

ASSESSMENT OF MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Executive Summary

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EXECUTIVE SUMMARY

Southern Downs Regional Council (SDRC) are seeking environmental approvals for the proposed Emu Swamp Dam. The Project includes a dam and associated urban and irrigation pipelines. The Coordinator General declared on 5 February 2007 that the Project was a significant project for which an Environmental Impact Statement (EIS) is required, and this EIS has been prepared to satisfy the requirement of the SDPWO Act.

The EIS for the Project was publicly released for comment on 12 January 2008. The comment period closed on 25 February 2008. On 22 March 2013 the Coordinator-General requested SDRC prepare a Supplementary Report to address the issues raised in submissions received.

Concurrent to the EIS process, the Project was referred to the Commonwealth Department of the Environment (DotE) (then referred to as the Department of Environment, Water, Heritage and the Arts) in December 2006. The (then) Stanthorpe Shire Council (SSC) nominated the Project as a “controlled action” under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The DotE determined on 3 January 2007 that the Project was a controlled action based on potential impacts to listed threatened species and communities, considered Matters of National Environmental Significant (MNES) under the EPBC Act.

The DotE requires a standalone assessment of impacts on MNES, and this report consolidates existing information relating to MNES which are potentially impacted by the Project. This report forms an appendix to the Supplementary Report.

The Project

The Emu Swamp dam site is located on the Severn River between Fletcher Road and Emu Swamp Road in the SDRC. The dam site is 5 km north of Ballandean and 15 km southwest of Stanthorpe. The proposed Emu Swamp Dam has a storage capacity of 10,500 ML with an associated inundation area of 196 ha. A buffer area of approximately 200 m in width (322 ha) is proposed surrounding the dam to protect the water quality within the dam and also to maintain local ecological connectivity. The buffer will be managed primarily for conservation purposes.

The urban pipeline is 23.2 km long and is largely located in road reserves. The irrigation pipeline route largely follows road reserves although there are some short sections crossing private lands. The irrigation pipelines are supplied from the urban pipeline. The total length of irrigation pipeline (excluding the urban pipeline section) is 102 km.

Threatened Species and Communities

In addition to desktop assessment of ecological values, a range of field surveys were completed across the Project area, including pipelines, between 2006 and 2014. These studies sought to clarify the presence or absence of listed threatened species and ecological communities and confirmed the presence of one threatened ecological community, five threatened flora species and four threatened fauna species within or adjacent to the Project area.

The White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) Grassy Woodland and derived Native Grassland (Box-Gum Grassy Woodland) ecological community was identified by

desktop investigations as potentially occurring in the Project area. The presence (and extent) of this ecological community within the Project area has been confirmed by field surveys.

The likelihood of occurrence of threatened species has been assessed based on an analysis of local and regional records of the species, an assessment of the species preferred habitat against the type and condition of habitat present within the Project area and knowledge gained during site surveys which comply with contemporary survey guidelines. Given the extensive nature of field surveys completed, only species found to be present or assessed as likely to occur within the Project area are comprehensively assessed in this report. The assessment focuses on the following EPBC Act listed threatened species and communities, the majority of which were recorded as present within the inundation area or pipeline investigation areas:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Threatened Ecological Community (critically endangered)
- *Boronia repanda* (endangered)
- *Acacia pubifolia* (vulnerable)
- *Callistemon pungens* (vulnerable)
- *Grevillea scortechinii* subsp. *scortechinii* (vulnerable)
- *Eucalyptus mckieana* (vulnerable)
- Spotted-tail quoll (endangered)
- Granite Belt thick-tailed gecko (vulnerable)
- Large-eared pied bat (vulnerable)
- Bell's turtle (vulnerable)
- Murray cod (vulnerable)

Residual Impacts

An assessment of impacts on the matters listed above found that adverse residual impacts are expected for the Box-Gum Grassy Woodland Ecological Community, *Callistemon pungens* and the Granite Belt thick-tailed gecko. All other species will be either avoided or will incur minor impacts which can be effectively mitigated on site.

The residual impact of the Project on the Box-Gum Grassy Woodland within the inundation area will be a loss of 71.55 ha. The impact of the loss of the community from the inundation area will be significant, on the basis that the dam will remove an area of vegetation along and adjacent to the Severn River.

The residual impact of the Project on *C. pungens* within the inundation area will be the loss of 45 plants. The impact of the loss of these plants will be significant for the section of the Severn River that will be inundated.

A resident population of the Granite Belt thick-tailed gecko will be displaced from habitat which is currently suitable and occupied and displaced individuals may not successfully inhabit the buffer area. As such, it is considered likely that there will be a residual impact of the project on 18.1 ha of primary habitat for the Granite Belt thick-tailed gecko.

Residual Impacts

The Project will result in unavoidable impacts to MNES for which offsets will be required. SDRC is committed to provide an offset for residual impacts on Matters of National Environmental Significance (MNES) in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy.

Desktop assessment and subsequent field analyses indicate that suitable biodiversity offsets are available within the sub-region for the relevant matters.

1. INTRODUCTION

1.1. Background

Southern Downs Regional Council (SDRC) is seeking environmental approvals for Emu Swamp Dam (the Project). The Project includes an urban and irrigation dam near Ballandean and associated urban and irrigation pipelines.

Stanthorpe Shire Council (SSC) (now part of the amalgamated SDRC) sought to have the environmental and planning approvals required for this Project to be assessed under the *State Development and Public Works Organisation Act 1971* (SDPWO Act).

An Initial Advice Statement was prepared and submitted to the Queensland Coordinator-General (CoG) on 13 September 2006. The Initial Advice Statement was submitted to the CoG to provide sufficient information to:

- enable consideration for declaration of the Project as a significant project under the SDPWO Act; and
- provide information to enable advisory agencies and the public to have input into the draft Terms of Reference (ToR) for the EIS.

The CoG declared on 5 February 2007 that the Project was a significant project for which an EIS is required, and this EIS has been prepared to satisfy the requirement of the SDPWO Act.

Draft ToR for the EIS were prepared by the CoG and advertised from 31 March 2007 inviting public comment. Submissions were accepted until 8 May 2007. Matters raised in submissions were considered by the CoG and where appropriate incorporated into the final ToR, which were presented to the Proponent on 27 June 2007.

The Environmental Impact Statement (EIS) for the Project was publicly released for comment on 12 January 2008. The comment period closed on 25 February 2008.

Thirty-three submissions on the EIS were received by the Coordinator-General. These comprised 18 submissions from individuals, one from an organisation, and fourteen from State and Federal government departments.

On 22 March 2013 the Coordinator-General requested SDRC prepare a Supplementary Report to address the issues raised in submissions received.

1.2. The Proponent

SDRC are a local government in the Granite Belt of Queensland near the border with New South Wales.

SDRC undertakes and delivers a wide range of municipal activities and services. All activities of SDRC are to service and support the community. SDRC has the responsibility to set local laws, collect rates and deliver municipal services to the community. Services provided by SDRC include animal control, building and development planning and control, cemetery management, disaster management, community health, laws and regulations, libraries, parking, rate collection and management, waste management, cleaning and recycling and water supply and wastewater management. All activities occur within the boundaries of the SDRC Local Government Area (LGA).

The Proponent of the Emu Swamp Dam when the EIS was released for public consultation was Stanthorpe Shire Council (SSC). Stanthorpe Shire Council and Warwick Shire Council were amalgamated on 15 March 2008 to form Southern Downs Regional Council (SDRC). Following the amalgamation, the SDRC is the Proponent for the proposed Emu Swamp Dam.

1.3. EPBC Act approval requirements

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas. Under the environmental provisions of the EPBC Act, actions that are likely to have a significant impact on a MNES are identified as "controlled actions" and cannot be undertaken without approval under the EPBC Act.

The Project was referred to DotE (then referred to as the Department of Environment, Water, Heritage and the Arts) in December 2006. The former Southern Downs Regional Council (Stanthorpe Shire Council (SSC)) nominated the Project as a "controlled action" under Section 75 of the EPBC Act. The DotE determined on 3 January 2007 that the Project was a controlled action with the following controlling provisions:

- Sections 18 and 18A (Listed threatened species and communities)

1.4. Report purpose

This report consolidates all information relating to MNES listed under the EPBC Act with potential to be impacted by the Project.

This report is a stand-alone document prepared for consideration by the DotE and the Coordinator-General as an Appendix to the Supplementary Report.

1.5. Report structure

This report is structured as follows:

- Regional Overview including project location, development history, regional land use;
- Project overview including project description, project need, benefits of additional water supply, project alternatives and environmental management;
- Overview of Ecology Surveys;
- Occurrence of MNES assesses the likelihood of occurrence of MNES within the Project area;
- Identification of potential impacts on MNES known or likely to occur, describing direct, indirect and offsite impacts;
- Assess the potential for adverse residual impacts on each MNES known or likely to occur within the Project area; and
- Biodiversity Offset Strategy for residual impacts on MNES.

2. REGIONAL OVERVIEW

2.1. Location

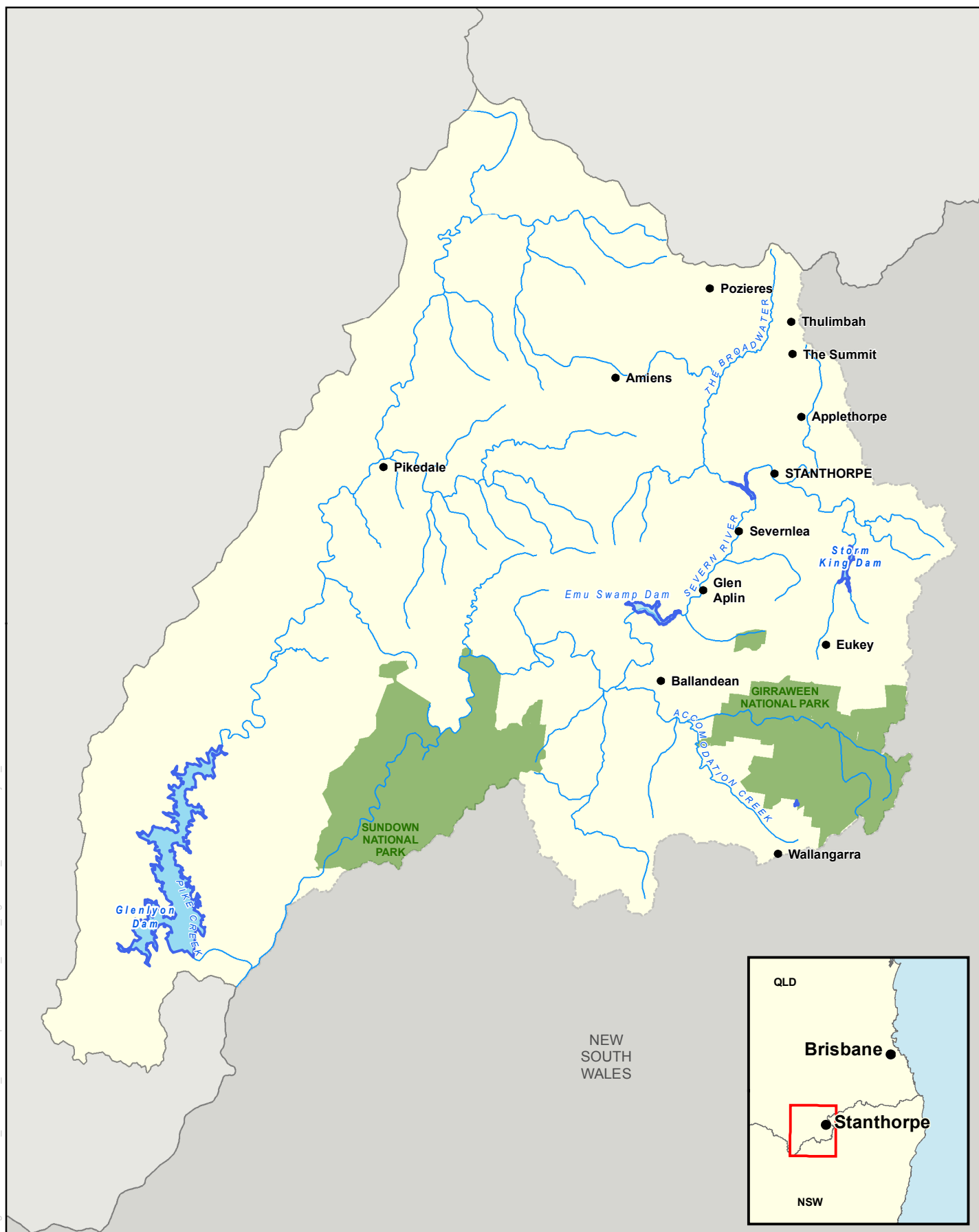
The Project area is located within SDRC region on the Granite Belt in Southern Queensland. The SDRC Region is located along the Queensland boundary with New South Wales and is approximately 175 km southwest of Brisbane.

The Emu Swamp dam site is located on the Severn River between Fletcher Road and Emu Swamp Road in the SDRC. The proposed dam site is 15 km southwest of Stanthorpe and 5 km northwest of Ballandean (refer to Figure 2-1).

2.2. Development History

The Project area has a long history of human development. Key phases in the development of the region include.

- Early European settlement, in the 1840s which saw the development of Glen Aplin and Ballandean in the late 1860s;
- Development of mining in the 1870s boosted the area's growth and was accompanied by a number of other important commercial, industrial and infrastructure developments to service mining activities including the Southern Railway;
- Development of fruit farming following the ending of the tin mining rush in the early 1880s. The increasing cultivation of orchards was accompanied by a number of support industries, including the establishment of sawmills;
- Government sponsored soldier settlement program was introduced to the area following the end of World War I;
- Large scale Italian settlement in the 1920s, which eventually contributed to the development of the wine industry in the 1930s and 1940s; and
- Developments post World War II, which saw the region continue to be dominated by fruit and vegetable growing, grazing and mining.



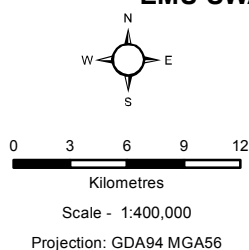
LEGEND

- Towns
- Watercourse
- National Parks
- Dams
- Southern Downs Regional Council
- New South Wales

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure 2-1

Location of Project



2.3. Regional Land Uses

The Southern Downs region is renowned for its horticultural activity. There is a range of fruits and vegetables grown in the area including apples, pears, stone fruit, lettuce, cauliflower, cabbage, capsicums and tomatoes. There is also a well-established wine-producing industry in the area. The estimated areas of crop production in the SDRC region is 4,210 ha, with 3,697 ha being based in the former Stanthorpe Shire region (Tancred & McGrath 2013).

There has been historic clearing of native vegetation in the region. Analysis of regional ecosystem mapping with approximately 50% of the former Stanthorpe Shire region mapped as non-remnant (or cleared). Native vegetation has generally been retained in areas with limited agricultural productivity (ie poor topography, poor soils or limited water availability).

Figure 2-2 Agricultural land use in Southern Downs region



Very little underground water is available in the Granite Belt and producers have invested significantly in on-farm and in-stream water resources (weirs) to help mitigate against climatic challenge of drought. The development of the weirs on the Severn River is discussed further in Section 2.5.

2.4. Severn River

The proposed Emu Swamp Dam will be located in the Granite Belt catchment which is part of the Border Rivers Drainage Basin. The major streams in the Granite Belt catchment are The Broadwater, Cannon Creek, Quart Pot Creek, Four Mile Creek, Accommodation Creek and Severn River.

The Severn River is an ephemeral river characterised by a rocky bottom, pools and riffles. There is significant monthly variability in the daily flow in the Severn River. There are two river height gauges on the Severn River at Farnbro (46 km downstream of the proposed dam) and Ballandean (8 km downstream of the proposed dam). The maximum gauge depth in the Severn River recorded was 6.24 m at Farnbro in February 1976 and 5.51 m at Ballandean in January 2011.

2.5. Development of the Severn River

Water supply development in the upper catchment of the Severn River has been considerable with construction of many dams and weirs on the streams and farms. There is reported to be 26 barriers on the Severn River from the confluence of Quart Pot Creek and the Broadwater to Nundubbermere Falls in Sundown National Park. The majority of these barriers are weirs for private use. A number of these weirs are significant structures with nine weirs which are 3 m high or greater.

The locations of significant weirs near the proposed dam site are presented in Figure 2-5. This section of the Severn River includes six weirs greater than 2 m in height and four smaller weirs. Figure 2-3 presents the 4 m weir at average mean thread distance (AMTD) 260.5 km (Mungall's Weir). Figure 2-4 presents the 2.9 m weir at AMTD 259.3 km (Booth Weir).

IQQM modelling shows there has been a significant reduction from the predevelopment to the existing entitlements scenario flows. The existing weirs restrict fish passage in periods of low and moderate / average flow but also provide refuges droughts and no-flow periods.



Figure 2-3 Severn River Weir AMTD 260.5 km



Figure 2-4 Severn River Weir AMTD 259.3 km



LEGEND

-  Weirs
-  Contours - 5 metre
-  Watercourse
-  Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES



0 0.25 0.5 0.75 1
Kilometres

Scale - 1:30,000

Projection: GDA94 MGA56

Figure 2-3

Existing Weirs near
the Project Area



3. PROJECT DESCRIPTION

3.1. Project overview

The Emu Swamp dam site is located on the Severn River between Fletcher Road and Emu Swamp Road in the SDRC. The dam site is 5 km north of Ballandean and 15 km southwest of Stanthorpe.

The Emu Swamp Dam Project has five major components:

- Emu Swamp Dam;
- Urban Pipeline;
- Irrigation Pipeline;
- Stalling Lane Access; and
- Recreational Area.

3.1.1. *Emu Swamp Dam*

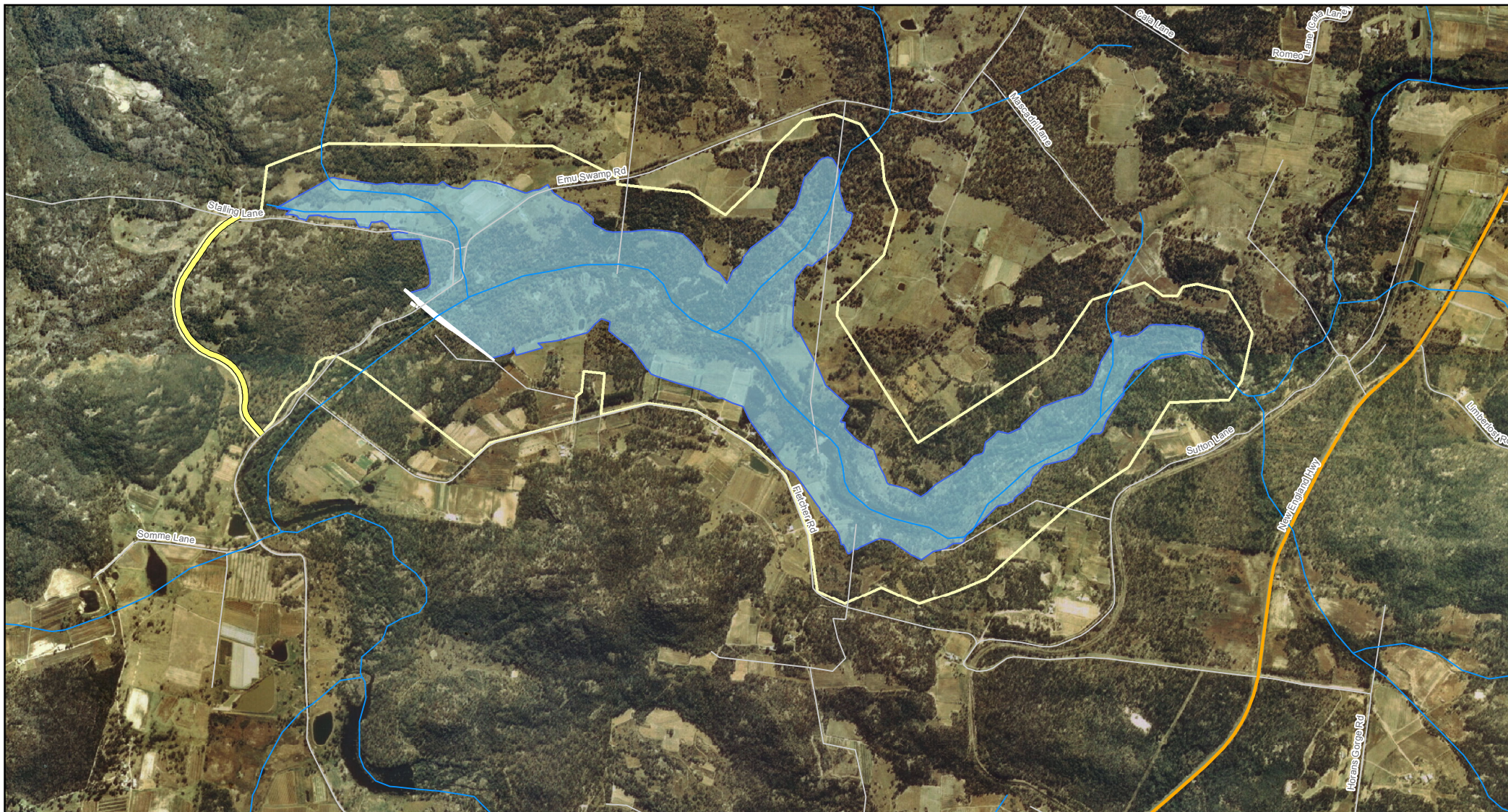
The proposed Emu Swamp Dam has a storage capacity of 10,500 ML. The Full Supply Level is 738 m AHD with an associated inundation area of 196 ha. Under the Border Rivers Resource Operations Plan (ROP) there is a water allocation for urban water supply of 1,500 ML. The proposed annual urban extraction volume for Emu Swamp Dam is 750 ML/yr. The proposed water allocation for the irrigation component is 1,740 ML/year as provided in the Water Resource (Border Rivers) Plan (WRP) and the ROP.

The proposed inundation area for Emu Swamp Dam is presented in Figure 3-1. A buffer area of approximately 200 m (322 ha) is proposed surrounding the dam to protect the water quality within the dam and also to maintain ecological connectivity.

3.1.2. *Urban Pipeline*

The urban pipeline is 23.2 km long and is largely located in road reserves. The route follows Fletcher Road, the New England Highway, Whiskey Gully Road, Brunckhorst Avenue, Hale Haven Drive, Rifle Range Road, Eukey Road/Sugar Loaf Road, Kingston Road, across private property, Greenup Street/Diamondvale Road and across SDRC land to the Mt Marlay water treatment plant. The urban pipeline route is presented in Figure 3-2.

The urban pipeline along Fletcher Road and the New England Highway will be 375 mm diameter reducing to 250 mm diameter at the Whiskey Gully Road intersection.



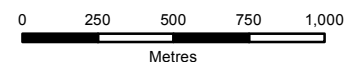
LEGEND

- Town Names
- Watercourse
- Road
- Highway
- Stalling Land Access
- Buffer Area
- Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure 3-1

Inundation Area and Buffer Area for Emu Swamp Dam



Scale - 1:25,000

Projection: GDA94 MGA56



3.1.3. *Irrigation Pipeline*

The irrigation pipeline route largely follows road reserves although there are some short sections crossing private lands. The irrigation pipelines are supplied from the urban pipeline. The total length of irrigation pipeline (excluding the urban pipeline section) is 102 km.

The Irrigation Pipeline route follows Eukey Road, the New England Highway, Horans Gorge Road, Mt Stirling Road, Winkler Road, Back Creek Road, Stables Road, Amiens Road, Cannon Creek Road, Bapaume Road, Swans Lane, Spring Creek Road, Barracks Road, Aerodrome Road, Applethorpe Road, Ellwood Road, Rogers Road, Church Road, Teale Road, Goodwin Road, Gangemi Road, Poziers Road, Newlands Road, Pfrunder Road, Pradella Road and Scotts Camp Road. The irrigation pipeline route is presented in Figure 3-2.

The irrigation pipeline will be constructed from flexible pipe materials like high-density polyethylene (HDPE) and polyvinyl chloride (PVC) and will range in size from 40 mm to 300 mm diameter.

Small concrete blockwork pump stations will be constructed on Old Caves Road (near the New England Hwy intersection), on Church Road (near the Ellwood Road intersection) and on Cannon Creek Road (near the Barkers Lane intersection). The indicative locations for the pump stations on the irrigation pipeline are presented in Figure 3-2.

3.1.4. *Stalling Lane Access*

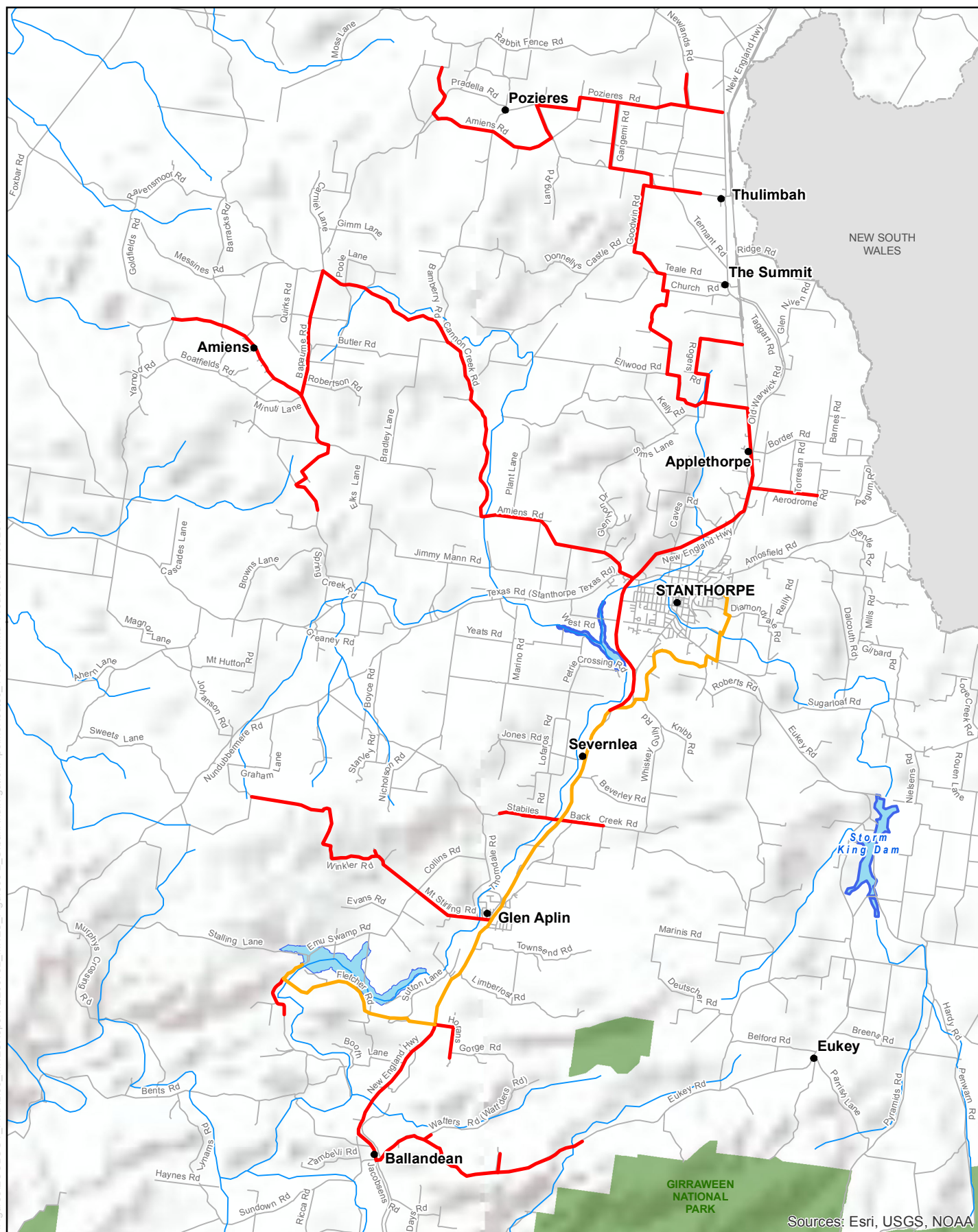
The inundation area for the proposed dam will result in the closure of Emu Swamp Road. As a result of this closure Stalling Lane will no longer be accessible from Emu Swamp Road. Stalling Lane currently provides access to two properties. To maintain this access, the Stalling Lane Access is proposed to be constructed from Fletcher Road to the western end of Stalling Lane. The location of the Stalling Lane Access is presented in Figure 3-1.

The alignment of the proposed Stalling Lane access will be modified as necessary to avoid areas of ecological value.

3.1.5. *Recreation Area*

Public recreation facilities will be provided on the left abutment of the dam after construction is completed. The expected facilities include:

- picnic area shelters with rainwater tanks, uncovered picnic tables, gas or electricity fuelled BBQs;
- playground equipment;
- toilet facilities with water tank, on-site septic tank treatment and pump out capability;
- boat ramp (5 m wide concrete extending to 3 m below FSL);
- gravel access from Fletcher Road; and
- gravel surfaced car park and boat trailer park.

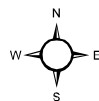


Sources: Esri, USGS, NOAA

LEGEND

- Town Names
- Watercourse
- Road
- Urban Pipeline
- Irrigation Pipeline
- Full Supply Level (738m AHD)
- National Parks
- New South Wales

EMU SWAMP DAM - ASSESSMENT OF MNES



0 1 2 3 4

Kilometres

Scale - 1:150,000

Projection: GDA94 MGA56

Figure 3-2

Urban and Irrigation Pipeline



3.2. Construction

3.2.1. Dam Construction

The major activities for the construction of the dam and associated facilities are detailed in Table 3-1.

Table 3-1 Emu Swamp Dam Construction Activities

Activity	Details
Environmental	Erosion and sediment control works Pre-clearing flora and fauna surveys. Relocation of fauna Identification and fencing of environmentally sensitive areas Retrieval of plant material for propagation
Clearing	Clearing for site establishment Clearing for quarry and sand pit development Clearing of dam construction site Clearing of inundation area (in stages following dam completion)
Quarrying and Sand Extraction	Removal of overburden Drilling, blasting and rock removal by excavators Sand removal by excavators
Concrete Manufacture	Operation of crushing and screening plants Stockpiling of aggregate and sand for concrete batching Operation of concrete batch plant
Dam Foundation Preparation	Excavation and removal of upper jointed and weathered rock Dental grouting to fill holes and non-uniform surfaces Flush grouting of open joints and surface fractures Drilling and injection of grout curtain
RCC Wall Construction	Construction of the RCC Wall Involves articulated trucks, dozer, rollers and water cart
Materials Haulage	Most construction materials will be sourced onsite and transported as required Truck haulage of materials not sourced on-site. This includes cement, fly ash, reinforcing steel, pipe, fittings etc
Intake Tower & Outlet	Reinforced concrete construction, pipe, gates, electrics Involves formwork, cranes, vibrators, stripping, building trades
Recreation Facilities	Removal of construction site facilities Picnic shelters, BBQs, toilet facilities Involves cranes, graders, trucks, concrete, building trades
Site Rehabilitation	Rehabilitation & reinstatement of disturbed construction site
Fish Lock	Reinforced concrete construction, pipe, gates, electrics

Pre-Construction

The main emphasis of the initial site development at the dam site will be establishment of the construction site. These works will include:

- closure of public access on Emu Swamp Road between the Fletcher Road intersection and (approximately) the eastern extent of the of the inundation area (deferred as long as possible);
- erection of security fencing around the construction site;
- construction of a hardstand area for offices and car parking (50 sites) – 2,500 m² site area;
- construction of site offices, laboratory, storage, crib, ablutions (18 units, 12 x 3 m – 2,000 m² site area);

- establish communications, power, water reticulation and ablution services;
- construction of workshop, maintenance facility and hardstand (2 units, 14 x 3 m – 2,000 m² site area);
- construction of a self-contained, bunded fuel tank (60,000 L), dangerous goods container for oil & grease;
- construction access roads within the construction site;
- construction of a temporary water storage in inundation area for harvesting construction water after rain;
- construction of a hardstand for materials handling at right and left abutments – 1,500 m² each side;
- establishment of quarry, crushing & screening plants and concrete batch plant on site;
- construct upstream gauging weir.

Clearing

Clearing for the Emu Swamp Dam Project will be undertaken in phases:

- initial site establishment at the dam construction site; and
- the remainder of the inundation area up to 2 m (vertical) below the FSL when the dam construction is well advanced.

Vegetation screening the construction site will be retained as long as possible reducing the visual, noise and dust impact on neighbours. It will also provide more time for clearing activities to be planned and implemented in the areas of ecologically important habitat.

Quarrying and Sand Extraction

The quarry and sand extraction areas are located in the inundation area of the Emu Swamp Dam.

The quarrying operation will commence with clearing and site levelling. The maximum quarry depth will be 5 m and the approximate dimension of the excavation will be 100 m by 200 m.

The programmed blast frequency is one blast per day. Blasting will be scheduled to occur in the afternoon on weekdays to minimise the disturbance to neighbours.

The sand required for the dam is 5,000 m³ – the excavation will be a maximum of 3 m deep and 50 m by 50 m in area. The sand excavation may be extended for pipeline bedding material.

Concrete Manufacture

Most materials for construction will be sourced from onsite including rock aggregate, sand and water. Rock material from the quarry will be crushed to form aggregate for concrete manufacture. Sand will be screened for coarse (1 to 5 mm) and fine (less than 1 mm) particle sizes. Rock aggregate and sand will both be stockpiled onsite prior to concrete batching. Cement and flyash will be transported to site and stored in silos.

The concrete batching plant will be relocated during construction to minimise haul distances for the left and right RCC wall constructions.

Dam Foundation Preparation

The RCC Wall will be constructed in two halves to facilitate water management during construction.

The foundations for each half will be prepared by removing jointed and weathered rock to about 1 m depth. Dental concrete and flush grouting will be undertaken to provide a level working face. A grout curtain of 75 mm

diameter holes drilled to about 12 m depth and pressure grouted will be established to prevent leakage under the wall.

RCC Wall Construction

Each half of the RCC Wall will be constructed continuously for a period up to 3 months. Concrete will be batched on-site, trucked to the dam wall site, spread in a 300 mm layer and compacted. The width of the layers reduces as the wall height rises. The work is undertaken with road construction equipment.

Site Rehabilitation

Following completion of the site construction works, areas outside of inundation area will be rehabilitated, materials cleared and all site construction infrastructure removed.

Downstream Works

Works downstream of the dam wall will be limited to the temporary construction access (20 m width for haul road), the spillway chute walls, the downstream release pipe and control house, fish transfer infrastructure, the pump station and the permanent access road.

An existing section of Emu Swamp Road will be retained as the permanent access road to the dam wall, outlet pipe and pumping station.

3.2.2. Pipeline Construction

The final alignment of urban and irrigation pipelines will be confirmed during detailed design. The process of constructing the pipelines can be separated into the following tasks:

- surveying (engineering, property and ecological);
- vegetation clearing and top soil recovery;
- trench excavation (with a 30 tonne excavator for urban pipeline or a small trenching machine/backhoe for the irrigation pipeline);
- pipelaying and backfilling;
- testing;
- rehabilitation (topsoil emplacement, seeding and watering to establish native ground cover; and
- maintenance.

For the purpose of the assessing potential impacts of the pipeline components of the Project the maximum size of the working corridors for the construction of the pipeline are:

- 12.5 m for the urban pipeline along the New England Highway, with a clearing width of 12.5 m;
- 7.5 m for the irrigation pipeline along the New England Highway, with a clearing width of 7.5 m; and
- 5 m for the urban and irrigation pipelines along local roads, with a clearing width of 5 m.

The working corridors have been adopted considering both the constrained working environment within the road corridor and environmental constraints identified during the EIS surveys. Activities within the construction corridor for the urban pipeline and for the irrigation pipeline are presented in Figure 3-3, Figure 3-4, Figure 3-5 and Figure 3-6.

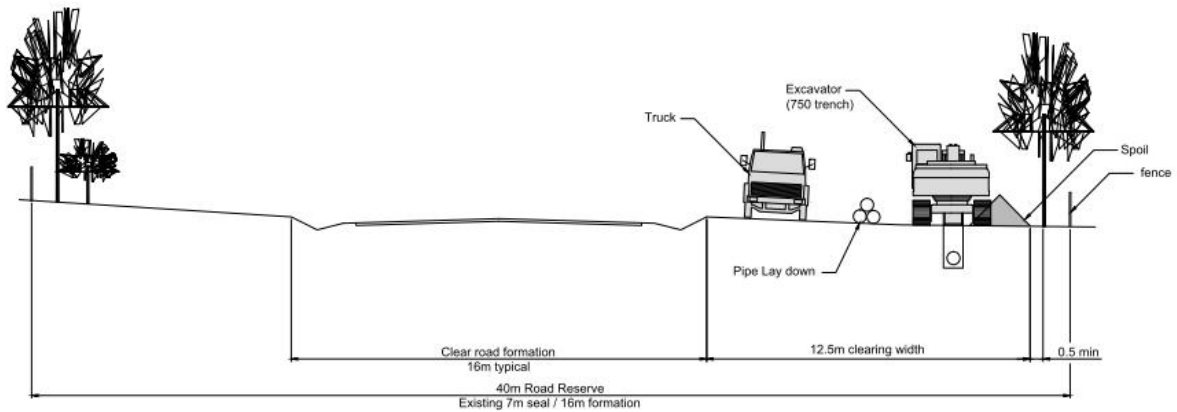


Figure 3-3 Cross section of activities within the construction corridor for the Urban Pipeline along the New England Highway

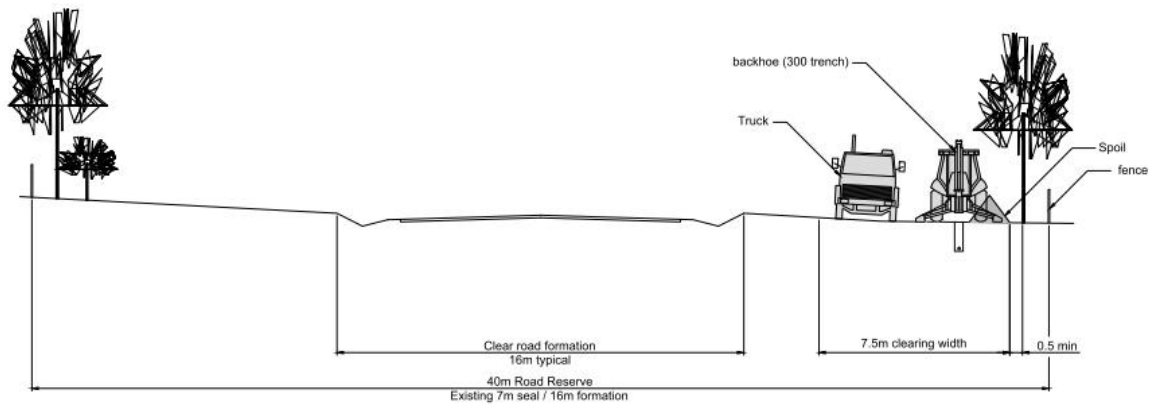


Figure 3-4 Cross section of activities within the construction corridor for the Irrigation Pipeline along the New England Highway

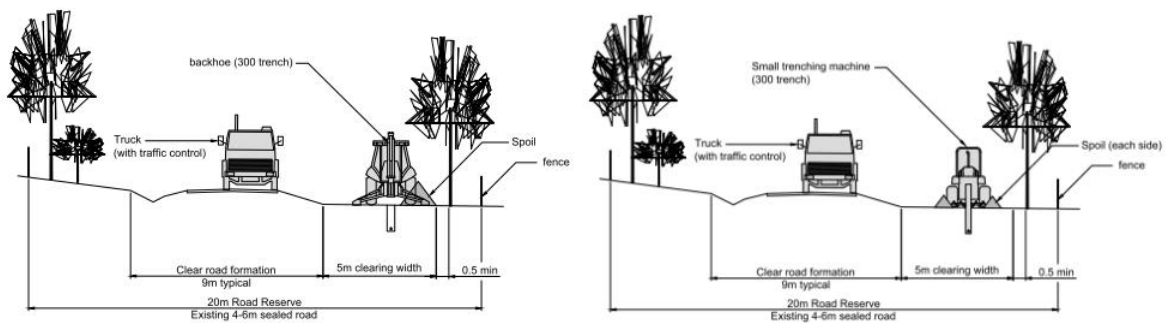


Figure 3-5 Cross section of activities within the construction corridor for the Urban and Irrigation Pipelines along local roads

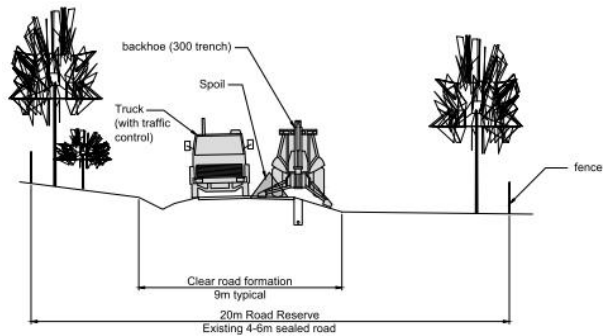


Figure 3-6 Cross section of activities within the construction corridor for the Urban and Irrigation Pipelines along local roads with unavoidable ecological constraints

3.2.3. Construction Program

The construction program for the Project will consist of the following work packages;

- early works;
- dam construction; and
- pipeline construction.

Early Works include all work to be undertaken before the construction site establishment including power supply to the dam site and construction of the Stalling Lane Access.

The construction of Emu Swamp Dam allows for flood diversion during the construction period and for efficient concrete transport for the RCC dam. The construction program will occur in four phases:

- pre-construction – clearing, site establishment, quarrying and sand extraction;
- right half RCC wall construction – the right half of the dam (when looking downstream) will be constructed first. This includes dam foundation preparation, construction of the RCC Wall and construction of the inlet tower and outlet works;
- left half RCC wall construction – construction of the left half of the dam including dam foundation preparation and construction of the RCC Wall; and
- rehabilitation and Commissioning

A construction program for Emu Swamp Dam is provided in Figure 3-7. The construction program occupies 16 months. The following activities need to be undertaken before construction can commence:

- obtain all environmental approvals and permits;
- undertake detailed engineering design;
- complete the land acquisition process and Native Title and cultural heritage requirements; and
- secure a biodiversity offset.

At this stage, it is anticipated construction would not commence until 2016.

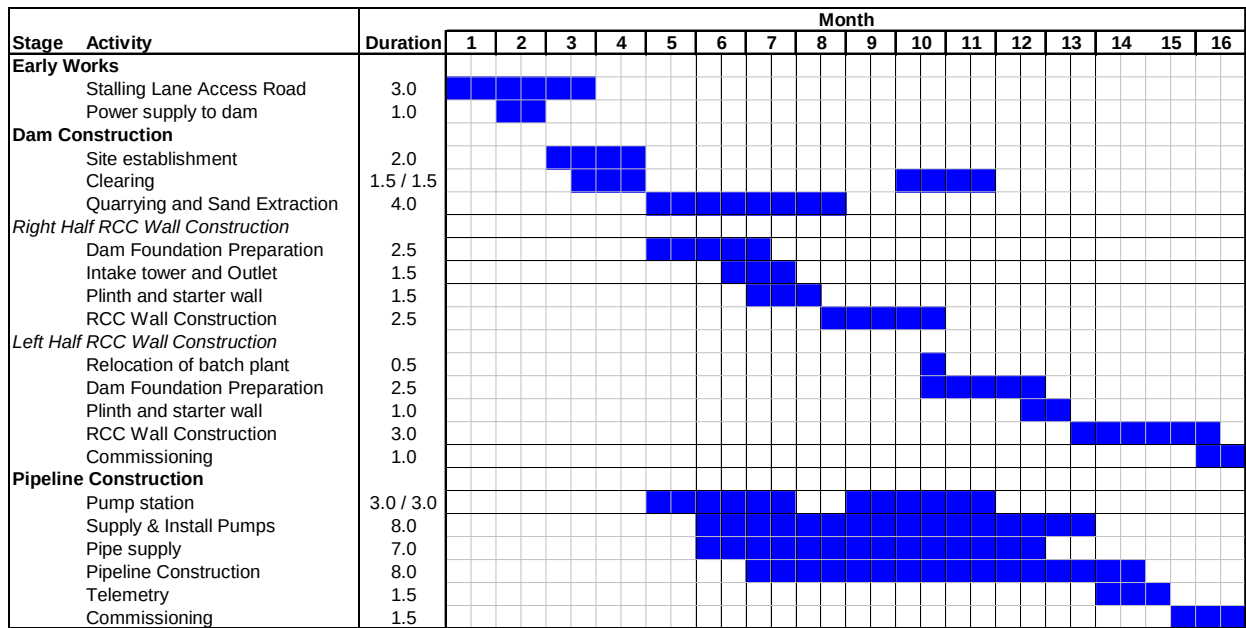


Figure 3-7 Construction Timeline for Emu Swamp Dam

3.3. Operation

3.3.1. Dam Performance

The performance of the dam has been analysed with the hydrology model (IQQM) for the Granite Belt supplied by the Department of Science, IT, Innovation and the Arts (DSITIA). The simulation period for this model is from the 1 January 1889 to the 31 December 2011 and is referred to as the “Extended IQQM” in the remainder of this chapter. The Extended IQQM represents an upgrade of the model used in the EIS as it now includes:

- extension of the model simulation period to 31 of December 2011;
- recalibration of the model inputs with additional gauge information of rainfall, streamflow and evaporation; and
- improved representation of farm dams in the system.

The proposed Emu Swamp Dam will have an annual urban water supply demand of 750 ML and irrigation water supply of 1,740 ML. The urban water allocation volume for the SDRC is 1,500 ML; however, this is proposed to be taken in a staged approach, with the pipeline infrastructure being developed with a capacity of 750 ML/yr. Therefore, the impact assessment for the proposed Emu Swamp Dam is based on the extraction of 750 ML/yr.

Table 3-2 presents the update performance of the proposed Emu Swamp Dam, while the performance of the existing Storm King Dam is presented for comparison.

Table 3-2 Dam Performance

	Proposed Emu Swamp Dam		Storm King Dam
	Urban Water Supply	Irrigation Water Supply	Urban Water Supply
Allocation Volume (ML/year)	1,500	1,740	700
Annual Extraction Volume (ML/year)	750	1,740	700
Mean Annual Diversion (ML)	742	1,676	691
Monthly Reliability (%)	99.9	96.6	97.6
Annual Reliability (%)	99.2	93.5	95.1

These results show that the proposed Emu Swamp Dam will have high reliability, greater than 99% monthly and annual reliability, for the urban water supply. For urban water supply it is preferred if the reliability is more than 99%. The irrigation supply reliability is also significantly above other comparable water supply schemes. The only time in the simulation period (1889 to 2011) that the proposed Emu Swamp Dam was predicted to fail to meet the water supply requirements is at the end of 2007, following an extended dry period.

3.3.2. Dam Storage Behaviour

Figure 3-8 presents the modelled storage exceedance curve for the proposed Emu Swamp Dam with annual allocations of 750 ML and 1,740 ML, for urban and irrigation water supplies respectively.

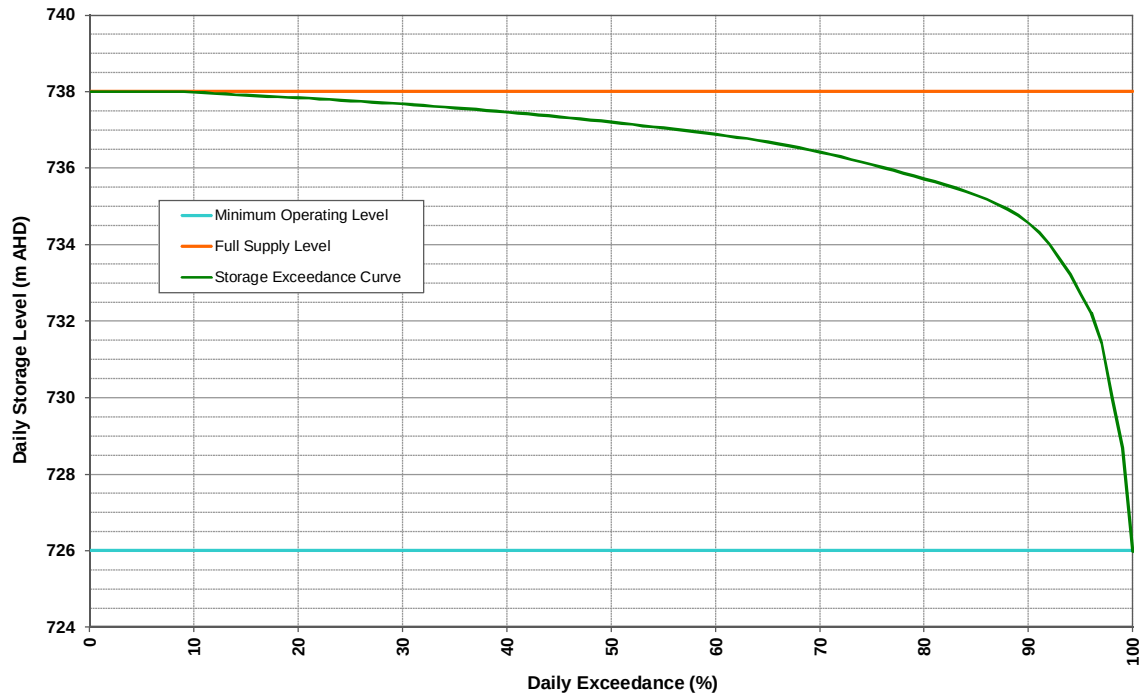


Figure 3-8 Dam Storage Behaviour

The exceedance curve presented in Figure 3-8 shows the percentage of days during the simulation when the storage equals or exceeds a particular storage level. It can be seen that during the modelled simulation period the proposed Emu Swamp Dam is above, at, or near full capacity (i.e. less than 1 m below the FSL) for 55% of the time. The dam fails (i.e. falls below the minimum operating level of 726 m AHD) for less than 1% of the time.

