilton Creek. There is some uncertainty around the persistence of the Hamilton Creek population considering eDNA failed to detect the species in 2018. Additionally, there is uncertainty around whether the Wimpole Road tributary population is a secure population, considering eDNA provided no information on whether eastern gambusia were also present, and the fact that site appears connected to both Cannibal Creek and Two Mile Creek (eastern gambusia are present in both systems) under a 100 year ARI flood event (Jacobs 2018). One additional 'population' detected by eDNA was located offline and marginally outside the 1 in 100 year ARI flood boundary, on the southern side of Cannibal Creek between Tonimbuk Road and Garfield North Road. This site could potentially be an important 'secure' population, but again the relative importance of the site remains unknown primarily because eDNA provided no information on the presence of eastern gambusia.

The habitat attributes that are expected to have a significant influence on dwarf galaxias abundance and distribution include shade levels, aquatic vegetation diversity and coverage, depth heterogeneity, the size and distribution of refuge pools, and the hydrological regime. The habitat suitability of Cannibal Creek appears high with regard to most key attributes, particularly with regard to the influence of the relatively intact Swamp Scrub and Swampy Riparian Woodland riparian zones. Although the existence of secure but semi-disconnected dwarf galaxias populations (i.e. eastern gambusia free habitat) boosts the long term persistence prospects for the species in the catchment, the health of the Cannibal Creek catchment population as a whole is likely to be primarily reliant on a large and well-connected population persisting within Cannibal Creek and associated floodplain habitats.

6 CONCLUSIONS

6.1 Existing conditions assessment

The aquatic fauna values of the Project Site are limited to online and offline dams of varying habitat value. These dams support shortfin eels, eastern snake-neck turtles, common yabby and common frog species.

To the north of the Project Site, the Two Mile Creek West catchment supports a range of native aquatic fauna including the patchily distributed southern pygmy perch, along with granular burrowing crayfish and small numbers of migratory species such as shortfin eel and common galaxias.

To the south of the Project Site, a series of online dams on No Name Creek (a tributary of Two Mile Creek West) support the nationally threatened dwarf galaxias, together with southern pygmy perch and granular burrowing crayfish. Dwarf galaxias is not known to occur anywhere else in the Two Mile Creek catchment, although a 1 in 100 ARI flood connection exists between Two Mile Creek West and a tributary of Cannibal Creek, a tributary where dwarf galaxias were recently detected using eDNA.

To the south west of the Project Site, an online dam on a tributary of Cannibal Creek supports a population of the non-threatened southern pygmy perch. Further downstream this tributary meets a larger tributary of Cannibal Creek on the Cannibal Creek floodplain. Another population of dwarf galaxias was detected at this location, with densities based on CPUE being higher than for No Name Creek.

Dwarf galaxias is the only aquatic matter of National Environmental Significance of relevance to the project. Australian grayling is unlikely to occur in the Cannibal Creek or Two Mile Creek catchment and the Bunyip River is well outside the expected limits of potential impact from quarry construction and operation.

The Cannibal Creek dwarf galaxias population is well known, and recent eDNA evidence (Jacobs 2018) indicates that the dwarf galaxias population in the Cannibal Creek catchment is likely to remain patchily distributed. The habitat attributes that are expected to have a significant influence on dwarf galaxias abundance and distribution include shade levels, aquatic vegetation diversity and coverage, depth heterogeneity, the size and distribution of refuge pools and the hydrological regime. The habitat suitability of Cannibal Creek appears high with regard to most key attributes, particularly with regard to the influence of the relatively intact Swamp Scrub and Swampy Riparian Woodland riparian zones.

The existence of secure but semi-disconnected dwarf galaxias populations (i.e. eastern gambusia free habitat) such as those in the upper reaches of No Name Creek and elsewhere are likely to be critical as insurance populations capable of providing periodic replenishment of downstream populations following periods of drought or successive years of poor recruitment, however the health of the Cannibal Creek catchment population as a whole is likely to be primarily reliant on a large and well-connected population persisting within Cannibal Creek and associated floodplain habitats.

7 LIMITATIONS

The following general qualifications apply to this study:

- This aquatic ecological assessment includes fish and decapod crustacea. Other animals that may be considered 'aquatic' include platypus, water rat, turtles and frogs. These animals are occasionally targets, but are more typically 'bycatch' of aquatic fauna surveys and were not specifically targeted by field surveys conducted for this investigation.
- Database interrogation can provide a useful list of species that have previously been recorded in a particular catchment, basin or region. However, these datasets (e.g. Victorian Biodiversity Atlas) are limited in three areas: 1) by whether or not suitable surveys have been conducted in the area, 2) the accuracy of information presented (e.g. identification/taxonomy), and 3) addressing temporal variation in species distributions. For these reasons, database assessment is only an indicator of the presence/absence of a particular species.
- Aquatic flora was examined in terms of the quality and quantity of habitat it provides to aquatic fauna, however taxonomic resolution at most sites was limited and it was not intended to constitute an aquatic flora survey.
- Fauna surveys provide a sample of the fauna species present at a given time and season and additional species that Ecology Australia did not detect may occur but may have been present in low abundance.
- Dwarf galaxias abundance and distribution is known to exhibit a high degree of spatial and temporal variation. The species can typically be far more widespread and abundant following flooding events, particularly if the flood coincides with the peak of the breeding period (winter).
- Despite the limitations listed, the survey effort combined with information gathered from other sources is considered adequate to assess the overall aquatic ecological values within of relevance to the project.