3.4. Project Need

3.4.1. Historical Background

A number of reports have been prepared over the last 33 years to identify suitable options for improving reliability of water supply for the town of Stanthorpe and rural industries in the Granite Belt area:

- Report on Water Resources Development Potential [in the] Granite Belt Area, (DPI, 1980);
- Granite Belt Dam Sites – Yield Analysis, Surface Water Branch Hydrology Report No 416308.PR. (Teske, 1983);
- Preliminary Report on the Effects of Upstream Land Use on Storm King Dam (Munro Johnson & Associates, 1983);
- Report on Stanthorpe Water Supply Strategy Study (Munro Johnson & Associates, 1984);
- Report on Granite Belt Damsites – Yield Analysis and Flood Hydrology at (1) Quart Pot Creek Damsite at 292.9 km, and (2) The Broadwater Damsite at 10.8 km (Huxley, 1986);
- Report on Granite Belt Investigation (DPI, 1988);
- Water Supply Headworks Strategy Study for Stanthorpe and Wallangarra (SKM, 1997);
- Water Supply Headworks Strategy Study for Stanthorpe and Wallangarra – Investigation of Alternative Dam Sites (SKM, 1997);
- Proposed Dam near Ballandean on the Severn River – Water Infrastructure Advisory Council Submission (SKM, 1998);
- Feasibility Study of Integrated Water Supply Proposals on the Granite Belt (SKM, 1999);
- Stanthorpe Water Supply Dam Options Review (SKM, 2005).
- Stanthorpe Shire Water Opportunities Urban Water Needs Analysis (SKM, 2006).
- Emu Swamp Dam Flood Hydrology and Failure Impact Assessment (SKM, 2007a);
- Stanthorpe Water Supply Strategy IQQM Modelling Report (SKM, 2007b);
- Stanthorpe's Next Water Supply Source Yield Assessment of Kia Ora Dam Site (SKM, 2007c);
- Stanthorpe Water Network Study (SKM, 2007d);
- Emu Swamp Dam Planning Report (SKM, 2007e); and
- South West Queensland Urban Water Demand Study – Stanthorpe (MWH, 2013).

Emu Swamp Dam has been adopted by SDRC for providing urban and irrigation water.

3.4.2. Current Water Supply and Usage

Water is supplied to Stanthorpe from Storm King Dam which is located southeast of Stanthorpe on Quart Pot Creek. Storm King Dam has a water allocation of 700 ML/year under the Border Rivers Resource Operations Plan (ROP). The storage characteristics of Storm King Dam are presented in Table 3-3.

Table 3-3 Dam Storage Characteristics of Storm King Dam

	Storage Characteristics
Full Storage Volume (ML)	2,180
Minimum Operating Volume (ML)	200
Inundated Area at Fully Supply Level (ha)	78
Catchment Area (km ²)	95
Stream	Quart Pot Creek
Average Mean Thread Distance (AMTD) (km)	300.7

Storage volumes in Storm King Dam from 1969 to 2013 are presented in Figure 3-9. Storm King Dam has been drawn down to very low levels on at least four occasions. In late 2007 Stanthorpe was left with just two months water supply from Storm King Dam. Total water consumption in Stanthorpe was severely constrained from 2003 to 2008 because of low water levels in Storm King Dam.

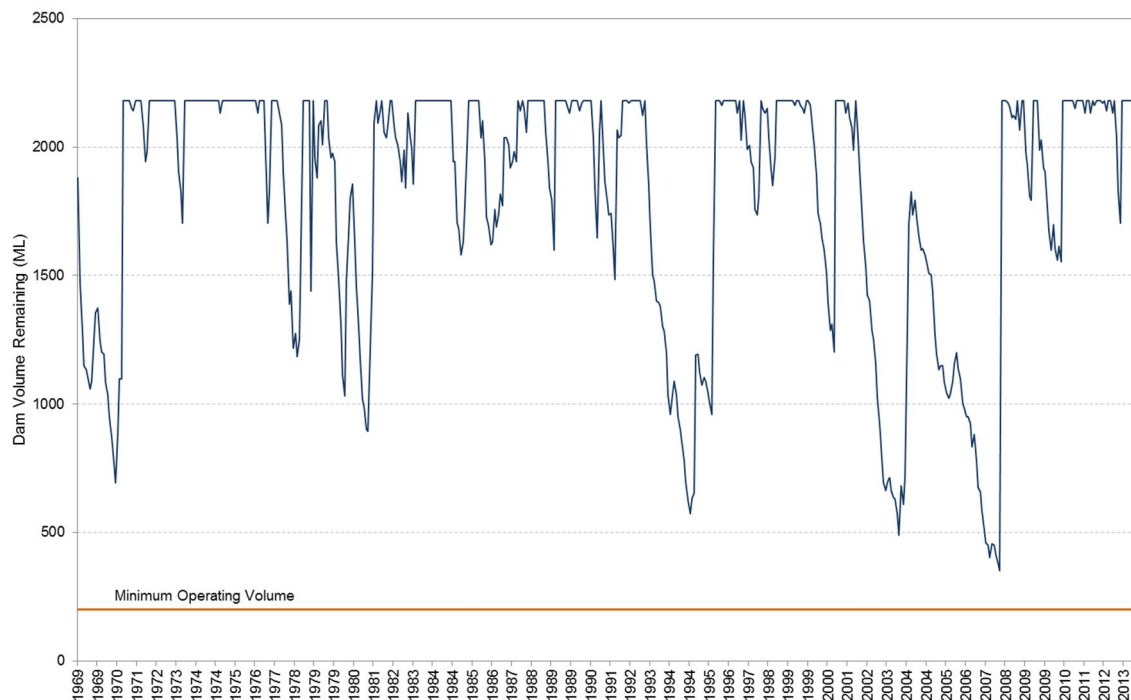


Figure 3-9 Storage Volumes in Storm King Dam 1969 to 2013

Despite the reduced water consumption over this period, dam levels in Storm King Dam were the lowest on record in late 2007. Historical evidence shows Storm King Dam lacks the capacity to provide a reliable water supply for the Stanthorpe community during periods of drought.

3.4.3. Projected Water Demand

Urban Water Demand

MWH (2010) were commissioned jointly by the Department of Environment and Resource Management (DERM) and Department of the Environment, Water, Heritage and the Arts (DEWHA) to identify existing water use and to forecast future water demand for the next 50 years for urban, industrial and rural sectors in South West Queensland. The study involved:

- analysis and climate correction of historical water production trends;
- analysis and climate adjustment of customer billing data and water consumption trends;
- forecasting of future total and per person baseline water demand for the next 50 years;
- assessment of water savings opportunities; and
- development of a demand forecast based on low, medium, high water savings.

Analysis of residential water consumption rates determined:

- the residential water consumption at Stanthorpe was 143 L/person/day with the average across residential and rural residential water users of 150 L/person/day (due to water restrictions during this period); and
- only 2% of water was used for external purposes as (due to restrictions on outdoor water use).

Baseline water production and residential consumption projections (MWH, 2010) from 2011 to 2056 are presented in Table 3-4. A 2011 baseline water production rate of 370 L/person/day was adopted to reflect normal conditions (ie without the influence of drought and/or water supply issues). The projected residential baseline consumption rates fall from approximately 200 to 190 L/person/day from 2011 to 2056 which is similar to the consumption rates in the EIS. Production includes residential and non-residential water demand.

Table 3-4 Water Production and Residential Consumption Projections

		2011	2016	2021	2026	2056
Total Annual Production (ML)	Baseline	684	705	729	755	952
	Demand management	671	674	686	708	895
Production per person (L/p/d)	Baseline	367	362	358	356	352
	Demand management	360	346	337	334	331
Residential consumption (L/p/d)	Baseline	206	201	197	194	189
	Demand management	200	191	185	180	176

Source: MWH, 2010

MWH (2010) also estimated water production and residential consumption projections (refer to Table 3-4) based on the implementation of preferred water demand management measures including:

- water efficiency labelling standards;
- demand measures in the Queensland Development Code MP4.1, MP4.2 and MP4.3;
- State Governmental residential rebates;
- education and non-residential programs;
- System Water Loss Management; and
- Water Efficiency Management Plans.

Even accounting for a range of water demand management measures, the baseline water production requirements for Stanthorpe exceed the water allocation of 700 ML/year for Storm King Dam from 2016 onwards. The MWH (2010) projections confirm that Storm King Dam is unable to provide Stanthorpe's water needs.

The above projected water demands are considered conservative because:

- population growth projections are low (0.81- 0.89%) – actual population growth for Stanthorpe in the 2006 – 2011 period was 14.5% (ABS, 2012); and
- growth in non-residential water was assumed to be proportional to residential growth - this provides minimal opportunities for business or industrial development in Stanthorpe.

Water supply in Stanthorpe has constrained business investment in the past. SDRC have been forced to encourage business development in Warwick in preference to Stanthorpe because of the reliability of the water supply. The impact of water supply constraints has influenced the following business investment decisions in the Stanthorpe area:

- a juice factory being established in Warwick in preference to Stanthorpe; and
- a proposed tourist resort did not proceed as there was insufficient water available.

Business Opportunities

A number of industries have been investigated to determine the potential impact on water demand at Stanthorpe. The selected industries include craft beer breweries, fruit juice production, vegetable washing and packing plants and abattoirs. These industries were investigated as they are considered viable future industries for Stanthorpe.

There are more than a dozen craft breweries in Australia. Stanthorpe's unique elevation and climate provide a special marketing opportunity and several enterprises have considered craft breweries at Stanthorpe in the past. Typical water demands for craft breweries ranges from 15 ML/yr (for small regional operations) to 120 ML/yr (for mid-size national craft breweries) and more than 200 ML/yr for the larger craft breweries with an international market.

The Granite Belt could support a fruit juice processing and bottling plant at Stanthorpe. More than 50,000 t/yr of apples and pears are produced locally. Typically fruit juice plants combine local fruit with fruit from other regions. The water demand for a plant processing 10,000 t/yr of apples and citrus is typically 50 ML/yr.

Granite Belt growers presently deliver "salad mix" ingredients to Brisbane plants for washing and packaging. The Granite Belt produces 7,000 t/yr of lettuce and baby-leaf. The major retail chains are likely to require growers to wash their produce (to remove soil, insects etc) prior to transport. At the water consumption rates of existing facilities this would guarantee a demand of 30 ML/yr at a Stanthorpe based "salad mix" packaging plant.

The Granite Belt produces 35,000 t/yr of tomatoes, capsicums, brassicas, celery, beans, cucurbits, herbs, table grapes and strawberries. If all of these had to be washed locally there would be an additional 150 ML/yr of industrial water demand.

Abattoirs at Stanthorpe have been mooted in the past. One proposal was to relocate the Wallangarra abattoir to more reliable water supply. The Wallangarra abattoir processes nearly a million small stock (mostly sheep) each year and uses 120 ML/yr of water. The abattoir at Warwick processes approximately 100,000 large stock (mostly cattle) each year and uses 300 ML/yr of water. An abattoir at Stanthorpe would require 100-300 ML year of water.

. As describe above, there are opportunities for business investment that will significantly increase water demand for non-residential use in Stanthorpe. Business investment could potentially increase water demand in the non-residential sector by several hundred megalitres each year.

Stanthorpe needs Emu Swamp Dam to be able to seek and capture investment and employment opportunities in this sector.

Irrigation Water Demand

The DSITIA IQQM model includes all of the existing irrigation allocations. The irrigation water use by individual farmers has a three year rolling cap that needs to match their allocation. The maximum and mean annual water irrigation diversions in the IQQM are 20,005 ML and 10,688 ML respectively. The proposed irrigation water of 1,740 ML/year represents an increase of 16% in average years above existing irrigation entitlements.

Currently horticulture, the major industry of the Granite Belt economy, is significantly restricted by water availability and reliability. Horticulture is a significant contributor to the local and state economies reflecting an abundance of reasonable quality land, high altitude and temperate climate. Market trends suggest an increase in demand for fresh and nutritious food, seasonal produce and 'localness'.

Additional irrigation water has been sought by irrigators and associated industries for many years. A number of surveys of growers were undertaken to determine the potential take up of additional irrigation water:

- Tancred (2001) surveyed 30 growers, 26 of whom said they would require around 5,155 ML of additional water.
- T. Sargent Services (2013) surveyed 48 growers in the Emu Swamp Dam catchment, 34 of whom said they would require around 3,955 ML of additional water.

There remains substantial unsatisfied demand for additional irrigation water in the region. The potential benefits associated with the supply of irrigation water are presented in Section 3.5.

Water is the main limiting factor affecting the expansion of horticultural production in the Granite Belt (Tancred & McGrath, 2013).

3.4.4. *Water Demand Management*

SDRC have prepared a Drought Management Plan that includes four levels of water restrictions including measures for residential and non-residential use: permanent water conservation measures, along with medium, high and extreme restriction levels. The plan also specifies maximum per person water usage targets for each of the restriction levels. The water usage targets range from 140 L/person/day (extreme restriction levels) to 230 L/person/day (permanent water conservation measures).

SDRC have adopted a range of demand management measures as part of the Drought Management Plan including outdoor conservation plans, water restriction levels, maximum consumption targets, and Water Efficiency Management Plans for businesses using more than 10 ML per annum. Even accounting for a range of water demand management measures, the projected water production requirements for exceed the water allocation of 700 ML/year for Storm King Dam from 2016 (MWH, 2010).

Growers have been early adopters of new techniques and technologies to improve water efficiency (Tancred & McGrath, 2013). Growers have invested heavily in evaporation controls such as suspended shade cloth, floating

covers and chemical formulations. The construction of a single large dam is considered to provide the best single option 'to minimise' evaporation as water savings are proportional to the reduced surface area of the water in storage and also loss through seepage (T. Sargent Services, 2013).

3.5. Benefits of Additional Water Supply

Local residents are broadly supportive of the Project and believe the provision of a reliable urban water supply is necessary for the further growth and sustainability of the Stanthorpe region. The development of a reliable irrigation supply was seen as important for the future development of primary industries in the region.

The benefits of providing additional urban water supply include:

- value adding industries can establish creating diversity in employment opportunities;
- restrictions on growth in Stanthorpe's will be removed; and
- tourism can increase.

The proposed Emu Swamp Dam is in a very important Queensland horticulture region, producing 5-8% of the State's total fruit and vegetable production and showing strong potential for future growth. Tancred and McGrath (2013) estimate the value of production of horticultural produce is \$283 million in the former Stanthorpe Shire Council region.

The Queensland Government intends to double Queensland's food production by 2040 which will increase demand on water. Irrigation water has potential to increase economic output through:

- additional water security increasing production during dry periods;
- increasing production of high value horticultural produce (eg tomatoes, strawberries, broccoli); and
- some expansion of horticultural areas (on the Granite Belt where sufficient cleared land is already available).

The benefits of providing additional irrigation water for the Granite Belt include:

- increased water security leading to increased small farmer security and confidence and the ability to plan for the future;
- expansion of agricultural production leading to an increase in employment opportunities;
- increased water availability in drought periods leading to improved productivity; and
- greater recognition of the economic importance of Stanthorpe to Queensland and promoting confidence in the local community.

SDRC commissioned T. Sargent Services (2013) to assess the economic impacts of the Project. Economic benefits from the construction and ongoing operations phases of the Project have been analysed.

The economic benefits from construction of the Project in the SDRC region and in Queensland are presented in Table 3-5.

Table 3-5 Economic benefits from construction of the Project

Impact Summary	Region	Direct	Indirect	Total
Output (\$)	SDRC	\$29.0M	\$17.1M	\$46.1M
	Queensland	\$87.6M	\$51.5M	\$139.1M
Employment (jobs)	SDRC	32	61	93
	Queensland	96	185	281
Wages and Salaries (\$)	SDRC	\$5.6M	\$3.9M	\$9.5M
	Queensland	\$17.0M	\$11.6M	\$28.6M
Value Added (\$)	SDRC	\$10.2M	\$6.7M	\$16.9M
	Queensland	\$30.9M	\$20.1M	\$51M

The benefits from the construction of the Project to the SDRC region are:

- an additional \$46.1 million in output (with direct and indirect outputs of \$29 million and \$17.1 million respectively);
- an additional \$16.9 million in value-added or Gross Regional Product (GRP) with direct and indirect impacts of \$10.2 million and \$6.7 million respectively;
- an additional \$9.5 million in wages and salaries paid with direct and indirect impacts of \$5.6 million and \$3.9 million respectively; and
- An additional 93 full time equivalent (FTE) jobs with direct and indirect employment of 32 and 61 FTE's respectively.

The benefits from the construction of the Project to Queensland are:

- an additional \$139.1 million in output (with direct and indirect outputs of \$87.6 million and \$51.5 million respectively);
- an additional \$51 million in value-added or Gross Regional Product (GRP) with direct and indirect impacts of \$30.9 million and \$20.1 million respectively;
- an additional \$28.6 million in wages and salaries paid with direct and indirect impacts of \$17 million and \$11.6 million respectively; and
- An additional 281 FTE jobs with direct and indirect employment of 96 and 185 FTE's respectively.

The recurrent economic impacts from the operation of the Project within the SDRC region are presented in Table 3-6. Granite Belt growers generally make decisions based on the amount of water they hold in storage. The economic benefits from the operation of the Project are primarily associated with the increased opportunity realised by the additional 'water security'. There will be considerable production and consumption flow-on effects associated with this.

Table 3-6 Recurrent economic impacts from operation of the Project to SDRC region

Impact Summary	Direct	Indirect	Total
Output (\$)	\$37.1M	\$6.1M	\$43.2M
Employment (jobs)	157	23	180
Wages and Salaries (\$)	\$13M	\$1.3M	\$14.3M
Value Added (\$)	\$16.3M	\$2.7M	\$19M

It is expected almost all of the economic impacts of the operations of the Project will be retained within the SDRC region. The ongoing benefits from the operation of the Project include:

- an additional \$43.2 million in growers output (with direct and indirect outputs of \$37.1 million and \$6.1 million respectively);
- an additional \$19 million in value-added or Gross Regional Product (GRP) with direct and indirect impacts of \$16.3 million and \$2.7 million respectively;
- an additional \$14.3 million in wages and salaries paid with direct and indirect impacts of \$13 million and \$1.3 million respectively; and
- An additional 180 FTE jobs with direct and indirect employment of 157 and 23 FTE's respectively.

3.6. Project Alternatives

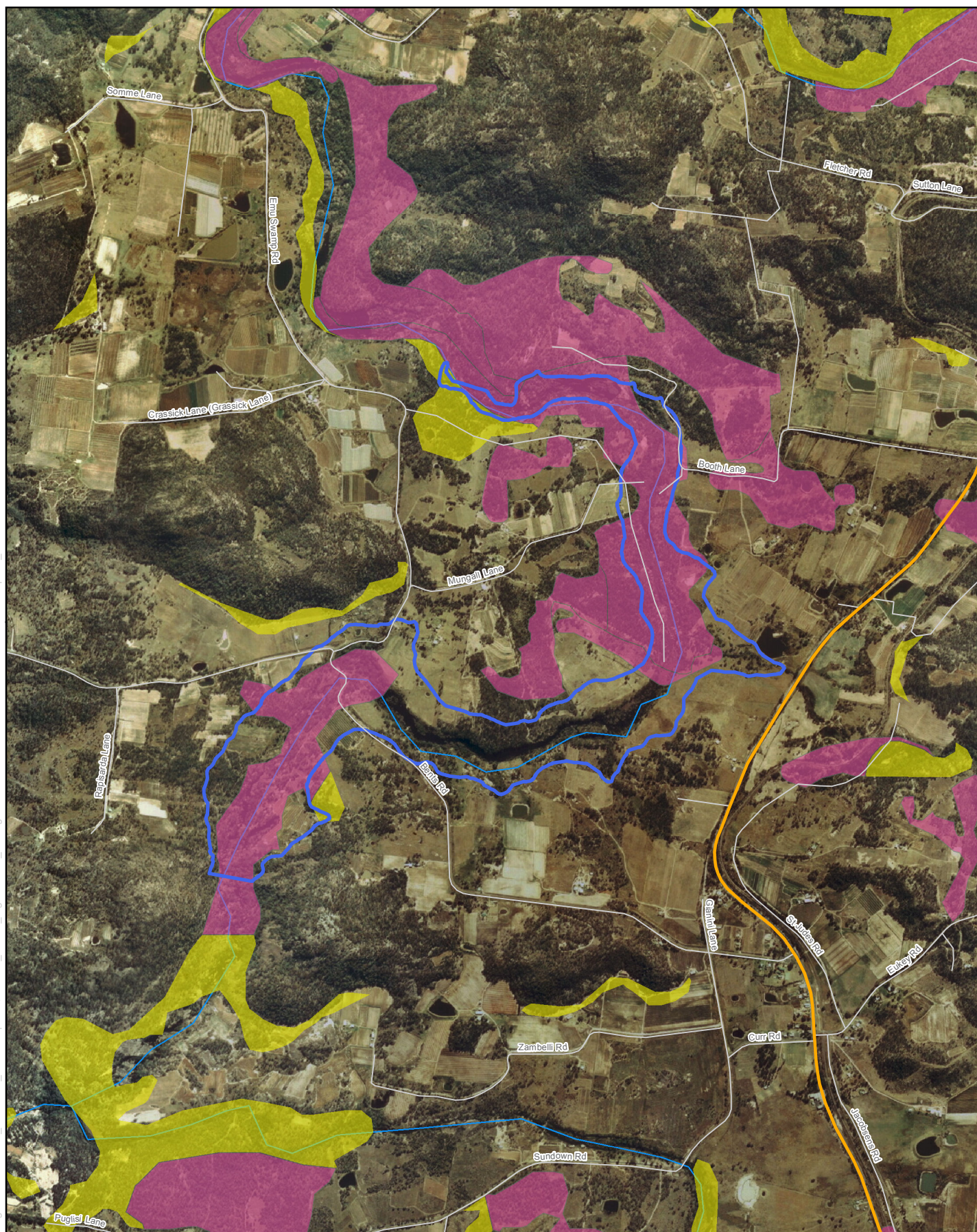
A number of submissions requested additional information on the potential alternatives to Emu Swamp Dam. Further detail on potential environmental impacts was requested for the potential alternatives.

SDRC (and previously Stanthorpe Shire Council) undertook a large number of studies as part of development of water supply strategy for the region since 1980. SDRC have resolved to progress with the Combined Urban and Irrigation Dam.

As described in Section 2.1 there has been a range of investigations over the last 33 years to identify suitable options for improving reliability of water supply for the town of Stanthorpe and rural industries in the Granite Belt area.

Only two dam options were identified that had capacity to supply the required urban and irrigation water:

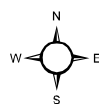
- the proposed Emu Swamp Dam option; and
- the Fletcher/Ballandean Dam option (refer to Figure 3-10).



LEGEND

- Road
- Highway
- Full Supply Level (700.6 AHD)
- Box-Gum Grassy Woodlands**
 - EPBC community confirmed
 - EPBC community presence not confirmed

EMU SWAMP DAM - ASSESSMENT OF MNES



0 0.2 0.4 0.6 0.8

Kilometres

Scale - 1:25,000

Projection: GDA94 MGA56

Figure 3-10

**Ecological Communities in the
Fletcher/Ballandean Dam Area Option**

A comparison of the two dam options is presented in Table 3-7.

- The Fletcher/Ballandean option has potential for greater impact on the critically endangered EPBC ecological community Box Gum Grassy Woodlands.
- The Fletcher/Ballandean option would inundate a section of the New England Highway requiring the road to be either relocated or raised onto an embankment above the flood level.
- The Fletcher/Ballandean option is located further away from Stanthorpe requiring a longer pipeline with a potential for increased impacts on vegetation communities along the pipeline route. There would also be higher electricity consumption and costs during operation due to the greater pumping distances.
- The Fletcher/Ballandean option would have higher capital cost as a result of inundating the New England Highway.

Table 3-7 Comparison of Emu Swamp Dam and Fletcher/Ballandean Dam

	Emu Swamp Dam	Fletcher/Ballandean Dam
Description	The Emu Swamp dam site is located on the Severn River west of the township of Severnlea.	This dam site is located on the Severn River approximately 2 km south of the Emu Swamp dam site.
Concept Design	A gravity concrete dam using Roller Compacted Concrete This pipeline will be about 21 km in length and the alignment will generally follow the New England Highway.	A gravity concrete dam using Roller Compacted Concrete This pipeline will be about 25 km in length and the alignment will generally follow the New England Highway.
Inundated Area	196 ha	163 ha (includes a section of the New England Highway)
Direct impacts to vegetation communities in inundation areas	Box Gum Grassy Woodland (CE) – 72 ha Regional Ecosystems	Box Gum Grassy Woodland (CE) – 89 ha Regional Ecosystems

3.7. Environmental Management

This section provides a broad overview of the impacts of the Project and describes the environmental management commitments that have been incorporated into the Project

3.7.1. *Overview of Impacts*

The key environmental impacts associated with the Project are:

- clearing of the inundation area;
- clearing associated with construction of the urban and irrigation pipeline;
- alteration to ecological connectivity;
- change in downstream flows that may alter riparian vegetation and stream dependent fauna;
- reduced opportunity for fish movement; and
- changes in water quality in the Severn River from construction and operation.

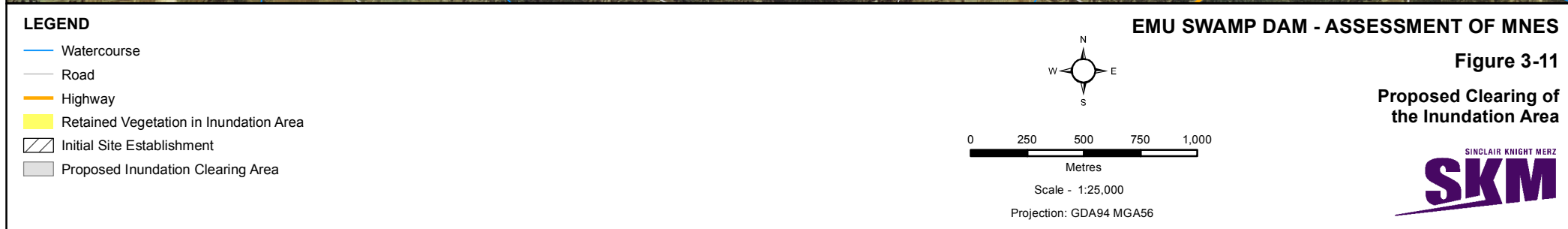
The potential impacts associated with the Project are described in more detail in Section 6.

3.7.2. *Clearing of the Inundation Area*

The clearing approach adopted for the project includes:

- locating dam construction activities within the inundation area;
- clearing the inundation area up to 2 m (vertical) below the FSL (to improve erosion control and encourage establishment of fringing riparian vegetation);
- staged clearing to allow safe dispersal of fauna;
- sequential clearing in a direction away from threatening processes or hostile environments, and towards any retained vegetation or habitat links;
- fauna spotter / catcher attendance at clearing activities; and
- retention of habitat features including mature trees, hollow-bearing trees, thick understorey, hollow logs and rocky outcrops where possible.

The proposed staged approach for the clearing of vegetation in the inundation area is presented in Figure 3-11. The first phase of clearing will be for initial site establishment at the dam construction site. The remainder of the inundation area up to 2 m (vertical) below the FSL will be cleared when the dam construction is well advanced.



3.7.3. *Construction of Linear Infrastructure*

SDRC are committed to minimising environmental impacts associated with the construction of the urban and irrigation pipelines. SDRC propose to undertake the following steps during detailed design and construction to achieve this:

- review of vegetation mapping;
- field survey mapping of vegetation communities and threatened flora;
- determine appropriate design and construction solution to minimise impacts;
- closely supervise construction;
- rehabilitation; and
- maintenance.

The maximum size of the working corridors for the construction of the pipeline are:

- 12.5 m for the urban pipeline along the New England Highway, with a clearing width of 12.5 m;
- 7.5 m for the irrigation pipeline along the New England Highway, with a clearing width of 7.5 m; and
- 5 m for the urban and irrigation pipelines along local roads, with a clearing width of 5 m.

The working corridors have been adopted considering both the constrained working environment within the road corridor and environmental constraints identified during the EIS surveys. APIA (2013) report the normal working width for major pipeline projects in Australia is approximately 20 to 40 m. The proposed working corridors for the Project represent a significant commitment by the Proponent to avoid potential impacts during construction of the Project

The potential disturbance footprint will be reduced further in areas of ecological value through alternative construction methodologies:

- narrow trenching;
- trenchless construction under vegetation communities and creek crossings;
- modifying the alignment to avoid vegetation communities and threatened flora;
- above ground construction around or between threatened flora species; and
- construction in SDRC road formations to avoid vegetation communities and threatened flora.

The alignment of the proposed Stalling Lane access will be modified as necessary to avoid areas of ecological value. The detailed design and construction process will include:

- review of vegetation mapping;
- surveys (engineering, property and ecological constraints);
- determine appropriate design and construction solution to minimise potential impacts;
- closely supervise construction;
- rehabilitation; and
- maintenance.

The implementation of this approach to the construction of linear infrastructure has been successfully demonstrated to minimise environmental impacts and avoid impacts to threatened flora and vegetation communities (J. Richard (pers) 2014)

3.7.4. Buffer Area

A buffer area is proposed surrounding Emu Swamp Dam to protect the water quality within the dam and maintain local ecological connectivity. The width of the buffer area is approximately 200 m with a total area of 322 ha.

SDRC propose to manage the buffer area for conservation purposes and in the long term it will provide habitat and fauna movement corridors. It is recognised that an active management regime will be required to achieve the proposed environmental outcomes. A Buffer Area Management Plan will be developed to outlining the environmental approaches that will be undertaken in the buffer area including:

- fencing of the buffer area to exclude cattle and other animals;
- removal of crops from within the buffer area;
- development of a specific Weed Management Plan (WMP) for the buffer area
- pest management within the buffer area;
- propagation of threatened flora located in the inundation area;
- ripping areas of compacted soil to facilitate establishment of planted species and regeneration;
- planting of habitat vegetation in cleared areas; and
- development of an appropriate fire management regime;
- placement of suitable habitat features such as large rocks and logs for wildlife including reptiles and mammals.

Within the buffer area there is currently 200 ha of native vegetation and 121 ha of cleared/non-remnant areas. Almost half of the native vegetation (98 ha) is considered endangered under the VM Act. The vegetation communities within the buffer area are presented in Table 3-8.

Table 3-8 Vegetation communities in the buffer area

Vegetation Community	RE	Status	Area (ha)
<i>Eucalyptus blakelyi</i> woodland on alluvial plains	13.3.1	Endangered	9.6
Riparian shrubland on anastomosing stream channels +/- emergent trees such as <i>E. blakelyi</i> , <i>E. bridgesiana</i> or <i>A. floribunda</i>	13.3.1x1	Endangered	3.3
<i>Eucalyptus melliodora</i> and/or <i>E. moluccana</i> / <i>E. microcarpa</i> and/or <i>E. conica</i> woodland on igneous rocks	13.12.8	Endangered	55
<i>Eucalyptus blakelyi</i> and/or <i>E. caliginosa</i> woodland to open forest on igneous rocks	13.12.9	Endangered	30
Shrubland on igneous rocks	13.12.6	Of Concern	12.6
<i>Eucalyptus andrewsii</i> , <i>E. youmanii</i> woodland on igneous rocks	13.12.2	Least concern	58
<i>Eucalyptus youmanii</i> on igneous rocks	13.12.5	Least concern	32
High Value Regrowth			0.7
Cleared/non-remnant	-		121
TOTAL			322.2

With effective management of the buffer area, the cleared/non-remnant areas (121 ha) vegetation will regrow to increase the area of vegetation and habitat in the buffer area. The eventual mix of vegetation communities is likely to reflect the communities that are currently present in the buffer area.

Land within the buffer area would be acquired by the SDRC for the Project. It is intended that regeneration of the buffer area would be secured using an appropriate legally binding mechanism.

3.7.5. Environmental Release Strategy

The *Water Resources (Border Rivers) Plan 2003* (Border Rivers WRP) was legislated to provide a sustainable framework for water allocation and water management.

The Border Rivers WRP specifies a range of Environmental Flow Objectives (EFOs) and Water Allocation Security Objectives (WASOs). These EFOs and WASOs are determined using the DNRW Integrated Quantity and Quality Model (IQQM).

Node J on the Severn River at Farnbro (AMTD 198.6 km) is the nominated node for the assessment of the EFOs performance for flows from the Granite Belt catchment. EFOs are defined by a number of performance indicators which are described in Table 3-9.

Table 3-9 Environmental Flow Objectives Performance Indicators – Definitions

Performance Indicators	Definition
Low Flow (days)	The total number of days in the simulation period in which the daily flow is not more than half the predevelopment median daily flow.
Summer Flow (days)	The average number of summer flow days in the simulation period. (summer flow days - days in summer in which the daily flow is more than the predevelopment median daily flow)
Beneficial Flooding Flow (ML)	The median of the wet season 90-day flows for the years in the simulation period. (Wet season 90-day flows – for a year means the total flow in a continuous 90-day period with the highest daily flows)
1 in 2 Year Flood (ML)	The daily flow that has a 50% probability of being reached at least once a year.

An environmental release strategy has been developed with the aim of maintaining the low flow regime for the Severn River, downstream of the proposed Emu Swamp Dam. The environmental release will pass flows through the dam of up to 30 ML/d when a flow is received into the dam. For example, if a flow of 8 ML/day is received into the proposed Emu Swamp Dam, 8 ML/d will be released from the dam to continue on downstream. When flows in excess of 30 ML/d are received by the dam, 30 ML/d will be released to continue on downstream.

Table 3-10 presents a percentage points change from existing entitlements to the Project relative to the predevelopment scenario. This method of assessment is presented as it is consistent with the DNRW assessment methodology.

Table 3-10 EFO Performance Indicators – Node J (Farnbro AMTD 198.6 km)

Performance Indicators	% of Predevelopment		% points of Predevelopment Flow Change from Existing Entitlements
	Existing Entitlements	Emu Swamp Dam	
Low Flow (days)	136	136	0
Summer Flow (days)	66	66	0
Beneficial Flooding Flow (ML)	65	53	-12
1 in 2 Year Flood (ML)	58	45	-13

The proposed environmental release strategy will meet the EFO requirements under the Border Rivers WRP.

3.7.6. Fish Transfer

The concept design for the proposed Emu Swamp Dam has been amended to include a lock-style fishway to provide fish movement both up- and downstream. The detailed design of the fishway will reflect the ecology and swimming ability of the river's fish community. The fishway will be designed to operate over the full range of river flow conditions, where practical, up to drown-out of the dam. The concept design for the proposed fishway has been developed in consultation with biologists experienced in fishway design and monitoring.

The key aspects of a fish-lock that have been considered include:

- attraction flows;
- holding chamber and lock chamber dimensions;
- fish-lock upstream exit points in the dam wall;
- spillway design and plunge pool location; and
- sufficient operating cycles to meet upstream migration patterns.

Attraction flows will be achieved by:

- a cut-in and notch in the dam wall crest to provide more vigorous flows than background flows, attracting fish towards the fishway; and / or
- a bypass / outlet pipe that releases water adjacent to the fishway structure.

Once attraction towards the entrance of the fishway is achieved, a controlled, continuous secondary attraction flow will be released through the lock and holding chambers. A velocity of approximately 0.8 m/s will be achieved through the lock and holding chambers to promote fish aggregation in the base of the lock. Holding and lock chamber dimensions will be in the order of 2–3 m in width and 3–5 m in length, consistent with similar successfully operated structures elsewhere in southern and central Queensland. The holding chamber will then be sealed and filled with water to reach a level appropriate to the dam water level.

Fish will exit the fishway via two upstream exit channels, which will range from 0.5–1.0 m wide and up to 2 m in height, to cover the range of water levels the dam will likely contain. Modelling has shown there to be a range of up to 12 m in proposed dam water levels. Exit channels will be placed at full capacity (736–738 m AHD) and at approximately (734–736 m AHD). Based on the predicted dam storage behaviour in IQQM the proposed upstream fish channels will allow for upstream fish passage for approximately 90% of days in the modelling period. Flow velocities of approximately 0.6 m/s will be achieved through the exit channels. Anti-predation screening may be included in the design to deter predatory fish species from aggregating at the exit channels in the dam wall.

Typically, smaller fish species are weaker swimmers than larger fish and are less able to negotiate faster flow velocities through a fishway. The hydraulic conditions within the fishway will provide an appropriate water depth for large fish whilst ensuring the velocities are suitable for smaller fish, without compromising the velocity required for fish attraction. Intermittent or fluctuating attraction flows for the upstream passage of fish have previously been identified as inadequate for fish attraction. The success of the fishlock will depend on careful consideration of attraction flows and release water during detailed design to ensure:

- water released from the dam does not provide a competing attraction source; and
- water released from the dam does not influence the attraction flow.

Safe downstream passage over the spillway will be provided through a cut-in, in the dam crest, up to 100 mm deep and up to 10 m wide. The cut-in may include a vertical slot, approximately 0.3–0.5 m wide and 0.2–0.4 m deep. The spillway below the cut-in and slot will be smoothed and will terminate in a plunge pool to minimise injury and mortality to fish passing over the spillway during increased flows. The dimensions of the plunge pool would ideally be as wide as the cut-in and extend approximately 3–4 m out from the toe of the dam wall.

The fishway will operate on a variable cycle with the potential to increase the number of cycles required during periods when upstream fish migration is more common, i.e. induced by seasonal rainfall events and associated flows.

The basis for the concept design is consistent with existing successful operational fishways in Queensland. Adherence to these design features and requirements will provide best-practice opportunity for fish passage, both upstream and downstream of the proposed dam wall.

Characteristics of the proposed fishway for Emu Swamp Dam are presented in Table 3-11.

Table 3-11 Characteristics of the proposed fishway for Emu Swamp Dam

Feature	Details
Fishway Type	Fishlock
Headwater operating range	Upper exit: 736–738 m AHD Lower exit: 734–736 m AHD
Minimum Tailwater operating level	721 m AHD
Holding chamber entrance velocity	0.8 m/s
Exit channel velocity	0.6 m/s

3.7.7. *Turtle friendly design*

The concept design for the proposed Emu Swamp Dam will be amended to include design features to enable the passage of each species of turtle likely to be found in the area, including Bell's Turtle. It is anticipated the design is likely to be a bypass system (Berghuis A. (pers) 6/3/2014). The design features will be produced in collaboration with DEHP and DEEDI, and will take into consideration the behaviour of each species. SDRC will undertake a turtle monitoring program for a two year period after construction to assess the effectiveness of turtle passage at the dam.

4. OVERVIEW OF ECOLOGY SURVEYS

4.1. Summary of studies

A range of terrestrial and aquatic flora and fauna studies were completed across the Project area (including pipelines) between 2006 and 2014 to assess terrestrial and aquatic ecological values. These are summarised in Table 4-1.

Table 4-1 Overview of field surveys completed

Survey	Company	Year	Scope of study
Terrestrial flora	3D Environmental	2007	Terrestrial flora survey and vegetation mapping within inundation area and on pipelines in accordance with the ToR for the project.
	SKM	2013/2014	Verification of the extent and condition of Box Gum Grassy Woodland within the Project area and wider locality. Targeted survey for <i>Callistemon pungens</i> within the Project area and wider locality so as to inform impact assessment and development of mitigation and offsets.
Terrestrial fauna	BAAM	2007	Terrestrial fauna survey within inundation area and on pipelines in accordance with the ToR for the project.
Aquatic ecology	Ecology Management	2007	Aquatic flora and fauna surveys on the Severn River in accordance with the ToR for the project.
	frc environmental	2013	Aquatic flora and fauna survey along the Severn River in non-drought conditions to inform impact assessment and clarify the presence/absence of threatened species. Targeted survey for Bell's Turtle on the Severn River and wider locality to inform impact assessment and development of mitigation and offsets.

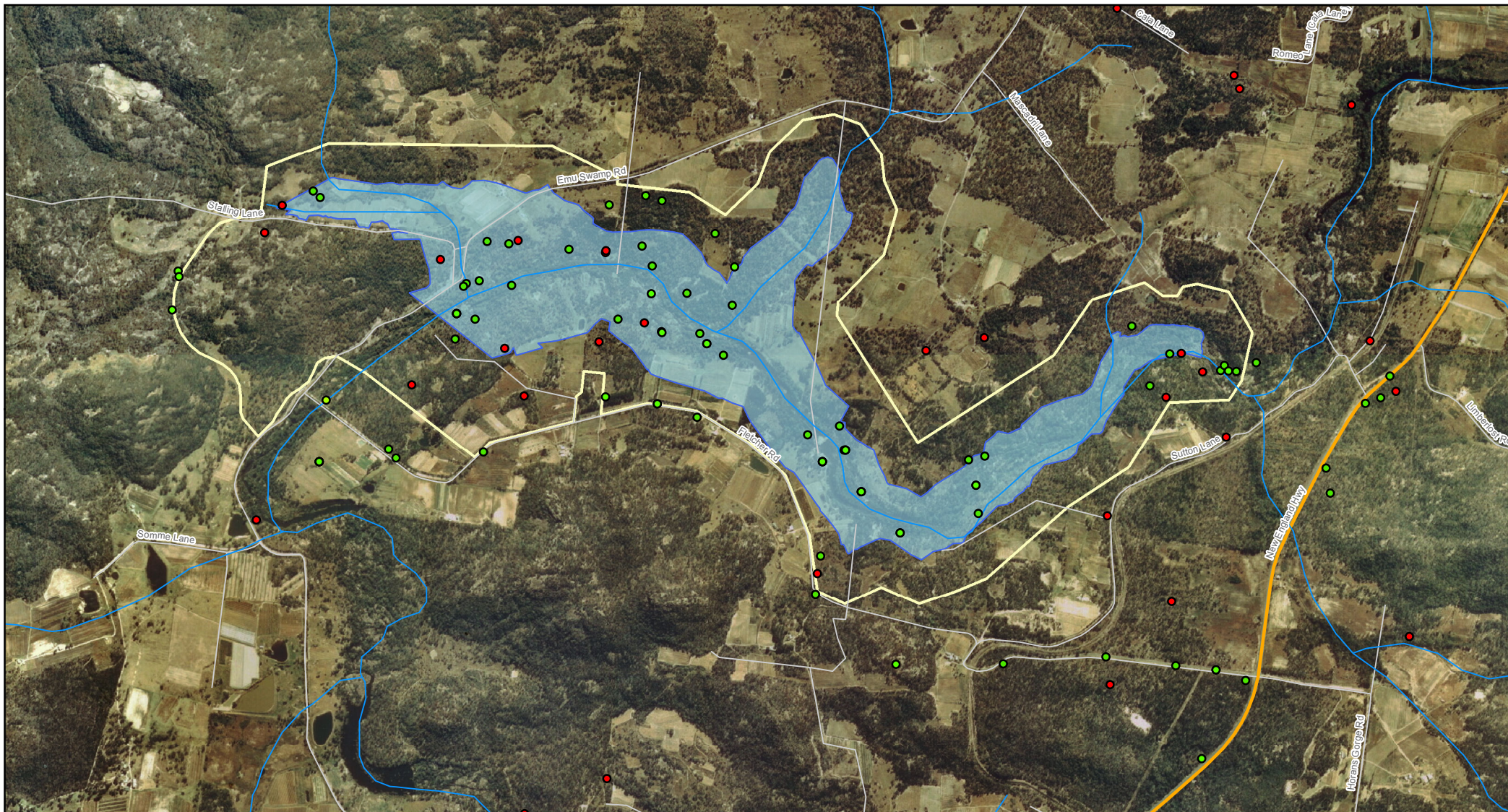
4.2. Survey effort and timing

4.2.1. Terrestrial flora

The total flora survey effort for the project is summarised in Table 4-2. Surveys have been completed during all seasons other than autumn and have allowed for the detection of the majority of species and groups of flora which are expected to occur in the Project area. A total of 426 flora survey sites have been sampled for the project. The locations of terrestrial flora sites are presented in Figure 4-1 and Figure 4-2. Further details of terrestrial flora survey effort are provided in Appendix C.1.

Table 4-2 Summary of Terrestrial Flora Survey Effort

Company	Year	Survey effort	Timing
3D Environmental	2007	48 survey sites within inundation area. 10 sites on Stalling Lane Access. 210 sites on pipelines.	Summer 2006 and Winter 2007.
SKM	2013	30 sites targeted for <i>Callistemon pungens</i>. 100 sites surveyed to allow mapping of Box-Gum Grassy Woodland. 28 BioCondition sites	Winter and Spring 2013.
Total Survey Effort		426 flora survey sites sampled for project.	Surveys completed in summer, winter and spring.



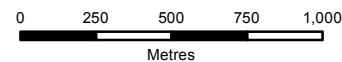
LEGEND

- Flora Survey Locations (SKM, 2014)
- Flora Survey Locations (3D Environmental, 2007)
- Watercourse
- Road
- Highway
- Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure 4-1

Flora Survey Sites within the
Inundation Area and Surrounds



Scale - 1:25,000

Projection: GDA94 MGA56



4.2.2. Terrestrial fauna

The total fauna survey effort for the project is summarised in Table 4-3. Surveys have been completed during all seasons other than spring and have allowed for the detection of the majority of species and groups of fauna which are expected to occur in the Project area. A total of 22 terrestrial fauna survey sites have been sampled for the project. The locations of terrestrial flora sites are presented in Figure 4-3. Further details of terrestrial fauna survey effort are provided in Appendix C.2.

Table 4-3 Summary of Terrestrial Fauna Survey Effort

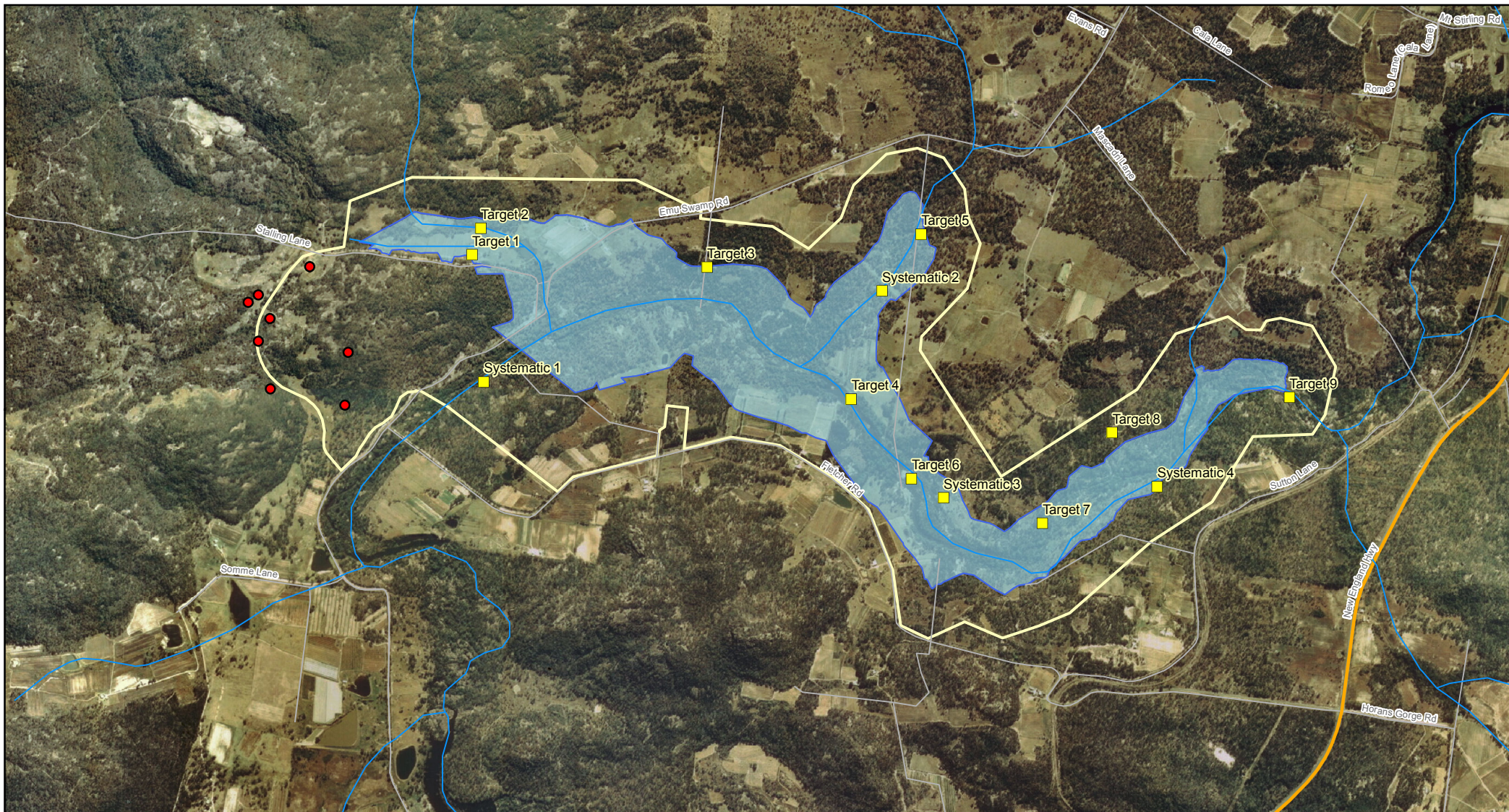
Company	Year	Survey effort	Timing
BAAM	2007	13 fauna survey sites established within inundation area and immediate surrounds. 8 sites surveyed specifically for Spotted-tailed Quoll. - Both irrigation and urban pipelines were walked or driven in their entirety with incidental observations of fauna recorded.	Summer, autumn and winter
Total Survey Effort		22 terrestrial fauna survey sites sampled for project and the pipelines were either walked or driven in their entirety with specific focus on threatened species.	Surveys completed in summer, autumn and winter

4.2.3. Aquatic flora and fauna

The total aquatic flora and fauna survey effort for the project is summarised in Table 4-4. Surveys have been completed during autumn and spring and have allowed for the detection of the majority of species which could be expected to occur in the Project area. A total of 45 aquatic flora and fauna survey sites have been sampled for the Project. The location of aquatic flora and fauna survey sites are presented in Figure 4-4. Further details of aquatic survey effort are provided in Appendix C.3.

Table 4-4 Summary of Aquatic Flora and Fauna Survey Effort

Company	Year	Survey effort	Timing
Ecology Management	2007	10 survey sites sampled for aquatic flora and fauna in Spring 2006. 10 survey sites sampled for aquatic flora and fauna in autumn 2007.	Spring and autumn.
FRC	2013	11 survey sites sampled in autumn 2013. 14 survey sites sampled for aquatic flora and fauna in spring 2013.	Autumn and spring.
Total Survey Effort		45 aquatic survey sites sampled for project.	Surveys autumn and spring.



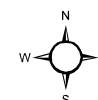
LEGEND

- Fauna Survey Sites (BAAM, 2007)
- Trap Sites
- Watercourse
- Road
- Highway
- Buffer Area
- Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure 4-3

Fauna Survey Sites within the
Inundation Area and Surrounds

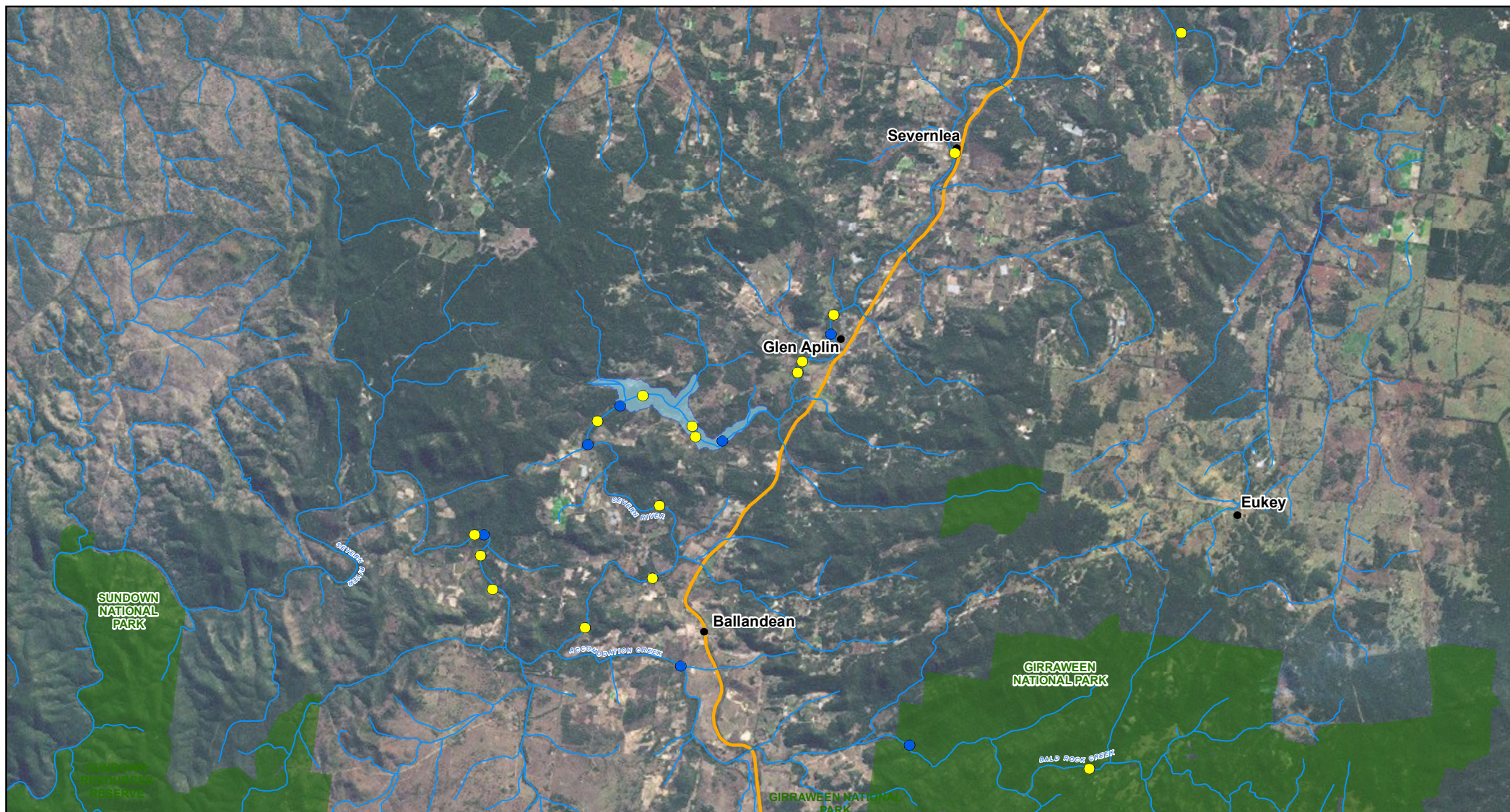


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Metres

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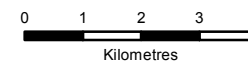
Projection: GDA94 MGA56

SINCLAIR KNIGHT MERZ
SKM



LEGEND

- Towns
- Aquatic Survey Sites (FRC Environmental, 2013)
- Aquatic Survey Sites (Ecology Management, 2007)
- Watercourse
- Highway
- National Parks
- Full Supply Level (738m AHD)



Scale - 1:130,000

Projection: GDA94 MGA56

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure 4-4

Aquatic Flora and Fauna Survey Sites



4.3. Adequacy of survey effort

A gap analysis has been carried out which assessed the ecological survey effort to date against the requirements of relevant SEWPaC survey guidelines. Survey guidelines provide advice on survey techniques for species threatened species and give guidance on SEWPaC's expectations with regard to surveys. Survey guidelines are available for threatened fish, bat, birds, frogs, mammals and reptiles. The results of the gap analysis are presented in Table 4-5. The gap analysis has been undertaken for threatened fauna known or likely to occur in the study area, and is based on information published at the time of the review (October 2013), including information presented in the EIS, and survey guidelines and species profiles published on the SEWPaC website.

Table 4-5 Gap analysis of threatened fauna species survey effort

Species	Common Name	Survey effort to date	SEWPaC survey guideline requirements	Gaps
Uvidicolus Sphyrurus	Granite Belt Thick-tailed Gecko	Trap/release program at four sites conducted over five days and four nights in December 2006 (Summer) and passive recording conducted in both December 2006 (Summer) and May/June 2007 (Winter) To target reptiles this included: Pitfall traps - At four trapping sites, four pitfall traps (20 or 10 litre containers, depending on substrate) were buried flush to the ground surface and connected by a 20 m drift fence. Diurnal searches – At four trapping sites active diurnal searches were undertaken involving investigation of ground layer, low vegetation, rock crevices and animal signs in the early morning and warmer parts of the day totalling 1 hr/site/day. Nocturnal surveys - Spotlights and head torches were used to search for reptiles at night. Targeted searches were undertaken for Granite Belt Thick-tailed Gecko in potential habitat areas (target sites).	Recommend conducting surveys in six steps: 1: Identify taxa that may occur in the study area 2: Determine optimal timing for surveys of 'target' taxa 3: Determine optimal location of surveys 4: Establish sampling design and survey effort - spatial and temporal sampling replication required 5: Select appropriate personnel to conduct surveys 6: Document survey methods and results Specific survey methods for Granite Belt Thick-tailed Gecko include: ▪ Day searches of rock outcrops (sheltering sites) using torches (no rock-turning searches to avoid disturbing sheltering sites). ▪ Nocturnal spotlighting of rocky habitat and adjacent woodland for active animals in the first three hours of darkness. ▪ Survey work undertaken in the warmer months of the year (November to February).	None – Reptile surveys were conducted as per the recommendations in the Survey Guidelines for Australia's Threatened Reptiles (SEWPaC 2011).

Species	Common Name	Survey effort to date	SEWPaC survey guideline requirements	Gaps
<i>Dasyurus maculatus maculatus</i>	Spotted-tail Quoll	Trap/release program (cage traps) at four sites and passive recording conducted over five days and four nights in December 2006. Traps were located in likely habitat area near Stalling Lane Access (approximate 5 ha area). To target mammals: Cage Traps - Two cage traps were deployed at four trapping sites over four nights in December 2006 (Summer). One cage traps was deployed at eight trapping sites over three nights in May/June 2007 (Winter). Traps were placed on the ground and baited with chicken and sardines. Diurnal searches – At each trapping site active diurnal searches were undertaken involving investigation for animal signs (e.g. scats, owl pellets, orts (bird feeding remnants), remains and tracks). Nocturnal surveys - Spotlights and head torches were used to search for mammals at night.	As above, recommend conducting surveys in six steps. Specific survey methods for Spotted-tail Quoll include: Sampling units of 100 hectares or more. - daytime searches for potentially suitable habitat resources - daytime searches for signs of activity, scats and latrines - hair sampling device (hair funnels) surveys, placed 100 metres apart and using a mixture of sardines, tuna oil and flour for bait. Hair funnels should be set for a minimum of 14 consecutive nights. Forty widely spaced hair-tubes within a 100 hectare sampling unit has approximately 96% likelihood of detection on occupied sites - remote cameras left on site for a minimum of three weeks Cage trapping surveys are not considered necessary at the first stage of detection, provided hair funnel surveys or remote cameras are employed. Should cage trapping surveys be required, the optimal survey time is during the breeding season, with peak activity occurring between May and August. Surveys conducted during April to August may detect males in areas where they may not usually occur, either as they move in search of females to mate with or move away from other more competitive males.	Cage trapping was undertaken in May/June. Eight trap sites were deployed within approximately 5 ha area. The number of trap nights (8 traps over three nights) was less than the recommended survey effort (10 traps per sampling site over four nights; 2 sampling sites per habitat type). No hair sampling or remote camera surveys undertaken as recommended in the Survey Guidelines for Australia's Threatened Mammals (SEWPaC, 2012). The survey was less than the recommended effort to detect this species, and as such it has been assumed for the purposes of impact assessment that potential foraging habitat exists throughout the FSL in 135 ha remnant vegetation.

Species	Common Name	Survey effort to date	SEWPaC survey guideline requirements	Gaps
<i>Chalin olobus dwyeri</i>	Large-eared Pied Bat	Trap/release program (harp traps) at four sites conducted over five days and four nights in December 2006 (Summer) and passive recording (Anabat) conducted in both December 2006 (Summer) and May/June 2007 (Winter). To target microbats an ANABAT II ultrasonic bat call detection unit and associated ZCAIM interface module were also used to capture the calls of insectivorous bat species throughout the night. Harp traps were used where suitable flight paths were identified.	As above, recommend conducting surveys in six steps. Specific survey methods include: ▪ Harp traps ▪ Mist nets ▪ Echolocation call detection ▪ Roost searches	Bat surveys were conducted as per the recommendations in the Survey Guidelines for Australia's Threatened Bats (DEWHA 2010). No maternity roosting sites occur within the project area or locality. Roost searches were not undertaken.
<i>Wollumbinia belli</i>	Bell's Turtle	A total of 12 sites were surveyed for turtles in the Project area, plus one reference site in May and September 2013. At each site, five custom-made turtle traps were baited with meat and set at each site for between six and ten hours. At each site, turtles were also surveyed for 1 hr/site using a combination of: ▪ muddling ▪ dip netting ▪ snorkelling ▪ evening spotlighting ▪ fyke nets ▪ ad hoc observation.	As above, recommend conducting surveys in six steps. Specific survey methods for turtles include: ▪ Snorkelling ▪ Traps baited with meat (liver) ▪ Traps suspended from branches overhanging the water ▪ Traps checked several times during the first two hours and during the day, for several hours after sunset and early the following morning. ▪ Seining The species is assumed most active in late spring and through summer.	Turtle surveys were conducted as per the recommendations in the Survey Guidelines for Australia's Threatened Reptiles for Bell's turtles (SEWPAC 2011) where possible. The following deviations from the guidelines are noted: ▪ Survey occurred in early spring although Bell's turtles were active in period. ▪ Traps baited with meat (heart) in line with Fielder (2010). ▪ Traps set in the morning for a period of 8 hrs and checked after dusk. ▪ Seining not conducted as water depths >2m

5. OCCURRENCE OF MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

5.1. Introduction

This section describes the potential occurrence of MNES within the Project area. The likelihood of occurrence of each species has been assessed (Section 5.4) based on an assessment of distribution records, a comparison of the species preferred habitat against the type and condition of habitat present within the Project area and the results of multiple field surveys completed over the past seven years..

5.2. Database search results

A search (21 February 2014) of the Protected Matters Search Tool (PMST) indicated that one threatened ecological community, 17 threatened flora species and 19 threatened fauna species protected under the EPBC Act have the potential to occur in the Project area. The list of communities and species generated by the PMST is based largely on modelled distributions and not actual specimen or sighting records and as such should be considered as an indicative list rather than a set of known records. Species and communities listed after the Project was determined as a “controlled action” are not considered in this assessment.

The Queensland Herbarium HERBRECS database search results (4 March 2014) indicate that a total of 13 flora species listed as Vulnerable or Endangered under the EPBC Act have been recorded from the search area.

Wildnet database search results (4 March 2014) indicate that a total of 12 flora species listed as Vulnerable or Endangered under the EPBC Act have been recorded from the search area. Only four fauna species listed as Vulnerable or Endangered under the EPBC Act have positively been recorded from the search area.

Records for threatened species in the Atlas of Living Australia and Australian Virtual Herbarium databases were analysed to determine the likelihood of occurrence (refer to Table 5-3 and Table 5-4) of these species in the Project area.

5.3. Records in Project Area

5.3.1. *Threatened ecological community*

White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) Grassy Woodland and derived Native Grassland (Box-Gum Grassy Woodland) was identified by the PMST (DEH 2006) as occurring in the Project area. This community is listed as Critically Endangered under the EPBC Act.

The presence and extent of this ecological community within the Project area was confirmed by field surveys which considered the condition criteria for inclusion within the listed community (3D Environmental 2007, SKM 2014).

5.3.2. *Threatened flora species*

Desktop searches (Protected Matters, HERBRECS and WildNet) indicated the potential occurrence of 17 EPBC Act listed flora species in the Project area. EPBC Act listed flora species recorded in the locality identified by database searches are presented in Table 5-1. No aquatic plant species listed under the EPBC Act were identified.

Table 5-1 EPBC Act listed flora species identified by database searches

Species name	Common name	EPBC Act Status ¹	Source		
			Protected Matters	HERBRECS	WildNet
<i>Acacia pubifolia</i>	Velvet Wattle	V	✓	✓	✓
<i>Acacia ruppii</i>	Rupp's Wattle	E	✓	✓	✓
<i>Boronia granitica</i>	Granite Boronia	E	✓	✓	✓
<i>Boronia repanda</i>	Repand Boronia	E	✓	✓	✓
<i>Cadellia pentastylis</i>	Ooline	V	✓	x	x
<i>Caladenia atroclavia</i>	Black-clubbed Spider-orchid	E	✓	✓	✓
<i>Callistemon pungens</i>	Prickly bottlebrush	V	✓	✓	✓
<i>Eucalyptus mckieana</i>	McKie's stringybark	V	x	✓	x
<i>Eucalyptus scoparia</i>	Wallangarra White Gum	V	✓	✓	✓
<i>Grevillea scortechinii</i> subsp. <i>scortechinii</i>	Black Grevillea	V	✓	✓	✓
<i>Homoranthus montanus</i>	No common name	V	✓	✓	✓
<i>Kardomia granitica</i>	No common name	V	✓	✓	✓
<i>Lepidium peregrinum</i>	Wandering Pepper-cress	E	✓	x	x
<i>Macrozamia machinii</i>	No common name	V	✓	x	x
<i>Phebalium glandulosum</i> subsp. <i>elgandilosum</i>	Rusty Desert Phebalium	V	✓	✓	✓
<i>Phebalium whitei</i>	No common name	V	✓	✓	✓
<i>Streblus pendulinus</i>	Siah's Blackbone	E	✓	x	x
<i>Tylophora woollsi</i>	No common name	E	✓	x	x

1 EPBC Act status: E = Endangered, V = Vulnerable

Five threatened flora (EPBC listed) species were recorded from field surveys of the Project area;

- *Acacia pubifolia*;
- *Boronia repanda*;
- *Callistemon pungens*;
- *Eucalyptus mckieana*; and
- *Grevillea scortechinii* subsp. *scortechinii*.

5.3.3. Threatened fauna species

The EPBC Online Protected Matters Search Tool indicated the potential occurrence of 19 EPBC Act listed fauna species in the Project area. Database searches (the WildNet database, Birds Australia's bird database, and the Queensland Museum's fauna database) have records for five of these species in the Project area. These are listed in Table 5-2. Preferred habitat and likelihood of occurrence are discussed in Section 5.4.2.

Table 5-2 EPBC Act listed fauna species identified by database searches

Species name	Common name	EPBC Act Status ¹	Source			
			Protected Matters	WildNet	Qld Museum	Birds Australia
<i>Anthochaera phrygia</i>	Regent Honeyeater	E	✓	✓		✓
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	✓	✓		
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	✓			
<i>Dasyurus maculatus maculatus</i>	Spot-tailed Quoll (SE mainland)	E	✓	✓	✓	
<i>Delma torquata</i>	Collared Delma	V	✓			
<i>Erythrotriorchis radiatus</i>	Red Goshawk	V	✓			
<i>Furina dunmali</i>	Dunmall's Snake	V	✓			
<i>Geophaps scripta scripta</i>	Squatter Pigeon (southern)	V				
<i>Lathamus discolor</i>	Swift Parrot	E	✓			
<i>Maccullochella peelii</i>	Murray Cod	V	✓			
<i>Nyctophilus corbeni</i>	Eastern Long-eared Bat	V	✓			
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	V	✓		✓	
<i>Poephila cincta cincta</i>	Black-throated Finch (southern)	E	✓			
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo (SE mainland)	V	✓			
<i>Pseudomys oralis</i>	Hastings River Mouse					
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	✓			
<i>Rostratula australis</i>	Australian Painted Snipe	E	✓			
<i>Uvidicolus sphyurus</i>	Granite Belt Thick-tailed Gecko	V	✓	✓		
<i>Wollumbinia belli</i>	Bell's Turtle	V	✓		✓	

Five EPBC Act listed terrestrial fauna species were recorded from field surveys within the Project area:

- Spotted-Tail Quoll (*Dasyurus maculatus maculatus*),
- Large-eared Pied Bat (*Chalinolobus dwyeri*),
- Murray Cod (*Maccullochella peelii*);
- Granite Belt Thick-tailed Gecko (*Uvidicolus sphyurus*); and
- Bell's Turtle (*Wollumbinia belli*).

5.4. Likelihood of occurrence

The likelihood of occurrence of each species has been assessed based on an analysis of local and regional records of the species, an assessment of the species preferred habitat against the type and condition of habitat present within the Project area and knowledge gained during site surveys. Only species found to be present or assessed as likely to occur are considered further in this report.

5.4.1. Threatened flora species

Following on from field surveys, an informed assessment of the likelihood of occurrence of threatened flora species is possible, primarily based on consideration of the presence or absence of key habitat features or habitat types. The likelihood of occurrence of EPBC Act listed threatened flora species identified in the Project area is assessed in Table 5-3.

Table 5-3 Likelihood of occurrence of EPBC Act listed flora species

Scientific name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
<i>Acacia pubifolia</i>	Velvet Wattle	V	Potential habitat in <i>E. andrewsii</i> and <i>E. youmanii</i> woodland (RE 13.12.2 & 13.12.5). Known from Ballandean, Wybera, Wallangarra and Fletcher districts. Known from remnant vegetation near Stalling Lane and roadside vegetation along Fletcher Rd.	Present – recorded during field surveys near the Stalling Lane access.
<i>Acacia ruppii</i>	Rupp's Wattle	E	Potential habitat <i>E. andrewsii</i> , <i>E. youmanii</i> woodland and <i>E. blakelyi</i> and/or <i>E. caliginosa</i> woodland to open forest (RE 13.12.2 & 13.12.9). HERBRECS search results and the Australian Virtual Herbarium indicate this species is restricted to Girraween National Park, adjacent areas in northern NSW and the NSW North Coast.	Unlikely – the species was not recorded during field surveys and database records (HERBRECS and the Australian Virtual Herbarium) indicate the species does not occur within or near Project impact areas.
<i>Boronia granitica</i>	Granite Boronia	E	The species is found on granite soils and scree slopes, amongst rock outcrops and in rock crevices. It is found in eucalypt woodlands and heathlands. It is known from sites around Stanthorpe including Girraween National Park and Amiens.	Unlikely - no database records and no suitable habitat present in the FSL, Stalling Lane or pipeline alignments.
<i>Boronia repanda</i>	Repand Boronia	E	In Queensland this species is found within 20k of Stanthorpe. It is endemic to the Stanthorpe Plateau with known national distribution restricted to scattered populations around Cottonvale, Thulimbah, Amiens and Passchendaele and a recently located record to the east of Stanthorpe on the border with New South Wales (Donatui 2006). It is found in <i>E. andrewsii</i> , <i>E. youmanii</i> shrubby woodland and open forest and shrubland/heath communities (RE 13.12.2-13.12.6) (Donatui 2006). The species prefers sites that are protected from frequent fire and has good drainage,	Likely – the species has previously been recorded adjacent to the irrigation pipeline alignment on Pozieres Road.

Scientific name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
			often restricted to rocky sites around granite outcrops and scree slopes (DotE 2014).	
<i>Cadellia pentastylis</i>	Ooline	V	In Qld from RE 13.11.7 vine thicket on metamorphics in Sundown National Park. In NSW west from near Tenterfield and north from Terry Hie Hie from vine thickets and woodlands (Harden 2002).	Unlikely – no suitable habitat present in the FSL, Stalling Lane or pipeline alignments.
<i>Caladenia atroclavia</i>	Black-clubbed Spider-orchid	E	<i>Caladenia atroclavia</i> is known to occur in Girraween National Park and at Wyberba, south of the Project site. It is found in <i>Eucalyptus campanulata</i> open forest on igneous rocks (RE 13.12.1).	Unlikely – no database records for the species are known from the Project site and there is no suitable habitat present in the FSL, Stalling Lane or pipeline alignments.
<i>Callistemon pungens</i>	Prickly Bottlebrush	V	Known in Queensland from Girraween National Park, the Severn River and around the Stanthorpe area. The species is also found in northern NSW (Hunter <i>et al.</i> 1998). Donatiu (2006) refers to habitat being in <i>E. conica</i> , <i>E. microcarpa</i> , <i>E. melliodora</i> woodland on alluvial plains and <i>E. camaldulensis</i> fringing open forest (RE 13.3.4 & 13.3.5) in riparian areas along rocky watercourses or sandy creek beds.	Present – recorded within FSL and adjacent to Stalling Lane access and pipeline alignments.
<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid	V	In Queensland, the species is known from Wide Bay and Moreton districts extending into NSW from Gibraltar Range National Park south into Victoria. A mostly coastal species but can be found in a range of habitats including dry sclerophyll forests, heaths, dunes, riparian (stream-side) areas, swampy forests, swampy areas and wetlands areas. Difficult to detect flowering between December and February yet generally found growing on sandy or stony clay soils, often in sandstone areas.	Unlikely – no database records and no suitable habitat present in the FSL, Stalling Lane or pipeline alignments.
<i>Eucalyptus mckieana</i>	McKie's Stringybark	V	<i>Eucalyptus mckieana</i> is known from a small area of the Northern Tablelands of NSW and the Stanthorpe region forms the northernmost extent of its known distribution. There are very few records of the species around Stanthorpe, it has been recorded at Severnlea and near the corner of Fletcher Road and the New England Highway, just to the east of the dam site. (It has been found in <i>E. andrewsii</i> , <i>E. youmanii</i> woodland on igneous rocks (RE 13.12.2) near the dam site.	Likely – the species was recorded in the vicinity of the Project during field surveys, but not in any impact areas.
<i>Eucalyptus scoparia</i>	Wallangarra White Gum	V	This species is known from mountain tops and upland granite pavements. It occurs in <i>E. scoparia</i> woodland on	Unlikely – no suitable habitat present in the FSL, Stalling Lane or pipeline alignments.

Scientific name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
			igneous rocks (RE 13.12.3) which is wholly confined to Girraween National Park. There is also a single record from Mt Ferguson near Amiens, north of Stanthorpe. The species is often found growing in large granite outcrops, on skeletal soils (DotE 2014).	
<i>Grevillea scortechinii</i> subsp. <i>scortechinii</i>	Black Grevillea	V	The species is endemic to Stanthorpe Plateau, known from several populations between Stanthorpe and Dalveen in vegetation along roadsides with potential habitat found mixed eucalypt woodlands and open forests, as well as shrubland communities (RE's 13.3.1, 13.12.1, 13.12.2, 13.12.6, 13.12.8, 13.12.9). (Donatiu 2006).	Present – recorded during field surveys along Pozieres Road adjacent to the irrigation pipeline alignment.
<i>Homoranthus montanus</i>	Mountain Mouse Bush	V	Records for this species are known from Stalling Lane and Sundown National Park. It is found in <i>E. youmanii</i> , <i>E. dealbata</i> , <i>E. caleyi</i> , <i>Callitris endlicheri</i> woodland on metamorphics, <i>E. youmanii</i> on igneous rocks and shrubland on igneous rocks (RE 13.11.1, 13.12.5, 13.12.6) (Donatiu 2006).	Possible – this species was not identified during field surveys within suitable habitat in the inundation area and Stalling Lane area. However, there are records from the Project area.
<i>Kardomia granitica</i> (formerly <i>Babingtonia granitica</i>)	no common name	V	Known from heath (RE 13.12.6) where it occurs in shallow peaty soils formed in the crevices of granite outcrops dominated by heath (Bean 1997 in Donatiu 2006). Three known populations at Ballandean, Doctors Ck near Lyra, & Girraween National Park (Donatiu 2006), to the south of the Project site.	Possible – this species was not identified during field surveys within suitable habitat.
<i>Lepidium hyssopifolium</i>	Basalt Pepper-cress	E	This species is not known from Queensland. It is recorded from around Armidale and Bathurst in NSW.	Unlikely – Project site is outside known range.
<i>Lepidium peregrinum</i>	Wandering Pepper-cress	E	This species was thought to be extinct until being found in 2001. Its population size is estimated to be very low, at around 192, based on 2001 surveys. It is found from two locations north of Stanthorpe. (DotE 2014o). In NSW it has been recorded in riparian forests on sandy alluvium soils (NSW DEH 2014)	Unlikely – lack of suitable habitat within the Project site.
<i>Macrozamia machinii</i>	no common name	V	The reported extent of this species range is restricted to around ten known populations all occurring within 40 km of Inglewood, in the Darling Downs (Atlas of Living Australia 2014). These populations occur in sandy soils in flat areas of open forest dominated by Smooth-barked Apple (<i>Angophora leiocarpa</i>), Stringybark She-oak (<i>Allocasuarina inophloia</i>), White Cypress Pine (<i>Callitris glaucophylla</i>), and <i>Lysicarpus angustifolius</i> .	Unlikely – Project site is outside known range, no sightings during field surveys.

Scientific name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
<i>Phebalium glandulosum</i> subsp. <i>eglandulosum</i>	Rusty Desert Phebalium	V	Known from three distinct populations extending from Stanthorpe south to Glen Innes (Donatiu 2006). It grows on sandy soils in heath, rocky crevices and scree in granite outcrops (DotE 2014p). Population of 20 individuals known from Passchendaele area, north-west of Stanthorpe (Donatiu 2006).	Unlikely – not recorded in field surveys and no database records in or near Project impacts areas.
<i>Phebalium whitei</i>	no common name	V	This species is found from Lyra to Girraween National Park in the Stanthorpe district (BRI collection records; Wilson 1970) (DEWR 2007). Two small populations known from Girraween National Park over about 10 ha with about 1000 plants in total (BRI Rare and Threatened Plant database 2001 in DEWR 2007). Occurs in Bald Rock Creek and Girraween National Park near Wallangarra (Stanley & Ross 1983). The species prefers granite soils in heathland communities and is found growing amongst granite rocks and boulders near waterways (DotE 2014q).	Unlikely – not recorded in field surveys and no database records in or near Project impacts areas.
<i>Streblus pendulinus</i>	Siah's Backbone	E	The species is found in warmer rainforests, mainly along watercourses, from Cape York to southern coastal NSW. It is found below 800m altitude. There are no records of the species in the vicinity of the Project site.	Unlikely – no suitable habitat present in the FSL, Stalling Lane or pipeline alignments.
<i>Tylophora woollsi</i>	no common name	E	Known from <i>Eucalyptus andrewsii</i> , <i>E. youmanii</i> woodland on igneous rocks (RE 13.12.2). Single HERBRECS record from Girraween National Park, the only known record in Queensland..	Unlikely – not recorded in field surveys and no database records in or near Project impacts areas.

¹ EPBC Act Status: E = Endangered, V = Vulnerable

5.4.2. Threatened fauna species

The likelihood of occurrence of EPBC Act listed threatened fauna species identified in the Project area is assessed in Table 5-4.

Table 5-4 Likelihood of occurrence of EPBC Act listed fauna species

Species name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
<i>Anthochaera phrygia</i>	Regent Honeyeater	E	Although occasionally found in agricultural land with only partial tree cover or in city parks and gardens, the Regent Honeyeater occurs mainly in dry box-ironbark eucalypt woodland and dry sclerophyll forest (Higgins <i>et al.</i> 2001).	Possible – There are two WildNet records for the Project area, though no location details or dates are known. There is also one Birds Australia record from Sundown National Park. The species possibly occurs in the inundation area and immediate surrounds at times, though it is most likely to move through the area due to a lack of favoured food trees. It is unlikely to regularly occur within the pipeline corridors but may occur regularly elsewhere in the general area.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	The Large-eared Pied Bat is rarely captured and consequently poorly known. Little is known of its roosting requirements, although it has been recorded roosting in disused mine tunnels, rock overhangs, caves and abundant Fairy Martin, <i>Petrochelidon ariel</i> , nests (Dwyer 1966; Eyre <i>et al.</i> 1997; Schulz 1998; Thompson 2002). The habitat requirements for the species are poorly understood. Most records from New South Wales are from dry and wet sclerophyll forest including <i>Callitris</i> forests, tall open eucalypt forests with a dry understorey, subalpine woodland, and sandstone outcrop country (Duncan <i>et al.</i> 1999). In south-eastern Queensland the species seems to be more associated with higher altitude moist forests and adjacent rainforest (Eyre <i>et al.</i> 1997).	Present – The Large-eared Pied Bat was recorded by Anabat at a trapping site during the summer survey. It was not listed for the area in either the EPA's WildNet or Queensland Museum's databases.
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	The species is found in three distinct populations, in eastern Australia, one being along the Great Dividing Range and Border Ranges. The species is found in grassy ground cover of eucalypt forests and woodlands, with interspersed mature subtropical rainforest. It is also known from heathland and communities that border cool temperate rainforest (DotE 2014q). There are no records from the Stanthorpe area (ALA 2014)	Unlikely – There are no database records from the Project area and suitable habitat is not present in the vicinity of the Project.

Species name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
<i>Dasyurus maculatus maculatus</i>	Spotted-Tail Quoll	E	They shelter in rock caves and hollow logs or trees, with basking sites usually nearby (Menkhorst & Knight 2001).	Likely – There is a Queensland Museum record from Ballandean and, despite the lack of WildNet records, the species almost certainly occurs in the inundation area and immediate surrounds, at least sporadically. It was reported as occurring by a landholder. It is likely that the woodland/forest areas provide foraging opportunities for Spotted-tailed Quoll though dens are more likely to be located in rocky areas to the west and south of the inundation area. The majority of the pipeline routes are not suitable, this species may traverse the areas at times.
<i>Delma torquata</i>	Collared Delma	V	The Collared Delma occurs in rocky areas associated with dry, open forests and Brigalow associations. This species shelters beneath rocks, logs and leaf litter and possibly in spider and insect holes (Wilson & Swan 2008).	Unlikely – There are no database records within 100 km of the Project site (Atlas of Living Australia 2014) nor was the species located during surveys. Additionally, its preferred habitat (Brigalow) is not present within the Project area.
<i>Erythrorhynchus radiatus</i>	Red Goshawk	V	The Red Goshawk prefers coastal and sub-coastal tall, open forest and woodland, tropical savanna traversed by rivers lined with timber and along the edges of rainforest. Nests are located above 20m in trees greater than 30m high.	Possible – The Project site is within the predicted distribution (Atlas of Living Australia 2014). There is a lack of suitable nesting habitat at the Project site. The species may feed in the Project area.
<i>Furina dunmali</i>	Dunmall's Snake	V	The Dunmall's Snake is known from woodlands and dry sclerophyll forest, especially Brigalow in the south east interior of Queensland but also Belah and Cypress Pine (Wilson & Swan 2008, Wilson 2009).	Unlikely – There are no database records within 100 km of the Project site (Atlas of Living Australia 2014) nor was the species located during surveys. Additionally, its preferred habitat (Brigalow) is not present within the Project area.
<i>Geophaps scripta scripta</i>	Squatter Pigeon (southern)	V	Occurs in open dry sclerophyll woodland with grassy understorey, nearly always near permanent water. Birds may occasionally feed in sown grasslands and pastures.	Unlikely – There are no database records for the Project site or its immediate surrounds. It is comparatively easy to observe when present and its occurrence is considered very doubtful. The species is likely to be locally extinct in the inundation area and immediate surrounds. It may still occur within the area encompassing the Urban and Irrigation Pipeline

Species name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
<i>Lathamus discolor</i>	Swift Parrot	E, M	Swift Parrots occur in woodlands, riparian vegetation and remnant patches of mature eucalypts in agricultural areas, though they prefer dry sclerophyll forest (Higgins 1999; NPWS 2003).	Possible – There are no database records for this species for the Project area. The EPBC Online Protected Matters Search Tool states that this 'species or species habitat may occur within area'. It is considered possible that the species could occur periodically in the area.
<i>Maccullochella peelii peelii</i>	Murray Cod	V	It has been found in shallow to deep pools only in upper reaches or small tributaries of rivers in granite country	Present (introduced) – Murray Cod is an introduced species in the Project area. It was not common and was found in weir pools. Being an introduced species to the catchment, Murray Cod was not specifically noted on the controlled action notification for Emu Swamp Dam.
<i>Nyctophilus corbeni</i> (southeastern mainland population)	Eastern (Greater) Long-eared Bat	V	Occurs in dry forest and woodland, mallee, and other arid and semi-arid habitats. It roosts in tree hollows or under bark (NPWS 2003). It is a little known species that is rarely caught (Churchill 1998).	Possible – There are no database records for the Project site or its immediate surrounds. The EPBC Online Protected Matters Search Tool states that the "species or species habitat may occur within area". However, little is known about the species and it is difficult to assess the likelihood or otherwise of its possible occurrence in the Project area.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	V	The species is known from Sundown National Park. The Atlas of Living Australia (2014) show one record from Stanthorpe. It prefers rocky habitats, slopes, outcrops, cliffs and gorges.	Unlikely – There are no records from the Project area and the species has not been observed during surveys.
<i>Poephila cincta cincta</i>	Black-throated Finch (southern)	E	Occur in dry open grassy woodlands and forests with seeding grasses and freestanding water. In south-eastern Queensland Black-throated Finches have been recorded from dry open forest on ridges, grassy hillsides and mountain flats (Higgins <i>et al.</i> 2006).	Unlikely – There are no database records for the Project area. The EPBC Online Protected Matters Search Tool states that this 'species or species habitat likely to occur within area'. The species is now possibly extinct in New South Wales and there were only six Atlas of Australian Bird records in southern Queensland for the period 1977 to 1981 and none for the Atlas of Australian Birds 2 (1998 – present) (Higgins <i>et al.</i> 2006).

Species name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo (SE mainland)	V	The Long-nosed Potoroo has been recorded in a variety of habitat types including disturbed subtropical and warm-temperature rainforests, tall open forests with a moist understorey, woodland with tussock grass, open forest with shrubby understorey, and heathlands.	Unlikely – There are no database records for the Project area. The EPBC Online Protected Matters Search Tool states that the “species or species habitat may occur within area”. It is not considered to be present due to a lack of suitable habitat.
<i>Pseudomys oralis</i>	Hastings River Mouse	E	The Hastings River Mouse occurs within open Eucalypt forest at altitudes of 300 – 1250 m. Habitat groundcover associations usually comprise grasses, ferns, rushes (e.g. <i>Lomandra</i> spp.) and, occasionally, heathy shrubs (Van Dyck <i>et al.</i> 2013).	Possible – There are no database records for the species within the project nor was the species located during field surveys. It is possible that suitable habitat for the species occurs within the project area.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	Commonly within dense vegetation close to water, primarily rainforest patches, stands of <i>Melaleuca</i> , mangroves or riparian vegetation.	Unlikely – There are no database records for the Project area. The EPBC Online Protected Matters Search Tool states that the “species or species habitat may occur within area”. It is not considered to be present.
<i>Rostratula australis</i>	Australian Painted Snipe	E, Mig	Occurs in ephemeral and permanent shallow wetlands, usually freshwater but occasionally brackish. Also use inundated grasslands, saltmarsh, dams, rice crops, sewage farms and bore drains. Feeds on vegetation, seeds and invertebrates (Marchant and Higgins 1993)	Unlikely – There are no database records for this species in the Project area apart from the Protected Matters Search Toll which states that this ‘species or species habitat may occur within area’. The section of the Severn River in the inundation area provides very little habitat for this species. What potential habitat is present is due to construction of weirs. There is no suitable habitat along the pipeline corridors.
<i>Uvidicolus sphyurus</i>	Granite Belt Thick-tailed Gecko	V	Occurs in rocky hills with dry open eucalypt forest or woodland, typically with boulders and exfoliating rock (NPWS 2003)	Present – One individual was recorded during a targeted search during the summer survey.

Species name	Common name	EPBC Act status ¹	Habitat	Likelihood of occurrence
<i>Wollumbinia belli</i>	Bell's Turtle	V	The known populations of Bell's turtle (<i>W. belli</i>) are found in the Namoi and Gwydir Rivers in northern NSW and in Bald Rock Creek in southern Queensland, in the headwaters of the Darling River system. Bell's turtles only occur in riverine habitats at a minimum elevation of 700 m above sea level. They prefer permanent, cold flowing streams that are well oxygenated. The known populations of Bell's turtles are in areas where granite boulders and bedrock are common, with coarse sand deposits in slower flowing areas.	Likely. – The area impacted by the Project provides suitable habitat for Bell's turtle. The Bell's turtle has not been recorded in or upstream of the proposed inundation area. There is only one record of it in the Severn River downstream of the proposed dam site (from the EIS), despite extensive searching. In contrast, 79 Bell's turtles were recorded in Bald Rock Creek using a similar searching effort (Fielder 2010).

¹ EPBC Act status: E = Endangered, V = Vulnerable, M = Migratory

5.5. MNES Requiring Impact Assessment

The threatened species and communities found to be present or assessed as likely to occur are considered further in this report. The assessment will assess the impacts on the following EPBC Act listed threatened species and communities:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Threatened Ecological Community (critically endangered) (assessed in Section 7);
- *Boronia repanda* (endangered) (assessed in Section 8);
- *Acacia pubifolia* (vulnerable) (assessed in Section 9);
- *Callistemon pungens* (vulnerable) (assessed in Section 10);
- *Grevillea scortechinii* subsp. *scortechinii* (vulnerable); (assessed in Section 11);
- *Eucalyptus mckieana* (vulnerable) (assessed in Section 12);
- Spotted-tail quoll (endangered) (assessed in Section 13);
- Granite Belt thick-tailed gecko (vulnerable) (assessed in Section 14);
- Large-eared pied bat (vulnerable) (assessed in Section 15);
- Bell's turtle (vulnerable) (assessed in Section 16); and
- Murray cod (vulnerable) (assessed in Section 17).

6. IDENTIFICATION OF POTENTIAL IMPACTS

This section describes the potential for changes to the environment as a result of project construction and operation.

6.1. Potential impacts associated with clearing the inundation area

Clearing of the inundation area will be staged such that land within the construction footprint of the dam wall will be cleared first, and the balance of the storage area will be cleared once construction is well progressed. The clearing will displace a range of common flora and fauna species over an area of approximately 200 ha which contains a mix of vegetation and cleared land. Approximately half of the inundation area is currently devoid of vegetation due to historical land clearing and continuing agricultural land uses. These cleared or partially cleared areas are likely to support flora and fauna assemblages which are greatly reduced in complexity when compared to large remnant systems.

All vegetation within the inundation area will ultimately be removed resulting in a direct reduction in vegetative biomass and plant species richness. Impacts of clearing on individual species of conservation significance will be mitigated or offset in accordance with current Commonwealth Government policy.

Impacts of vegetation clearing on individual fauna (mortality of individuals) can be greatly reduced by staged, directional clearing under supervision by an experienced spotter/catcher. All fauna which currently occur within the inundation area will gradually be displaced as the clearing proceeds and ultimately as the impoundment fills over time. A range of mitigation strategies have been proposed for those threatened fauna species likely or known to occur within the inundation area, and offsets proposed for those species considered likely to suffer residual impacts.

6.2. Potential Impacts associated with clearing for pipeline construction

Clearing for pipeline construction will be limited to a narrow corridor (5 m, 7.5 and 12.5 m) which will enable a degree of flexibility in the final alignment, such that features of ecological significance can be avoided.

Within treed areas, gaps of such narrow width are unlikely to create barriers to movement of flora or fauna species which occur on either side of the pipeline alignment. Ecological function of these areas is unlikely to be compromised provided that weed species invasion is controlled and construction activities are restricted to the corridor, with limited or no disturbance outside the designated corridor.

6.3. Potential impact of storage on habitat

6.3.1. *Terrestrial Habitat*

The operation of the dam will have both short and long-term, and positive and negative impacts on terrestrial vertebrate fauna. Impacts associated with inundation are:

- creation of a large waterbody deep enough to provide a range of habitats and food resources for a variety of waterbirds;
- changing water levels that will affect soil moisture levels;
- changing water levels that will affect shoreline vegetation composition and survival, including potential colonisation by terrestrial weed species;

- minor changes in downstream flow regime that may alter riparian vegetation and stream-dependent vertebrate fauna;
- alterations to downstream water quantity and quality and changes in the extent of flood events;
- creation of edge effects along the borders of the inundation area;
- provision of a permanent water resource for a range of vertebrate fauna species which are likely to use the impoundment as a watering point including birds, flying and non-flying mammals;
- creation of habitat for a suite of amphibians which are able to breed in impoundments; and
- creation of a water barrier to the dispersal of terrestrial non-volant (non-flying) fauna through the local landscape.

The inundation area will shift from supporting primarily terrestrial species (with some semi-aquatic and aquatic species within the stream channel) to supporting primarily aquatic species. The habitat value for aquatic species is discussed below.

6.3.2. *Aquatic Habitat*

During the filling phase, existing habitats will be inundated as the dam begins to fill. The ecosystems within the inundation water will change from riverine (lotic) to lake (lentic) habitats. Initially, the lotic ecosystems will fill to bank full widths as if in flood, but then the area above the banks will be gradually inundated until the dam is at inundation area. The length of the filling phase is dependent on the rate of inflow, and the inundation area may fill during a single flood event or it may take several years.

The inundation of the dam will result in the loss of pool, run, glide, backwater, riffle and cascade habitat along approximately 4.4 km of the Severn River. Coarse sediment (boulders, cobbles, pebbles and gravel) present within the inundation area may be smothered in fines and sands once the inundation area is filled (as suspended fine sediments are likely to settle out of the water column in the relatively still waters of the inundation area). However, the aquatic habitat in the Severn River is similar throughout the Project area (i.e. upstream of, within, and downstream of the proposed dam site). The distance from the confluence of the Broadwater and Quart Pot Creek (i.e. the headwaters of the Severn River) to the downstream extent of the Project area (as defined in this report) is approximately 34.5 km, and field surveys indicate that aquatic habitat is similar throughout this area. The inundation will result in the loss of aquatic habitat in this section of the Severn River, but is highly unlikely to result in the loss of any unique aquatic habitat that supports aquatic flora and fauna.

The fish species recorded within the water storage area are not habitat specialists. That is, no species are expected to be lost from the dam due to the changes in habitat type. However, there will be a shift in community composition due to the expected changes in habitat and sediment type. The increased extent of shallow margins may provide ideal habitat for several species, particularly if they are colonised by aquatic plants. For example, gudgeons and catfish prefer habitats that include aquatic plants (Allen et al. 2002). Most species recorded in the study area have previously been recorded in habitats with a variety of substrates. However, the shift in substrate composition may result in the loss of spawning habitat for species that deposit eggs on gravel surfaces or hard surfaces, such as freshwater catfish.

The inundation area will provide a stable pool habitat for aquatic fauna. While the length of riverine sections will decrease and there will be an increase in deep areas, there may be a net increase in diversity of habitat because of that offered by the over-bank areas in the tributaries. The stability and potential diversity of the habitat created by the dam may result in an increase in fish abundance and diversity in the inundation area.

During operation of the dam there is expected to be some overhanging vegetation along the margins of the water storage area at inundation area, though the likely ratio of this habitat compared with open water with no canopy cover will be substantially reduced. When water levels are below inundation area there will be little overhanging vegetation except where the storage remains in a former stream channel and surviving riparian vegetation can still perform that function or where deep areas abut existing forest. Appropriate material will be salvaged for use as 'large woody debris' fish habitat in the inundation area.

The dam will provide less diversity of physical habitat, hence it is important to re-create some through strategies such as placing snags in relatively (<5 m) shallow water and not clearing to the inundation area to provide structural diversity.

6.4. Potential impacts to aquatic fauna passage

Dams create barriers that prevent or impede movement (i.e. general movement through a waterway) and migration (i.e. movement for a specific purpose such as reproduction) of aquatic fauna, including fish and platypus, in waterways. A dam wall is, without mitigation, a complete barrier to upstream fauna movement and an almost complete barrier to downstream movement. During construction the construction site will also represent a barrier to aquatic fauna. Many of the native fish in Queensland waterways migrate upstream and downstream and between different habitats during particular stages of their life cycle. Fish passage is already restricted in the Severn River in the vicinity of the Project by existing weirs and, if unmitigated, the dam will further restrict fish movement and migration in the catchment.

During construction, impacts from the obstruction of flow and passage will be mitigated through the use of a diversion channel to connect the river upstream and downstream of the construction site. Removal of the larger aquatic fauna through a carefully managed salvage program before construction begins, will also mitigate potential impacts during construction.

The impediment to passage from the dam wall has the potential to affect fish migration and breeding, isolate fish populations and, in the long-term, could decrease genetic diversity in populations upstream and downstream of the dam.

A fishway has been included in the design to accommodate both movement directions and is intended to service the needs of other fauna, including turtles. The design of the facility will be finalised following further consultation with relevant agencies and experts, and in general accordance with the process provided by Queensland Fisheries. However, the concept design is for a fishlock arrangement, similar to that installed on Ned Churchward Weir, which will operate such that at least the current opportunity for movement is maintained.

The dam will affect fish species differently, depending on their need to move and migrate and their ability to navigate fishways. Most of the fish caught move throughout the freshwater reaches of rivers over the course of their lifetimes. The timing of these movements and migrations in Australian fishes is often unpredictable. In some species, migrations occur during periods of low flow, while others migrate in response to periods of high flow, either upstream or downstream. The use of fish locks by fish within a particular family or even genus is not always consistent. Therefore, generalisations made about the behaviour of related groups of fishes may not be accurate.

Potential impacts on turtle passage might be minimised through the use of a fishway or moistened covered passages that would allow turtles to walk around the dam wall (SPRAT 2013). Turtles prefer to walk upstream rather than use fishways, and fish locks can be detrimental to turtles if they drown or become trapped in the hydraulic mechanisms of the lock, as has been observed at the Ned Churchward Weir fish lock (Hamann et al. 2004). Never-the-less turtles have been observed passing through fish locks, such as the Paradise Dam fish lock, however these were predominantly Krefft's river turtle (*Emydura macquarii krefftii*). Other species that used the river near the dam, including Elseya and Chelodina species, either did not use the fishway, or used it in very low numbers (QPIF 2009; DEEDI 2012). Where measures are taken to prevent turtles from accessing high velocity water release sites and the hydraulic mechanism, negative impacts associated with fish locks will be minimised, and some turtle passage will be maintained. Specific features to enable safe passage for turtle species that may occur in the area, including Bell's turtle, will be designed in collaboration with appropriate experts, and agencies (including the DEHP and Queensland Fisheries) and incorporated into the proposed dam. The fishlock will be designed to ensure that turtles will not be adversely impacted.

Fish locks and fish lift structures are likely to provide adequate passage for most fish species present, if they are designed to mitigate the flaws found in previous structures, maintained in working order, monitored and fine-tuned to improve performance. Platypus have also been known to use fish locks (DEEDI 2012). Impediments to fish movement at the dam wall will be reduced by constructing fishway structures that (from Stuart et al. 2007):

- use an impassable downstream barrier to direct fish away from the spillway towards the fish lock opening, and/or have a downstream entrance near the spillway to allow the passage of larger fish attracted to large flows;
- have upstream structures that direct fish migrating downstream towards the lock;
- can vary attraction flows in accordance with river flows;
- can operate over a range of head and tailwater levels;
- use high quality water (surface) as attractant provided with little turbulence;
- provide attractant flows and lock cycles for fish migrating downstream;
- use a sloping lock chamber rather than a follower cage to encourage exit from the lock;
- are maintained in working order, monitored and fine-tuned to improve performance;
- are remotely operated and functional year round; and
- reduce the chances of fish migrating upstream passing back over the spillway.

Restrictions to fish passage and associated impacts (e.g. decreased recruitment) may be offset where fish habitat and movement is enhanced by:

- restoration of passage at existing barriers through their removal and / or installation of fishways at existing weirs in the Project area;
- habitat restoration and / or protection in the Project area (for example, placement of woody debris in dam margins); and
- allocation of water specifically to enhance aquatic habitat downstream of the dam over and above the proposed environmental releases.

It is proposed a survey will be undertaken of the existing privately owned weirs upstream and downstream of the proposed dam. The team of specialist ecologists in consultation with Queensland Fisheries will develop concept designs to improve fish passage at existing weirs. The team will engage with the weir owners and make the

concept designs available. A demonstration fishway will be constructed at one of the existing weirs, with the owner's permission, as part of the Project.

6.5. Potential impacts from change in flow regime

The proposed dam may change the current flow regime in the river by reducing flow in the river downstream of the dam site and altering the timing, frequency and size of seasonal flow events. The number of existing weirs downstream of the dam site could also exacerbate any decrease in flow downstream of the proposed dam. Potential impacts associated with a change in the existing flow regime may include: a decrease in the persistence of and connectivity between some pool – run / riffle habitat sequences; a reduction in the availability and suitability of aquatic habitat for native flora and fauna; and altered migratory or breeding cues for some aquatic fauna (particularly fish). However, the proposed release regime from the dam includes environmental releases and modelling indicates the decrease in water depth will be small.

Environmental flows from the dam will comprise a release equivalent to the inflow, up to 30 ML/day, in order to maintain the natural flow regime for low flows and the ephemeral nature of the Severn River. For example, if 8 ML/day enters the storage then 8 ML/day will be released downstream, but if flow greater than 30 ML/day enters the storage then 30 ML/day will be released downstream. Modelling for the SEIS indicates that the dam will spill for 46 days of the year, with an average of 0.4 of a year (i.e. 4-5 months) between spills. The average duration of spills is predicted to be 14 days. The proposed combination of environmental releases and spills will contribute to maintaining a flow regime consistent with the current flow regime and will mitigate impacts to flora and fauna. In particular, the combination of low flow releases and high flow spills are expected to provide suitable conditions to trigger migration and reproduction in aquatic fauna.

Hydrology modelling presented in Appendix A.1 indicates that between the proposed dam site and the confluence of the Severn River and Accommodation Creek, changes to the stream flows would only represent a change in water depth of up to 100 mm compared to 500 to 800 mm depth without the dam.

The Severn River is an ephemeral river characterised by a rocky bottom, pools and riffles. There is significant monthly variability in the daily flow in the Severn River. Flood events of up to 5.51 m gauge depth have been recorded at Ballandean. There has already been considerable development on the Severn River with a number of in-stream weirs. The predicted change in water depth of up to 100 mm is not considered to be a significant in relation to the natural variability in water depth and there is significant reduction water flows following development within the catchment.

6.6. Potential impacts from changes in water quality

At proposed dam site

Quarrying and sand extraction within the inundation area will have the potential to increase erosion and subsequently sedimentation of the Severn River in the short term. Discharge from excavation sites has the potential to impact receiving water quality. These activities will be managed using a variety of techniques and approaches which are widely implemented across the construction industry and proven to be effective. As such, impacts on water quality due to quarrying and sand extraction within the Project area are expected to be negligible.

In the catchment

Granite Belt farmers are currently very efficient water users and have implemented a number of measures to reduce water use and losses from water storages. Historically, irrigation water supplies have been taken from local rivers and creeks, rainwater tanks, on-farm runoff dams to collect rainfall and groundwater resources (when available).

The limited water availability for irrigation means growers have been early adopters of new techniques and technologies to improve water efficiency. The irrigation technologies typically applied in the region include micro-sprays, drip irrigation and soil moisture monitoring. These methods of irrigation seek to maximise the effectiveness of the available water resources in the region. Irrigation techniques that result in agricultural runoff are considered a wasteful ineffective use of water resources.

The provision of irrigation water through the Project is not expected to result in an increase in runoff from agricultural areas because:

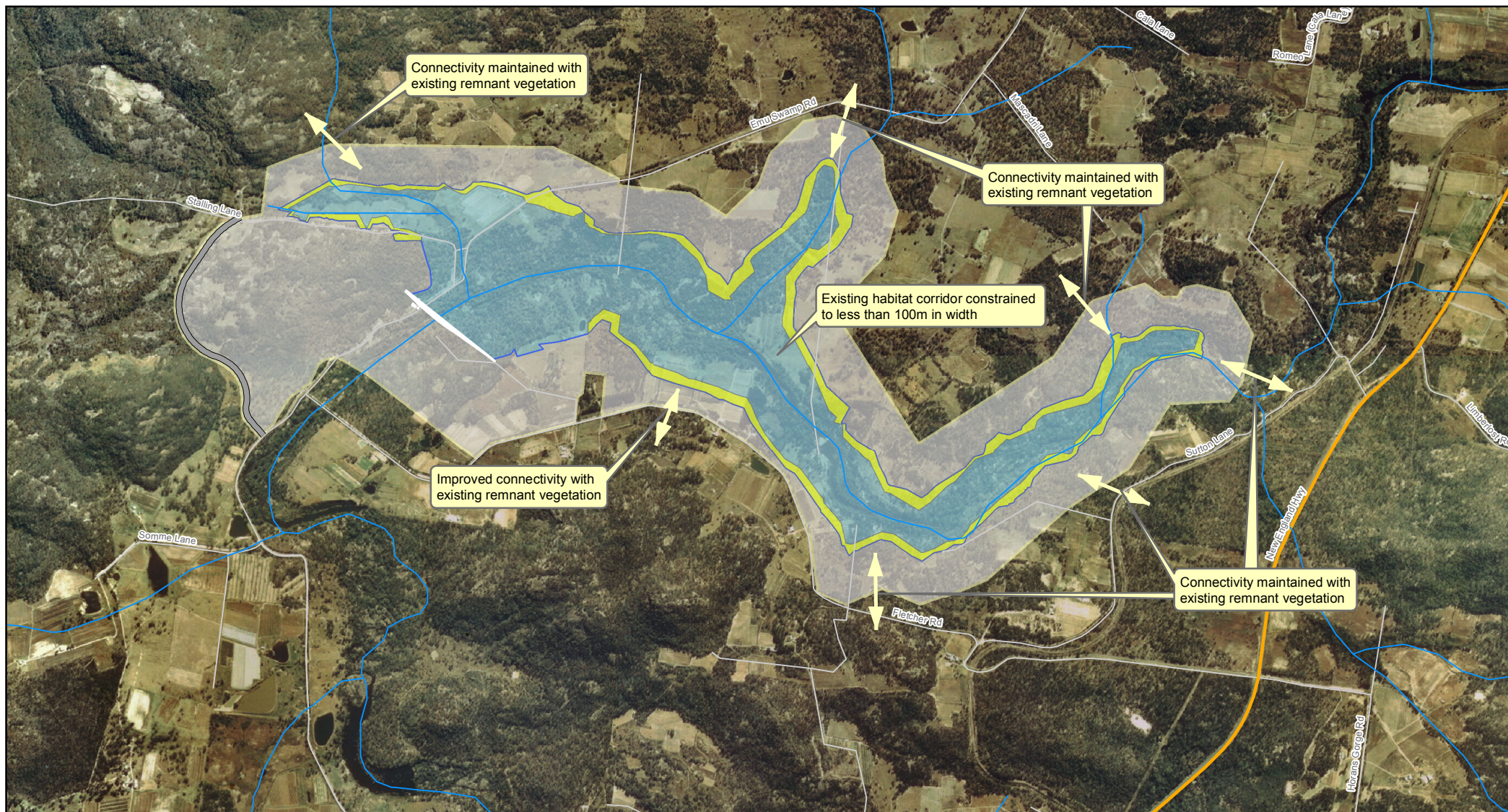
- the proposed irrigation water entitlement of 1,740 ML/yr represents an 11% increase above the current mean annual irrigation entitlements; and
- growers will continue to implement water efficient irrigation technologies to maximise returns from the water provided.

6.7. Potential impacts on ecological connectivity

The impoundment will impact on riparian vegetation for approximately 4.4 km of the Severn River which potentially provides dispersal pathways for terrestrial fauna. The width of riparian habitat within the inundation area ranges from less than 100 m wide at one location (refer to Figure 6-1) to over 500 m wide in others. The clearing of this riparian habitat has the potential to isolate patches of remnant vegetation and impact on local ecological connectivity.

SDRC will revegetate and manage the buffer area around the inundation area of the dam to reconnect patches of vegetation to mitigate potential impacts on local connectivity. The size of the buffer area is approximately 200 m in width, approximately 5 km in length with a total area of 322 ha (refer to Figure 6-1). Rehabilitation and management of the buffer will create a movement corridor of similar width to the current riparian habitat in the inundation area. Cleared and degraded areas in the buffer area will regrow to achieve native vegetation. The proposed buffer area will ultimately provide a contiguous corridor around the inundation area maintaining connectivity with existing remnant vegetation.

Rehabilitation and management of the buffer area will create a movement corridor of at least similar value to the existing riparian habitat in the inundation area. The Project is not expected to have residual impacts on local connectivity.



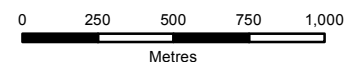
LEGEND

- Watercourse
- Road
- Highway
- Stalling Land Access
- Regeneration Area
- Retained Vegetation in Inundation Area
- Full Supply Level (738m AHD)

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Figure 6-1

Local Connectivity



Scale - 1:25,000

Projection: GDA94 MGA56



6.8. Potential indirect impacts on vegetation communities

Waterlogging

Potential indirect impacts include alteration to native vegetation around the FSL where soils may become water logged at times. Modelling of the dam storage capability undertaken (refer to Appendix A) indicated the dam could be above, at, or near full capacity (i.e. less than 1 m below the FSL) for 55% of the time. Vegetation dominated by species that naturally occur in riparian areas (e.g. Blakely's Red Gum) is unlikely to be adversely impacted by soil saturation.

Investigation of vegetation attrition around Glenlyon Dam (which supports a landscape and suite of tree species ecologically similar to that found within the Project area), found that there is limited or no evidence of plant death above FSL. Vegetation above FSL on Glenlyon Dam retains its remnant structure and is indistinguishable from vegetation further upslope in terms of structure and species composition. This supports the view that waterlogging is not likely to result in the loss of vegetation above FSL or at least, that impacts on adjacent vegetation due to waterlogging will be relatively insignificant.



Figure 6-2 Vegetation above the full supply level at Glenlyon Dam

Edge effects

Clearing of the FSL and pipeline corridors will expose vegetation to edge effects. Edge effects are associated with altered microclimates at forest edges that result in higher levels of light, temperature and wind disturbance. This can create more favourable conditions for weed growth, decreases in native plant diversity and an increase in aggressive edge specialist species such as Noisy Miner (*Manorina melanocephala*) which exclude other native woodland birds. Given the partially cleared nature of both the inundation area and the pipeline alignments, it is considered that these areas would already have incurred edge effects. The nature of woodland habitats (relatively few, scattered trees and wide canopy separation) renders them less susceptible to edge effects than closed forest types such as rainforest, where microclimates are much more sensitive to change.

Fragmentation

Fragmentation is the breaking apart of continuous woodland into many small patches. It typically leads to lower species diversity and lower population sizes, for both animals and plants (Rawlings et al. 2010). Construction of the dam will reduce the size of the native vegetation on the Severn River and thus contribute to the further fragmentation of the vegetation communities. Vegetation communities on the Severn River are already fragmented and the project will not fragment a continuous woodland area. A buffer area of approximately 200 m width is proposed surrounding the dam to protect the water quality within the dam and also to maintain ecological connectivity.

Construction of the urban and irrigation pipelines may also contribute to fragmentation, but as these pipelines are to be constructed within cleared road reserves and trenchless construction methods used where possible, they will result in a minimal contribution to fragmentation.

6.9. Weeds and Pests

The Project has the potential to introduce and spread a range of weed species around the inundation area and on the pipeline alignments. The project provides an opportunity to manage, control and eliminate weed species from the work areas and from the buffer area around FSL, thereby improving the resilience of these habitat areas.

Vertebrate pests such as foxes, pigs and cats are already present within the Project area and represent a threat to many native fauna species, including threatened species known or likely to occur within the inundation area in particular. The Project presents an opportunity to develop and implement an integrated pest management plan and ultimately to reduce populations of vertebrate pests and predation pressure on a range of vertebrate fauna.

6.10. Additional land clearing

The Project will result in additional water (an additional 1,740 ML) being made available to irrigators across the Granite Belt Catchment. The maximum and mean annual water irrigation diversions in the IQQM are 20,005 ML and 10,688 ML respectively. The proposed irrigation water of 1,740 ML/year represents an increase of 16% in average years above existing irrigation entitlements. The estimated water demand in the former Stanthorpe Shire Council area is approximately 16,500 ML/year which clearly exceeds the volume of water which will be available after the dam is constructed.

The provision of additional irrigation water through the Project is not expected to result in additional land clearing because:

- there is sufficient cleared land to expand cropping areas without requiring the clearing of remnant vegetation. Tancred & McGrath (2013) advise that the cropped areas, particularly apples, have decreased substantially over the last 35 years (even though overall production has been maintained or increased) due to agronomic advances and water use improvements. Cleared areas represent approximately 50% of the total area in the former Stanthorpe Shire region suggesting that further clearing would be unnecessary; and
- significant regulatory protection exists which prevents the clearing of remnant vegetation under the EPBC Act, VM Act and NC Act.

7. WHITE BOX-YELLOW BOX-BLAKELY'S RED GUM GRASSY WOODLAND AND DERIVED NATIVE GRASSLAND

7.1. Biology

The White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Threatened Ecological Community (TEC) (hereafter referred to as Box-gum Grassy Woodland) is characterised by a species-rich native grassy understorey with the dominance, or prior dominance, of White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*) trees. In the Nandewar Bioregion, Grey Box (*E. microcarpa* or *E. moluccana*) may also be dominant or co-dominant. The canopy cover is generally patchy with a sparse shrub layer (TSSC 2006g). The Box-gum Grassy Woodland occurs on moderate to highly fertile soils at altitudes from 170-1,200 m where rainfall is 400-1,200 mm per year (NSW Scientific Committee 2002).

Given that the Box-gum Grassy Woodland occurs on high quality soils, its habitat is high value agricultural land and, as a result, very little of the previous extent of the community remains. Persisting communities tend to be shrubbier and occur on lower quality, and therefore less arable, soils (Prober 1996). Shrubs can occur naturally in Box-gum Grassy Woodlands, however in poorer soils throughout its range the community degrades into shrubby woodlands. Remnant Box-gum Grassy Woodlands with a continuous shrub layer greater than 30% is considered to be a shrubby woodland and not part of the listed community (TSSC 2006g).

The Box-gum Grassy Woodland ecological community has an overstorey of an appropriate *Eucalyptus* spp. with a native, predominantly grassy understorey. The listing advice considers an understorey patch with the correct diversity, but with the absence of what would have previously been the correct species of overstorey trees, to be the threatened ecological community (TEC). If the correct overstorey exists, but without a substantially native understorey, this is considered degraded and therefore not a viable member of the TEC (TSSC 2006g).

This ecological community has been heavily cleared across much of its natural range. It is likely that over 90% of the original extent of this TEC has been cleared with the remaining areas of the community being highly fragmented, isolated or at risk of degradation (TSSC 2006a).

The Box-Gum Grassy Woodland can exist in a number of structural forms. The variety of community structures have resulted from human changes. The recovery plan (DECCW 2010) states that in the unmodified form, the community is a woodland, with widely distributed trees and a sparse canopy cover. The understorey comprises a dense cover of native grasses and herbs.

On sites with poor soils, the community will form a shrubby woodland.

In a modified form, the overstorey remains, with the understorey replaced with exotic species, for improved pastures. In this situation, with the understorey dominated by exotic species, the community will not form the TEC. However, it will retain components of the community that are valuable for restoration and management of the woodland (DECCW 2010).

The Box-gum Grassy Woodland is listed as critically endangered under the EPBC Act.

7.2. Regional distribution

The Box-gum Grassy Woodland community occurs along the western slopes and tablelands of the Great Dividing Range from Southern Queensland through NSW to central Victoria (Figure 7-1) (Beadle 1981). It occurs in the Brigalow Belt South, Nandewar, New England Tableland, South Eastern Queensland, Sydney Basin, NSW North Coast, South Eastern Highlands, South East Corner, NSW South Western Slopes, Victorian Midlands and Riverina Bioregions (TSSC 2006a).

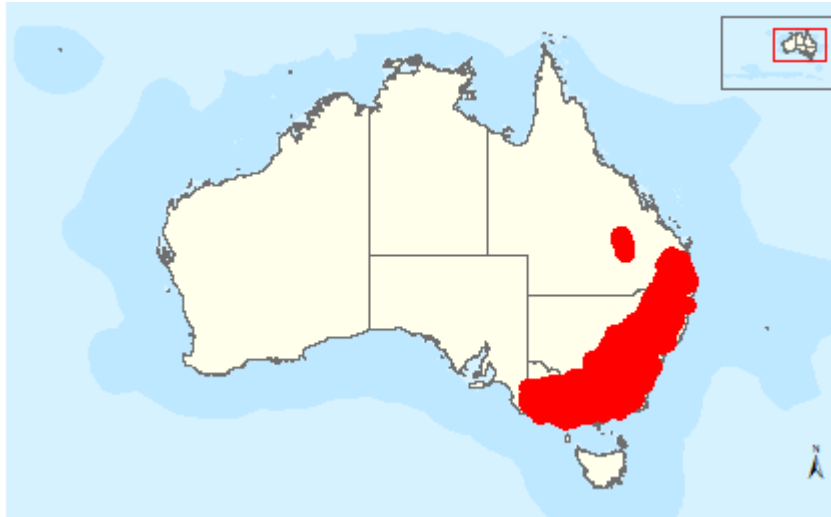
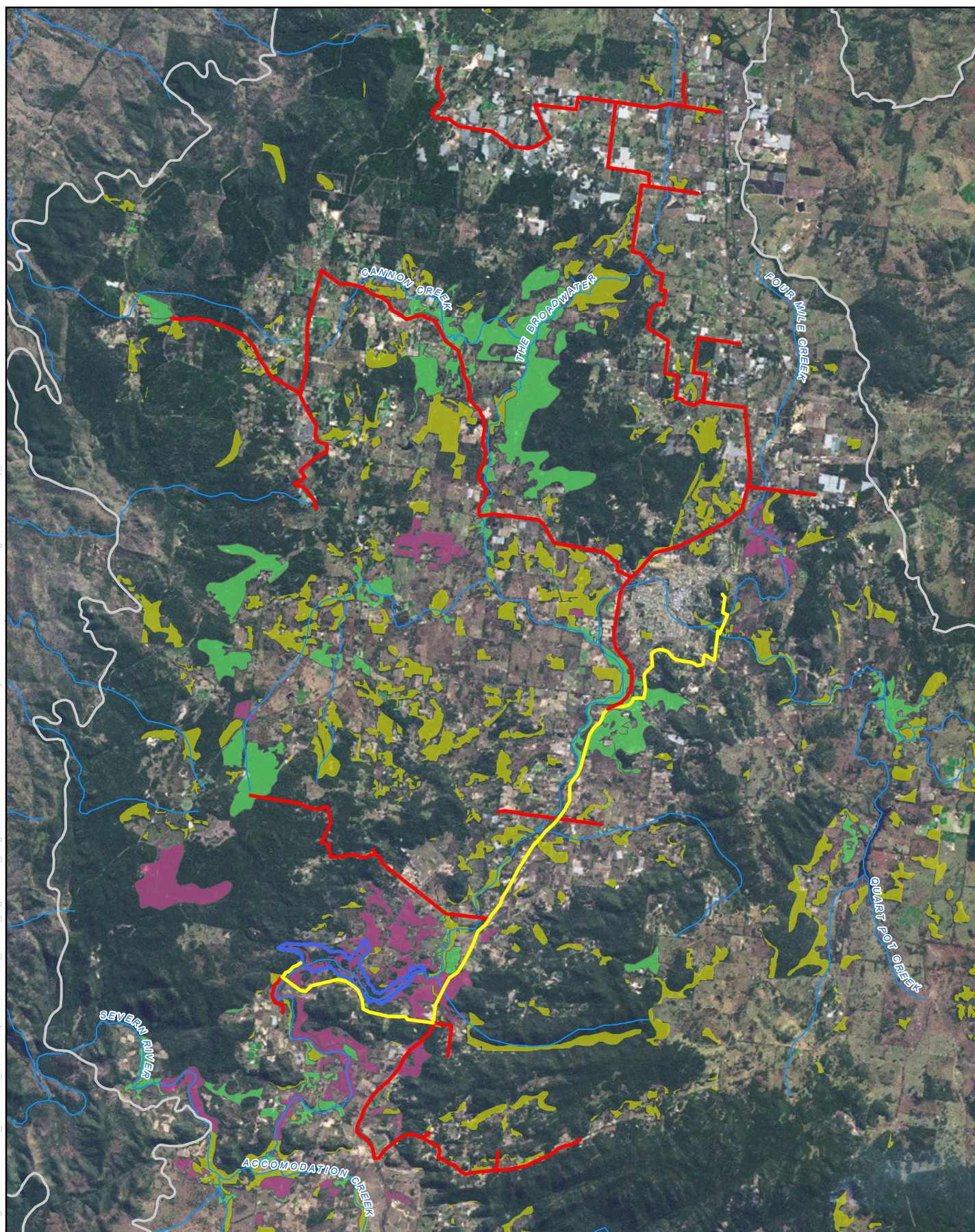


Figure 7-1 Box-Gum Grassy Woodland distribution (DotE 2014a)

The community is widespread, with high levels of fragmentation, especially on high quality and fertile soils. In Queensland, the TEC is found in a range of landzones that includes alluvial flats, and hills and lowlands on metamorphic or granitic rocks.

Spatial analysis and field surveys have confirmed the presence of 1,611 ha of Box-gum Grassy Woodland in the Stanthorpe Plateau sub-bioregion. A further 5,073 ha Box-gum Grassy Woodland has been identified as potentially occurring in this bio-region. The location of confirmed and potential Box-gum Grassy Woodland in the Stanthorpe Plateau sub-bioregion is presented in Figure 7-3. Less than half (44%) vegetation surveyed was surveyed contained the listed community. Conservatively assuming 40% of the potential Box-gum Grassy Woodland (2,672 ha) meets the EPBC criteria there is a further 2,029 ha of this community. It is estimated that approximately 3,640 ha of Box-gum Grassy Woodland is present [1,611 ha (confirmed) + 2,029 ha (potential)] in the in the Stanthorpe Plateau sub-bioregion (SKM 2014).

Current estimates indicate that a total of 416,325 ha of the ecological community (in various condition states) remain (DECCW 2010). As such, the extent of the community within the Stanthorpe Plateau sub-bioregion represents around 1% of the total remaining extent of Box-Gum Grassy Woodland.



LEGEND

- Watercourse
- Urban Pipeline
- Irrigation Pipeline
- Stanthorpe Plateau Sub-bioregion
- Full Supply Level (738m AHD)

Box-Gum Grassy Woodlands

- EPBC community confirmed
- EPBC community not present
- EPBC community presence not confirmed

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0 1 2 3 4

Kilometres

Scale - 1:150,000

Projection: GDA94 MGA56

Figure 7-2

Regional Distribution of Box-Gum
Grassy Woodland Threatened
Ecological Community (SKM, 2014)



7.3. Occurrence in Project Area

Field surveys for regional mapping were undertaken by 3D Environmental (2007) as part of the Environmental Impact Statement in 2007. Spatial analysis was used to identify vegetation mapped by DNRM (2011) and 3D Environmental (2007) in the study area, including along the Severn River downstream to Accommodation Creek, as containing the REs in the study area that may contain the TEC. Field surveys were then carried out in these locations, using the methods described below, to verify the presence or absence of the TEC (SKM 2014).

The listing advice for this community (TSSC 2006) provides condition criteria to assess Box-Gum Grassy Woodland vegetation. A flowchart (DEH 2006) was prepared to aid in the identification of the community.

The presence of Box-Gum Grassy Woodland within the Project area is presented in Table 7-1.

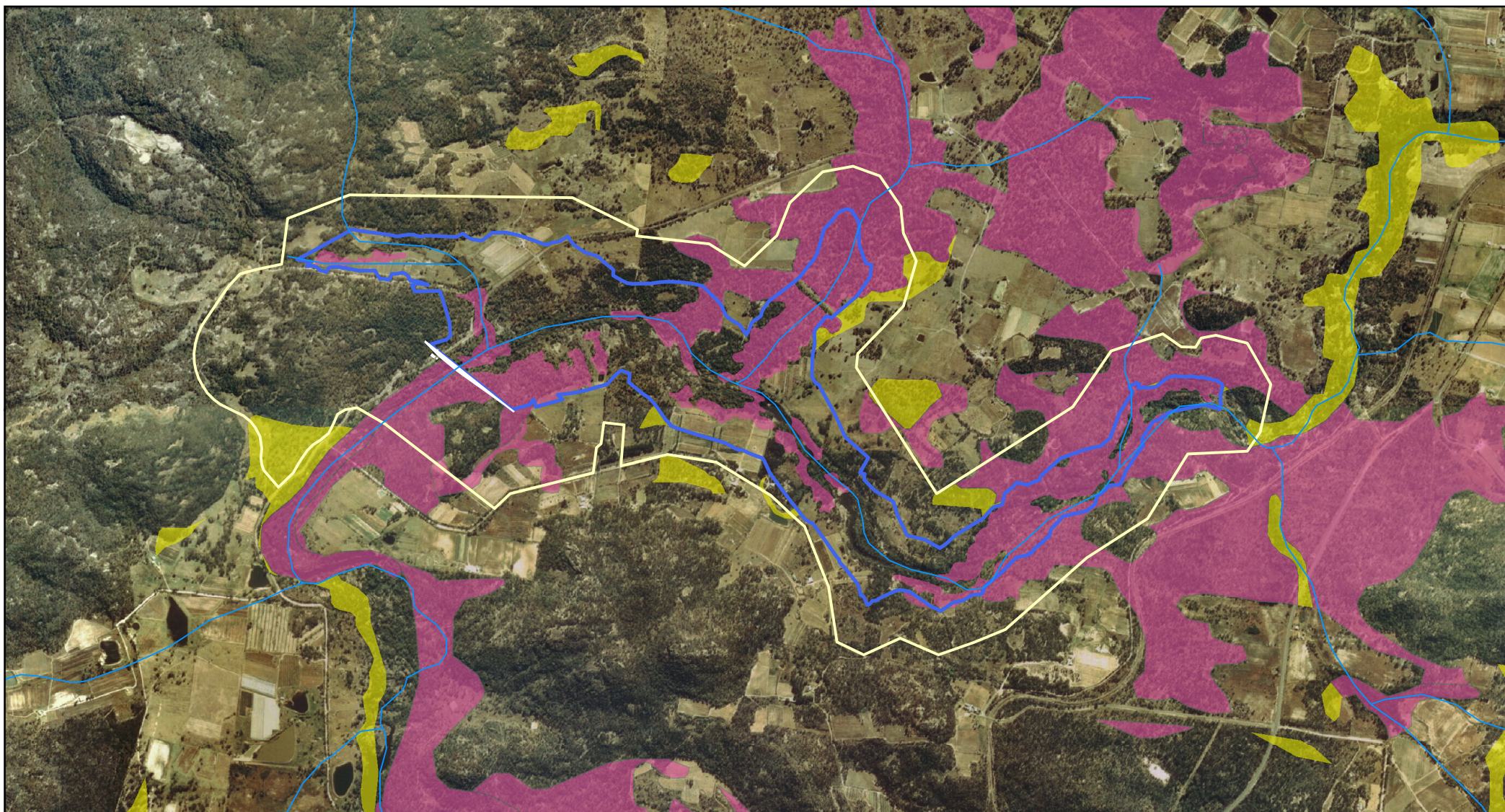
Table 7-1 Occurrence of Box-Gum Grassy Woodland in the Project area

Inundation Area	Stalling Lane	Urban and Irrigation Pipeline	Total
71.55 ha	0.74 ha	11.47 ha	83.76 ha

The presence of the Box-Gum Grassy Woodland in the inundation area and downstream of the presence to Accommodation Creek is presented in Figure 7-3. The stretch of the Severn River from the dam downstream to Accommodation Creek runs through the Box-Gum Grassy Woodland community. Field surveys confirmed that approximately 6.6 km of the Severn River runs through the listed community.

Field observations indicated that much of the native vegetation in the study area had been impacted by fires and as a result was dominated in areas by shrubby regenerating *Callitris* and *Leptospermum* species. Vegetation communities with a continuous shrub layer of more than 30% cover are excluded from the listed ecological community, as they are considered to be shrubby woodland and do not constitute Box-Gum Grassy Woodland (DEH 2006). Figure 7-4 shows an example of the Box-Gum Grassy Woodland in the Project area.

The impacted area of 83.76 ha is approximately 2.3% of the TEC in the Stanthorpe Plateau sub-bioregion.



LEGEND

— Watercourse

— Buffer Area

— Full Supply Level (738m AHD)

Box-Gum Grassy Woodlands

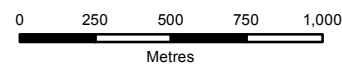
— EPBC community confirmed

— EPBC community presence not confirmed

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Figure 7-4

Box-Gum Grassy Woodlands in the
Inundation Area and Downstream
of the Proposed Dam



Scale - 1:25,000

Projection: GDA94 MGA56





Figure 7-4 Box-Gum Grassy Woodland identified during field surveys

7.4. Threatening processes

The recovery plan for the Box-Gum Grassy Woodland community, prepared by the NSW Department of Environment, Climate Change and Water (DECCW 2010) states that agricultural and horticultural development, land subdivision, mining, construction of public infrastructure, firewood collection, changing fire regimes, chemical use, slashing, increased soil nutrients and use of chemicals, weed and pest invasion, climate change, altered soil salinity and acidity and declining tree health and revegetation are all activities or processes that are a threat to the community. The highly fragmented, isolated and modified nature of the community remnants are subject to further degradation and require active management (DECCW 2010).

A thorough description of these threats is available in the Box-Gum Grassy Woodland recovery plan produced by the NSW Department of Environment, Climate Change and Water (DECCW 2010).

7.5. Recovery Plan Actions

Important work has been undertaken in regard to the recovery of the Box-Gum Grassy Woodland including the collection of baseline information, component species surveys, development of a minimum condition criteria and assessment method, remote sensing modelling and various mapping exercises (DECCW 2010). A national recovery plan, "National Recovery Plan, White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and

Derived Native Grassland, A critically endangered ecological community", has been produced by the NSW Department of Environment, Climate Change and Water (DECCW 2010).

The overall objective of the recovery plan is to promote the recovery and prevent the extinction of the Box-Gum Grassy Woodland through achieving no net loss of the community, increasing the protection of high-value sites, managing and restoring degraded sites, promoting connectivity between remnants and improving land manager attitudes toward, and raising awareness of, the TEC. The recovery plan sets the following actions as critical to achieving these objectives (DECCW 2010):

- Improve existing information
 - Establish standards for monitoring, condition assessment, reporting and data sharing
 - Collate existing data and mapping for access and use by stakeholders
 - Identify and fill data gaps
 - Investigate and establish additional protocols for assessment techniques (remote sensing, non-technical monitoring)
- Increase protection of Box-Gum Grassy Woodland
 - Develop and implement a cross-jurisdictional strategy for the comprehensive and representative protection of Box-Gum Grassy Woodland
 - Identify gaps in the current system of conservation land in preserving the variation of the TEC. This will allow targeted expansion of the protected area through direct acquisition, conservation agreements (or similar), and incentive or long-term stewardship schemes.
 - Avoid loss of protected land containing Box-Gum Grassy Woodland to freehold
 - Develop best practice management plans and quantitative targets for managed areas of the TEC
- Improve community engagement
 - Employ a national coordinator to support the continued operation and expansion of the conservation management networks, and 10 part-time facilitators to implement the recovery plan
 - Develop and maintain a database with all relevant data to support the recovery plan
 - Educate stakeholders and foster indigenous involvement in management of the TEC
 - Install signage to indicate high quality occurrences of the TEC
- Continue research into ecosystem function and management
 - Monitor condition and diversity of protected sites, and use data to investigate long term effects of management activities and define best practice models
 - Target restoration efforts towards high recovery potential sites, covering a range of states
 - Control high threat weeds without impacting existing diversity within the TEC
 - Investigate distribution of component species (including animals, non-vascular plants), to understand variations and relationships, also to identify faunal groups as condition indicators
 - Link with other organisations and programs, and continue to disseminate research results to stakeholders

- Improve compliance and regulatory activities
 - Develop and implement a strategy to enhance government and non-government understanding of issues surrounding Box-Gum Grassy Woodland conservation, and improve the consideration of the TEC into development and planning
 - Integrate conservation issues for the TEC with other landscape conservation programs
 - Development assessments to be performed by qualified ecologists at an appropriate time of year

7.6. Potential Impacts

The Project will reduce the extent of Box-Gum Grassy Woodland by 83.76 ha. The most recent estimate of the extent of the community quoted in the Recovery Plan states 416,325 ha of the community (in various condition states) remain. Based on this extent, the Project will impact on at least 0.02% of the community.

Clearing of the community will occur within the inundation area of the dam and along the urban and irrigation pipelines. Clearing along the pipelines will occur along Fletcher's Road, the New England Highway south of Mount Stirling Road, the New England Highway between Fletcher's Road and Eukey Road. The Box-Gum Grassy Woodland will also be affected by habitat loss due to inundation.

Downstream river flows will be altered as a result of the Project. Frequent low flows and infrequent high flows will be unchanged; however medium flows will be impacted for the section of the Severn River between the dam and Accommodation Creek.

Apart from direct clearing of the community within the Project impact areas, the construction and operation of the dam and pipelines is unlikely to cause a substantial decline in quality of the community.

7.7. Avoidance and mitigation measures

The impact of the Project on the Box-Gum Grassy Woodland within the inundation area of the dam cannot be avoided, as the location of the impact area is a result of the placement of the dam wall. Alternate dam sites have been investigated, as described in Section 3.6. The Emu Swamp Dam causes a smaller impact to the Box-Gum Grassy Woodland compared with the Fletcher/Ballandean option. The Emu Swamp Dam will result in the inundation of 71.55 ha compared to the Fletcher/Ballandean option, which will impact on 89 ha. The creation of a buffer area around the dam will be used to allow the community to regenerate through natural regeneration, weed control and some planting of overstorey and understorey species.

The impact of the urban and irrigation pipelines has been minimised by locating the pipelines in a manner that avoids the clearing of vegetation within the road reserve. The small diameter of the pipelines allows for the flexible placement of the pipeline, with the ability to avoid vegetation. The corridor for the pipeline has been reduced to the narrowest width possible for the safe and effective construction of the pipeline. The clearing width for the pipeline will range from 5 m to 12.5 m. This is a significant reduction compared with standard clearing width for pipelines in Australia, that typically range between 20 m and 40 m. Once the pipeline is constructed, a vital component of the community, grasses, herbs and shrubs will be permitted to regrow over the corridor.

Weed pest management

Weed infestation within the Box-Gum Grassy Woodland is a main threatening process, with introduced species often smothering native grasses, herbs and forbs. The removal of weeds from the Box-Gum Grassy Woodland

will help address the decline in the understorey of the community and provide the space for native species to increase coverage and vigour in the community. In the Stanthorpe area, the main weed found in the Box-Gum Grassy Woodland is African Lovegrass (*Eragrostis curvula*). Control and management of African Lovegrass and other weeds will be necessary to see the improvement in the coverage and health of the understorey. The weed management techniques to be used to manage weeds will include herbicides, applied specifically to weeds that pose a threat to the community.

Other weed management techniques such as limited grazing and fire may be used and will be assessed in relation to the threat posed by weeds and relative advantage of these techniques compared to herbicide use.

Regeneration and Revegetation

The Box-Gum Grassy Woodland will be encouraged to regenerate within the buffer area of the Dam. Areas of the woodland are located within the buffer area and will not be affected by the Dam and these areas will be used as the source of seed for the regenerating community. Rehabilitation of Box-Gum Grassy Woodland will be undertaken in accordance with *A Guideline of Managing Box-Gum Grassy Woodlands* (Rawlings et al. 2010).

Material from the cleared Box-Gum Grassy Woodland from the inundation area will be spread over sites where the community will regenerate. This will provide seeds and plants that will be used to form the start of the regenerating community. Mulch and fallen timber will also be used to start regeneration and will be spread across the regeneration sites.

Prior to starting the regeneration of the community, an assessment of the regeneration sites will be completed to determine whether the ground will be treatment in preparation of the spreading of cleared material. For example it may be necessary to remove weeds, loosen top soil or burn the regeneration sites to improve the success rate of establishing the community.

7.8. Residual impacts

The residual impact of the Project on the Box-Gum Grassy Woodland within the inundation area will be a loss of 71.55 ha. The impact of the loss of the community from the inundation area will be significant, on the basis that the dam will remove an area of vegetation along and adjacent to the Severn River of about 5 km in length. The residual impact of the Project on the Box-Gum Grassy Woodland within Stalling Lane will be a loss of 0.74 ha.

The residual impact of a loss of the Box-Gum Grassy Woodland along the pipeline route will not be significant as the loss of vegetation along the alignment of the pipeline will be at the edges of vegetation which are adjacent to cleared areas and roads. Consequently, clearing for the pipelines will not further fragment areas of the community. Once the pipeline is constructed, a vital component of the community, grasses, herbs and shrubs will be permitted to regrow over the corridor. The canopy coverage of the community is typically in the range of 20% to 50%, with the crowns of the overstorey trees being widely separated.

The residual impact of the Project on the Box-Gum Grassy Woodland is 72.29 ha.

8. BORONIA REPANDA

8.1. Biology

Boronia repanda (common name Repand Boronia), a member of the family Rutaceae, is a low shrub with single or multiple stems that grows to a height of 1.5 m. The stems are woody and smooth to glandular-warty. Young branchlets and leaves have white, stellate hairs. Its bark is dark grey-brown and smooth (young growth is red-brown). The leaves are oppositely arranged on the stem, 3-18 mm long and 1-3 mm wide with conspicuous oil dots and small rounded teeth on the margin.

The flowers of *B. repanda* are pale to bright pink or occasionally white with eight stamens and filaments 1.5 to 3 mm long. This species flowers mainly in spring from July to November with hairy fruit appearing during spring or summer. Although regeneration of *B. repanda* generally follows fire, it is particularly sensitive to frequent fire events where the soil-stored seedbank is quickly depleted (DotE 2014e).

Boronia repanda is listed as endangered in the EPBC Act.

8.2. Regional Distribution

Boronia repanda is known from 10 populations, nine in Queensland and one in NSW (the AVH reports 76 locations for *B. repanda*) (Figure 8-1). All confirmed populations in Queensland occur within a 20 km area near Stanthorpe including Cottonvale and Thulimbah, to the north of Stanthorpe. The NSW location is close to the NSW-Queensland border, east of Stanthorpe (CHAH 2014, DotE 2014e). The total population size of this *B. repanda* is estimated to be less than 15,000 individuals (Hunter & Bell 2006) with the total size of Queensland populations estimated as approximately 1,000 individual plants (Donatiu 2006).

This species occurs primarily on sites with good drainage that are protected from fire at altitudes of up to 900 m. It is restricted to rocky sites amongst granite outcrops and scree and well-drained grey/yellow/brown sandy loam soil. *B. repanda* is found within dry sclerophyll forest and heathland. *Boronia repanda* is often found in association with *G. scortechinii* subsp. *scortechinii* (DotE 2014e).



Figure 8-1 *Boronia repanda* distribution (DotE 2014e)

8.3. Occurrence in Project Area

Boronia repanda was not identified during surveys for the EIS (3D Environmental 2007). The species is, however known from a number of HERBRECS records on Pfunders Road and Poziers Road adjacent to the irrigation pipeline in disturbed roadside vegetation with *G. scortechinii* subsp. *scortechinii* (Figure 8-2). Donatiu (2006) notes the population on Pozieres Road on Shire roadside & private freehold consists of 50 -100 individuals. As the total Queensland population has been estimated at around 1,000 individual plants (Donatiu 2006), the group on Pozieres Road is considered significant for the local, regional and state populations of this species.

8.4. Threatening Processes

It is thought that *B. repanda* is affected by clearing for agriculture and fire-reduction purposes, quarrying, inappropriate fire regimes, and consisting of a small number of small populations with no populations under secure conservation tenure (small, isolated populations render species more susceptible to local extinctions following stochastic disturbance events) (DotE 2014e, Hunter & Bell 2006).

B. repanda occurring in Queensland are killed by fire after which they germinate from seed. Frequent fires may deplete the soil seedbank and result in a localised loss of the species.

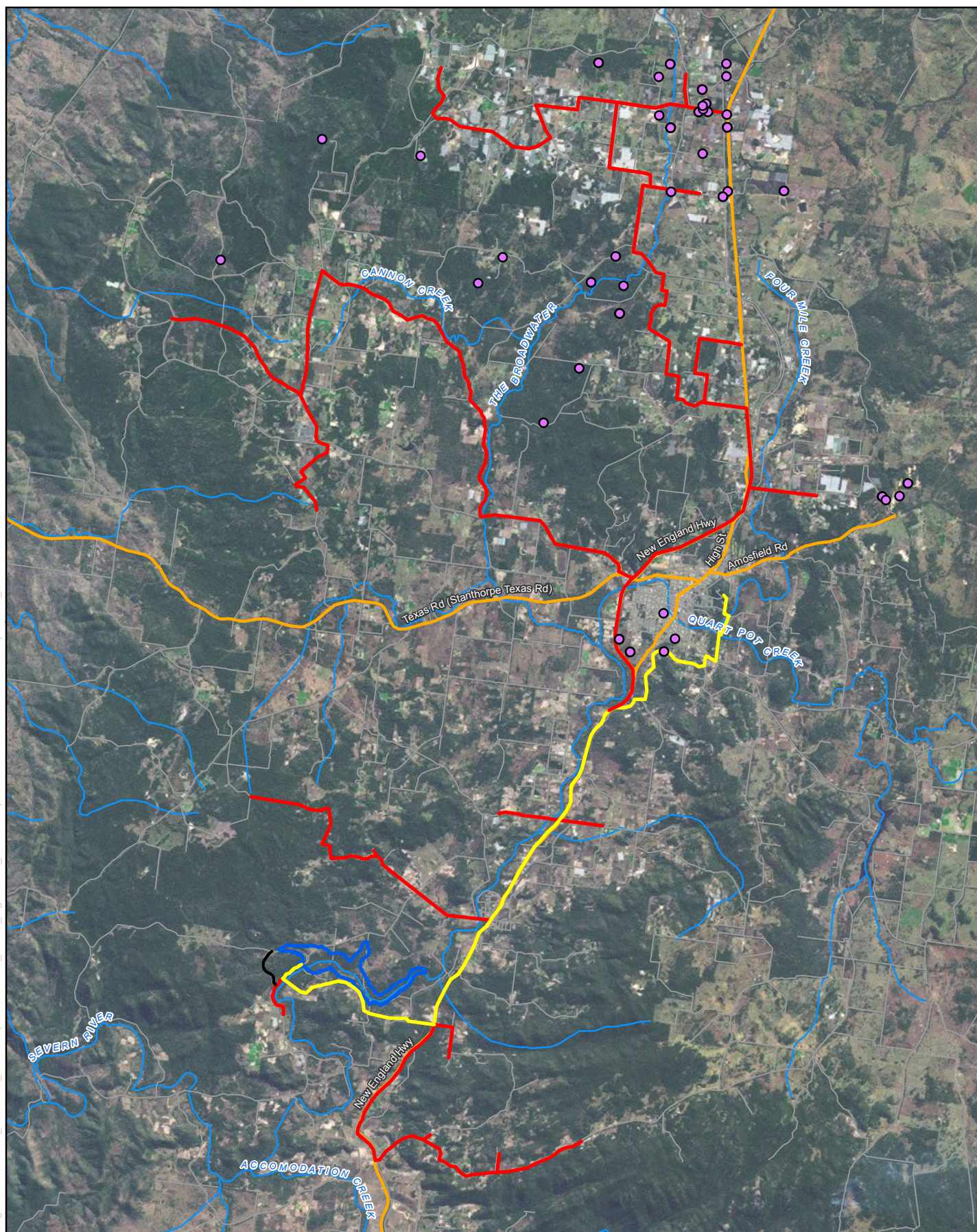
B. repanda is one of the rarest boronias in eastern Australia. Inappropriate collection of seed and cuttings for propagation material is another threat to the species (DotE 2014e).

8.5. Recovery Plan Actions

There is currently no recovery plan for this species however a plan is currently under preparation (DotE 2014e). The NSW Office of Environment and Heritage (2014a) has released a Priority Action Statement PAR for *B. repanda*, and NSW National Parks and Wildlife Service (NPWS, 2002) includes management of *B. repanda* in its National Recovery Plan for *B. granitica*.

The actions and recommendations from NSW NPWS (2002), DotE (2014e) and DECC (2014b) cover the following:

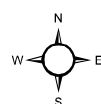
- Further survey for the species and monitor known populations
- Collate existing habitat, distribution, biological and ecological information
- Undertake predictive modelling and use aerial photography, topographic and cadastral maps to identify potential habitat and possible further incidences of *B. repanda*
- Investigate alleged clearing
- Genetic studies to determine provenance and potential population genetic divergence
- Investigate and assess disturbance responses of different ecotypes
- Secure lands which contain this species under conservation agreements
- Investigate land tenure for the NSW populations of *B. repanda*, educate landholders about its protection
- Acquire access to private properties to allow management of *B. repanda*
- Use gathered information to review the status of *B. repanda*



LEGEND

- *Boronia repanda* (database) (Atlas of Living Australia 2014)
- Watercourse
- Road
- Highway
- Urban Pipeline
- Irrigation Pipeline
- Stalling Lane Access
- Full Supply Level (738m AHD)

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Kilometres

Scale - 1:150,000

Projection: GDA94 MGA56

Figure 8-2

Boronia repanda Database
Records and Survey Results



8.6. Potential Impacts

B. repanda was not recorded in the inundation area of the dam, however a group of 50-100 individuals occurs on Pozieres Road in disturbed roadside vegetation with *Grevillea scortechinii* subsp. *scortechinii*. This population occurs in degraded roadside vegetation which is unlikely to be habitat critical to the survival to the species. and The irrigation pipeline alignment has been designed to avoid this population. As such the Project will not lead to a long term decrease in size, or area of occupancy, of this population; nor will the population undergo fragmentation.

A weed management plan will be implemented for the entire Project area, including pipeline construction areas, to prevent invasive species becoming established in vulnerable species habitat. Site hygiene protocols will be implemented in accordance with an environmental management plan (EMP) to prevent introduction of disease.

8.7. Avoidance and mitigation measures

Where this species occurs near the irrigation pipeline, the construction corridor has been placed on the southern side of the road to avoid direct impacts.

The impact of the urban and irrigation pipelines on *B. repanda* has been avoided by locating the pipelines in a manner that avoids the clearing of vegetation within the road reserve. The small diameter of the pipelines allows for the flexible placement of the pipeline, with the ability to avoid the clearing of *B. repanda*. The width of the easement for the pipeline has been reduced to the narrowest width possible for the safe and effective construction of the pipeline. The clearing width for the pipeline will range from 5 m to 12.5 m. This is a significant reduction compared with standard clearing width for pipelines in Australia, that typically range between 20 m and 40 m. Once the pipeline is constructed, *B. repanda* will be permitted to regrow over the easement.

8.8. Residual impacts

As the Project will not cause any direct or indirect impact to *B. repanda*, there are not any residual impacts to the species.

9. ACACIA PUBIFOLIA

9.1. Biology

Acacia pubifolia (common name Velvet Wattle or Wyberba Wattle), a member of the family Mimosaceae, is a low shrub or small tree with dark, fibrous bark that grows to a height of 8 m (TSSC 2014d). This species is common on rocky hillsides and flowering of this species occurs between September and October. The leaf-like phyllodes are dull blue-green, thick and straight (or slightly curved), 2-10 cm long, 8-30 mm wide, with prominent veins, a rounded tip and covered in velvety hairs. The flowers are golden/yellow and arranged in dense spikes 2-5 cm long. The seed pods have slight constrictions between the seeds and are up to 8 cm long and 4 mm wide while the seeds are about 4 mm long and black with a small aril (seed stalk) (McDonald *et al.* 2005, TSSC 2014d).

Acacia pubifolia is listed as vulnerable in the EPBC Act.

9.2. Regional Distribution

The Australia's Virtual Herbarium reports 100 locations for *Acacia pubifolia*, all from northern NSW (primarily around Armidale, Tamworth, Glen Innes and Tenterfield) and southern Queensland (primarily around Wyberba and the western section of Girraween National Park) (Figure 9-1) (CHAH 2014, DotE 2014d, TSSC 2014d). This species occurs primarily in dry, scrubby woodland on granite hillsides with sandy, stony, loam and metasediment soils in eucalypt-scrub woodland or *Eucalyptus/Callitris* spp. forest (DotE 2014d, TSSC 2014d).

The distribution of this species overlaps with the "White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland" EPBC Act-listed TEC.



Figure 9-1 *Acacia pubifolia* distribution (DotE 2014d)

9.3. Occurrence in Project Area

Threatened flora surveys undertaken in 2007 for the EIS identified a population of *A. pubifolia* along the Stalling Lane Access. Fifteen plants were recorded within a 1,000 m² search area, mostly adjacent to the proposed alignment (Figure 9-2) (3D Environmental 2007).

A search of records on Australia's Virtual Herbarium shows 11 occurrences in the local area. The records in the vicinity of the Project are presented in Figure 9-2 (CHAH 2014). There are records from Stalling Lane and Fletcher Road.

9.4. Threatening Processes

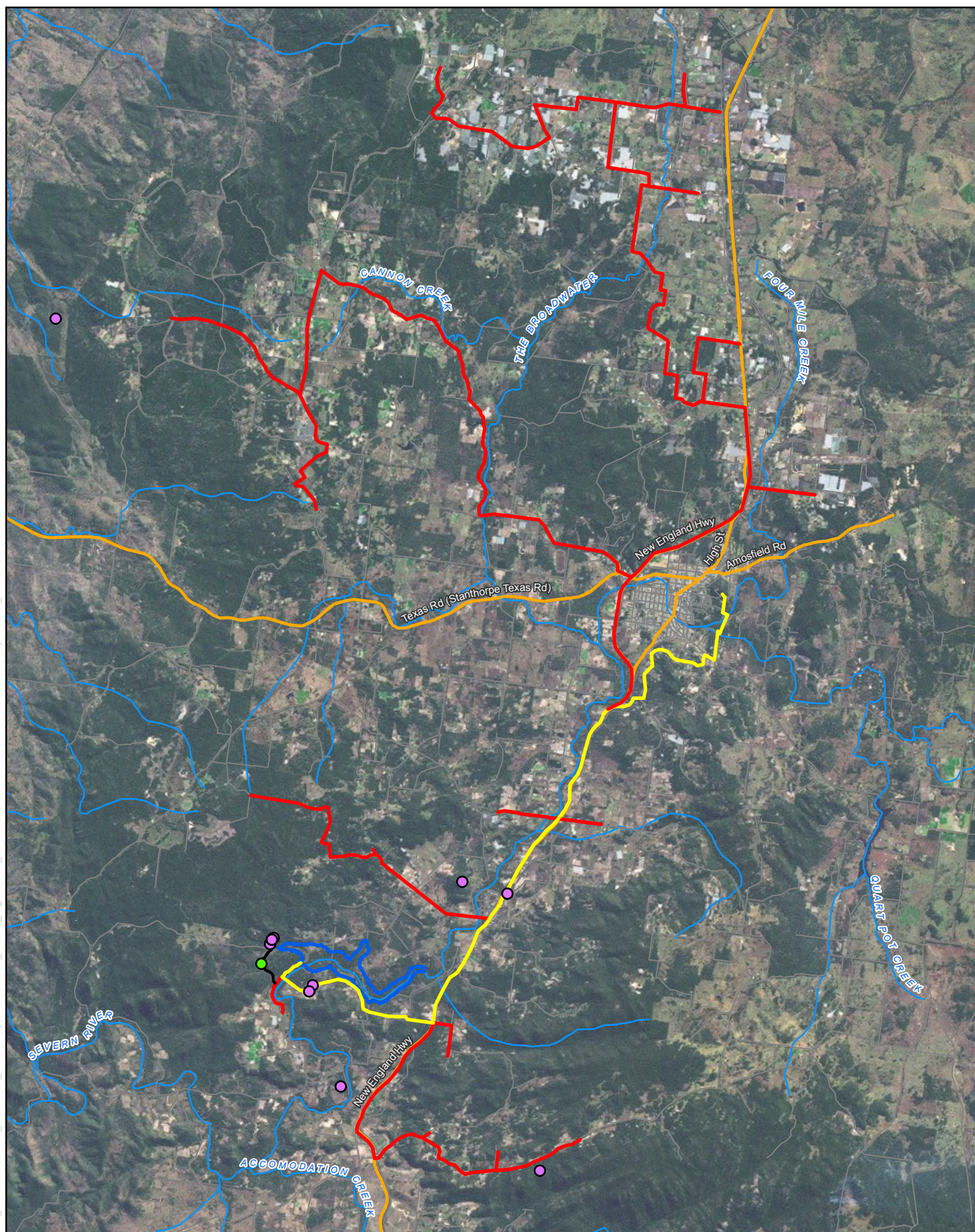
The principal threat to *A. pubifolia* has been identified as inappropriate fire regimes whereby fires can be too frequent (shorter than five years) or infrequent (longer than 30 years) or of insufficient intensity/heat to trigger seed germination. Additional threats include grazing by domestic stock and feral goats, habitat destruction, clearing for agriculture, loss and fragmentation of habitat, development, weed invasion, mining and roads (DotE 2014d, TSSC 2014d).

9.5. Recovery Plan Actions

A recovery plan is not currently required for this species, as described on the SPRAT database (DotE 2014d). The Conservation Advice lists a range of "Research Priorities" including implementation of a monitoring program, more accurate population studies including boarder searches for occurrences and propagation trials (TSSC 2014d).

The NSW DECC maintains a Priority Action Statement (PAS) for *A. pubifolia* (2014a). The PAS and the Conservation Advice note that the following recovery and threat abatement actions can be implemented to support the recovery of *A. pubifolia*:

- Habitat loss, disturbance and modification
 - Map known populations of *A. pubifolia*
 - Assess habitat condition and threats at known *A. pubifolia* sites. Identify populations with high conservation priority.
 - Monitor populations and manage threats to all areas of vegetation containing *A. pubifolia*. Monitor recovery including management effectiveness.
 - Control access to known populations of *A. pubifolia*
 - Manage infrastructure or development activities involving clearing to avoid adverse effects on *A. pubifolia*
 - Pursue formal conservation arrangements for *A. pubifolia*
- Trampling, browsing, grazing
 - Manage threats at known sites to avoid adverse effects on *A. pubifolia* from grazing, including from introduced pests (such as feral goats)
 - Develop and implement a stock management plan to target roadside verges and stock routes



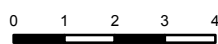
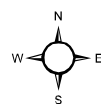
LEGEND

- *Acacia pubifolia* (3D Environmental)
- *Acacia pubifolia* (database) (Atlas of Living Australia 2014)
- Watercourse
- Road
- Highway
- Urban Pipeline
- Irrigation Pipeline
- Stalling Lane Access
- Full Supply Level (738m AHD)

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Figure 9-2

Acacia pubifolia Database
Records and Survey Results



Scale - 1:150,000

Projection: GDA94 MGA56

- Fire
 - Develop and implement a suitable fire management strategy for *A. pubifolia*, including requirements for ecological burns. Incorporate into regional fire plans and hazard reduction burn planning.
 - Work with Rural Fire Services to include mitigation measures in their planning, risk register and operations
- Conservation information
 - Raise awareness of *A. pubifolia* within the local community, especially landowners and road/rail maintenance staff
 - Involve local Land Care groups in *A. pubifolia* management
 - A Voluntary Conservation Agreement or covenant may be appropriate for populations near Warrabah National Park. *A. pubifolia* populations on nearby private land may be suitable for incentive funding.
 - Develop and disseminate environmental impact assessment guidelines for *A. pubifolia*
- Enable recovery of additional sites and/or populations
 - Establish an ex-situ collection site
 - Investigate seed viability and complete germination studies, in storage and the natural environment
 - Investigate options for linking and/or improving existing populations, and establishing new populations if appropriate
 - Identify and model the preferred habitat for *A. pubifolia*

9.6. Potential Impacts

Acacia pubifolia occurs near the proposed Stalling Lane realignment which will be adjusted to avoid these plants. As a result, the Project will not lead to a long term decrease in the size or area of occupancy of this population. The Project will not fragment any existing populations of the species or impact the breeding cycle of this species, however a small area of habitat suitable for this species will be lost.

A weed management plan will be implemented for the entire Project area, including the Stalling Lane area to prevent invasive species becoming established in vulnerable species habitat.

A weed management plan will be implemented for the entire Project area, including pipeline construction areas, to prevent invasive species becoming established in vulnerable species habitat. Site hygiene protocols will be implemented in accordance with an environmental management plan (EMP) to prevent introduction of disease.

9.7. Avoidance and mitigation measures

The impact of the Stalling Lane Access Road on *A. pubifolia* has been avoided by aligning the road to avoid clearing of the species.

The Stalling Lane Access construction alignment will be adjusted to avoid direct impacts on these plants.

9.8. Residual impacts

As the Project will not cause any direct or indirect impact to *A. pubifolia*, there are not any residual impacts to the species.

10. CALLISTEMON PUNGENS

10.1. Biology

Callistemon pungens is a purple-flowered bottlebrush in the family Myrtaceae. It is a very distinctive shrub/small tree that grows to a height of 2-5 m. Its leaves are 2-3 cm long have a pungent tip 1-2 mm long and distinctive oil glands are obvious on the leaf surface. The flower spike is 5-6 cm long and 2.5-4.5 cm in diameter. The stamens of *C. pungens* are generally purple, however they can also be red, white, pink or mauve depending on the subspecies (Craven 2009). This species flowers over spring and summer but primarily in November (Craven 2009, TSSC 2008b).

Craven (2006) proposed that this species, along with all Australian species of the genus *Callistemon*, be reclassified in the genus *Melaleuca*. A species name of *Melaleuca williamsii* was proposed as *M. pungens* was already assigned to a different species (Craven 2006). The name *M. williamsii* has been adopted in Queensland by the Queensland Herbarium however it is still known as *C. pungens* at the federal level. It is likely that those identified in Stanthorpe belong to the subspecies *fletcheri* (i.e. *M. williamsii* subsp. *fletcheri*) (Craven 2009).

Callistemon pungens is listed as vulnerable in the EPBC Act.

10.2. Regional Distribution

Most known *C. pungens* observations are from between Tamworth (NSW) and Stanthorpe (Qld), generally not coming within 100 km from the east coast (Figure 10-1) (CHAH 2014). This species is usually associated with rocky watercourses with sandy granite or basalt creek beds (TSSC 2008b). In Queensland, *C. pungens* is found around Stanthorpe, particularly on the banks of the Severn River where it is usually found growing in the crevices of granite outcrops (CHAH 2014, Craven 2009).



Figure 10-1 *Callistemon pungens* distribution (DotE 2014b)

10.3. Occurrence in Project Area

Field surveys for *C. pungens* were completed during July and October 2013 and also during general flora surveys during December 2006 and June/July 2007 for the EIS (3D Environmental 2007). Before the surveys of 2013, a range of information sources were reviewed to determine where suitable habitat exists for *C. pungens* in the study area:

- Terrestrial Flora Baseline Study, Emu Swamp Dam Project (3D Environmental 2007)
- Australia's Virtual Herbarium (CHAH 2013)
- DNRM vegetation mapping (regional ecosystems, high value regrowth, essential habitat and pre-clearing)
- The regional ecosystem description database (REDD) (DNRM 2011)

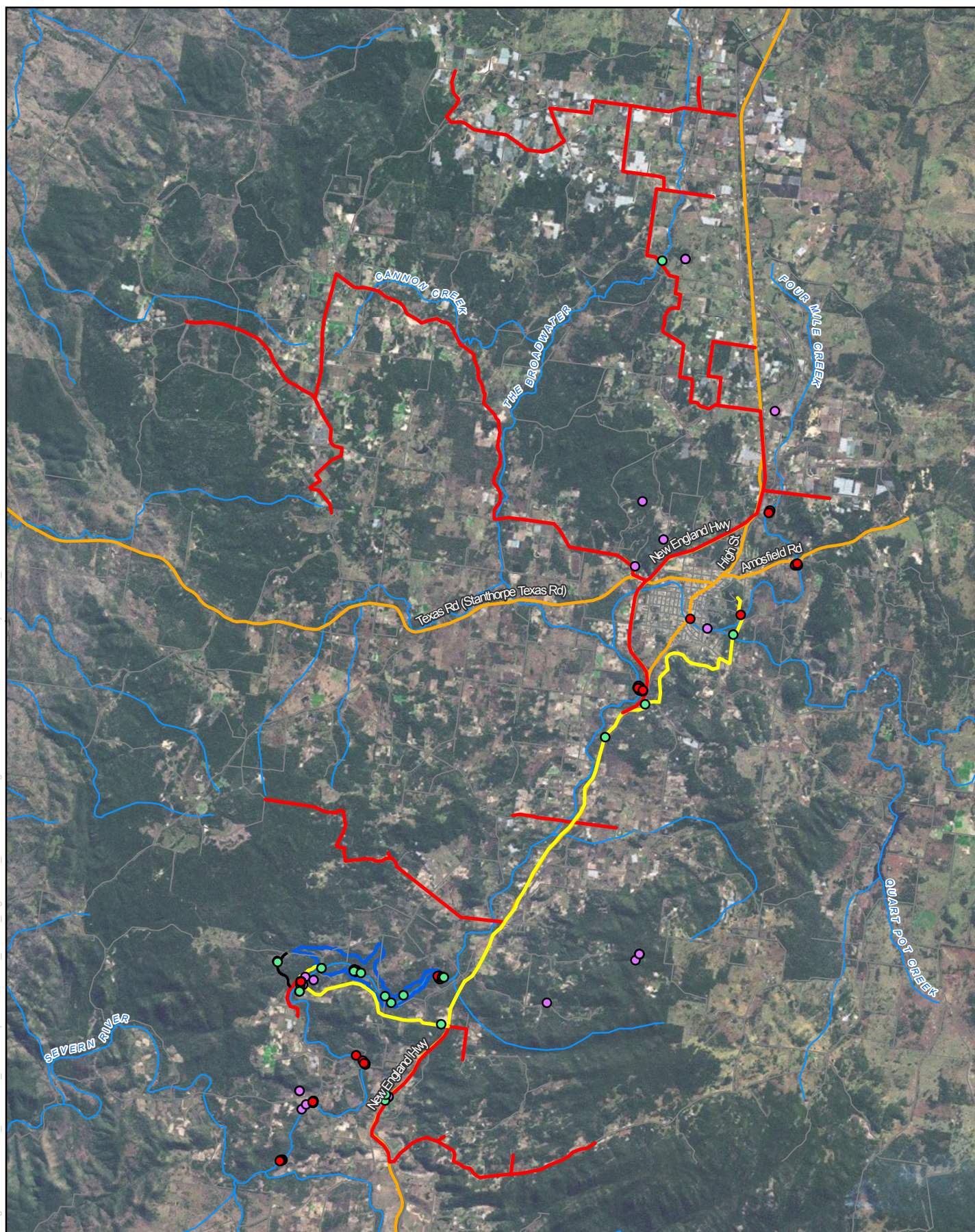
In addition to review of the above data sources, specimens of *C. pungens* held at the Queensland Herbarium were examined by SKM ecologists to develop familiarity with the species' characteristics and to note habitat information recorded on the specimen labels.

The Emu Swamp EIS terrestrial flora surveys (3D Environmental 2007) identified 7 *C. pungens* in the inundation area, four in the Stalling Lane alignment, four in the urban pipeline corridor and three close to the irrigation pipeline corridor. Other individuals were found outside the Project impact areas, including one next to Teale Road (10 km north of Stanthorpe), one 80 m to the west off the New England Highway south of Booth Lane and two approximately 100 m upstream of the FSL.

SKM surveys during July and October 2013 located a total of 287 *C. pungens*, with multiple plants at each of the locations shown in Figure 10-2. Thirty-eight plants were recorded in the inundation area (Figure 10-3), and 249 plants were found outside Project impact areas. Based on SKM and 3D Environmental survey data, a total of 56 *C. pungens* are known to be located within Project impact areas (Table 10-1).

Table 10-1 *Callistemon pungens* locations

Location	Source	Number of <i>C. pungens</i> plants
Inundation Area	SKM	38
Inundation Area	3D Environmental	7
Stalling Lane	3D Environmental	4
Urban Pipeline	3D Environmental	4
Irrigation Pipeline	3D Environmental	3
Total		56



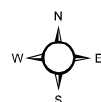
LEGEND

- *Callistemon pungens* (SKM)
- *Callistemon pungens* (3D Environmental)
- *Callistemon pungens* (database) (Atlas of Living Australia 2014)
- Watercourse
- Urban Pipeline
- Irrigation Pipeline
- Road
- Highway
- Stalling Lane Access
- Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure 10-2

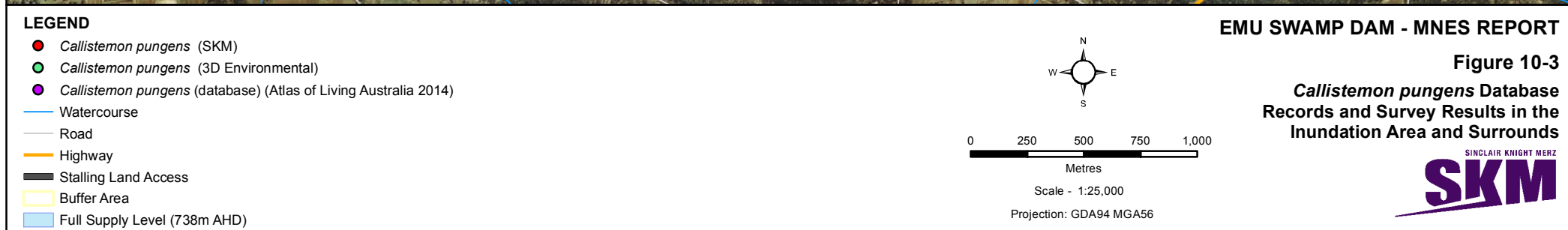
Callistemon pungens Database
Records and Survey Results



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Kilometres

Scale - 1:150,000

Projection: GDA94 MGA56



Plant samples collected in the field have been positively identified by the Queensland Herbarium as *C. pungens*. The samples were also sent to a senior botanist in NSW (Tony Rodd) who provided species identification based on leaf morphology and location data. Tony Rodd has confirmed the identification of the species as *M. williamsii* subsp. *fletcheri* (synonymous with *C. pungens*). Additional flowering samples collected in October 2013 were consistent with this identification and verified by the Queensland Herbarium. Figure 10-4 shows an example of *C. pungens* identified during the October 2013 field survey.

A search of records on the Atlas of Living Australia shows 13 occurrences within a 5 km radius of the Project site (Atlas of Living Australia 2014). Seven of these records are concentrated around the Emu Swamp Road/Fletcher Road intersection, south-west of the dam wall and just outside the Project footprint.



Figure 10-4 *Callistemon pungens* identified during field surveys

10.4. Threatening processes

The main threats to *C. pungens* are habitat loss, weed invasion (specifically Japanese honeysuckle, *Lonicera japonica* and blackberry, *Rubus anglocandicans*) and habitat fragmentation. The effects of fire on *C. pungens* is not well known, however anthropogenic modification of natural fire regimes are thought to be a threat (a 5-15 year fire regime is considered suitable for the survival of this species) (TSSC 2014b).

The recovery of *C. pungens* can be supported through ongoing monitoring of threats and recovery; minimising impacts from public access; minimising land use change; removal of, and protection from the invasion of weeds and implementation of appropriate fire regimes.

10.5. Recovery Plan Actions

A recovery plan is not currently required for this species (DotE 2014b). The Conservation Advice lists a range of “Research Priorities” including implementation of a monitoring program and more accurate population studies in order to better inform future regional and local priority actions (TSSC 2014b).

The Conservation Advice and the NSW Office of Environment and Heritage (2014) note that the following priority actions (regional and local) should be implemented to support the recovery of *C. pungens*:

- Habitat loss, disturbance and modification
 - Identify populations with high conservation priority
 - Monitor populations and manage threats to all areas of vegetation containing *C. pungens*. Monitor recovery including management effectiveness.
 - Control access to known populations of *C. pungens*
 - Manage weed eradication measures and infrastructure or development activities to avoid adverse effects on *C. pungens*. Minimise adverse effects of land use.
 - Pursue formal conservation arrangements for *C. pungens*
- Invasive weeds
 - Develop and implement a plan to control threatening weeds
 - Manage sites to remove and prevent the introduction of threatening weeds.
- Fire
 - Develop and implement a suitable fire management strategy and regime for *C. pungens*, at intervals and of intensities that promote seed germination
 - Work with Rural Fire Services to include mitigative measures in their planning, risk register and operations
- Conservation information
 - Raise awareness of *C. pungens* within the local community
- Enable recovery of additional sites and populations
 - Undertake appropriate seed collection and storage, germination and propagation to identify the requirements for successful establishment
 - Investigate options for linking and/or improving existing populations, and establishing new populations if appropriate

10.6. Potential Impacts

The Project will lead to the loss of 45 plants of *C. pungens* from the inundation area of the Dam. The plants along the pipeline route can be protected by pipeline re-alignment. The greatest impact to the species is to occur within the inundation area of the dam. The location of *C. pungens* within and nearby the inundation area is presented in Figure 10-3. Small numbers of plants are also present along the pipeline network mainly along Fletcher’s Road and the New England Highway, south of Stanthorpe (refer to Figure 10-2).

The impacts will be caused by flooding and clearing for construction of the dam wall, roads and the pipeline network.

The inundation area of the dam will be permanently lost has habitat for the species, other terrestrial species and communities. Habitat for the species will continue to be available along the pipeline route and regeneration or replanting of *C. pungens* will be possible following the construction of the pipeline. Habitat will also be available within the buffer area surrounding the dam, and *C. pungens* will be able to regenerate in this area, as well able to be planted.

10.7. Avoidance and Mitigation Measures

The impact of the Project on *C. pungens* within the inundation area of the dam cannot be avoided, as the location of the impact area is a result of the placement of the dam wall. The creation of a buffer area around the dam will be used to re-establish and regenerate plants of the species. Weed control will also be undertaken to aid in the re-establishment of the species within the buffer zone.

The impact of the urban and irrigation pipelines has been minimised by locating the pipelines in a manner that avoids the clearing of vegetation within the road reserve. The small diameter of the pipelines allows for the flexible placement of the pipeline, with the ability to avoid vegetation. The width of the corridor for the pipeline has been reduced to the narrowest width possible for the safe and effective construction of the pipeline. The clearing width for the pipeline will range from 5 m to 12.5 m. This is a significant reduction compared with standard clearing width for pipelines in Australia, that typically range between 20 m and 40 m. Once the pipeline is constructed, *C. pungens* will be permitted to regrow over the easement.

10.8. Residual impacts

The residual impact of the Project on *C. pungens* within the inundation area will be loss of 45 plants. The impact of the loss of these plants will be significant for section of the Severn River that will be inundated for the dam. Individuals of the species found in the vicinity of the dam but outside the inundation area will not be affected by the Project and will continue to survive after the Project is completed.

11. GREVILLEA SCORTECHINII SUBSP. SCORTECHINII

11.1. Biology

Grevillea scortechinii subsp. *scortechinii* (common name Black Grevillea), a member of the family Proteaceae, is a low spreading shrub that is usually a groundcover but sometimes grows up to 1.5 m in height and has branches of up to 60 cm in length, that radiate from a central stem (Leigh *et al.* 1984). Its leaves are stiff and papery with sharply toothed edges and its flowers are black and green. This species may be confused with the closely related Backwater Grevillea (*Grevillea scortechinii* subsp. *sarmentosa*) however *G. scortechinii* subsp. *scortechinii* can be distinguished by its longer pistil and stipe length, papery (rather than leathery) leaf texture and leaves that only ever have primary divisions (DotE 2014c).

Grevillea scortechinii subsp. *scortechinii* is listed as vulnerable in the EPBC Act.

11.2. Regional Distribution

Grevillea scortechinii subsp. *scortechinii* is currently known from four sites near Stanthorpe, Queensland. This species occurs in sclerophyll woodland or remnant roadside associations in granitic, sandy-loamy soils. It occurs chiefly on flats and lower slopes (including slopes below rocky outcrops), and does not extend into poorly drained areas (TSSC 2008c). It is represented in Queensland by 11 herbarium collections, the majority of which are from Pozieres Road, approximately 30 km north of the Project site. The Australian Virtual Herbarium reports 21 locations for *G. scortechinii* subsp. *scortechinii*, primarily around Stanthorpe and Thulimbah (CHAH 2014).

The distribution of this species overlaps with the “White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland” EPBC Act-listed TEC.



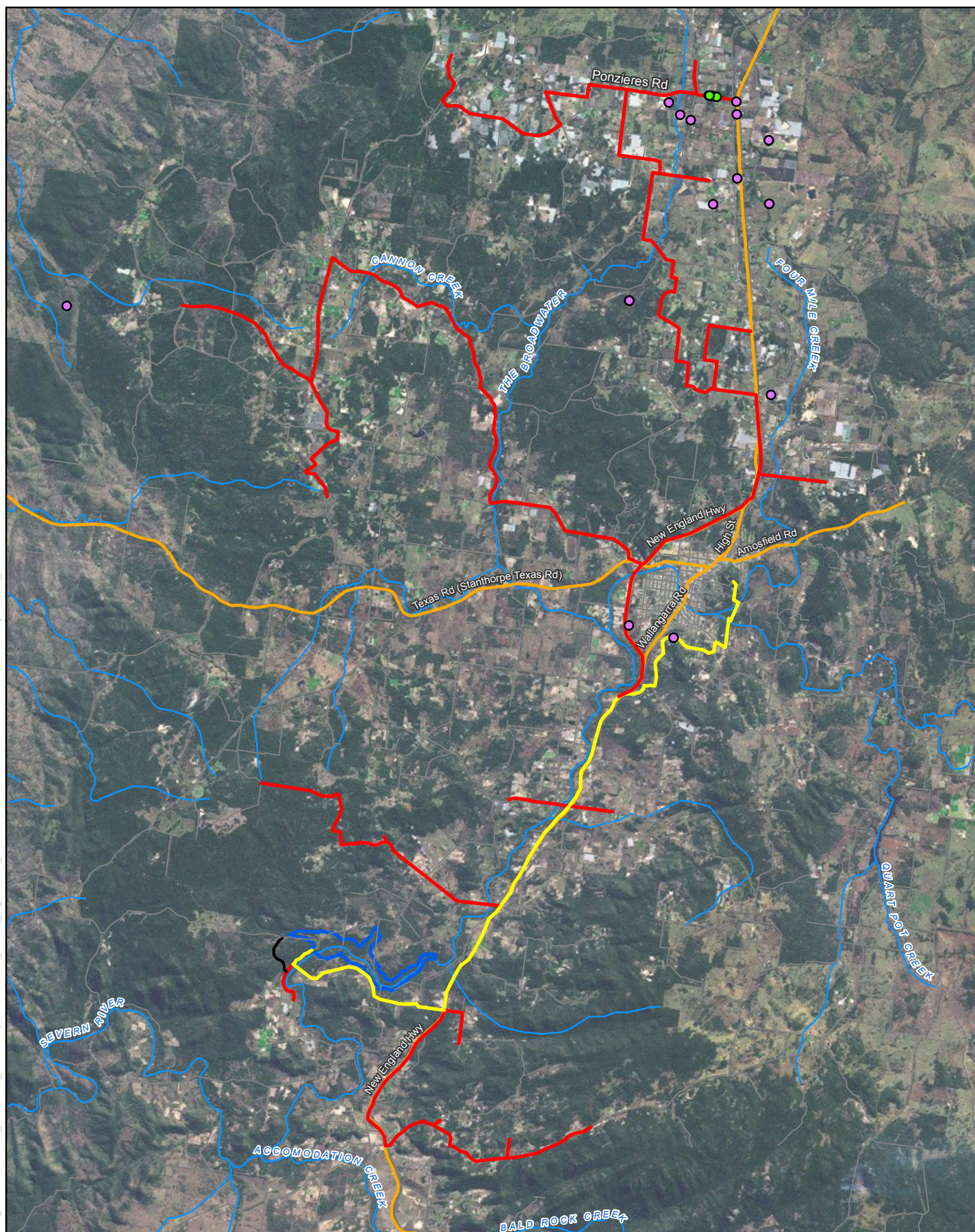
Figure 11-1 *Grevillea scortechinii* subsp. *scortechinii* distribution (DotE 2014c)

11.3. Occurrence in Project Area

Threatened flora surveys undertaken in 2007 for the EIS identified a population of *G. scortechinii* subsp. *scortechinii* on Pozieres Road, to the north of the study area (

Figure 11-2). The population consisted of approximately 50 individuals over a linear distance of approximately 100 m (3D Environmental 2007). Plants were found on the northern side of the road in a narrow verge of disturbed regrowth located between the road drain and a *Pinus* plantation. One plant was observed on the southern side of the road on the immediate road margin adjoining an apple orchard windbreak. This population is in an area that is highly vulnerable to roadside disturbance such as edge effects, weeds, inappropriate management and frequent fire. *Grevillea scortechinii* subsp. *scortechinii* was not identified within any of the Project impact areas.

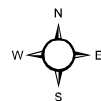
The AVH does not report any sightings of this species significantly south of Stanthorpe with the nearest sighting falling c. 15 km from the dam location.



LEGEND

- *Grevillea scortechinii* subsp. *scortechinii* (3D Environmental)
- *Grevillea scortechinii* subsp. *scortechinii* (database) (Atlas of Living Australia 2014)
- Watercourse
- Urban Pipeline
- Irrigation Pipeline
- Road
- Highway
- Stalling Lane Access
- Full Supply Level (738m AHD)

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0 1 2 3 4
Kilometres

Scale - 1:150,000

Projection: GDA94 MGA56

Figure 11-2

Grevillea scortechinii subsp.
scortechinii Database Records
and Survey Results



11.4. Threatening Processes

The main identified threat to *G. scortechinii* subsp. *scortechinii* is land clearing for pasture and orchard development. Additional threats include disturbance to roadside corridors including roadside burning, grading, clearing and weed invasion (TSSC 2014c).

11.5. Recovery Plan Actions

A recovery plan is not currently required for this species (DotE 2014c). The Conservation Advice lists a range of "Research Priorities" including implementation of a monitoring programme, more accurate population studies including boarder searches for occurrences and propagation trials (TSSC 2014c).

The Conservation Advice also notes that the following recovery and threat abatement actions can be implemented to support the recovery of *G. scortechinii* subsp. *scortechinii*:

- Habitat loss, disturbance and modification
 - Identify populations with high conservation priority
 - Monitor populations and manage threats to all areas of vegetation containing *G. scortechinii* subsp. *scortechinii*. Monitor recovery including management effectiveness.
 - Control access to known populations of *G. scortechinii* subsp. *scortechinii*
 - Manage weed eradication measures and infrastructure or development activities to avoid adverse effects on *G. scortechinii* subsp. *scortechinii*. Minimise adverse effects of land use.
 - Pursue formal conservation arrangements for *G. scortechinii* subsp. *scortechinii*
- Invasive weeds
 - Develop and implement plans to control threatening weeds
 - Manage sites to remove and prevent the introduction of threatening weeds.
- Fire
 - Develop and implement a suitable fire management strategy and regime for *G. scortechinii* subsp. *scortechinii*, at intervals and of intensities that promote seed germination
 - Work with Rural Fire Services to include mitigative measures in their planning, risk register and operations
- Conservation information
 - Raise awareness of *G. scortechinii* subsp. *scortechinii* within the local community, especially landowners and road/rail maintenance staff
- Enable recovery of additional sites and populations
 - Undertake appropriate seed collection and storage, germination and propagation to identify the requirements for successful establishment
 - Investigate options for linking and/or improving existing populations, and establishing new populations if appropriate

11.6. Potential Impacts

The Project will not cause an impact to *G. scortechinii* subsp. *scortechinii*. The species has not been found within the inundation area of the Dam. It has been identified in around Pozieres, to the north of the Project site, along the route of the urban and irrigation pipeline.

Impact to the species found along the urban and irrigation pipeline will be avoided. The urban and irrigation pipeline will be aligned to avoid the clearing of *G. scortechinii* subsp. *scortechinii*.

11.7. Avoidance and Mitigation Measures

The impact of the urban and irrigation pipelines on *G. scortechinii* subsp. *scortechinii* has been avoided by locating the pipelines in a manner that avoids the clearing of vegetation within the road reserve. The small diameter of the pipelines allows for the flexible placement of the pipeline, with the ability to avoid the clearing of *G. scortechinii* subsp. *scortechinii*. The width of the easement for the pipeline has been reduced to the narrowest width possible for the safe and effective construction of the pipeline. The clearing width for the pipeline will range from 5 m to 12.5 m. This is a significant reduction compared with standard clearing width for pipelines in Australia, that typically range between 20 m and 40 m. Once the pipeline is constructed, *G. scortechinii* subsp. *scortechinii* will be permitted to regrow over the easement.

11.8. Residual impacts

As the Project will not cause any direct or indirect impact to *G. scortechinii* subsp. *scortechinii*, there are not any residual impacts to the species.

12. EUCALYPTUS MCKIEANA

12.1. Biology

Eucalyptus mckieana (common name McKie's Stringybark), a member of the family Myrtaceae, is a medium sized tree that grows to a height of 30 m. This species usually has a straight trunk and red-brown stringy or fibrous bark that extends to the ends of the branches. The juvenile leaves are bristly and very narrow and adult leaves are glossy or grey-green, 6–9 cm long and 1–2 cm wide. The fruit are ball-shaped, 5–7 mm wide, and grow clustered in groups of eleven or more. *Eucalyptus mckieana* is one of a group of related stringybark species that have hairy seedlings, reticulate venation (i.e. forming a network) on the adult leaves, numerous oil glands, buds in 7s or more, and inflorescences that are axillary (in the leaf axis). The species is distinguished by the ascending disc of the fruits, the clearly stalked buds and fruits, and leaves having the same colour on both sides. The juvenile leaves are also narrower than in related species (TSSC 2008f).

Eucalyptus mckieana is listed as vulnerable in the EPBC Act.

12.2. Regional Distribution

Eucalyptus mckieana is known from a small area of the Northern Tablelands of NSW and the Stanthorpe region forms the northernmost extent of its known distribution (Figure 12-1). There are very few records of the species around Stanthorpe, it has been recorded at Severnlea and near the corner of Fletcher Road and the New England Highway.

Eucalyptus mckieana is known from a fairly small area of the Northern Tablelands of NSW and the Stanthorpe region forms the northernmost extent of its known distribution (Figure 12-1).

This species usually grows in gently undulating to flat areas, on the drier western side of the New England Tablelands and on the upper western slopes at altitudes of approximately 600–1050 m. The mean annual rainfall for this area is approximately 650–750 mm. It grows on a range of soil types including deep clay loams on metasediments but more commonly on sandy loams derived from granites and quartz porphyrites; found on both moderately fertile and siliceous, relatively infertile, granitic soils (TSSC 2008f).

The distribution of this species overlaps with the “White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland” EPBC Act-listed TEC.



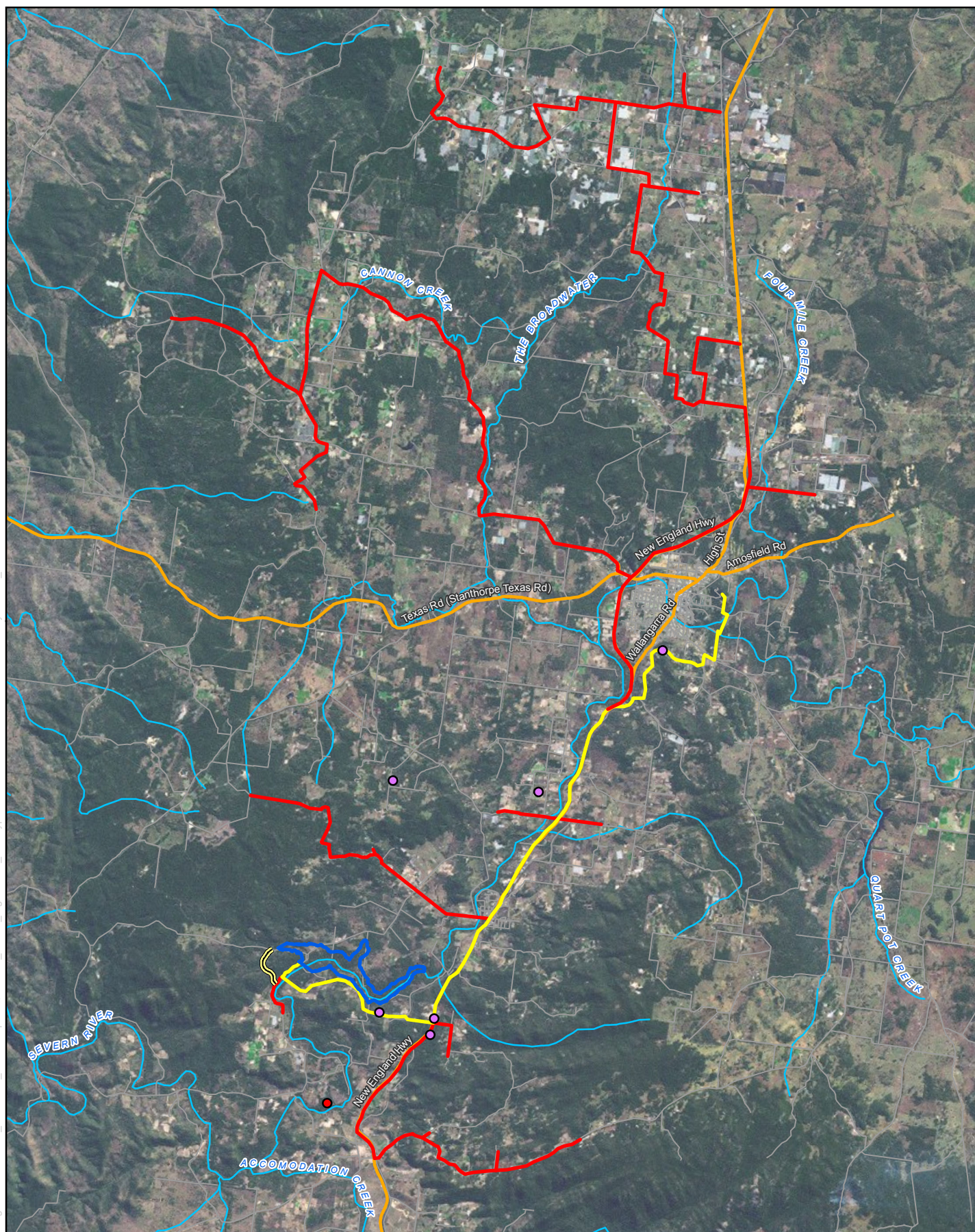
Figure 12-1 *Eucalyptus mckieana* distribution (DotE 2014k)

12.3. Occurrence in Project Area

Eucalyptus mckieana was identified in the vicinity of the Project in July 2013 but not in any impact areas (Figure 12-2).

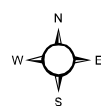
The occurrences of *E. mckieana* in the vicinity of the Project are at the northernmost extent of its known distribution. A record about 1 km south of Stanthorpe is the northernmost confirmed location in the Atlas of Living Australia for this species (Atlas of Living Australia 2014).

There are three known locations of *E. mckieana* within 5 km of the Project: one about 400 m west of Rhumbalara Railway crossing on Fletcher Road (about 250m south of the inundation area) and one on either side of Horans Gorge Road, east of the New England Highway (1.5 km east of the inundation area) (Figure 12-2) (Atlas of Living Australia 2014). This species was identified during surveys for the Supplementary EIS however the survey site was well outside the Project impact areas, approximately 1 km west of the proposed pipeline alignment and 4 km south of the FSL. The species was not identified during surveys for the EIS (3D Environmental 2007) and there have been no individuals of this species identified in the impact areas of the Project.



LEGEND

- *Eucalyptus mckieana* (SKM)
- *Eucalyptus mckieana* (database) (Atlas of Living Australia 2014)
- Watercourse
- Road
- Highway
- Urban Pipeline
- Irrigation Pipeline
- Stalling Lane Access
- Full Supply Level (738m AHD)



0 1 2 3 4
Kilometres

Scale - 1:150,000

Projection: GDA94 MGA56

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Figure 12-2

Eucalyptus mckieana Database
Records and Survey Results



12.4. Threatening processes

The main identified threats to *E. mckieana* include clearing and fragmentation of habitat for agriculture, development and rural subdivision; grazing by domestic stock and feral rabbits; destruction of trees and disturbance of habitat by timber-harvesting activities and collection of firewood (TSSC 2008f).

Much of the distribution of this species is on moderate soils in flattish to gently sloping country which has been subject to fairly extensive clearing for grazing. Other areas in which it occurs have been subject to considerable disturbance by mining (TSSC 2008f).

12.5. Recovery Plan Actions

A recovery plan is not currently required for this species (DotE 2014k). The Conservation Advice lists a range of “Research Priorities” including implementation of a monitoring programme and more accurate population studies and survey work, undertaking seed germination trials and investigating the significance of the species to local Aboriginal communities in order to better inform future regional and local priority actions (TSSC 2008f).

The Conservation Advice also notes that the following priority actions (regional and local) can be implemented to support the recovery of *E. mckieana* (TSSC 2008f):

- Habitat loss, disturbance and modification
 - Identify populations with high conservation priority.
 - Monitor populations and manage threats to all areas of vegetation containing *E. mckieana*. Monitor recovery including management effectiveness.
 - Control collection of firewood, retain standing and fallen dead timber in stands containing *E. mckieana*
 - Manage agriculture, timber harvesting, or development activities to avoid adverse effects on *E. mckieana*. Notify appropriate agencies for protection of *E. mckieana* on roadsides and utility easements during construction and maintenance.
 - Pursue formal conservation arrangements for *E. mckieana*
 - Manage weed control to avoid significant adverse impact on *E. mckieana*
- Invasive weeds
 - Control weeds where required
- Trampling, browsing, grazing
 - Develop and implement a stock management plan to target roadside verges and stock routes
 - Exclude stock from remnants and eradicate rabbits to allow natural revegetation
- Fire
 - Develop and implement a suitable fire management strategy and burn regime for *E. mckieana*.
 - Work with rural fire services to include mitigative measures in their planning, risk register and operations
- Conservation information
 - Raise awareness of *E. mckieana* within the local community
 - Develop sustainable management guidelines and technical material to assist landholders
- Enable recovery of additional sites and/or populations
 - Collect and store seeds

- Link and/or improve existing populations. Investigate establishing new populations if appropriate.

12.6. Potential Impacts

The impact will not cause a direct or indirect impact on *E. mckieana*. The species is not present in the inundation area of the dam or along the route of the urban or irrigation pipeline.

12.7. Avoidance and mitigation measures

The Project will avoid direct and indirect impacts on *E. mckieana*. Consequently, the Project does not need to take specific actions to avoid the species or implement mitigation measures.

12.8. Residual impacts

As the Project will not cause any direct or indirect impact to *E. mckieana*, there are not any residual impacts to the species.

13. SPOTTED-TAIL QUOLL

13.1. Biology

The Spotted-tail Quoll (*Dasyurus maculatus maculatus*, family: Dasyuridae) is a nocturnal, cat-sized, carnivorous marsupial with reddish-brown fur and short legs with a pointed face. It has distinctive white spots over its back and tail and a pale belly. The Spotted-tail Quoll is the only Australian Quoll with a spotted tail, although it may be difficult to distinguish on juvenile animals. The Spotted-tail Quoll is predominantly nocturnal and rests during the day in dens, however this species will also hunt during the day. Males are generally larger than females in both length and weight and both sexes mature at about one year of age (DotE 2014i, NSW OEH 2014).

This subspecies has been recorded from a wide range of habitats, including: temperate and subtropical rainforests in mountain areas, wet sclerophyll forests, lowland forests, open and closed eucalypt woodlands, inland riparian and River Red Gum (*Eucalyptus camaldulensis*) forests, dry 'rainshadow' woodlands, sub-alpine woodlands, coastal heathlands. There are occasional sightings from open country, grazing lands, rocky outcrops and other treeless areas (DotE 2014i).

Individuals also require an abundance of food, such as birds and small mammals, and large areas of relatively intact vegetation through which to forage (NSW NPWS 1999a). Radio-tracking studies (Claridge *et al.* 2005) of the Spot-tailed Quoll in Kosciuszko NP in 2002 resulted in home range estimates of 620–2560 ha for males, and 90–650 ha for females. The mean home range for males was 992 ± 276 ha, and 244 ± 72 ha for females (Claridge *et al.* 2005). The presence of suitable habitat in a broad sense is not indicative of good quality habitat for the Spotted-tailed Quoll, with large, intact areas of habitat a prerequisite for its occurrence. The structure of Spotted-tailed Quoll populations is driven by the presence of female breeding ranges which are stable home range areas associated with highly productive areas of remnant vegetation, typically within extensive tracts of bushland.

The Spotted-tail Quoll is listed as endangered in the EPBC Act.

13.2. Regional distribution

The Spotted-tail Quoll is distributed from south-east Queensland (as far north as Bundaberg and east to Stanthorpe), down the east coast of NSW to eastern Victoria (Figure 13-1) (DotE 2014i, NSW OEH 2014).

This species has been recorded across a range of habitats including temperate and subtropical rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops and crevices or caves. Individuals also require an abundance of food, such as birds and small mammals, and large areas of relatively intact vegetation through which to forage. This subspecies is moderately arboreal and approximately 11% of travelling is done in trees (DotE 2014i, Jones *et al.* 2001).

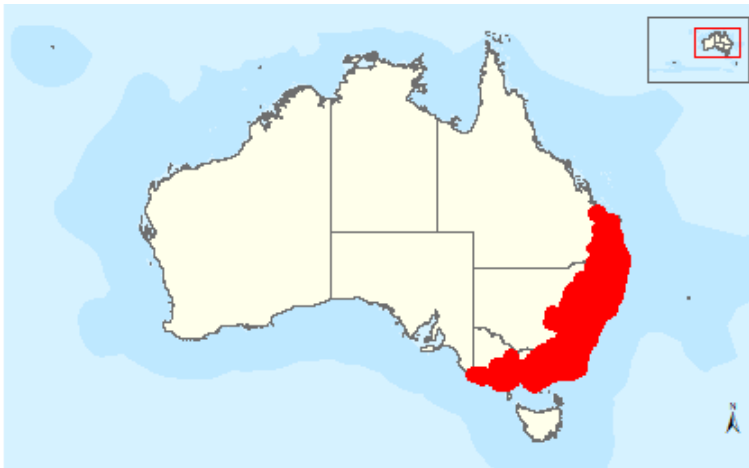


Figure 13-1 Spotted-tail Quoll distribution (DotE 2014i)

The Atlas of Living Australia (2014) reports four records within a 15 km radius of the project; one in Stanthorpe, one north of Broadwater, one c. 2 km west of Ballandean and one west of Bald Rocks National Park (just off the New England Highway). There are also a number of records in the eastern half of Bald Rocks National Park. The species is almost certainly underreported in the district, with a recent study of the Eukey locality (Balance Environmental, 2013) (approximately 10km to the east of the Project area) finding that “Anecdotal evidence from people attending the Eukey Farm Ecology event suggests that the quoll is still encountered regularly in the district, often when it raids poultry enclosures for an easy meal.”

The Spotted-tailed Quoll is considered likely to occur patchily from Bald Rock-Giraween National Parks in the east through to Sundown National Park in the west. Larger tracts of vegetation on private land and within State Forests are also likely to support this species.

13.3. Occurrence in Project Area

The Spotted-tail Quoll was not recorded within or nearby the Project area, despite a specific trapping effort, nor were any traces of the species located. It was reported by a landholder within the Project area.

The Spotted-tailed Quoll is unlikely to permanently occupy the Project area, and this is supported by a lack of evidence of repeated usage, particularly an absence of latrine sites. Latrines of the Spot-tailed Quoll are sites where groups of individuals repeatedly urinate and defecate over long periods of time. This results in the bleaching of the soil substrate and an accumulation of scats. For a highly cryptic species such as the Spotted-tailed Quoll, latrines provide focal points for studies into distribution, diet, habitat, population structure, and management. Latrines are typically found in rocky creek beds, at the bases of cliffs, and on roads (DotE 2014i).

It is likely that the woodland/forest areas in the Project area provide foraging and dispersal opportunities for Spotted-tailed Quoll though sheltering opportunities (i.e. dens) are more likely to be located in rocky areas to the west and south of the inundation area. Figure 13-2 shows the distribution of potential denning habitat (Primary habitat) and areas likely to be used for foraging purposes only (secondary habitat). Patches of rocky habitat which are less than 50 ha in area or isolated from larger tracts of vegetation are unlikely to be utilised as denning habitat as they are smaller than an individual female's home range. Such areas are not considered primary habitat.



LEGEND

- Watercourse
- Road
- Highway
- Buffer Area
- Full Supply Level (738m AHD)

Potential Habitat

- Primary Habitat (Potential denning and foraging habitat)
- Secondary Habitat (Foraging habitat only)



0 250 500 750 1,000
Metres

Scale - 1:40,000

Projection: GDA94 MGA56

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Figure 13-2

**Potential Habitat Area for
Spotted-tailed Quoll in the
Inundation Area and Surrounds**



Fragmented areas of vegetation such as that which occurs in the Project area are likely to provide dispersal pathways, particularly for male Spotted-tailed Quolls whose home ranges typically overlap those of several females. The primary value of the Project area for the Spotted-tailed Quoll is considered to be as a component of a broader east-west dispersal pathway.

13.4. Threatening processes

The main threat to the Spotted-tail Quoll is loss, degradation and fragmentation of its habitat. The main drivers of habitat loss are clearing of native vegetation and timber harvesting. These drivers also result in reduced prey abundance, greater pest and predator incursion and changed fire regimes.

Additional threats include predation by foxes, dingos and domestic dogs. Given the prey and habitat overlap with introduced pests such as cats and foxes, competition for resources may also be affecting this species. Altered fire regimes, direct killings by landholders, road mortality, poisoning by cane toads and non-target 1080 poisoning are additional threats.

13.5. Recovery Plan Actions

There is currently no recovery plan for this species however this has been judged as required and it is currently under preparation (DotE 2014i). A number of threat abatement and recovery recommendations are listed in DotE (2014i) including:

- Reduction of 1080 baiting in areas where the Spotted-tail Quoll is known and ensure that pest control activities comply with best practice protocols
- Habitat management at a landscape level
- Continuing research, surveys and monitoring programmes
- Manage or avoid habitat disturbance in reserved areas known to support Spotted-tail Quoll populations
- Protection of critical Spotted-tail Quoll habitat should be incorporated into fire management prescriptions
- Investigate any Spotted-tail Quoll sightings in areas with few recent records
- Develop a detection model to assess the presence and habitat use of Spotted-tail Quolls

The NSW Office of Environment and Heritage (2014b) developed a Species Action Statement for the Spotted-Tail Quoll, as an interim measure while a targeted approach is developed. Actions include:

- Establish and maintain regional working groups to coordinate research and management
- Review survey methods and research new methods to identify an optimal survey protocol
- Conduct field and community surveys for the Spotted-tail Quoll where distributions are poorly known, starting with areas identified for large-scale urban development and coastal reserves
- Map distribution and develop a database, keeping both up to date with new data.
- Identify long-term study sites across the range and within different habitat types
- Systematic monitoring at key sites distributed across the range
- Develop standard data collection protocols, including the collection of genetic material
- Research genetic diversity of populations
- Research and publish ecological information to determine measures of habitat quality
- Liaise with key Aboriginal groups and record understanding of the Spotted-tail Quoll's local distribution, abundance, ecology and threats. Consult with Aboriginal land managers regarding intended conservation management efforts on lands of interest to them.

- Develop licence and agreements with managers of captive Spotted-tail Quoll populations to allow recruitment to captive populations from wild populations, and to facilitate use of captive animals for research
- Develop a communications strategy to educate and increase awareness of the Spotted-tail Quoll. Support community participation in survey and monitoring programs. Include information on 'quoll-proof' poultry runs and aviaries. Seek funding to assist landholders to modify poultry runs and aviaries.
- Gather and use public records and data to identify sections of road where Spotted-tail Quoll are frequently killed. Install signage to alert drivers to their presence. Implement measures to reduce the numbers of animals killed, and assess their effectiveness.
- Habitat requirements of Spotted-tail Quoll to be adequately preserved within legislative protection mechanisms.
- Develop environmental impact assessment guidelines for the Spotted-tail Quoll, including information on survey methods and effort, inappropriate development types, and impact mitigation measures.
- Fire management strategies on habitat reserves to protect rocky outcrops and riparian zones. Research and publish findings on the impact of wildfires and prescription burns on the Spotted-tail Quoll, including predator/ prey relationships.
- Research disturbance thresholds and adequacy of existing habitat protection mechanisms in timber production forests. Renegotiate habitat retention prescriptions if necessary.
- Research predator/ prey interactions to better understand ecosystem-level consequences of 1080 baiting. Investigate impact of fox and wild dog baiting on the Spotted-tail Quoll. Develop protocol for use of poison baits with reduced impacts on Spotted-tail Quolls.
- Investigate demographics of Spotted-tail Quoll populations and develop population viability models
- Assess potential risks to the Spotted-tail Quoll posed by cane toads, as part of the DEC Toad Action Plan
- Deliver a seminar on Spotted-tail Quoll biology and conservation

13.6. Potential Impacts

The Project will reduce primary habitat for the species (potential denning habitat) by 9.2 ha and reduce secondary habitat (foraging only) by 75.1 ha within the inundation area and will indirectly impact the species from the displacement of prey species and feral predator species into adjacent areas more likely to support Spotted-tail Quoll. These impacts will be mitigated by the implementation of a pest management plan to control and prevent the establishment of feral predator species into adjacent habitat as a result of the Project. By reducing predation and competitive pressure in the immediate locality, the Spotted-tailed Quoll is considered likely to utilise the buffer area surrounding the FSL.

Vegetation along the pipeline corridors is unlikely to provide potential habitat for this species due to the fragmented and disturbed condition of vegetation in the road reserves where the pipelines will be constructed. Population scale movement will be unaffected in the long-term and fragmentation is therefore unlikely.

The Project is not anticipated to impact on sheltering (i.e. breeding) habitat. The Project construction does, however, have the potential to disrupt the breeding cycle of a population from the clearing and inundation of habitat, and disturbance to adjacent habitat from noise and dust.

Clearing and inundation of habitat for the Project has the potential to interfere with the recovery of the species from reduction of female territories. Any such impacts on any local population will be minor and short-term and will be mitigated by restoration of habitat in the buffer area around the dam.

13.7. Avoidance and Mitigation Measures

The project will result in the unavoidable loss of 9.2 ha of primary habitat and 75.1 ha of secondary habitat for the Spotted-tailed Quoll. The primary mitigation measure proposed is the rehabilitation of a 322 ha buffer area around the inundation area. The intention is that this buffer be managed for conservation purposes and in the long term it is likely to provide habitat and movement corridors for the Spotted-tailed Quoll. Additional mitigation strategies include the following:

- Development and implementation of a vertebrate pest management plan across the Project area. Dogs and foxes are known to predate Spotted-tailed Quoll, and these species will be targeted by the vertebrate pest management plan.
- Salvage of suitable habitat features such as large rocks and logs from the impact area and placement of these features into suitable habitats within the adjacent buffer area.

Restoration of former habitat was flagged as an appropriate management response for the Spotted-tailed Quoll by Burnett and Marsh (2004) who noted that “Restoration of former habitats includes replanting of cleared habitats, especially where replanting acts to reconnect areas of known or potential quoll habitat. Revegetation needs to proceed hand in hand with other responses, including the control of eutherian carnivores and cane toads and reducing the deliberate and accidental killing by humans. Restoration of former habitats might also include control of the above pressures in relatively intact habitats from which *D. maculatus* has disappeared.”

The merits of habitat restoration for the Spotted-tailed Quoll have been acknowledged by the Queensland Government, who recently funded a project entitled “Extending habitat for endangered Quolls around D'Aguilar National Park”, a restoration project managed by Wildlife Queensland.

13.8. Residual impacts

The Spotted-tailed Quoll has not been verified as present within the Project area, with only anecdotal records of its occurrence. It is considered unlikely that the Spotted-tailed Quoll is resident within the Project area. It is considered likely to disperse through or forage in the Project area, although unlikely to use the areas within FSL for denning purposes. The area of habitat lost in the short term may form part of the home range of a single adult Spotted-tailed Quoll or individuals dispersing from natal ranges and the habitat loss will be mitigated by the protection and rehabilitation of a 322 ha buffer area around the FSL. The buffer will facilitate movement of Spotted-tailed Quoll and provide habitat in its own right.

As the area of habitat impacted will effectively be replaced on site, and movement corridors re-instated and enhanced (impacts can effectively be mitigated on site), it is considered unlikely that there will be an adverse residual impact on the Spotted-tailed Quoll.

14. GRANITE BELT THICK-TAILED GECKO

14.1. Biology

The Granite Belt thick-tailed gecko (*Uvidicolus sphyrurus*) is a robust gecko that grows to 10 cm in length with a large head and a short, bulbous tail. It is coloured pale brown to fawn with darker variegations and small transversely aligned pale spots. Its original tail is blackish with approximately four cream bands (Swanson 2012, TSSC 2008e, Wilson & Swan 2008).

The Granite-belt Thick-tailed Gecko occurs in dry sclerophyll open forest and woodland associated with outcrops of granite, basalt, sandstone and metamorphic rocks (H. Hines & G. Swan in Cogger *et al.* 1993). The majority of sites are associated with granite outcrops (Cogger *et al.* 1993). Surveys conducted in north-eastern NSW indicate that geckos may show a preference for easterly aspects and the base of rock scarps.

The Granite Belt thick-tailed gecko is most commonly found in undisturbed habitat remnants on rock outcrops and stony hills within eucalypt and cypress-pine open forest or woodland between 500 and 1100 m elevation. The Granite Belt Thick-tailed Gecko was formerly thought to be restricted to granitic substrates, but records from regenerating habitat on basalt and metasediment lower slopes and flats indicate a broader pattern of occurrence.

The composition of vegetation appears to have little influence on the occurrence of geckos. Geckos show a preference for canopy cover between 45 and 60% (open forest to woodland), low vegetation cover in the ground layer (average 34%), medium rock cover (average 37%) and high litter cover (average 25%). Individual shelter sites include rocks, decaying logs, bark, and litter in rocky rubble. Shelter sites are usually laying on a litter substrate and shaded by nearby vegetation. Litter depth at shelters located during CRA surveys varied between one and 10 cm (TSSC 2008e).

The Granite Belt Thick-tailed Gecko is listed as vulnerable in the EPBC Act.

14.2. Regional distribution

The Granite Belt Thick-tailed Gecko occurs between Tamworth in NSW and Stanthorpe in Queensland between 500 and 1,500 m above sea level (Figure 14-1) (Atlas of Living Australia 2014, TSSC 2008e). This species is most commonly found on granite and favours dry eucalypt forest of woodland with boulders, rock slabs, fallen timber and deep leaf litter. This species is active at night and shelters by day under rock slabs and fallen timber (TSSC 2008e).

The distribution of this species overlaps with the "White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland" EPBC Act-listed TEC.

The Granite Belt thick-tailed gecko occurs on the Granite Belt and other rock outcrops in rugged terrain of the NSW Northern Tablelands and North-west Slopes (New England Tableland, Nandewar and Brigalow Belt South Bioregions), extending over the Queensland border (about 100 km) to Girraween National Park and west of Stanthorpe-Warwick (Durikai State Forest). The number of populations is uncertain but within Queensland include populations in Durikai State Forest, Sundown National Park and Girraween National Park. Durikai State Forest represents the northern distributional limit of the species. Populations are mostly fragmented, with over 50 discrete sites currently known for the species across its distribution that are separated by at least 2 km (NSW DECC, 2014).

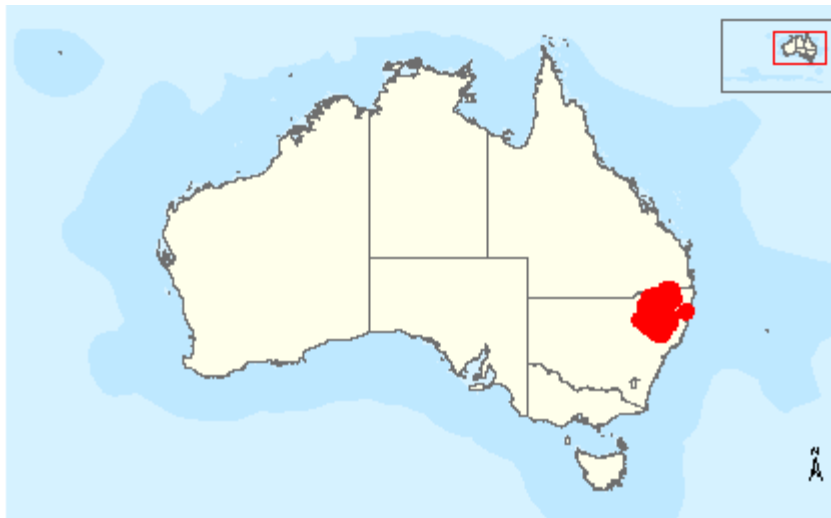


Figure 14-1 Granite Belt Thick-tailed Gecko distribution (DotE 2014f)

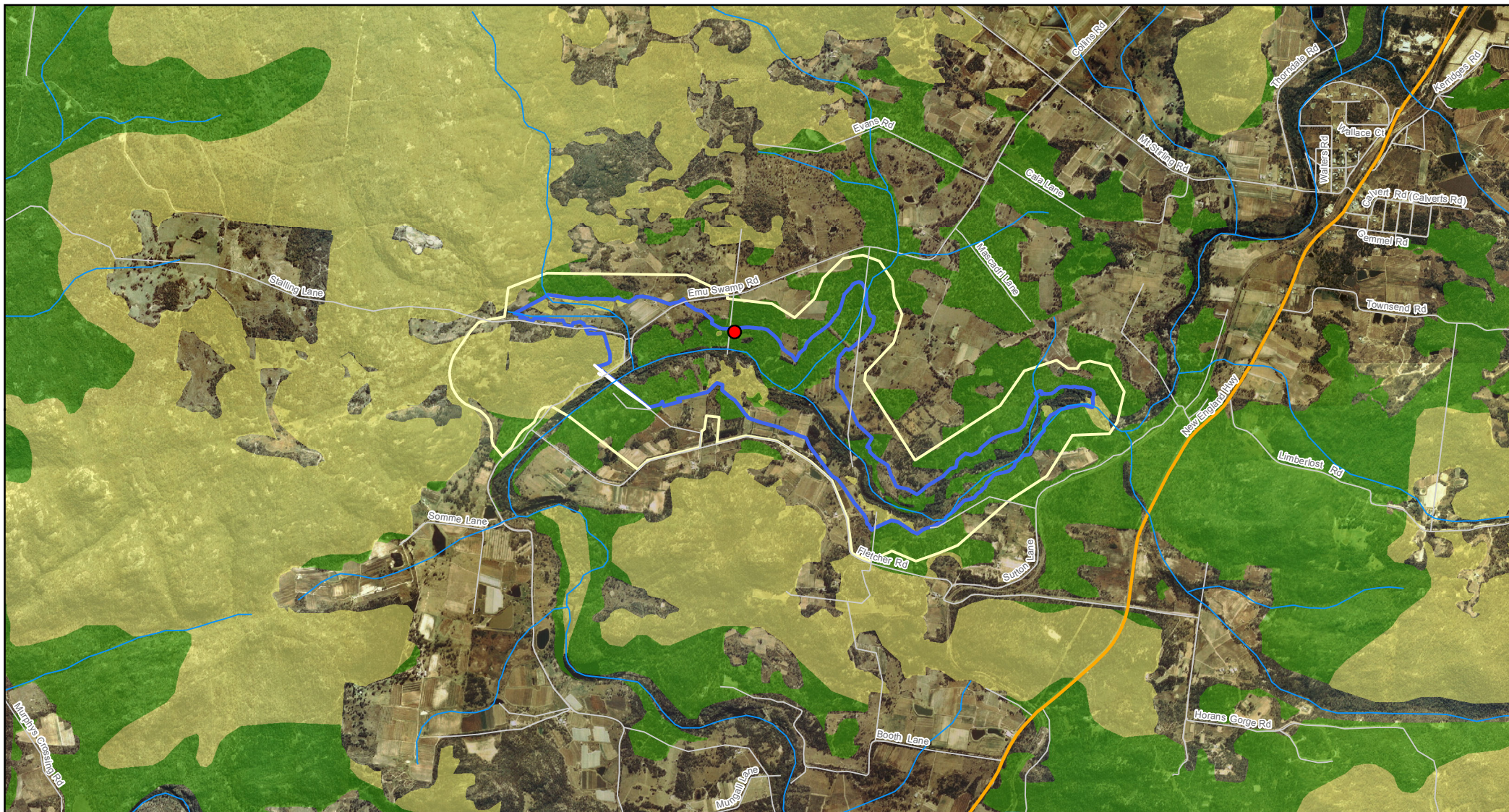
14.3. Occurrence in Project area

One individual Granite Belt Thick-tailed Gecko was identified during surveys for the EIS within the inundation area of the dam (Figure 14-2). Suitable habitat was identified in the Stalling Lane Access. The primary habitat of this species within the Project area is associated with rocky hillslopes and rock pavements, which are features of *E. andrewsii* woodland on rocky hillsides and shrublands on rock pavements and the areas most likely to provide shelter and breeding sites. There is 18.1ha of primary habitat within the Project area based on the presence of rocky habitats which are essential to the occurrence of the Granite Belt thick-tailed gecko.

Vegetation types which occur away from rocky hillsides and rock pavements provide connectivity between preferred rock outcrops and may provide foraging resources. These areas are considered secondary habitat and cover approximately 70 ha within the Project area. The nearest observation to the Project in the Atlas of Living Australia is 500 m east of the New England Highway near Severnlea (Atlas of Living Australia 2014). The presence of several individuals within 1 km of each other is indicative of a local population within a broader habitat network which exists within Girraween and Bald Rock National Parks to the east, Sundown National Park to the west, and well vegetated private landholdings in between these reserves.

Figure 14-2 shows the distribution of primary habitat and secondary areas in the inundation area and surrounds.

No estimates of population size are available, even of sample densities, but there were 15 museum specimens in 1993 (Cogger *et al.* 1993) and there are now 83 NSW records of the species in the NSW Wildlife Atlas database. Frequency of encounter during targeted surveys is low, with typically only one animal found per site surveyed for several person-hours. Its abundance was described as very sparse to sparse (Ehmann 1992). It is not possible to estimate the size of the local population of this species.



LEGEND

- Granite Belt Thick-tailed Gecko Location
- Watercourse
- Road
- Highway
- Buffer Area
- Full Supply Level (738m AHD)
- Potential Habitat**
- Primary Habitat
- Secondary Habitat

EMU SWAMP DAM - ASSESSMENT OF MNES



0 250 500 750 1,000
Metres

Scale - 1:40,000

Projection: GDA94 MGA56

Figure 14-2

Potential Habitat Area for Granite Belt Thick-tailed Gecko in the Inundation Area and Surrounds



14.4. Threatening Processes

The main threats to the Granite Belt Thick-tailed Gecko include habitat clearing for agriculture and development, collection of bush rock and dead wood for fires, inappropriate fire regimes, grazing and trampling of habitat by domestic stock and feral goats, and predation by cats and foxes (TSSC 2008e). Additional threats include climate change, habitat fragmentation, weed invasion and alteration of hydrological regimes (DotE 2014f).

14.5. Recovery Plan Actions

A recovery plan is not currently required for this species (DotE 2014f). The Conservation Advice lists a range of “Research Priorities” including implementation of a monitoring programme, more accurate population studies and site-specific management strategies in order to better inform future regional and local priority actions (TSSC 2008f).

The Conservation Advice also notes that the following priority actions (regional and local) can be implemented to support the recovery of the Granite Belt Thick-tailed Gecko (TSSC 2008f):

- Habitat loss, disturbance and modification
 - Identify key habitats and potential for linking key populations
 - Manage threats to vegetation containing occurrences of the Granite Belt Thick-tailed Gecko
 - Investigate suitable habitat to identify new occurrences of the Granite Belt Thick-tailed Gecko
 - Prevent collection of bushrock and dead fallen timber in the Granite Belt Thick-tailed Gecko's habitat. Provide firewood and encourage use of gas fire BBQs in recreational areas to discourage collection of fallen timber and litter.
 - Manage development to avoid adverse effects on the Granite Belt Thick-tailed Gecko. Minimise impacts from land use.
 - Pursue formal conservation arrangements
- Trampling, browsing, grazing
 - Develop and implement a stock management plan to target roadside verges and stock routes
 - Appropriate management of grazing in and around known sites on private property
 - Prevent grazing at known sites on leased crown land
- Animal predation and competition
 - Control and eradicate feral goats, foxes and cats in the local area
- Fire
 - Develop and implement a suitable fire management strategy and burn regime for the Granite Belt Thick-tailed Gecko
 - Work with rural fire services to include mitigative measures in their planning, risk register and operations
- Conservation information
 - Raise awareness of Granite Belt Thick-tailed Gecko within the local community
- Enable recovery of additional sites and/or populations
 - Investigate options for linking, improving, and establishing populations

14.6. Potential Impacts

For vulnerable species, important populations are considered to be key source populations either for breeding or dispersal, populations that are necessary for maintaining genetic diversity, and populations that are near the limit of the species range. As the population within the Project area falls between two large conservation reserves which are known to support the species, it may be important to dispersal and the maintenance of genetic diversity of the species. The population is therefore considered an important population of the Granite Belt Thick-tailed Gecko.

The project will cause a loss of 88.5 ha potentially suitable habitat for this species in the inundation area, comprised of 18.1 ha of primary, rocky habitat and approximately 70.4 ha of supporting or secondary habitat which may connect rocky areas and provide some foraging resources. This will reduce the area of occupancy of the local population in the short term. The impact of short term habitat loss will be mitigated by the rehabilitation of the 322 ha buffer area around the inundation area which currently supports a mix of remnant vegetation, non-remnant vegetation and cleared areas.

Similarly, disturbance to remnant vegetation within the inundation area will impact on east-west habitat connectivity along the Severn River. The rehabilitation of the 200m wide buffer area will restore landscape connectivity in the medium to long term and will provide for the dispersal of this species.

Predation by introduced carnivores (particularly foxes and cats) is a threatening process which is likely to currently impact the Granite Belt Thick-tailed Gecko within the study area. Implementation of a pest management plan will immediately reduce predation pressure for the local population for this species, thereby increasing long-term viability.

In addition, a weed management plan will be implemented for the entire Project area, including pipeline construction areas, to prevent invasive species becoming established in vulnerable species habitat. Site hygiene protocols will be implemented in accordance with an environmental management plan (EMP) to prevent introduction of disease.

14.7. Avoidance and mitigation measures

The Project will result in the unavoidable loss of suitable habitat for an important population of the Granite Belt Thick-tailed Gecko. The primary mitigation measure proposed is the rehabilitation of a 322 ha buffer area around the FSL. The intention is that this buffer be managed for conservation purposes and in the long term it is likely to provide both habitat and movement corridors for the Granite Belt Thick-tailed Gecko. Additional mitigation strategies include the following:

- Pre-clearing surveys of suitable habitat within the Project area which aim to relocate individuals of the Granite-belt Thick-tailed Gecko out of the impact area and into suitable habitats within the adjacent buffer area;
- Salvage of suitable habitat features such as large rocks and logs from the impact area and placement of these features into suitable habitats within the adjacent buffer area; and
- Gas-fired or electric barbeques in the recreation area to avoid firewood collection around the inundation area.

14.8. Residual impacts

Notwithstanding the fact that the Project will result in a net increase in habitat for the local population of the Granite Belt Thick-tailed Gecko over the longer term (within the proposed buffer area), there remains a risk associated with the lag time between the commencement of rehabilitation activities and the point at which the habitat becomes suitable for the species.

A resident population will be displaced from habitat which is currently suitable and occupied and displaced individuals may not successfully inhabit the buffer area. It is considered likely that there will be a residual impact of the Project on 18.1 ha of primary habitat for the Granite Belt Thick-tailed Gecko.

15. LARGE-EARED PIED BAT

15.1. Biology

The Large-eared Pied Bat (*Chalinolobus dwyeri*, family: Vespertilionidae) is a medium-sized insectivorous bat measuring a total length of approximately 100 mm and weighing 7–12 grams. It has shiny, black fur on the body with a white stripe on the ventral side of the torso where the wing membranes join. The ears are very large and easily touch when pressed together above the head. The wattle (lobes of skin at the corner of the mouth) adorn the lower lip and between the corner of the mouth and the bottom of the ear. A second lobe of skin along the side of the lower lip is also well developed. Its relatively short, broad wings suggest it flies slowly and with considerable manoeuvrability (Churchill 2008, DotE 2014h).

Available roosts are not evenly distributed throughout the landscape. The species requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors which are used for foraging (Pennay 2010 pers. comm. cited in TSSC 2010az). Almost all records have been found within several kilometres of cliff lines or rocky terrain (Qld DERM 2011). Roosting has also been observed in disused mine shafts, caves, overhangs and disused Fairy Martin (*Hirundo ariel*) nests (Hoye & Dwyer 1995; Schulz 1998). It also possibly roosts in the hollows of trees (Duncan *et al.* 1999).

The structure of primary nursery roosts appears to be very specific, i.e. arch caves with dome roofs (that need to be deep enough to allow juvenile bats to learn to fly safely inside) and with indentations in the roof (presumably to allow the capture of heat). These physical characteristics are not very common in the landscape and therefore a limiting factor. Retaining connectivity between remnant vegetation is likely to be important (NSW DECC 2007d; Pennay 2008; TSSC 2010az).

The Large-eared Pied Bat is listed as vulnerable in the EPBC Act.

15.2. Regional distribution

The species current distribution is poorly known but records exist from Shoalwater Bay, north of Rockhampton, Queensland, through to the vicinity of Ulladulla, NSW (Figure 15-1) (Atlas of Living Australia 2014, DotE 2014h). There has also been an observation near Mt Isa, western Queensland however most observations occur within 200 km of the east coast (Atlas of Living Australia 2014). Most of the observations are around Sydney in NSW (Atlas of Living Australia 2014, DotE 2014h). In Queensland, records are known from sandstone escarpments in the Carnarvon, Expedition Ranges and Blackdown Tablelands. It is likely that these areas support a high proportion of the Queensland populations of the Large-eared Pied Bat, although estimates of the number of individuals present and their distribution in these areas has not been established. Additional records exist in the Scenic Rim near the NSW/Queensland border.

Sandstone cliffs and fertile woodland valley habitat is important to the Large-eared Pied Bat and almost all records of the species have been within several kilometres of cliff lines or rocky terrain. Roosting has also been observed in disused mine shafts, caves, overhangs, tree hollows and disused Fairy Martin (*Hirundo ariel*) nests. This species has a foraging preference for rich riparian areas near rocky escarpments and generally stays within 3-5 km of its roost (G. Ford 2014, pers. comm., 21 Jan). It has been assumed that the species is sensitive to clearing though narrow connecting riparian strips are sometimes heavily used (Churchill 2008, DotE 2014h). No

maternity roost sites are known in Queensland (TSSC 2010az). In NSW, four maternity roost sites have been recorded (Qld DERM 2011), however, one was permanently flooded in 1976 and one was abandoned in 2009 (TSSC 2010az).

Habitat modelling based on surveys in the southern Sydney region (NSW DECC 2007d) suggest that the Large-eared Pied Bat is largely restricted to the interface of sandstone escarpment (for roost habitat) and relatively fertile valleys (for foraging habitat) (Pennay 2008). Survey work in the Brigalow Belt South region of NSW supports this modelling (Pennay 2008). The record from the Project area is inconsistent with this pattern inasmuch as there is no sandstone escarpment in close proximity to the record. This indicates use of a broader range of roost sites than generally acknowledged in the literature, however, all known primary roost sites (particularly maternity roosts) are confined to sandstone escarpment.

The distribution of this species overlaps with the “White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland” EPBC Act-listed TEC.



Figure 15-1 Large-eared Pied Bat distribution (DotE 2014h)

15.3. Occurrence in Project Area

The Large-eared Pied Bat was recorded by Anabat at a trapping site during surveys for the EIS. It was not known from the area prior to the surveys with the closest records from Mt Barney and Koreelah National Parks, approximately 40-50 km north-east of the Project site (Atlas of Living Australia 2014). The species is considered most likely to roost in rocky outcrops and overhangs, most commonly found in *E. andrewsii* woodland on rocky hillsides in the Project area, and this is considered the primary habitat of the species in the locality (Figure 15-2). Whilst there is some speculation that the species roosts in a wide variety of situations, there is little empirical evidence which supports this view, and published accounts of roosting behaviour are almost entirely associated with rocky outcrops, overhangs and caves. All other areas of remnant vegetation are considered foraging habitat only, and of secondary importance to the Large-eared Pied Bat.

Potential roost sites are primarily located to the west of the Project area, with smaller areas to the south, whilst all remnant vegetation could be utilised as foraging habitat.



LEGEND

- Large-eared Pied Bat Location
- Watercourse
- Road
- Highway
- Buffer Area
- Full Supply Level (738m AHD)

Potential Habitat

- Primary Habitat (Potential roosting habitat and foraging habitat)
- Secondary Habitat (Foraging habitat only)



0 250 500 750 1,000
Metres

Scale - 1:40,000

Projection: GDA94 MGA56

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure 15-2

Potential Habitat Area for
Large-eared Pied Bat in the
Inundation Area and Surrounds



15.4. Threatening processes

The primary, confirmed threat to the Large-eared Pied Bat is disturbance and damage to primary nursery sites by animals, particularly goats, and humans. Clearing of vegetation and timber harvesting in or around roosts have the potential to affect foraging resources and fragment surrounding vegetation. These impacts are likely to be particularly detrimental in the vicinity of maternity roosts where pregnant and lactating females require sufficient food resources to raise their young. Clearing can also alter the microclimate, through affecting solar radiation and groundwater levels (DotE 2014h). Additional threats include mine-induced subsidence of cliff lines, predation by introduced predators such as cats and foxes, fire, vegetation clearance in the proximity of roosts and loss of genetic diversity (Department of Environment and Resource Management 2011).

15.5. Recovery Plan Actions

A national recovery plan has been produced for the Large-eared Pied Bat by the Department of Environment and Resource Management (2011). The overall objective of the recovery plan is “to ensure the persistence of viable populations of the large-eared pied bat throughout its geographic range”. The specific objectives of the recovery are as follows (Department of Environment and Resource Management 2011):

- Identify priority roost and maternity sites for protection
 - Review all existing information on the Large-eared Pied Bat. Map known colonies and develop habitat models.
 - Identify priority colonies and sites for conservation
 - Locate roost structures that require surveying
 - Carry out targeted surveys to clarify distribution and abundance, identify priority roost sites
 - Revise distribution and habitat model. Report on findings and provide recommendations for conservation.
- Implement conservation and management strategies for priority sites
 - Protect known roosts and foraging habitats
 - Install bat gates and remedial works where required
 - Establish fire prescriptions for areas containing priority roosts/ maternity sites
 - Control introduced species (such as goats)
 - Monitor effectiveness of management strategies
- Educate the community and industry to understand and participate in the conservation of the Large-eared Pied Bat
 - Start education and extension programs to increase awareness and participation in the recovery plan
 - Encourage and help the involvement of community and industry groups in the recovery process
 - Increase awareness and advise of progress through press releases
- Research the Large-eared Pied Bat to augment biological and ecological data to enable conservation management
 - Develop and implement a research strategy investigating habitat requirements and limitations, selection and management of roost and maternity sites, diet and foraging strategy, and threatening processes
- Determine the meta-population dynamics throughout the distribution of the Large-eared Pied Bat

- Collect and analyse genetic material from individuals across the geographic range of the Large-eared Pied Bat to allow analysis of population genetics.

15.6. Potential Impacts

For vulnerable species, important populations are considered to be key source populations either for breeding or dispersal, populations that are necessary for maintaining genetic diversity, and populations that are near the limit of the species range. There are no known maternity sites for the Large-eared Pied Bat within the project area, the record occurs within close proximity (i.e. within 50 km) to another record, suggesting genetic exchange between populations and the species is not approaching distributional limits in the Project area. As such, the population present within the Project area is not considered to be an important population of the Large-eared Pied Bat.

The project will cause a loss of 88.5 ha potentially suitable habitat for this species in the inundation area, comprised of 18.1 ha of primary habitat (potential roosting and foraging habitat) and approximately 70.4 ha of supporting or secondary habitat which may provide foraging resources. Any impacts on the population will be minor (regardless of whether or not the population may be considered important) as foraging habitat will remain upstream and downstream of the FSL, and no maternity roosts or habitat will be impacted.

There will be limited impact on habitats most likely to support roosting individuals of the Large-eared Pied Bat (rocky areas, caves, overhangs) as these are primarily located to the west of the Project area.

The impact of short term habitat loss within the FSL will be mitigated by the rehabilitation of the 322 ha buffer area around the FSL which currently supports a mix of remnant vegetation, non-remnant vegetation and cleared areas. This will provide suitable foraging habitat for the Large-eared Pied Bat.

Similarly, disturbance to remnant vegetation within the FSL will impact on east-west habitat connectivity along the Severn River in the short term. The rehabilitation of the 200 m wide buffer area around the FSL will restore landscape connectivity in the medium to long term and will provide for the dispersal of this species. There are no known barriers to the movement of this species, which has been recorded from linear riparian areas within an otherwise cleared landscape. As such, a mosaic of cleared and vegetated land is likely to allow the Large-eared Pied Bat to move between more extensive remnants.

Further, insects attracted to the dam will provide a foraging resource for the species. No population of this highly mobile species will be fragmented due to the Project and foraging habitat will remain upstream and downstream of the dam and will be rehabilitated in the surrounding landscape as part of the OAMP. As a result, the species is unlikely to decline in the region.

15.7. Avoidance and Mitigation Measures

The Project will result in the loss of 18.1 ha of primary habitat and 70.4 ha of secondary habitat for the Large-eared Pied Bat. The primary mitigation measure proposed is the rehabilitation of a 322 ha buffer area around the FSL. The intention is that this buffer be managed for conservation purposes and in the long term it is likely to provide habitat and movement corridors for the Large-eared Pied Bat. This species has been recorded foraging in primarily regrowth habitats (Umwelt 1996) and fragmented woodlands, such as those present within the inundation area itself and it is considered likely that the Large-eared Pied Bat will forage within the proposed buffer area.

Additional mitigation strategies include pre-clearing surveys of suitable habitat within the Project area which aim to relocate individuals out of the impact area and into suitable habitats within the adjacent buffer area.

A weed and pest management plan will be implemented to control the establishment of invasive species in the Project area.

15.8. Residual impacts

The project will result in the loss of 18.1 ha of primary habitat and 70.4 ha of secondary habitat for the Large-eared Pied Bat. This species has a general preference for foraging over forested areas but will presumably fly over cleared land to access more productive foraging habitats. As such, the impoundment associated with the construction of the project is not likely to be a barrier to movement. The margins of the dam are likely to increase in significance as foraging habitat for this species over time and the rehabilitation of the buffer will directly benefit the Large-eared Pied Bat and ultimately increase the availability of foraging habitat in the locality.

This species is expected to utilise habitats above FSL currently and although some shift in foraging behaviour may occur in the short term, it is not likely to drive the decline of the local population of the Large-eared Pied Bat as foraging resources will remain accessible immediately adjacent to the impact area. There will be an increase in foraging habitat which is managed for conservation purposes, and a continuous, 200 m wide vegetated corridor will be established around FSL. As impacts can be mitigated on site, adverse residual impacts on the local population of the Large-eared Pied Bat are not expected.

16. BELL'S TURTLE

16.1. Biology

The Bell's Turtle (*Wollumbinia belli*, family: Chelidae) often has a pale to bright yellow stripe extending from the lower jaw along the side of the neck to the forelimb, sometimes continuous with a yellow chin and throat. The head and neck are shorter in length than the shell which has a black under-surface. Mature specimens have slightly upturned carapace edges at the sides. The species can be very difficult to distinguish from the Saw-shelled Turtle (*Wollumbinia latisternum*) (Swanson 2012, TSSC 2013).

The Bell's Turtle prefers narrow sections of rivers, 30-40 m wide, in granite country, preferring shallow to deep pools in upper reaches or small tributaries of major rivers flowing through granite bedrock. Inhabited pools are usually less than 3 m deep, where there is a sandy or rocky substrate with small patches of weed. Much of the land adjacent to its habitat is now used for grazing sheep and cattle. Some riparian vegetation remains including introduced willow trees grow alongside gum trees (DotE 2014g, TSSC 2013).

Plant material such as fine aquatic weeds, stems of plants up to 30 mm long and terrestrial leaves form the bulk of the diet. Invertebrates are also taken, including crayfish (*Carex* sp.) and aquatic insects. All turtles examined had consumed large amounts of sediment (Cann 1998). Nesting occurs between October and mid-January, when females lay 8 to 23 firm eggs. Hatchlings emerge after 80 days when incubated at 27°C (Cann 1998).

The Bell's Turtle is listed as vulnerable in the EPBC Act.

16.2. Regional distribution

The known populations of the Bell's Turtle are found in the Namoi and Gwydir Rivers in northern NSW and in Bald Rock Creek in southern Queensland, in the headwaters of the Darling River system (Figure 16-1) (Atlas of Living Australia 2014, TSSC 2013).



Figure 16-1 Bell's Turtle distribution (DotE 2014g)

The Bell's Turtle population in the aforementioned Bald Rock Creek in Queensland was thought to potentially be a distinct species due to some morphological differences with the populations in NSW. Genetic analyses completed by Fielder (2010) did not support this theory and concluded that the separate populations are the same species.

The known population of Bell's Turtle population in Queensland is small (estimated less than 400 individuals) and primarily occurs within an 8 to 10 km reach in Bald Rock Creek. Most individuals occur in permanent pools at either end of this reach, within areas approximately 1.4 km long. There has been substantial habitat modification in the lower reaches of Bald Rock Creek. The EIS reported one Bell's turtle in the Severn River near Somme Lane. Fielder (2010) surveyed a variety of habitats, such as off-stream wetlands and private in-stream impoundments, at multiple locations in the Border Rivers catchment, including above and below Nundubbermere Falls on the Severn River, but did not catch any Bell's turtles in these areas.

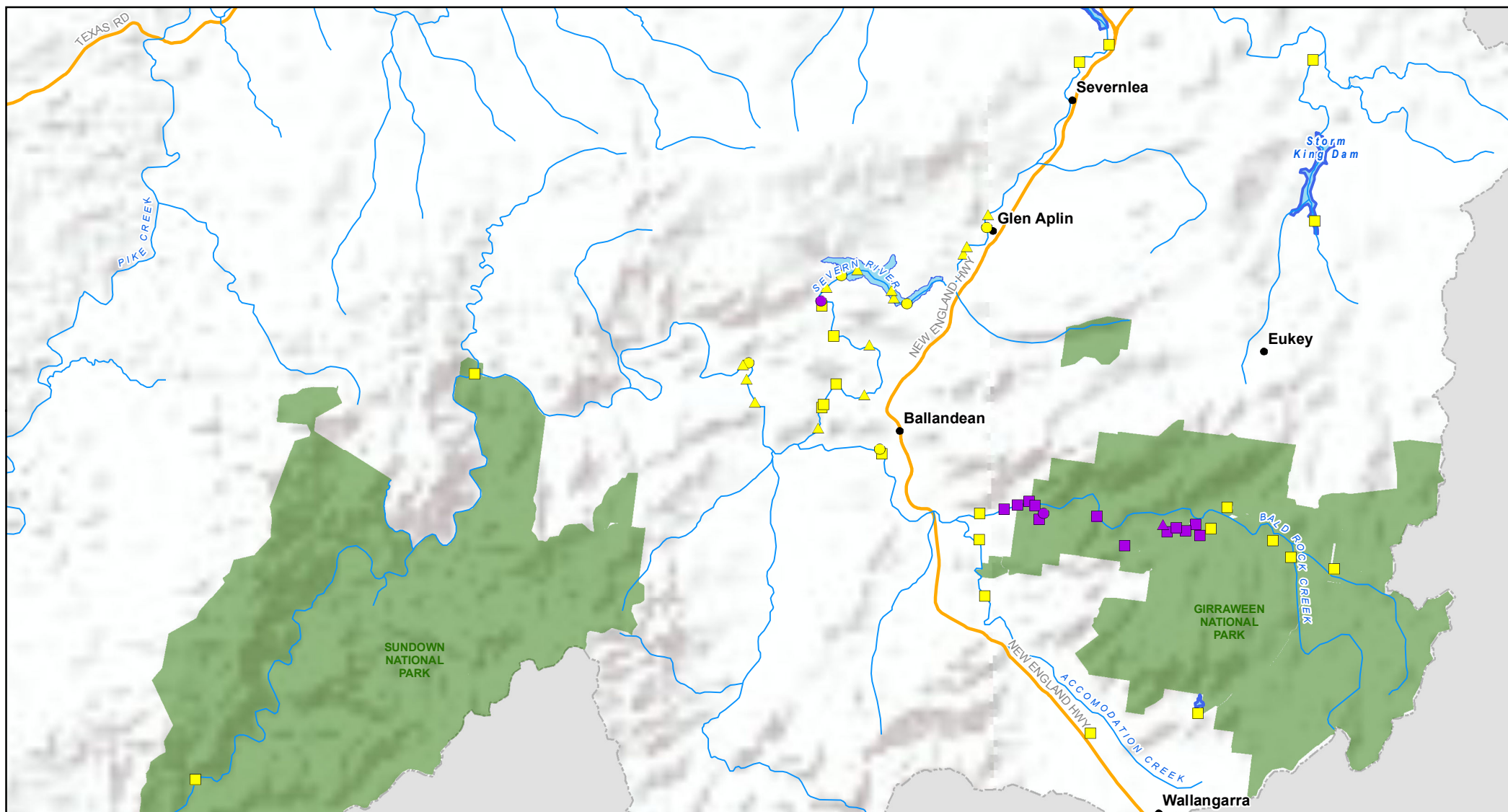
16.3. Occurrence in Project area

The location of survey sites and records of Bell's turtle in Queensland is presented in Figure 16-2.

One Bell's Turtle has been recorded in the Severn River near Somme Lane, downstream of the proposed dam wall (Ecology Management 2007). There is suitable habitat Bell's Turtle in the Project Area, however despite extensive searching, this is the only record of the species from the Severn River downstream from the proposed dam site (Fielder 2010). There are no reported observations at or upstream of the dam site.

One Bell's Turtle was caught during targeted surveys in 2013 at a reference site in Bald Rock Creek (frc environmental 2013). No Bell's Turtles were caught within or downstream of the Project area during this survey effort. The only site at which Bell's Turtle is known to be a resident species in Queensland is in a short section of Bald Rock Creek within Girraween National Park (refer to Figure 16-2).

Although preferred habitat occurs in the study area and based on the available data, there is little evidence that there is a significant population of Bell's turtle in the Project area or in upstream or downstream reaches of the Severn River.



LEGEND

● Town Names

Fielder Surveys 2002-2009

- Present
- Not caught

Project EIS Surveys 2006-2007

- Present
- Not caught

Project SEIS Surveys 2013

- ▲ Present
- ▲ Not caught

— Watercourse

— Highway

— Full Supply Level (738m AHD)

■ National Parks

■ New South Wales

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure 16-2

Survey sites and records
of Bell's turtle in Queensland



0 1.5 3 4.5 6
Kilometres

Scale - 1:190,000

Projection: GDA94 MGA56



16.4. Threatening Processes

The main identified threats to the Bell's Turtle are pollution and sedimentation of its habitat, trampling and damage to river banks and riverside vegetation by grazing stock, changes to natural stream flows through removal of water for irrigation and predation of nests by foxes. In some areas, Bell's Turtle also suffers from an eye ailment that can leave up to 50% of an adult population blind, the cause of which is as yet unknown (TSSC 2013).

The species may also be periodically affected by extensive low rainfall conditions and may be affected by global climate change (DotE 2014g, TSSC 2013).

16.5. Recovery Plan Actions

A recovery plan is not currently required for this species (DotE 2014g). The Conservation Advice lists a range of "Research Priorities" including investigating the cause and extent of blindness affecting Bell's Turtle populations, targeted surveys to determine the full geographic range of this species (including habitat preferences) and investigating the basic biology and ecology of this species (TSSC 2013).

The Conservation Advice also notes that the following priority actions (regional and local) can be implemented to support the recovery of the Bell's Turtle (TSSC 2013):

- Habitat loss, disturbance and modification
 - Survey suitable habitat to locate additional populations. Identify populations of high conservation priority.
 - Protect riparian vegetation in known known and potential habitat areas for Bell's Turtle
 - Ensure chemicals or other processes used for weed management or agriculture avoid a significant adverse impact on Bell's Turtle
 - Manage changes to hydrology to avoid adverse impact on Bell's Turtle. Develop management plans to maintain/restore natural river flows.
 - Establish aquatic reserves in identified prime habitat areas
 - Monitor populations to identify key threats, as well as population recovery and management effectiveness
 - Control and constrain access to known sites on public land
- Trampling, browsing, grazing
 - Water stock away from riverbanks to avoid stock trampling
 - Fence river banks to reduce grazing pressure
- Animal predation and competition
 - Implement threat abatement/ feral animal management plans, including for foxes
- Diseases, fungi and parasites
 - Implement hygiene protocols to prevent further outbreaks of blindness once cause is identified
- Conservation information
 - Raise awareness of Bell's Turtle within the local community, particularly among landholders

16.6. Potential Impacts

One Bell's Turtle was reported from the weir pool at Somme Lane, on the Severn River, downstream of the proposed dam (Ecology Management, 2007). The species was not caught from the Severn River in additional targeted surveys undertaken in 2013. The species was never recorded outside of Bald Rock Creek in extensive studies completed by Fielder (2010) using the same methods employed in Bald Rock Creek. Although preferred habitat occurs in the study area, there is little evidence that there is a significant population of the Bell's turtle in the Project area or in upstream or downstream reaches of the Severn River.

For vulnerable species, important populations are considered to be key source populations either for breeding or dispersal, populations that are necessary for maintaining genetic diversity, and populations that are near the limit of the species range. As presence of a resident population within the Project area is unlikely based on historical data, recent surveys and known patterns of distribution, it is concluded that an important population of Bell's Turtle is not present within the Project area.

The Project will flood potential habitat for the Bell's Turtle within the inundation area and may modify potential habitat downstream of the dam from changes to natural stream flows, however the Project is unlikely to reduce the area of occupancy, or cause the fragmentation, of an important population. It is also unlikely that the Project will affect habitat critical to the survival of the species or disrupt the breeding cycle of an important population, as the Project area is unlikely to be used for nesting. As a result, the Project is unlikely to lead to a long-term decrease in the size of an important population of the Bell's Turtle.

The Project does have the potential to fragment potential habitat upstream and downstream of the dam. The potential impacts associated with fragmentation are not considered significant as there are no records of this species upstream of the proposed dam.

As with other turtles, major current threats are related to predation of eggs by goannas and feral animals (foxes and pigs) or damage to nest banks by cattle (Young 2001). Feral animals and cattle already pose a threat to turtles in the Project area but the Project will not result in feral animals becoming established in potential habitat downstream and upstream of the inundation area.

16.7. Avoidance and Mitigation Measures

While there is only one record of Bell's fauna downstream of the proposed dam, and no records in the inundation area or upstream, there is preferred habitat for this species in the study area. Consequently a conservative approach will be taken, and potential impacts to this species will be mitigated. In particular, there is a commitment to maintain habitat connectivity between habitat upstream and downstream of the proposed dam and this will be achieved by the establishment of an aquatic fauna passageway, with specific design considerations for Bell's turtle. The design of the aquatic fauna passageway will be finalised following further consultation with relevant agencies and experts.

16.8. Residual impacts

There are no significant adverse residual impacts expected on Bell's Turtle as a result of the Project.

17. MURRAY COD

17.1. Biology

The Murray Cod (*Maccullochella peelii*, family: Percichthyidae) is the largest freshwater fish found in Australia, capable of growing up to 1.8 m in length and weighing over 100 kg (although commonly weighing 10 kg). It possesses a broad, depressed head with a rounded snout and a concave forehead profile, and has a large mouth and jaws that are approximately equal in length. The caudal fin is rounded and 65–81 scales are present in the lateral line. It is olive-green with small brown spots, rounded pectoral (side) fins, creamy white undersides, and occasional red edges to its fins. The Murray Cod is a long-lived predator that is highly territorial and will aggressively attack any fish entering its area. The growth rate of this species varies; probably due to temperature, habitat and food availability (DotE 2014j).

The Murray Cod has the ability to live in a diverse range of habitats, including clear rocky streams (such as those found in the upper western slopes of NSW), to slow flowing, turbid rivers and billabongs. Within the large range of habitats, the Murray Cod is usually found near complex structural cover such as large rocks, snags, overhanging vegetation and other woody structures. The Murray Cod is considered a main channel specialist as it is frequently found in the main river channel and larger tributaries (DotE 2014j).

Spawning occurs in spring – summer and is triggered by increasing temperature, day length and possibly flow. Males guard the eggs which are laid on hard substrates, often inside hollow logs. The larvae drift downstream and a reverse movement by older fish occurs in late winter – spring and appears triggered by flow and/or temperature.

The Murray Cod is listed as vulnerable in the EPBC Act.

17.2. Regional distribution

The Murray Cod is found extensively throughout the Murray Darling Basin in the south-eastern region of Australia (Figure 17-1). Historically, the species occurred throughout the entire Basin, with the exception of the upper reaches of some tributaries. It still occurs throughout most of the Basin with the exception of some localised extinctions. Some translocated populations exist outside the species' natural distribution in impoundments and waterways in NSW and Victoria (DotE 2014j). Ecology Management (2007) state that numbers of the Murray Cod have significantly reduced since pre-European times, primarily as a result of overfishing (commercial and recreational), habitat change, barriers to movement, competition from introduced species and river regulation (i.e. alteration to flooding regimes, flows, etc.).

The Murray Cod has the ability to live in a diverse range of habitats from clear rocky streams to turbid rivers and billabongs. It is usually found near complex structural cover such as large rocks, snags, overhanging vegetation and other woody structures. The Murray Cod is considered a main channel specialist as it is frequently found in the main river channel and larger tributaries. Juveniles are most commonly found in the main river channel until about one year of age (DotE 2014j).

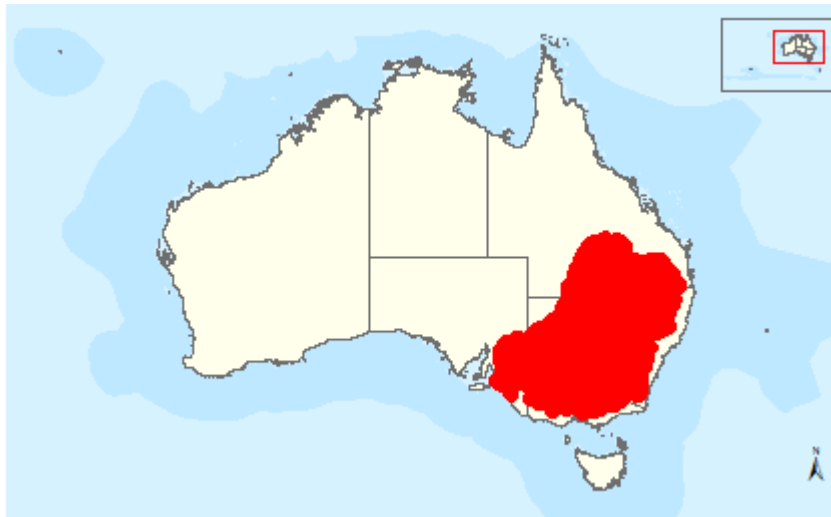


Figure 17-1 Murray Cod distribution (DotE 2014j)

17.3. Occurrence in Project area

The Murray Cod has been introduced to the catchment of the Upper Severn River which does not form part of its natural range. Annual re-stocking of this species still occurs in the area (Ecology Management 2007). A number of individuals were caught in the Severn River for the EIS (Ecology Management 2007) but none were captured in targeted surveys completed by frc environmental (2013b). The population of Murray Cod above Nundubbermere Falls is considered to be a translocated or stocked population and not a wild population of the species. It is therefore not considered to be of specific conservation value. The population is likely to be maintained by the release of hatchery bred fish.

Ecology Management (2007) recorded the Murray Cod from Bents Weir, some 15 km downstream of the proposed dam wall. There are no confirmed records of the Murray Cod within the Project area or upstream of the proposed dam.

The nearest record on the Atlas of Living Australia (2014) is about 30 km to the south of the Project in Tenterfield Creek.

17.4. Threatening processes

The Murray Cod has undergone a marked decline since European settlement and its threats are well documented. The main threats to this species include: flow regulation, a product of water impoundments, irrigation channels and direct pumping from rivers; habitat degradation through the loss of the snags on which this species relies; lowered water quality caused by flow diversion, impoundments and sustained dry periods; barriers; pests and weeds; commercial and recreational fishing; loss of genetic diversity; disease and climate change (DotE 2014j, National Murray Cod Recovery Team 2010).

17.5. Recovery Plan Actions

A national recovery plan has been produced for the Murray Cod by the (Victorian) Department of Sustainability and Environment (National Murray Cod Recovery Team 2010). The overall objective of the recovery plan is “to

have self-sustaining Murray Cod populations managed for conservation, fishing and culture". The specific objectives of the recovery are as follows (each specific objective has a number of recovery actions, see the recovery plan for more information) (National Murray Cod Recovery Team 2010):

- Determine the distribution, structure and dynamics of Murray Cod populations across the Murray Darling Basin
 - Review and collate published information on the Murray Cod
 - Identify gaps in available information. Implement a survey program to fill identified gaps. Undertake a genetic study of Murray Cod across the Murray Darling Basin.
 - Investigate role of Murray Cod within the ecosystem. Model significance of larger individuals. Develop management strategies to achieve sustainability where there is an unsustainable, skewed population structure.
 - Identify Spatial Management Units to guide management of the Murray Cod. Determine the structure and dynamics of Murray Cod populations within and between Units. Identify key recruitment areas in each Unit. Prioritise Units requiring urgent/ specific actions. Monitor and maintain these Units.
 - Identify, protect, rehabilitate key aquatic and riparian habitats for the Murray Cod
 - Quantify environmental parameters that drive recruitment and population growth
 - Develop decision support tools and models to allow future management actions to be evaluated within a risk management framework.
 - Develop an integrated, long-term monitoring program for assessing recovery of Murray Cod populations in each Spatial Management Unit
- Manage river flows to enhance recruitment to Murray Cod populations
 - Determine influence of flows on critical life history components and movement, including responses to prescribed flows
 - Identify and model flow regulation practices to maximise recruitment and boost Murray Cod populations
 - Develop and implement flow management practices to assist recovery of Murray Cod populations
- Undertake risk assessments of threats and evaluate benefits of recovery actions on Murray Cod populations for each Spatial Management Unit
 - Assess availability and condition of riparian and instream habitat in each Unit, identify key areas for rehabilitation, and integrate this information into relevant strategies. Test effects of habitat manipulations on Murray Cod.
 - Identify barriers to movement of Murray Cod populations. Facilitate fish passage and monitor the response of Murray Cod populations.
 - Quantify the impacts of cold water pollution on Murray Cod populations. Develop, test, implement and monitor the results of a plan to ameliorate cold water pollution.
 - Investigate fish kills involving Murray Cod. Take opportunities to collect scientific data. Determine the status of Murray Cod in affected areas and develop management responses to protect Murray Cod and promote recovery. Identify high risk areas and develop an early warning system based on changes to water quality.
 - Establish a fish kills database and website

- Implement consistent fish kill response protocols across the Murray-Darling Basin, with links and knowledge-sharing between agencies
- Quantify loss of Murray Cod through irrigation systems and improve water diversion practices to reduce fish loss
- Investigate additional sustainable recovery management options. Establish a trial site to test revised recovery options. Develop and apply a population model for Murray Cod to assess impacts of threats and recovery options.
- Determine the need for stocking/ translocation to restore or enhance Murray Cod populations.
- Establish and encourage uptake of a whole-of-government responsibility defining agency roles, responsibility and accountability for protecting Murray Cod in each jurisdiction.
- Determine the habitat requirements of Murray Cod life stages and populations
 - Determine changes in habitat use with different life stages and populations and identify key habitat conditions for management focus
 - Survey and map potential habitat using ecological and bioclimatic information
 - Implement protocols for rehabilitation of Murray Cod habitat, facilitate expansion of Murray Cod into formerly occupied areas, protect structural habitats in floodplain channels
 - Identify and protect habitat areas critical to the survival of Murray Cod
 - Develop contingency plans for unusual circumstances
- Manage the recreational fishery for Murray Cod in a sustainable manner while recognising the social, economic and recreational value of the fishery
 - Determine annual harvest of Murray Cod
 - Review existing and potential fishing regulations and modify where appropriate to ensure sustainable Murray Cod fisheries
 - Review use and impacts of set-lines on Murray Cod, and compliance activities for Murray Cod across the Murray-Darling Basin and modify regulations if necessary
 - Provide information to politicians, magistrates and the public on the community and conservation value of Murray Cod
 - Determine the contribution of stocking programs to Murray Cod populations and fishing catch, also damage and mortality rates of angler captured and released individuals
 - Ensure Murray Cod stocked into the wild are genetically and ecologically appropriate
 - Implement quality assurance measures for hatcheries
- Encourage community ownership for Murray Cod conservation
 - Promote Murray Cod as an icon species
 - Document the significance of the Murray Cod to the community, especially in Aboriginal culture and oral history, and for contemporary rural communities
 - Assess level of public recognition, understanding and 'ownership' of the Murray Cod, and the issues surrounding its management. Involve the community in management and conservation of the Murray Cod. Publicise the results of research and management.
- Manage Recovery Plan implementation

- Establish a long-term structure for the implementation of the Recovery Plan through the employment of a national coordinator
- Develop interim targets for each Spatial Management Unit to measure progress towards the aspirational goal
- Early engagement with appropriate management agencies to ensure that required management actions will be integrated with existing strategies and implemented in a timely manner.
- Compile results of new research results into an appropriate form for use by management agencies to inform practices
- Coordinate communication and information exchange at national, state and regional levels
- Integrate Murray Cod recovery with major natural resource management programs and policies
- Ensure funding submissions are organised through appropriate management agencies each year, or as required
- Establish a process for assessment of Recovery Plan actions, including effective collation and dissemination of results
- Complete a formal review and evaluation at the end of the Recovery Plan

17.6. Potential Impacts

Potential impacts on Vulnerable species such as the Murray Cod are considered significant only in the case that an important population is impacted. The population of Murray Cod above Nundubbermere Falls, which is stocked and maintained by the release of hatchery bred fish, is not considered an important population.

frs environmental (2013b) reviewed potential impacts on Murray Cod as a result of the Project and found that of the potential impacts, the inundation and operation of the dam, obstruction of flow and passage by the dam and changes to the downstream flow regime may have the greatest impact on the species. They also found that potential impacts of these, and other Project activities, can be minimised where appropriate mitigation measures are implemented. Potential impacts on Murray Cod included the following:

- increased turbidity and sedimentation, and input of nutrients or other contaminants associated with the soil from works including vegetation clearing, earthworks, quarrying and sand extraction;
- loss of in-stream habitat from works including vegetation clearing, earthworks, quarrying and sand extraction;
- loss of in-stream habitat from dam inundation;
- restriction of passage and isolation of populations by the dam wall and during construction;
- loss of in-stream habitat due to a changed flow regime downstream of the dam;
- improved conditions for exotic species from dam inundation and a changed flow regime downstream of the dam; and
- reduction in food sources from changed water quality and flow condition.

17.7. Avoidance and mitigation measures

frs environmental (2013b) found that overall, there will only be minor impacts to Murray Cod if mitigation measures are implemented. Proposed mitigation measures include the following:

- preparation and implementation of an erosion and sediment control plan and construction of sediment dams before works begin;
- complete construction works in the dry season, if possible;
- translocation of fauna from in-stream areas directly affected by works ;
- maintenance of riparian vegetation and in-stream woody debris along dam margins;
- inclusion of fishlock on dam, with screens to re-direct large fauna towards the fishlock and away from off-takes;
- maintenance of passage for aquatic fauna during construction using diversion channels;
- managed environmental releases and spills to maintain connectivity and flow regime consistent with current conditions;
- prepare a management plan to control exotic and pest species such as mosquitofish and goldfish within and downstream of the dam;
- monitoring during construction and operation to confirm the absence of direct impacts key species and assess overall impacts to aquatic ecology; and
- fauna salvage and relocation where in-stream works will have a direct disturbance on aquatic flora and fauna

17.8. Residual impacts

The residual risk to the Murray Cod is considered to be negligible for all potential impacts other than the creation of a barrier to movement via the construction of a dam wall. Development of an appropriately designed fish lock system, which accommodates the movement of Murray Cod, is considered likely to mitigate this risk. The potential for adverse residual impacts on the Murray Cod is considered very low, and should be viewed in the context of the population being a stocked population.

18. BIODIVERSITY OFFSETS STRATEGY

SDRC is committed to provide an offset for residual impacts on Matters of National Environmental Significance (MNES) in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy.

The Project has residual impacts on the following MNES:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Grassy Woodland);
- *Callistemon pungens*; and
- Granite Belt Thick-tailed Gecko.

The Biodiversity Offset Strategy (Appendix I of the Supplementary Report) has examined the potential offset availability in the Stanthorpe region and presents a preferred offset solution. The Project's potential offset availability for residual impacts on MNES and the calculated offset potential are presented in Table 18-1.

Table 18-1 Potential offset availability for residual impacts on MNES

MNES	Residual impact	Offset Availability
Box-Gum Grassy Woodland	72.3 ha	1,089 ha (ground-truthed)
<i>Callistemon pungens</i>	45 plants	Propagation of plants
Granite Belt Thick-tailed Gecko	18.1 ha	370 ha of habitat

SDRC proposes to meet the Project's offset requirements by securing and managing direct, land-based offsets. SDRC will legally secure the final offset areas using a legally binding mechanism. The final offset package will be agreed with the Department of the Environment (DotE) and offsets will be secured prior to the commencement of any clearing activities for the Project.

An Offset area management plan (OAMP) will be prepared and implemented for the Project offset areas and will include regular monitoring, reporting and adaptive management pathways to enable adjustment of the management approach where necessary. The objectives of the OAMP will be to remove and manage threats and to assist improvement of the biodiversity values to achieve a conservation gain. Existing native vegetation on offset areas will need to achieve remnant status under the OAMP.

The OAMP will describe each offset area, the values it contains and the specific management actions to be undertaken. The OAMP will cover all aspects of management including signage, fire management, fencing, grazing management, weed and pest control, assisted regeneration and threatened species management. The OAMP will also contain details of timing, responsibilities and performance indicators.

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Appendix A Downstream Hydrology

This section describes the spills and environmental releases from Emu Swamp Dam, which will create the streamflow directly downstream of the dam. The discussion of the flow statistics with the proposed Emu Swamp Dam and the associated environmental release strategy is presented in Section A.1.

Figure A-1 presents a daily time series of spills and environmental releases from the proposed Emu Swamp Dam.



Figure A-1 Dam Release and Spills

Table A-1 presents the key spill statistics for the proposed Emu Swamp Dam. The proposed Emu Swamp Dam was predicted to spill in 88 years of the 123 year of the simulation period. This assessment shows that the dam spills on average 46 days per year and that the average period between spills is 0.4 years. The average duration of a spill from the dam is 14 days. Figure A-2 shows the annual number of spill days in the simulation period.

Table A-1 Dam Spill Statistics

Spill Statistics		
Total number of days of spill in the simulation period (123 years)	(days)	4,015
Total number of years in the simulation period with spills	(years)	88
Average duration of spills	(days)	14
Average number of days of spill per year	(days)	46
Average period between spills	(years)	0.4
Longest period between spills	(years)	6.8

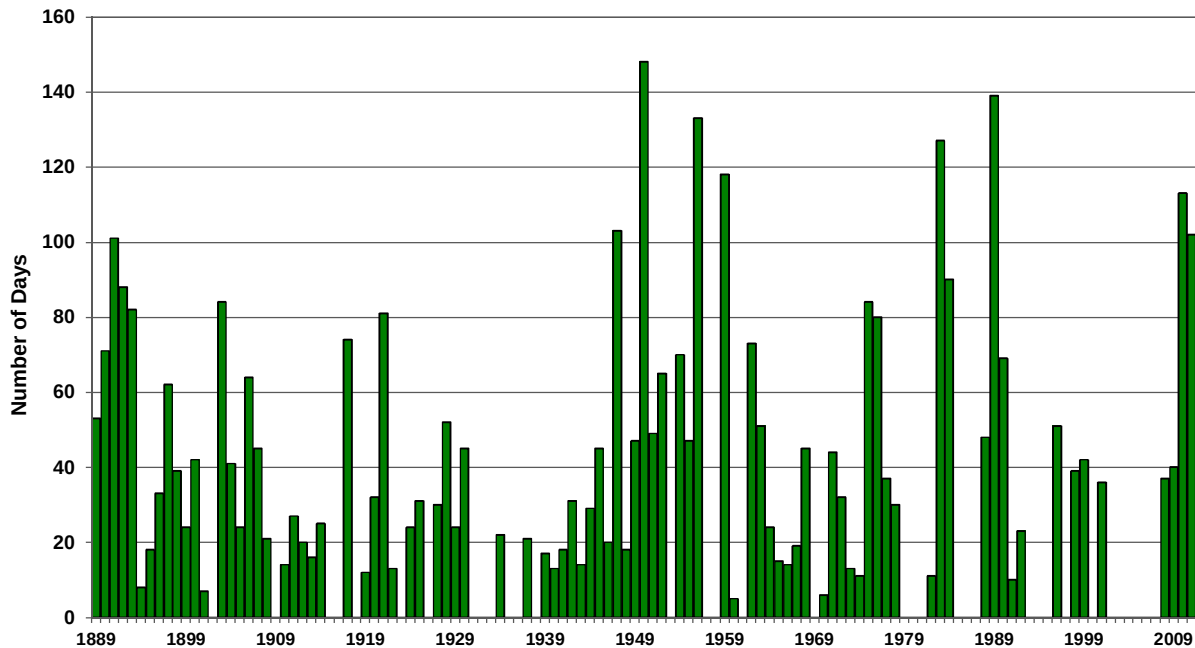


Figure A-2 Dam Annual Number of Spill Days

A.1 Flow Statistics

As outlined in Section 7.1.3 of the EIS, changes in streamflow were assessed at a number of locations:

- Severn River downstream of the proposed the dam site at Ballandean Gauge – this shows the change to streamflow in the reach downstream of the dam to Accommodation Creek (Figure A-3);
- Severn River immediately downstream of the confluence with Accommodation Creek – this shows the changes to streamflow for the Severn River downstream of the Accommodation Creek confluence (Figure A-5);
- Dumaresq River at Farnbro – this is shows the changes in streamflow in the Sundown National Park (Figure A-6).

The proposed Emu Swamp Dam will not impact of the flow regime upstream of the proposed dam location.

The flow statistics show that the change to the flow regime at the Ballandean Gauge predominantly occurs between the 2% and 20% daily exceedance, as shown in Figure A-4. It is important to compare the depth of flow in the river through this range, in order to understand the potential impact to the aquatic and terrestrial environment. Figure A-4 shows the cross section at this location in the river, which shows a defined channel with a channel depth of approximately 2 m.

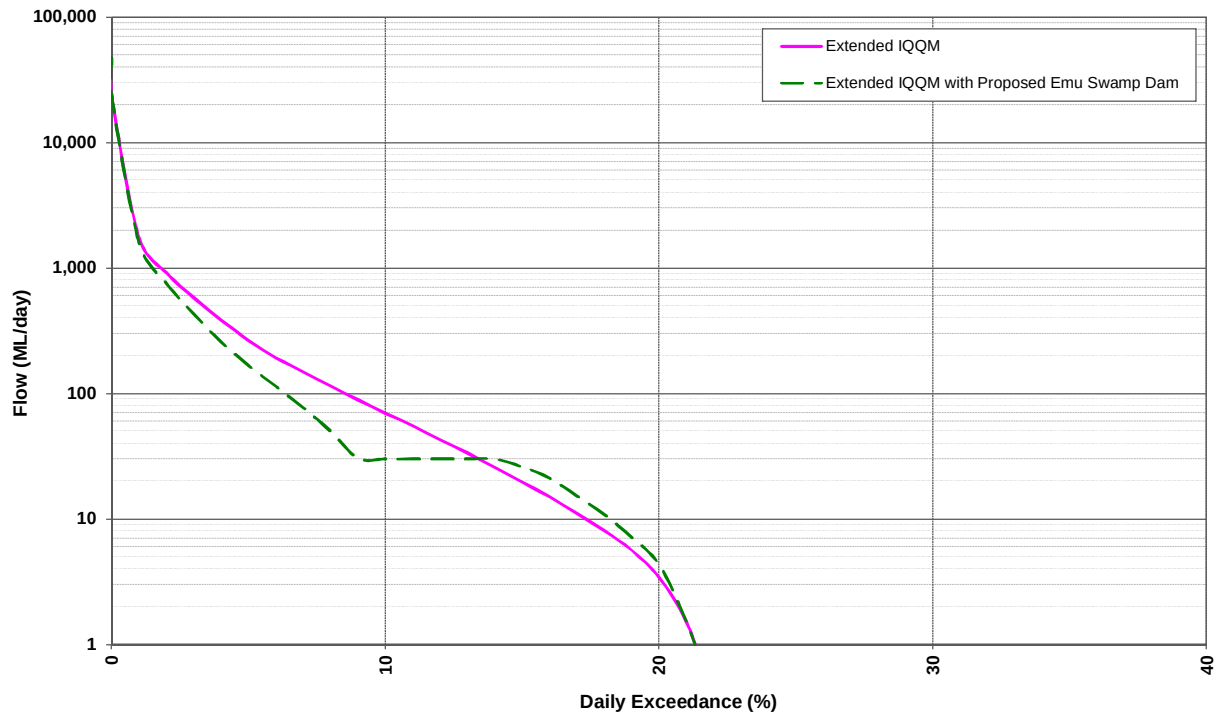


Figure A-3 Flow Duration Curve – Downstream of the Dam Site (Ballandean Gauge)

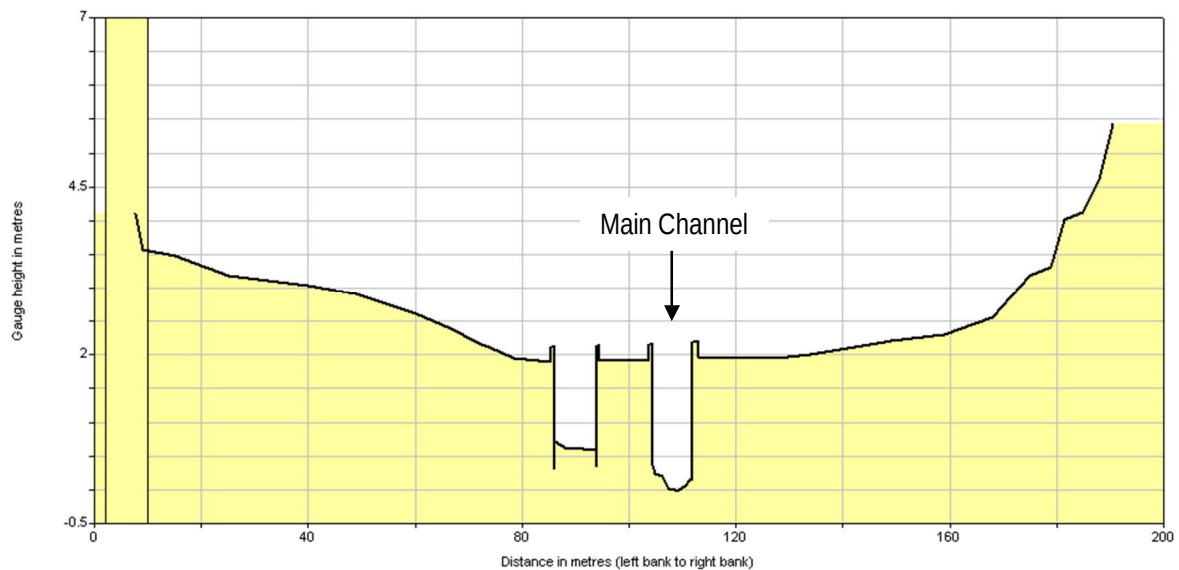


Figure A-4 Cross Section at Ballandean Gauge (adapted from DNRW Website)

Table A-2 presents the predicted flow and gauge depth at Ballandean gauge for the 5%, 10% and 15% daily exceedance. This table shows that the predicted change in flow depth is in the order of 100 mm. This is considered to be a negligible change, which is likely to have minimal impact on water quality and instream ecological requirements.

Table A-2 Flow Statistics – Ballandean Gauge

Daily Exceedance (%)	Scenario	Flow (ML/d)	Gauge Depth (m)	Change in Flow Depth (m)
15%	Extended IQQM	20	0.84	+ 0.1 (100 mm)
	Extended IQQM with Proposed Emu Swamp Dam	26	0.94	
10%	Extended IQQM	70	0.64	- 0.1 (100 mm)
	Extended IQQM with Proposed Emu Swamp Dam	30	0.54	
5%	Extended IQQM	264	0.50	- 0.04 (40 mm)
	Extended IQQM with Proposed Emu Swamp Dam	167	0.64	

Figure A-5 presents the change in the flow regime downstream of the Accommodation Creek confluence. This figure shows that the change in the flow regime occurs between the 2% and 15% daily exceedance. There is no rating curve available for this location to determine the change in the flow depth; however, this change is considered to be less than the change at the Ballandean Gauge, as outlined above.

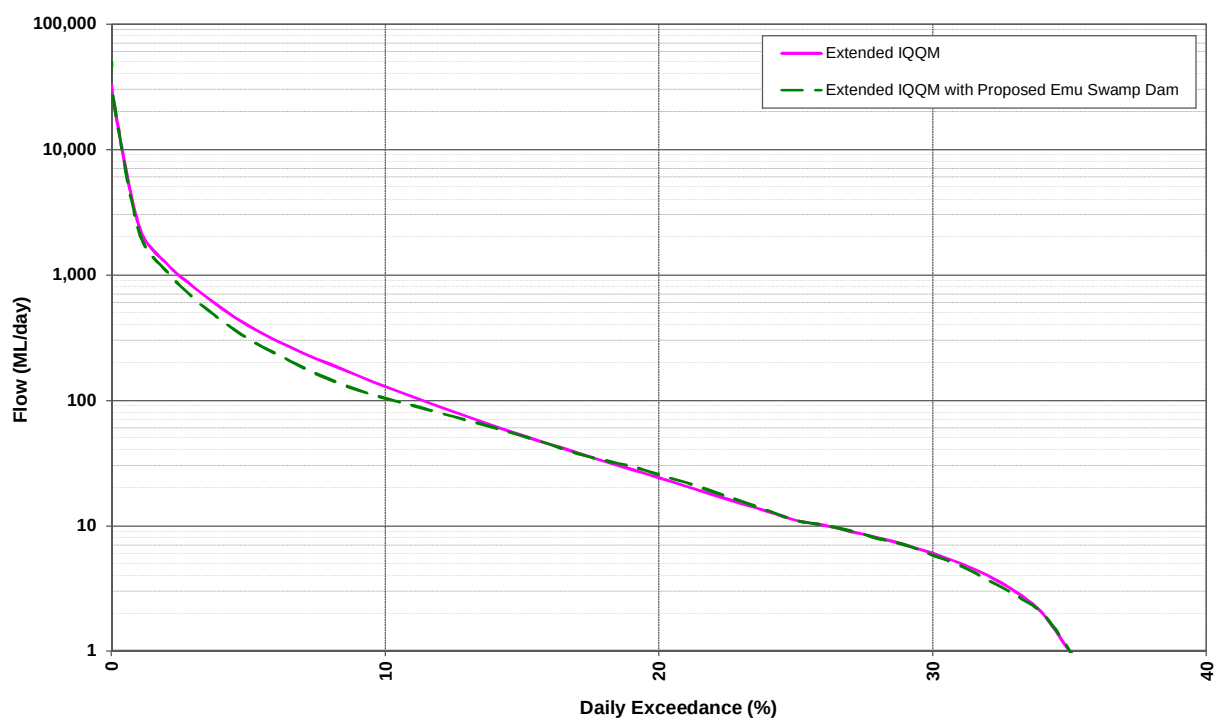


Figure A-5 Flow Duration Curve – Downstream of the Accommodation Creek Confluence

The flow statistics show that the change to the flow at Farnbro occurs between the 1% and 18% daily exceedance, as shown in Figure A-6 and Figure A-7. It is important to compare the depth of flow in the river through this range, in order to understand the potential impact to the aquatic and terrestrial environment. Figure A-8 shows the cross section at this location in the river, which shows a wide channel.

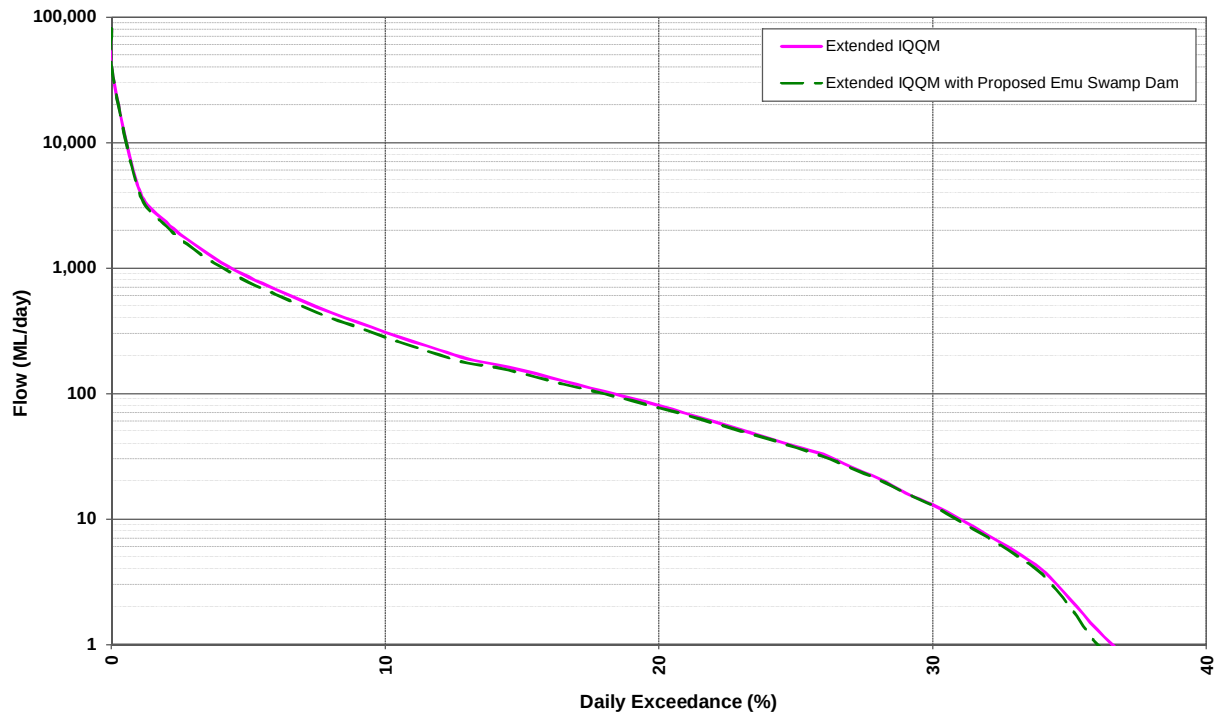


Figure A-6 Flow Duration Curve – Farnbro

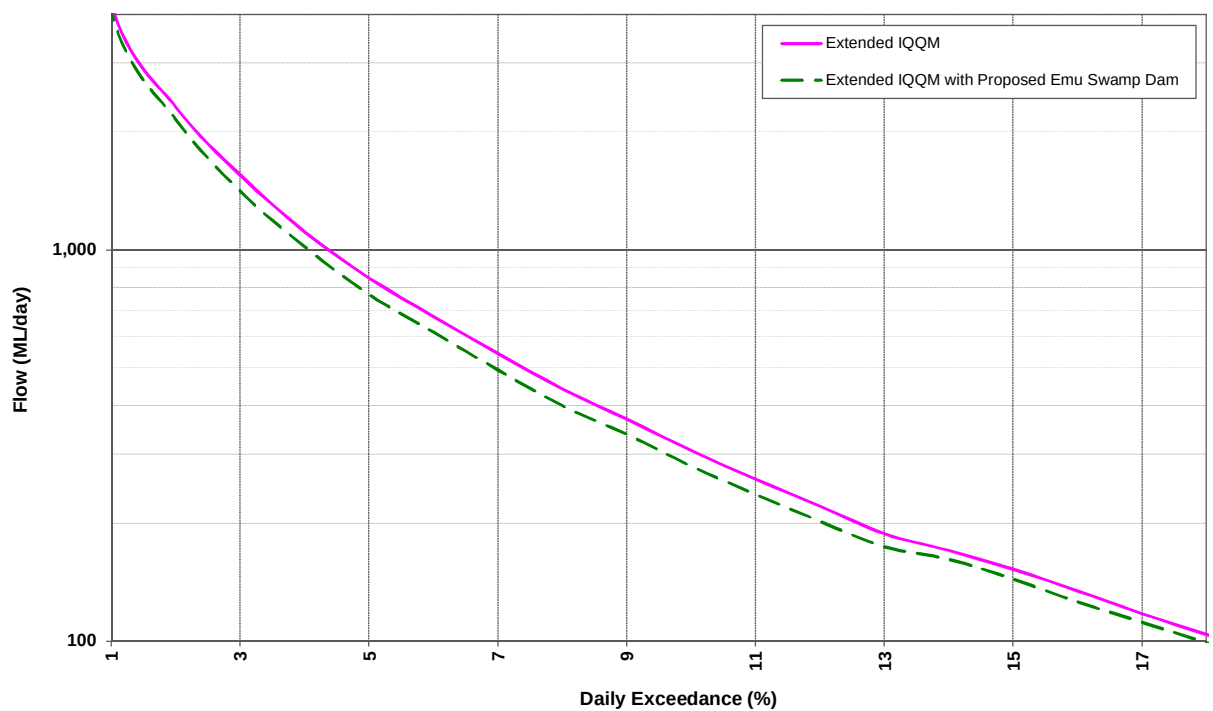


Figure A-7 Flow Duration Curve – Farnbro – Zoom

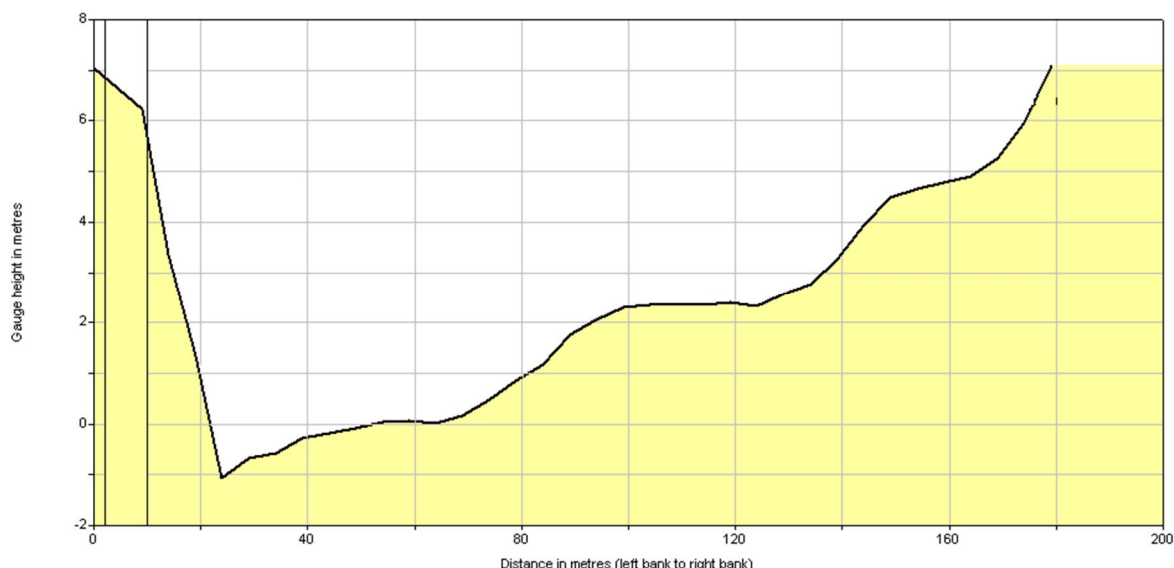


Figure A-8 Cross Section at Farnbro Gauge (adapted from DNRW Website)

Table A-3 presents the predicted the flow and flow depth at Farnbro for the 5%, 10% and 15% daily exceedance. This table shows that the predicted change in flow depth is in the order of 0 – 20 mm. This is considered to be a negligible change in these flow depths, which is likely to have minimal impact on water quality and instream ecological requirements.

Table A-3 Flow Statistics – Farnbro Gauge

Daily Exceedance (%)	Scenario	Flow (ML/d)	Flow Depth (m)	Change in Flow Depth (m)
15%	Extended IQQM	152	0.38	0
	Extended IQQM with Proposed Emu Swamp Dam	144	0.38	
10%	Extended IQQM	306	0.46	- 0.01 (10 mm)
	Extended IQQM with Proposed Emu Swamp Dam	280	0.45	
5%	Extended IQQM	847	0.66	- 0.02 (20 mm)
	Extended IQQM with Proposed Emu Swamp Dam	768	0.64	

Appendix B

EPBC Act Protected Matters Report



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

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[Summary](#)

[Details](#)

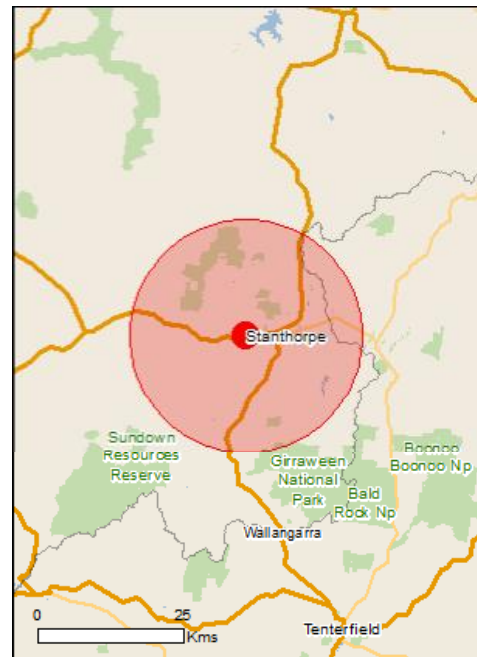
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[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

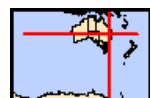
[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

Buffer: 20.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	39
Listed Migratory Species:	13

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As [heritage values](#) of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	1
Listed Marine Species:	14
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	8
State and Territory Reserves:	17
Regional Forest Agreements:	1
Invasive Species:	37
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (RAMSAR)	[Resource Information]
Name	Proximity
Narran lake nature reserve	Upstream from Ramsar

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	Community may occur within area
New England Peppermint (<i>Eucalyptus nova-anglica</i>) Grassy Woodlands	Critically Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia		
Regent Honeyeater [82338]	Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Dasyornis brachypterus		
Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Erythrorchis radiatus		
Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Geophaps scripta scripta		
Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Black-throated Finch (southern) [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Nyctophilus corbeni South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pseudomys oralis Hastings River Mouse, Koontoo [98]	Endangered	Species or species habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Other		
Macrozamia machinii [64583]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Acacia pubifolia Velvet Wattle [19799]	Vulnerable	Species or species habitat likely to occur within area
Acacia ruppii Rupp's Wattle [7559]	Endangered	Species or species habitat likely to occur within area
Boronia granitica Granite Boronia [18598]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Boronia repanda Repand Boronia, Border Boronia [21315]	Endangered	Species or species habitat likely to occur within area
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area
Caladenia atroclavia Black-clubbed Spider-orchid [20859]	Endangered	Species or species habitat likely to occur within area
Callistemon pungens [55581]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus scoparia Wallangarra White Gum [9640]	Vulnerable	Species or species habitat likely to occur within area
Grevillea scortechinii subsp. scortechinii Black Grevillea [4243]	Vulnerable	Species or species habitat known to occur within area
Homoranthus montanus [24319]	Vulnerable	Species or species habitat likely to occur within area
Kardomia granitica a shrub [83201]	Vulnerable	Species or species habitat likely to occur within area
Lepidium peregrinum Wandering Pepper-cress [14035]	Endangered	Species or species habitat likely to occur within area
Phebalium glandulosum subsp. eglandulosum Rusty Desert Phebalium [17140]	Vulnerable	Species or species habitat known to occur within area
Phebalium whitei [19322]	Vulnerable	Species or species habitat likely to occur within area
Streblus pendulinus Siah's Backbone, Sia's Backbone, Isaac Wood [21618]	Endangered	Species or species habitat likely to occur within area
Tylophora woollsii [20503]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Delma torquata Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Uvidicolus sphyrurus Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko [84578]	Vulnerable	Species or species habitat likely to occur within area
Wollumbinia belli Bell's Turtle, Western Sawshelled Turtle, Namoi River Turtle, Bell's Saw-shelled Turtle [86071]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus		
White-throated Needletail [682]		Species or species habitat known to occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus		
Spectacled Monarch [610]		Species or species habitat may occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area
Xanthomyza phrygia		
Regent Honeyeater [430]	Endangered*	Species or species habitat known to occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat likely to occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land		[Resource Information]
The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.		
Name		
Defence - STANTHORPE TRAINING DEPOT		
Commonwealth Heritage Places		[Resource Information]
Name	State	Status
Historic		
Stanthorpe Post Office	QLD	Listed place

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Extra Information

Places on the RNE

[\[Resource Information \]](#)

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Horans Gorge Environmental Park	QLD	Indicative Place
Mount Marlay	QLD	Indicative Place
Girraween National Park	QLD	Registered
Historic		
Ballandean Station Homestead including Outbuildings	QLD	Registered
Carnarvon Rail Bridge	QLD	Registered
Diamond Residence	QLD	Registered
Stanthorpe Post Office	QLD	Registered
Stanthorpe Soldiers Memorial	QLD	Registered

State and Territory Reserves

[\[Resource Information \]](#)

Name	State
Bungawarra	QLD
Dragonweyr	QLD
Egernia	QLD
Girraween	QLD
Granitica	QLD
Greenhood Ridge	QLD
Hillview	QLD
Horans Gorge	QLD
Kurrajong Place	QLD
Mount Tully Cottage	QLD
Possum Lane	QLD
Scotney	QLD
The Sanctuary	QLD
Tinkerbell	QLD
Tumbledown	QLD
Wattle Gully	QLD
Wylah	QLD

Regional Forest Agreements

[\[Resource Information \]](#)

Note that all areas with completed RFAs have been included.

Name	State
North East NSW RFA	New South Wales

Invasive Species

[\[Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis		
Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata		
Nutmeg Mannikin [399]		Species or species habitat likely to occur

Name	Status	Type of Presence
Passer domesticus House Sparrow [405]		within area Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw		Species or species

Name	Status	Type of Presence
Creeping, Funnel Creeper [85119]		habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126] Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat likely to occur within area Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892] Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Coordinates

-28.6564 151.8693

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Department of Environment, Climate Change and Water, New South Wales](#)
- [-Department of Sustainability and Environment, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment and Natural Resources, South Australia](#)
- [-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [-Environmental and Resource Management, Queensland](#)
- [-Department of Environment and Conservation, Western Australia](#)
- [-Department of the Environment, Climate Change, Energy and Water](#)
- [-Birds Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-SA Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Atherton and Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [-State Forests of NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

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Appendix C Detailed Description of Ecology Surveys

C.1 Terrestrial Flora

C.1.1 3D Environmental – 2006

3D Environmental undertook desktop review and field surveys in 2006 and 2007 of the inundation area, buffer area and pipeline alignments to determine potential impacts on vegetation communities and species of conservation significance occurring in the Project areas.

Desktop literature review

A search of relevant databases provided background information regarding the presence and distribution of flora species known from the Project area and the broader region. This included searches of the Commonwealth EPBC Act Online Protected Matters Search Tool, the Queensland Herbarium HERBRECS database and the Queensland Department of Environment and Heritage Protection (DEHP) WildNet database. Regional Ecosystem (RE) mapping sourced from DNRM provided the basis for vegetation community assessment, and site data extracts sourced from the Queensland Herbarium HERBRECS and CORVEG databases provided a basis for assessment of flora species distributions. Previous vegetation mapping was also reviewed, as well as biodiversity/conservation assessments, recovery plans and published ecological research completed by government agencies and private organisations over relevant sections of the Project area.

Aerial photograph analysis and site location

A stereoscopic assessment of April 1999 1:40, 000 scale colour aerial photographs, the most recent available at the time, allowed the establishment of preliminary vegetation line work and polygon attribution, completed in reference to the available RE mapping. Historical aerial photographs (1989) were utilised in the Project as an aid to understanding site history, and to assist in the classification of non-remnant or regrowth vegetation.

A suite of survey sites were chosen from aerial photograph analysis to ensure that the field survey:

- Targeted a representative range of habitats within the Project area
- Sampled those communities that were useful for providing reference conditions for disturbed communities (best type examples)
- Directed detailed sampling towards those communities that could not be adequately categorised through aerial photograph interpretation (API), or were considered critical to a range of threatened flora species

Further sites were added opportunistically during the field survey to provide a more complete data coverage and to verify the mapping units. A summary of the survey locations for individual Project components is provided in Table C-1.

Table C-1 Vegetation survey effort

Project area	Survey effort	Number of locations
Inundation Area	Secondary	15
	Quaternary	33
Stalling Lane Access	Secondary	3
	Quaternary	7
Urban Pipeline	Quaternary	42
Irrigation Pipeline	Quaternary	168

Field survey technique

Field survey methods followed Queensland Herbarium standards (Neldner *et al.* 2005) using a combination of formalised secondary, tertiary and quaternary level sampling procedures, as well as informal site observations. Field proformas from Neldner *et al.* (2005) were modified to suit sampling requirements specific to this Project and to incorporate data on vegetation condition, fauna habitat features and landscape function. The core field information recorded included site location, tenure, air photo and site photo references, landform and geological features, and vegetation community structure. Complete species lists were compiled wherever these were considered appropriate. Canopy height was meticulously measured at all sample locations using a clinometer and linear regression table, and canopy cover was recorded in secondary sites using measured crown intercept transects. A Garmin GPS 60 (Geographic Positioning System) was used to accurately record map coordinates for the site locations (GDA94).

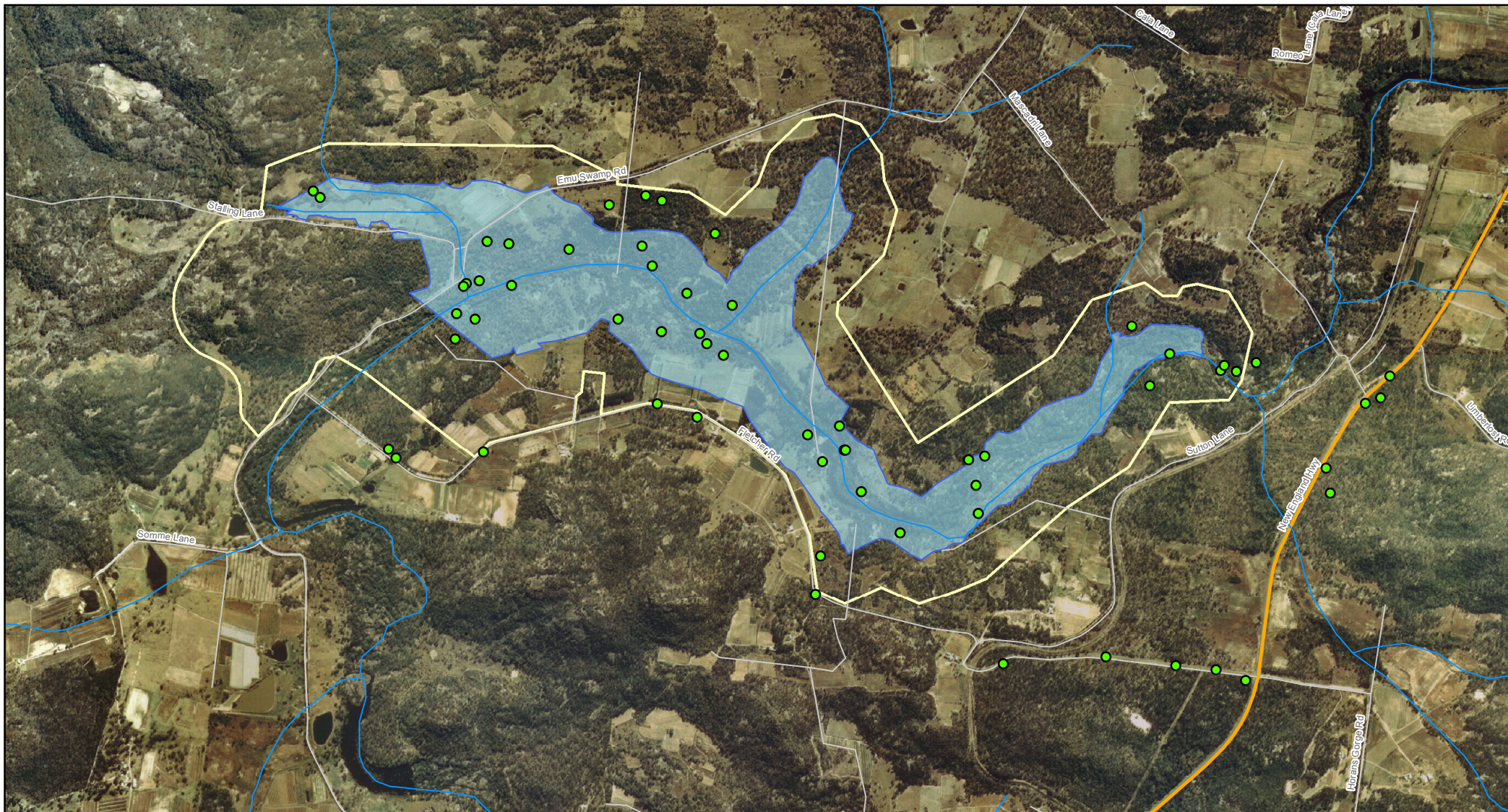
Secondary sites consisted of a standard 50 m × 10 m plot located along the contour. Attempts were made to avoid sampling on vegetation community boundaries, which was difficult in some of the linear vegetation communities. Bitterlich measurements to measure basal area were completed at all sites except in linear communities where the method proved inappropriate. Full species lists for all strata were established during the secondary sampling procedure wherein the 500 m² plot was intensively sampled, followed by a detailed search of the vicinity to record additional species. While the vicinity search was broadly defined by the extent of the basal area sweep, it was in all cases confined to the target community. The abundance of all species within the plot was recorded by stem counts and a visually assessed ranking of cover abundance using the Braun-Blanquet scale.

Tertiary sites were completed in a similar fashion to the secondary procedure, except that non-woody species were not recorded. Several sites recorded at tertiary level comprised a full species list in a search area established via a radial sweep of the Bitterlich device. Survey to quaternary level was completed on sites where access permission was granted, and comprised a description of the floristic structure, composition, and the associated landform. Wherever a vegetation community was considered to be potential critical habitat for a threatened species, the search area was broadened and a more extensive species list was established from the extended search area. Flora species were also recorded on walking traverses, again with particular attention to locating threatened and regionally significant taxa.

Botanical voucher specimens were collected throughout the field survey to verify site floristics and to enable identification of those species that were taxonomically problematic. All material was pressed, labelled, and cross referenced, and of sufficient size and quantity to be incorporated into the Queensland Herbarium collection, if required. Expert advice on species identification was provided by Queensland Herbarium Advisory Services. Site/species field data was entered into an Excel spreadsheet, enabling analysis of flora values within vegetation communities and REs.

The field survey of the water storage was completed in two phases enabling a thorough assessment of vegetation communities and individual species. An initial survey was completed in December 2006, during which the bulk of the vegetation communities were sampled and floristic data gathered. A secondary winter survey was completed in June 2007. This allowed an assessment of seasonal floristic variation and allowed targeted searches for winter flowering (or emerging) species. Winter survey methods included secondary sampling of standard 50 m × 10 m plots in representative REs in conjunction with a thorough floristic search of a 1 ha area in the site locality. Numerous meander searches were also undertaken through a range of ecosystems.

Single phases of survey were completed for the Urban Pipeline (December 2006), the Stalling Lane Access (June 2007), and the Irrigation Pipeline (July 2007). These surveys were directed at identifying constraints and as such, were focused on the identification of threatened flora species, vegetation communities (including REs) with special conservation significance, and declared weed species. Comprehensive species lists were not compiled for these portions of the Project although potentially significant species were collected and voucher specimens submitted for verification to the Queensland Herbarium. Due to the proximity of the Stalling Lane Access to the water storage, and the inclusion of a number of detailed secondary survey locations in the road survey effort, floristic data collected during this survey has been incorporated into the overall species lists. Vegetation survey locations are shown on Figure C -1 and Figure C -2.



LEGEND

- Flora Survey Locations (3D Environmental)
- Watercourse
- Road
- Highway
- Regeneration Area
- Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure C-1

3D Environmental Survey
Locations in Inundation Area

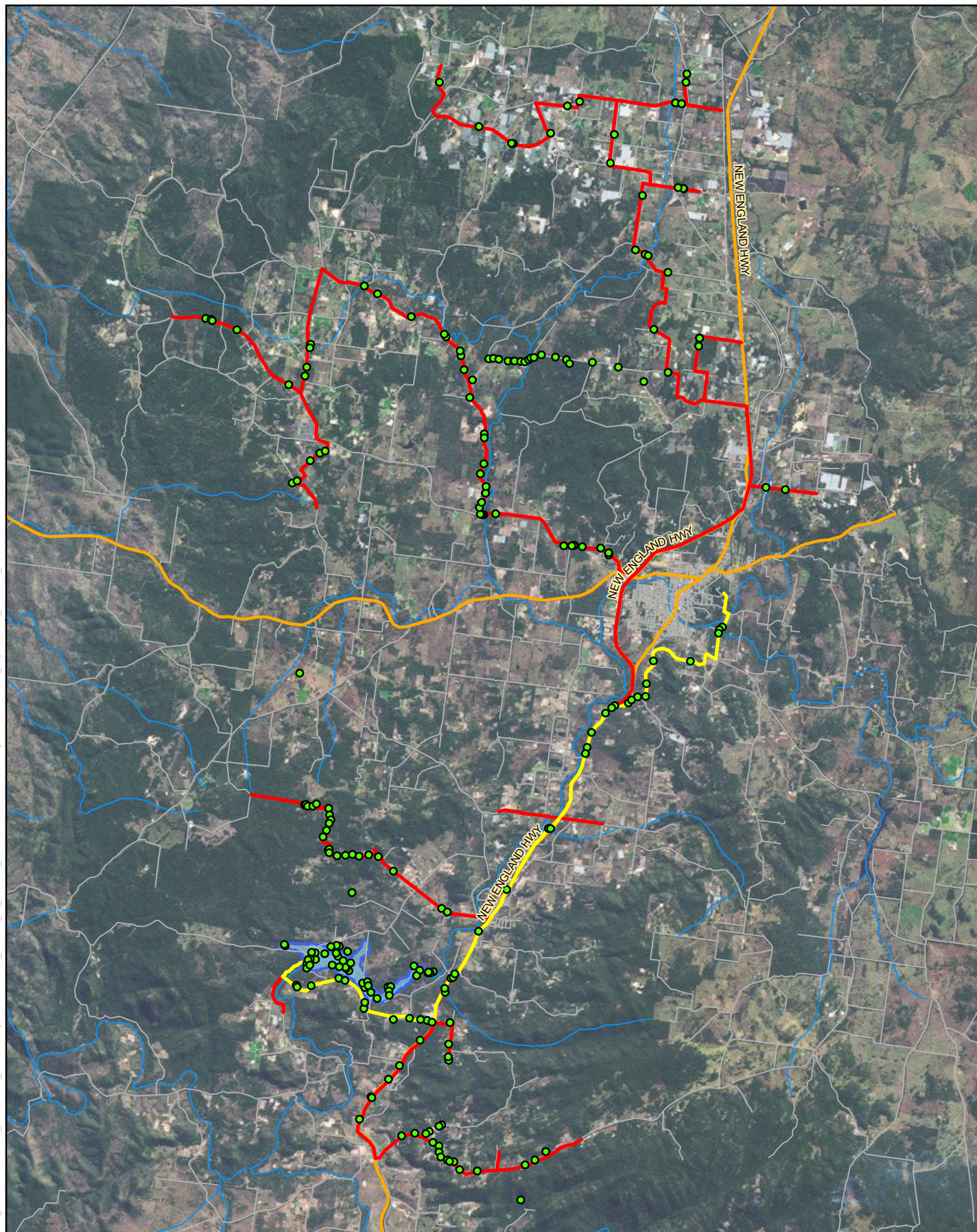


0 250 500 750 1,000
Metres

Scale - 1:25,000

Projection: GDA94 MGA56





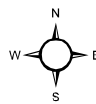
LEGEND

- Flora Survey Locations (3D Environmental)
- Road
- Highway
- Urban Pipeline
- Irrigation Pipeline
- Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure C-2

3D Environmental Survey
Locations Along Pipeline Alignments



0 1 2 3 4
Kilometres

Scale - 1:150,000

Projection: GDA94 MGA56

Classification of land and vegetation

Under the Queensland RE system of vegetation classification, vegetation communities are described by a three-part code of which the primary subdivision is the bioregional zone, followed by geology or land zone, with vegetation being the final subdivision in the classification. REs are assessed on a state wide basis for conservation significance, as regulated by Queensland's *Vegetation Management Act 1999* (VM Act). Vegetation structure is classified according to the system of Specht (1970) as modified by Neldner *et al.* (2005), (Table C-2). This classification has been applied consistently to vegetation throughout the field survey and broader flora baseline study.

Table C-2 Structural formation classes qualified by height for non-rainforest vegetation: Neldner *et al.* (2005) modified from Specht (1970)

Projective Foliage Cover	70 – 100%	30 – 70%	10 – 30%	< 10%
Approximate crown cover %	80 – 100%	50 – 80%	20 – 50%	< 20%
Crown separation	Closed or dense	Mid-dense	Sparse	Very sparse
Growth Form	Structural Formation Classes (qualified by height)			
Trees > 30 m	Tall closed-forest (TCF)	Tall open-forest (TCF)	Tall woodland (TW)	Tall open-woodland (TOW)
Trees 10 – 30 m	Closed-forest (CF)	Open-forest (OF)	Woodland (W)	Open-woodland (OW)
Trees < 10 m	Low closed-forest (LCF)	Low open-forest (LOF)	Low woodland (LW)	Low open-woodland (LOW)
Shrubs 2 – 8 m	Closed-scrub (CSC)	Open-scrub (OSC)	Tall shrubland (TS)	Tall open-shrubland (TOS)
Shrubs 1 – 2 m	Closed-heath (CHT)	Open-heath (OHT)	Shrubland (S)	Open-shrubland (OS)
Shrubs <1 m	-	Dwarf open-heath (DOHT)	Dwarf shrubland (DS)	Dwarf open-shrubland (DOS)
Succulent shrub	-	-	Succulent shrubland (SS)	Dwarf succulent shrubland (DSS)
Hummock grasses	-	-	Hummock grassland (HG)	Open hummock grassland (OHG)
Tussock grasses	Closed-tussock grassland (CTG)	Tussock grassland (TG)	Open tussock grassland (OTG)	Sparse-tussock grassland (STG)
Herbs	Closed-herbland (CH)	Herbland (H)	Open-herbland (OH)	Sparse-herbland (SH)
Forbs	Closed-forbland (CFB)	Forbland (FB)	Open-forbland (OFB)	Sparse-forbland (SFB)
Sedges	Closed-sedgeland (CV)	Sedgeland (V)	Open-sedgeland (OVI)	-

As a general rule applied in this Project and consistent with standard herbarium methods, a vegetation polygon is classified as non-remnant if its total width is less than 15 m, and the vegetation polygon is less than 1 ha in size and isolated from remnant vegetation communities.

Mapping scale

For vegetation surveys, Neldner *et al.* (1995) recommend a minimum of half the sampling density required by the Food and Agricultural Organisation of the United Nations (FAO 1979) for soil survey. This equates to a minimum of two sites/km² for 1:25 000 scale mapping, and 12.5 sites/km² for 1:10, 000 scale mapping. As such, a

proposed water storage area of 2.5 km² (excluding the pipeline easements) requires 31 sites for 1:10,000 scale mapping, assuming total cover of remnant vegetation. With cleared horticultural lands comprising 28% of the Project area, site data requirements for 1:10,000 scale mapping in the Project area are reduced significantly. With 48 sites sampled within the water storage, the collected site information exceeds data requirements for 1:10,000 scale mapping. Highly detailed delineation of vegetation communities was constrained, however, by the spatial resolution of the available 1:40,000 scale aerial photographs used for the study.

Digital processing and accuracy

The marked aerial photographs were scanned at a resolution of 300 dpi. Each photo was then registered within ArcMap using the geo-registration extension against the digital cadastral database (DCDB). Upon completion of photo registration, the identified boundaries were captured as line work. Final editing was performed when all of the boundaries had been captured, prior to generation of polygons in ARC/INFO format.

The accuracy for the 1:40,000 scale aerial photography is equivalent to 1 mm on the photograph being equal to 40,000 mm on the ground. All aerial photograph line-work was between 1-2 mm on the aerial photography generating an accuracy of 40 to 80 m. The RMS error obtained during photo registration varies depending on the underlying terrain. In general, the RMS error for the 1:40,000 scale aerial photography is in the range of 40 to 80 m, with variation due mainly to the underlying terrain. Steeper terrain produces greater radial distortion on each photograph.

Imagery supplied by SSC (now SDRC) was utilised as a supplementary control for air photo registration on the Irrigation Pipeline. Spatial inconsistencies in the DCDB and Spot Imagery, which were used as a primary means of spatial registration, introduced an additional source of error into the spatial processing. The accuracy of floristic collection points and survey locations was within the range of 4-8 m, determined by GPS.

Flora assessment methods

The site selection method targeted samples of representative habitats throughout the Project area for vegetation mapping purposes and also allowed assessment of the vascular flora of the Project area. Structural and floristic data was entered onto proformas and transferred into Excel format within a site by species framework. The dataset included a range of fields relevant to the site e.g. location, condition status, community type, RE and VM Act status. Data relevant to individual species, such as collection number, conservation status, exotic status, bioregional endemism, disjunction, and distribution limit was assigned as determined by the literature review.

The resultant dataset provided a detailed flora list for the survey and allowed identification and mapping of a range of flora values, including taxa of state significance and other priority species and their habitats. Lists derived from the HERBRECS and WildNet databases and information contained within published and unpublished literature for the area were also assessed to assist in predictive analysis of species distributions. Interpretation of raw data assists in the assessment of spatial distribution of known records of threatened flora and in identification of their habitat. Data output also assists in the development of a flora species checklist.

C.1.2 SKM - 2013/2014

Scientific License

The field survey was undertaken in accordance with SKM's Scientific Purposes Permit number WISP10848512 issued by the Department of Environment and Heritage Protection (DEHP) under S12(E) Nature Conservation (Administration) Regulation 2006, valid from 1 March 2012 to 28 February 2017.

Methodology

The listing advice for this community (TSSC, 2006) provides condition criteria to assess Box-Gum Grassy Woodland vegetation. A flowchart (DEH, 2006) based on these criteria was used to assess patches of remnant and regrowth vegetation in the field. The flowchart uses characteristics such as overstorey species, proportion of native understorey, patch size and evidence of recruitment to determine if the vegetation is the listed ecological community.

Random meanders were undertaken to identify *Callistomen Pungens* at each survey site. This involved searching suitable habitat for a minimum of 30 minutes on foot by two ecologists.

BioCondition sites were surveyed in accordance with the BioCondition assessment manual Version 2.1 (Eyre *et al.*, 2011a).

Field Survey 1 (July 2013)

Field surveys were undertaken during winter over a three week period from 1 to 19 July 2013. This survey was undertaken between 1-5, 8-12 and 15-19 July 2013.

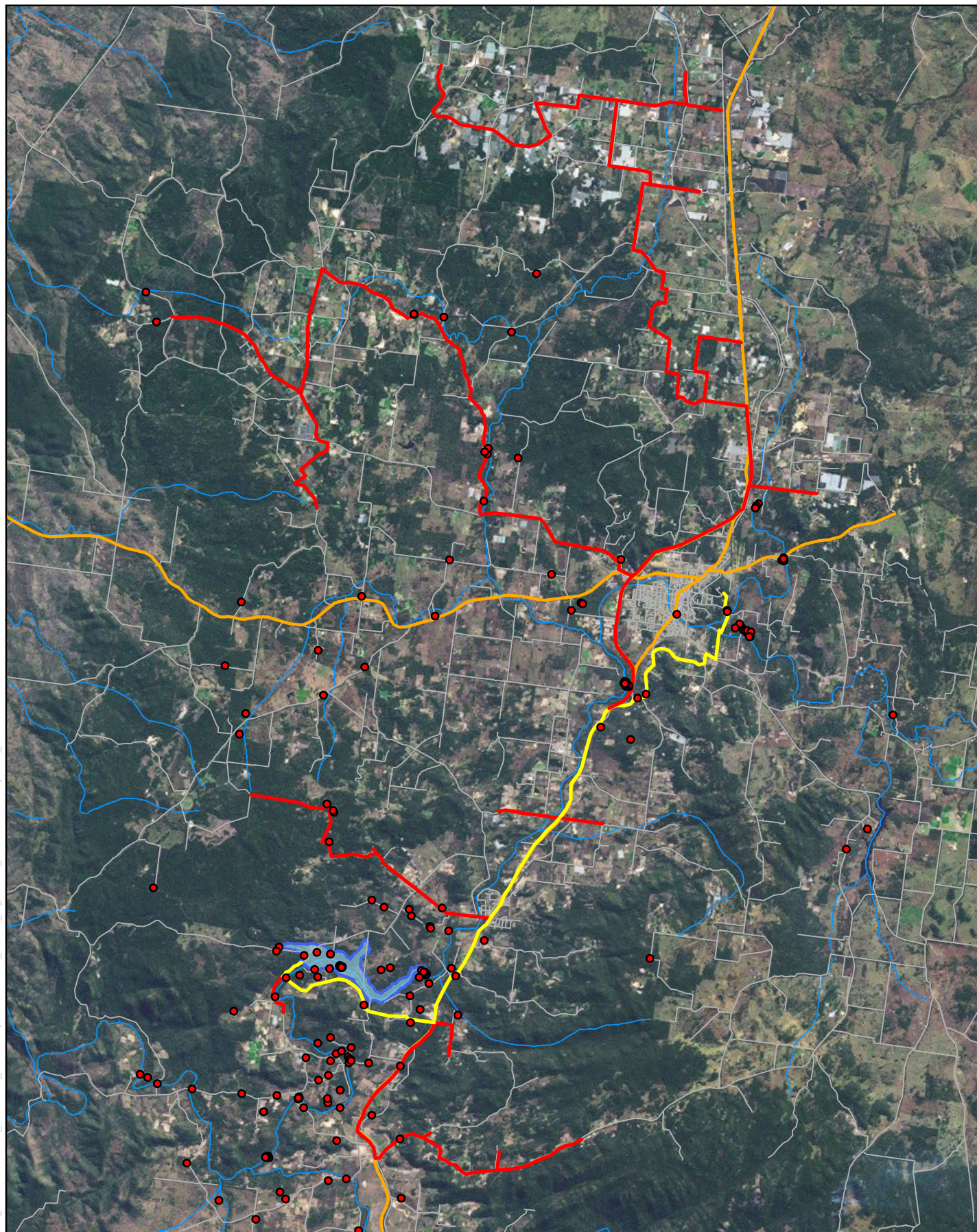
Access to survey sites was not possible in some instances where land holders did not give permission to enter properties. Where land access was not provided effort was made to find alternative sites. A total of 81 Box-Gum Grassy Woodland sites, 25 *M. williamsii* random meanders and 26 BioCondition sites were completed.

Field survey 2 (November 2013)

An additional survey for *M. williamsii* was undertaken between 28-30 October 2013 during the flowering period to confirm the identification of *M. williamsii* at existing sites, and to identify additional sites that provide suitable habitat for *M. williamsii* as potential translocation sites. Random meander searches were undertaken at each survey site, involving searching suitable habitat for a minimum of 30 minutes on foot by two ecologists. Flowering samples of *M. williamsii* from the survey sites were sent to the Queensland Herbarium to confirm identification.

Field Survey 3 (January 2014)

An additional survey for potential Box-Gum Grassy Woodland offset sites was undertaken from 29-31 January 2013. The purpose of this survey was to investigate additional sites that could be used as offsets for Box-Gum Woodlands disturbed by the Project. During field survey 3, 19 sites were visited and surveyed against the Box-Gum Grassy Woodland condition criteria, as described above.



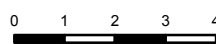
LEGEND

- Flora Survey Locations (SKM, 2014)
- Flora Survey Locations (3D Environmental, 2007)
- Road
- Highway
- Urban Pipeline
- Irrigation Pipeline
- Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure C-3

SKM Flora Survey Sites



Scale - 1:150,000

Projection: GDA94 MGA56

C.2 Terrestrial Fauna

C.2.1 BAAM – 2006/2007

Biodiversity Assessment and Management (BAAM) undertook desktop assessment and field surveys in 2006 and 2007 incorporating habitat assessments, trapping, active searches, bird census, nocturnal surveys, Anabat detection and targeted searches for threatened species.

Desktop assessment

Prior to the field survey, public databases were searched in order to provide background information regarding terrestrial vertebrate fauna species known from the region and local area. This included searches of the EPBC Act Online Protected Matters Search Tool, the DEHP WildNet database, the Birds Australia bird database, and the Queensland Museum fauna database for the Project area and surrounds. Information gained from this phase of the Project was used to:

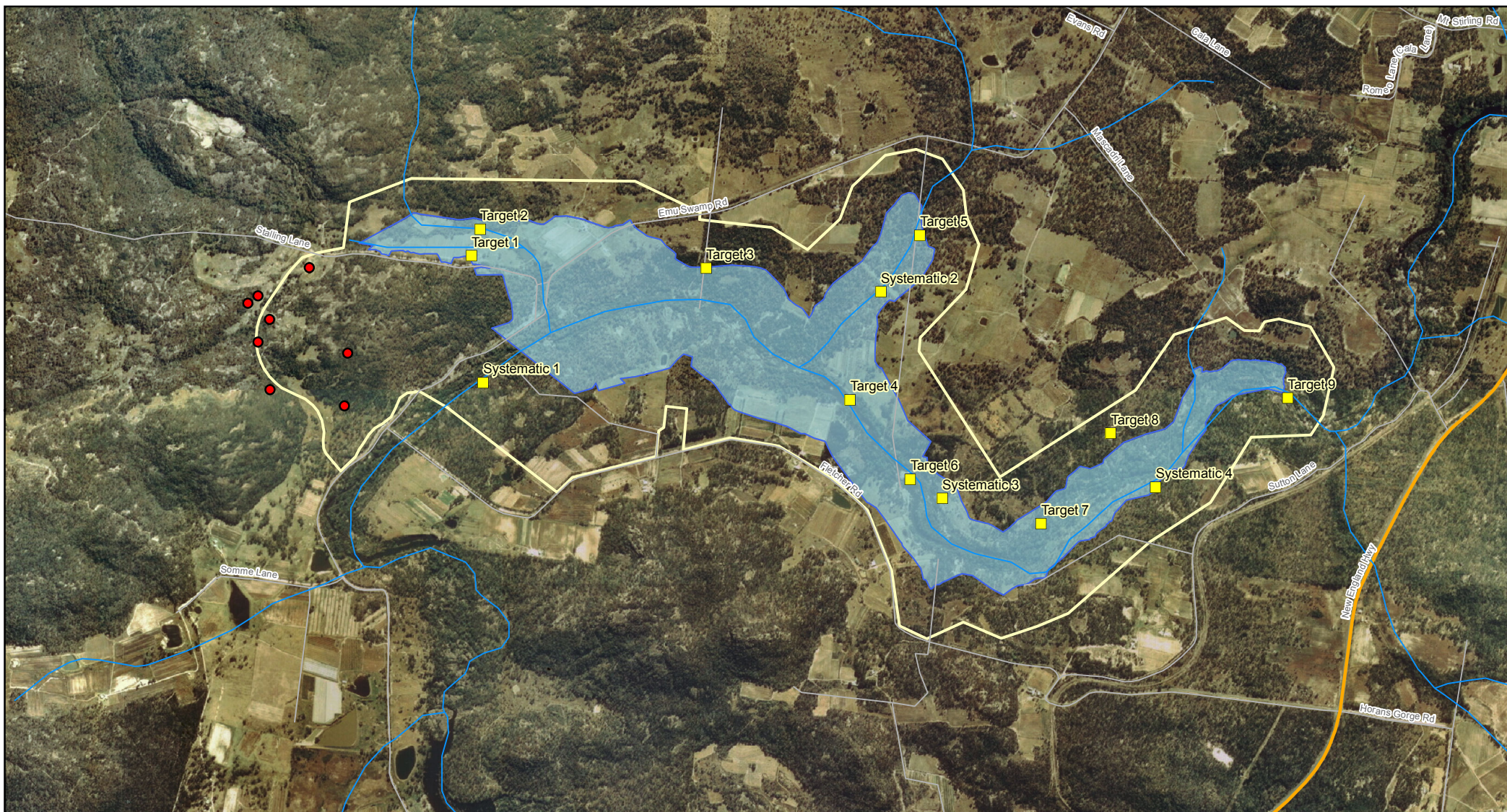
- Ensure that survey methods were designed to detect species of significance known from the region;
- Determine which species are most likely to occur if suitable habitat was located within the Project area. Species with recent, nearby records were considered more likely to occur if suitable habitat was located in the Project area.

In addition, all other relevant information relating to the Project, Project area and the survey was reviewed, where available. This included aerial photography, mapping of vegetation, geology, land zones and topography, and all relevant planning documentation/mapping administered by SSC (now SDRC) and the Queensland Government.

Field surveys

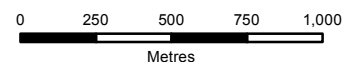
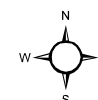
Two fauna surveys were conducted for the water storage and Stalling Lane Access: a summer survey from 19 to 23 December 2006 and an autumn/winter survey from 26 May to 1 June 2007. Four systematic fauna survey sites were established within, or immediately adjacent to, the inundation area. The location of fauna survey sites is shown on Figure C-4.

It is likely that the woodland/forest areas provide foraging opportunities for Spotted-tailed Quoll though dens are more likely to be located in rocky areas to the west and south of the inundation area. Targeted surveys were undertaken along the Stalling Lane Access at locations presented on Figure C-4.



LEGEND

- Fauna Survey Sites (BAAM, 2007)
- Trap Sites
- Watercourse
- Road
- Highway
- Buffer Area
- Full Supply Level (738m AHD)



Scale - 1:25,000

Projection: GDA94 MGA56

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure C-4

BAAM Fauna Survey Sites



The specific survey techniques employed during the summer terrestrial vertebrate fauna survey are presented in Table C-3. Survey sites were located within each of the four broad habitat types described in Table C-4.

Table C-3 Fauna survey techniques for Summer and Autumn/Winter surveys

Survey technique	Summer survey	Autumn / Winter survey
Box traps	Over four nights 20 Elliot type 'A' traps and 2 cage traps were deployed at each of four systematic survey sites. Traps were placed on the ground 5-8 m apart using a variety of baits (rolled oats, peanut butter, oil and vanilla +/- salami). Trap placement was influenced by vegetation diversity, the size and shape of the vegetation patches and by naturally occurring features such as logs, rock outcrops, tree bases and clumping vegetation. These traps were cleared early morning and reset in late afternoon in accordance with animal ethics requirements.	For the targeted surveys for the Spotted-tailed Quoll (<i>Dasyurus maculatus maculatus</i>), one cage trap was deployed at each of eight trap sites over three nights. Traps were placed on the ground and baited with chicken and sardines. Trap placement was influenced by vegetation diversity, the size and shape of the vegetation patches and by naturally occurring features such as logs, rock outcrops, tree bases and clumping vegetation. These traps were cleared early morning and reset in late afternoon in accordance with animal ethics requirements.
Diurnal searches	Active diurnal searches were undertaken at each of four trapping sites. This involved intensive investigation of ground layer (under logs, rocks and leaf litter), low vegetation (under bark and in tree stumps) and rock crevices for all amphibians, reptiles, bats and animal signs (e.g. scats, owl pellets, orts (bird feeding remnants), remains and tracks). Searches were conducted in conjunction with the morning bird censuses and trap clearing activities, as well as during the warmer parts of the day when reptile activity was likely to be at its peak, totalling approximately 1 hr/site/day.	
Diurnal bird censuses	Birds were surveyed at each of four trapping sites using a timed transect technique. Each site was surveyed for approximately 30 minutes in the morning and afternoon by pausing at each fifth ground trap for six minutes. Birds were identified from either direct observation or their calls. Additional bird records were collected during random meander searches of other habitats or areas that were considered suitable for cryptic or rare species, as well as during other survey elements and opportunistically.	
Pitfall traps	At each of four trapping sites, four pitfall traps (20 or 10 litre containers, depending on substrate) were buried flush to the ground surface and connected by a 20 m drift fence. These traps were open for four nights and were cleared early morning and reset in late afternoon in accordance with animal ethics requirements.	Not undertaken
Nocturnal surveys	A combination of high-powered spotlights and head torches were used to sample nocturnal mammals (flying, arboreal and terrestrial), birds (owls and nightjars), reptiles and frogs across the Project area. During the spotlighting sessions, species specific detection was assisted by the use of call playback surveys undertaken for nocturnal birds and nocturnal mammals using recordings.	
Anabat and harp traps	An ANABAT II ultrasonic bat call detection unit and associated ZCAIM interface module were also used to capture the calls of insectivorous bat species. The use of the ZCAIM unit allows the ANABAT II detector to be left unattended throughout the night, thereby ensuring that peak activity periods for bats are recorded each night. Harp traps were also used where suitable flight paths were identified.	
Targeted searches	During the survey period, special effort was made to detect the presence of species of special conservation significance obtained from the database searches, with particular focus on reptiles, Stephen's Banded Snake (<i>Hoplocephalus stephensii</i>), Granite Belt Thick-tailed Gecko (<i>Uvidicolus sphyrurus</i>) and the micro-bat South-eastern Long-eared Bat (<i>Nyctophilus corbeni</i>).	

Habitat assessments were undertaken along the proposed urban pipeline during the summer survey in December 2006. Habitat assessment of the proposed irrigation pipeline was undertaken from 9 to 11 July 2006.

Table C-4 Habitat descriptions – inundation area

Site	Description
1	Open woodland with a low canopy dominated by half-bark box trees e.g. Yellow Box (<i>Eucalyptus melliodora</i>) and slightly more abundant stringybarks e.g. Blakely's Red Gum (<i>E. blakelyi</i>). Black Cypress Pine (<i>Callitris endlicheri</i>) is also common as a low- to mid-canopy species. The shrub layer is relatively open, consisting predominantly of Dogwood (<i>Jacksonia scoparia</i>) and some <i>Callitris</i> recruitment. The ground layer consists of native tussock grasses interspaced by deep leaf litter. Fallen timber is common, and the site is characterized by emergent granite rock.
2	Open woodland, essentially the same vegetation community as Site 1, though structurally different. The canopy is relatively similar, with a low open structure consisting of Yellow Box, Youman's Stringybark (<i>E. youmanii</i>), Blakely's Red Gum and Orange Gum (<i>E. prava</i>). However, Site 2 includes several Apple-topped Box (<i>E. bridgesiana</i>) with mallee type growth. Most significantly, the shrub layer is dominated by Kunzea Brachyandra (<i>Leptospermum brachyandra</i>) which forms thick dense stands up to three metres tall. Under these dense shrubs the ground cover is reduced to leaf debris, though in areas where the shrubs are less dense the ground cover is dominated by tussock grasses. Fallen timber is abundant and of a variety of sizes. Granite rocks, including some large exfoliating slabs, emerge from the ground in places. The site includes a small dam with open water. The dam edges, though somewhat disturbed by cattle and feral pigs, contain <i>Myriophyllum</i> waterweed.
3	Non-remnant vegetation. The canopy is absent due to historical clearing activities. The low, but very dense, shrub layer consists of regrowth canopy species including Youman's Stringybark, Orange Gum, Broad-leaved Apple (<i>Angophora subvelutina</i>) and some Black Cypress Pine. These species were probably dominant in the canopy prior to clearing. Some shrub species, including <i>Acacia</i> species and Dogwood, are also common. The site differs from the other systematic survey sites by its comparative lack of fallen timber, fewer emergent granite rocks and the domination of the ground cover by thick, relatively tall Blady Grass (<i>Imperata cylindrical</i>).
4	Yellow Box, Youman's Stringybark, Blakely's Red Gum and Orange Gum woodland. The canopy consists of similar species to sites 1 and 2 but is taller, with greater foliage providing increased shelter and foraging resources. No, or very few, <i>Callitris</i> trees are present either as a mid-canopy species or in the understorey. However, Dogwood is quite common and forms the bulk of the relatively sparse shrub layer. The ground cover consists of tussock grasses interspersed with abundant fallen timber and leaf litter. On the higher portions of the site, granite outcrops are abundant as both large boulder piles embedded into the surface and open flat exfoliating slabs. The site is close by the Severn River, where the eucalypt canopy is replaced on the river banks by low dense Tea Tree (<i>Melaleuca alternifolia</i>). Water within the river at this location was restricted to a series of small pools.

C.3 Aquatic Ecology

C.3.1 Ecology Management – 2006/2007

Ecology Management (EM) undertook aquatic ecology surveys in 2006 and 2007. Survey sites were located upstream, within and downstream of the proposed dam site as well as on Accommodation Creek and Bald Rock Creek.

Field surveys

Surveys were undertaken at ten locations by in late spring 2006 and early autumn 2007. The location and description of the sites is presented in Table C-5 and shown on Figure C-5.

Sites were selected based on the general geographic spread required, an aerial reconnaissance of the system above Nundubbermere Falls and ground survey of historic rapid assessment sites. Survey methods at each site included aquatic habitat assessment, water quality testing and survey of aquatic plants, macroinvertebrates and fish.

Table C-5 Aquatic field survey sites (2007)

Site	Location	Description
1	Severn River near Glen Aplin (Thorndale Rd)	Upstream of dam. Deep natural pool
2	Severn River, within Campbell's Weir	Within water storage. Weir pool.
3	Severn River, below Campbell's Weir	Within water storage. Shallow. Downstream of existing weir.
4	Severn River near Stalling Lane	Dam wall footprint. Shallow, natural.
5	Severn River near Somme Lane	Downstream of dam; upstream of Accommodation Creek. Shallow.
6	Severn River near Somme Lane	Downstream of dam; upstream of Accommodation Creek. Deep weir pool
7	Severn River on Bents Road ("second crossing")	Downstream of dam; downstream of Accommodation Creek. Shallow
8	Severn River at Bents Weir	Downstream of dam; downstream of Accommodation Creek. Deep weir pool
9	Accommodation Creek on Sundown Road	Reference tributary – shallow
10	Bald Rock Ck on Anderson Road	Reference tributary – deep (upstream end of weir pool)

Aquatic Habitat

Aquatic habitat was assessed using State of the Rivers survey protocols and field sheets (Anderson 1993), particularly sheets 4, 5, 9 and 10. These were supplemented by detailed notes entered on field data sheets. Photographs were taken of all sites in upstream and downstream directions and to capture significant features.

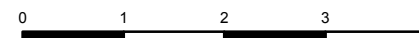
Aquatic Plants

Aquatic plants were initially assessed using State of the Rivers methodology, in particular Sheet 9. This assessment covers submerged, floating and emergent vegetation separately and describes each in terms of total cover and percentage of exotic and native species. At many sites, substrates could not be thoroughly assessed due to the highly tannin stained nature of the water. Combined with the latter point, as the region shows a limited submerged macrophyte community, the assessments were reduced to descriptions of visible components. Species identifications were based on Stephens & Dowling (2002) and Sainty & Jacobs (1994).



LEGEND

- Towns
- Aquatic Survey Sites (Ecology Management)
- Watercourse
- Highway
- National Parks
- Full Supply Level (738m AHD)



Scale - 1:75,000

Projection: GDA94 MGA56

EMU SWAMP DAM - ASSESSMENT OF MNES

Figure C-5

Ecology Management
Aquatic Survey Sites 2007



Macroinvertebrates

The sampling approach aimed to clearly separate the available habitats. Five Surber samples were collected from the edge at deep sites and from shallow habitat at riffle or glide sites where the edge was often an undercut. Surber samples were considered more suitable than the AusRivAS dip net sampling methods as the Surber samples are replicated and provide quantitative data.

Dip net samples were also collected independently from macrophytes, tree root or undercut habitats when present. When habitat was abundant, dip net sampling was restricted to approximately 20 sec. When habitat was limited the full area was sampled in less than 20 sec. No benthic samples were collected from deep water because the uneven and mainly rocky substrate does not suit any known sampling apparatus.

All samples were wholly preserved in isopropyl alcohol and returned to the laboratory for sorting. Macroinvertebrates were sorted by staff in the EM/Hydrobiology laboratory. The subsampling technique of Wrona *et al.* (1982) was employed for larger samples. The fauna from sorted samples was identified and counted by staff of Applied Freshwater Science. Identification was to the level used by DNR in AusRivAS, meaning family for insects (except Chironomidae which was taken to sub-family) and higher levels for other groups such as microcrustacea, oligochaetes, molluscs, nematodes and acarina.

Fish

Fish were sampled using equipment and methods to accord with those used in the northern Murray Darling region by David Moffat (DNRW pers. comm. 2000). Additional gear included a back pack electrofisher. Fishing gear included:

- Four 2 m drop × 15 m gill nets, each comprised of 3 × 5 m panels (one each of 3, 4 and 5 inch nylon monofilament mesh randomly arranged within the net), with floating head-line and sinking foot-line
- Two 19 mm and 25 mm gill nets were also used in March 2007
- Ten collapsible baitfish traps, each baited with cat biscuits
- Backpack electrofisher

Fyke and seine nets could not be used because the substrate was often uneven boulders in shallow areas or the water was too deep in pools.

The method of fishing is described below:

- Gear was set over a length of river of approximately 100 m
- Gear was set to fish as independently as possible (that is, one net did not channel fish into another)
- Gill nets were generally set oblique to the river bank
- Bait fish traps were set from the bank and adjacent to cover (vegetation, snags, etc.) when present

All gear was set to fish overnight, a soak time of between 14 and 18 hrs. All gill nets were set at least 15 m apart, up to a maximum distance of 25 m. The exception to this was in small pools where nets had to be separated by a smaller distance or fewer nets were placed due to restricted space. Small shallow pools (< 0.5 m depth) were not sampled with gill nets. These areas were often most effectively sampled with the electrofisher and bait traps.

All fish caught were counted, measured (fork length) and wounds, lesions and deformities were recorded if present. Native fish were released alive wherever possible. Introduced fish were euthanised. Identifications were based on Allen (1989), McDowall (1996) and Allen, Midgely & Allen (2002). Where identification was difficult in the field, one or two specimens were retained for identification in the laboratory.

Any fish, prawns or crayfish caught in the bait traps were identified and the number of each species was recorded. Catches from each trap were recorded separately.

The electrofisher used was a Smith Root LR24 model backpack electrofisher with a net sewn into the anode pole. The voltage, frequency and waveform settings used on the electrofisher were adjusted to achieve the best response from the fish and crustaceans at the time of sampling, but were typically set to standard pulse waveform of 30 Hz frequency at 600 volts.

Ten replicate passes were made through the range of habitats over a timed duration (50 sec each).

C.3.2 frc environmental – 2013

FRC undertook aquatic ecology field surveys in 2013 to further assess impacts of the Project and provide a response to submissions received for the EIS.

Survey Design

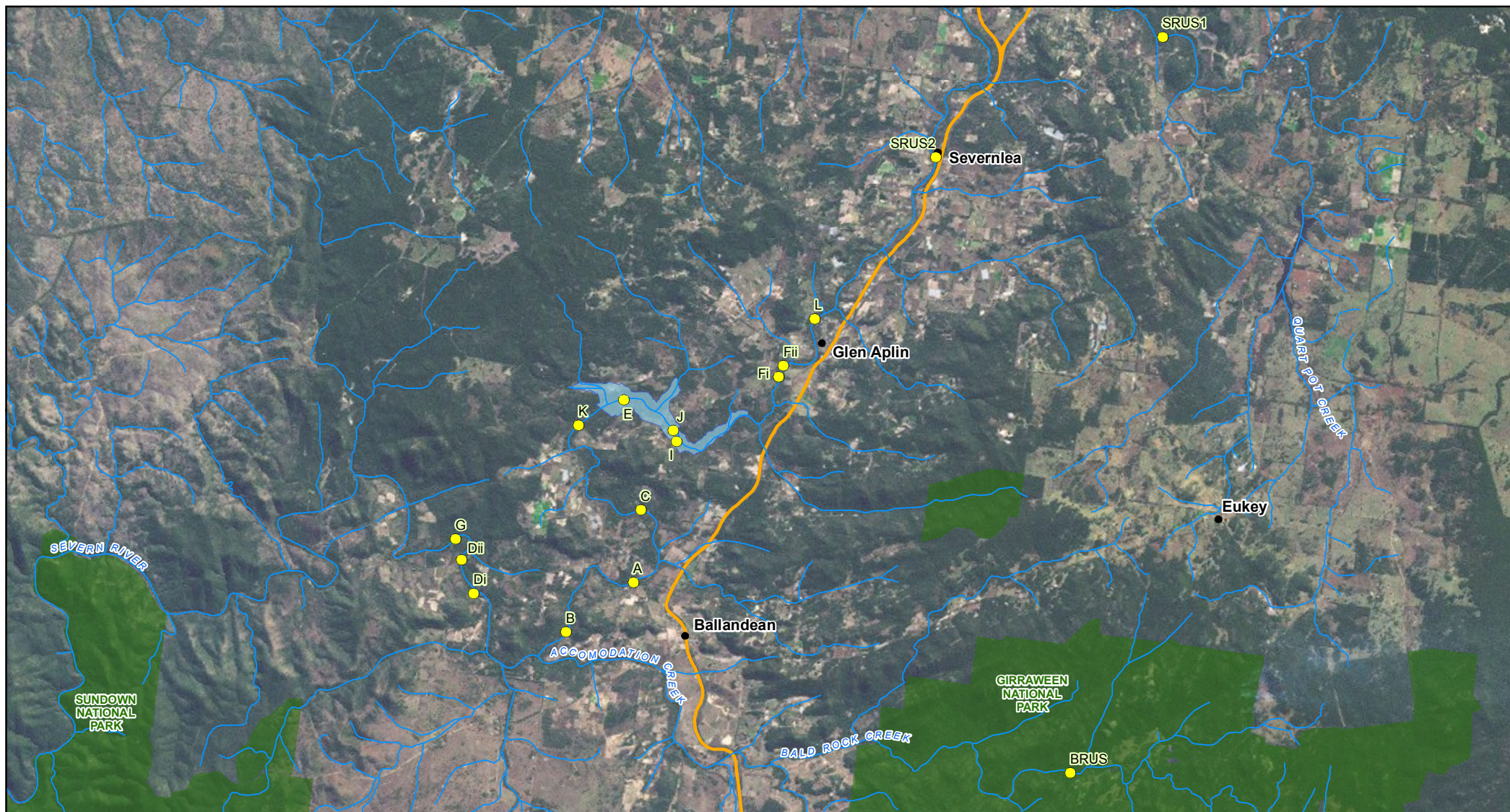
Additional field surveys were completed from 20 to 26 May 2013 and from 9 to 15 September 2013. The May survey comprised an assessment of freshwater turtles and aquatic habitat. The September survey comprised an assessment of aquatic habitat, aquatic plants, freshwater turtles, fish and platypus.

Site Details

A total of 13 sites were surveyed (Table C-6 and Figure C-6). Turtles were surveyed at 12 sites; aquatic habitat, aquatic plants, fish and platypus were surveyed at 13 sites. Of the sites surveyed for freshwater turtles, sites F and D were moved slightly between the May and September surveys, as access restrictions prevented a return to the locations surveyed in May. There was no accessible reference site for the turtle survey in May.

Table C-6 Site location details.

Site	Month Surveyed	Easting	Northing	Description of Location	Surveyed for:
Upstream of the Proposed Dam Inundation area					
SRUS1	September	398403	6827832	Approximately 25 km upstream of the proposed dam site	Aquatic habitat, aquatic plants, fish and platypus
SRUS2	September	393001	6824977	Approximately 14 km upstream of the proposed dam site	Aquatic habitat, aquatic plants, fish and platypus
L	May and September	390118	6821121	Approximately 7 km upstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
Fii	September	389376	6820006	Approximately 6.3 km upstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
Fi	May	389263	6819746	Approximately 5.9 km upstream of the proposed dam site	Aquatic habitat, turtles
Within Proposed Dam Inundation area					
I	May and September	386835	6818211	Approximately 2.1 km upstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
J	May and September	386753	6818469	Approximately 1.8 km upstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
E	May and September	385571	6819198	Approximately 0.5 km upstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
Downstream of the Proposed Dam					
K	May and September	384494	6818591	Approximately 1.6 km downstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
C	May and September	385977	6816579	Approximately 4.7 km downstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
A	May and September	385802	6814846	Approximately 7.6 km downstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
B	May and September	384199	6813675	Approximately 10.2 km downstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
Di	May	381996	6814586	Approximately 14.2 km downstream of the proposed dam site	Aquatic habitat, turtles
Dii	September	381710	6815393	Approximately 15.3 km downstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
G	May and September	381568	6815888	Approximately 16.4 km downstream of the proposed dam site	Aquatic habitat, aquatic plants, turtles, fish and platypus
Reference area					
BRUS	September	396211	6810315	Bald Rock Creek in Girraween National Park	Aquatic habitat, turtles



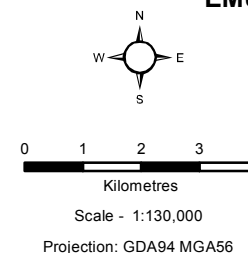
LEGEND

- Towns
- Aquatic Survey Sites (FRC Environmental)
- Watercourse
- Highway
- National Parks
- Full Supply Level (738m AHD)

EMU SWAMP DAM - ASSESSMENT OF MNES

FigureC-6

FRC Environmental Aquatic Ecology Survey Sites 2007



SINCLAIR KNIGHT MERZ
SKM

Aquatic Habitat Survey Methodology

The condition of in-stream habitat at each site was assessed based on the Australian River Assessment System (AUSRIVAS) protocol described in the Queensland *AUSRIVAS Sampling and Processing Manual* (DNRM 2001), including the following parameters:

- in situ water quality
- water depth and velocity
- bank erosion
- substrate composition (silt / clay, sand, pebble, cobble and boulder)
- channel diversity (pool, riffle, run etc.), and
- in-stream habitat (in-stream vegetation, large woody debris and substrate characteristics).

The habitat at each site was also assessed for physical barriers to fish passage and the suitability for Bell's turtles and turtle nesting.

Habitat bio-assessment score datasheets (DNRM 2001) were used to produce an overall habitat condition assessment score.

Aquatic Plants Survey Methodology

Aquatic plants were surveyed using methods similar to those outlined in the *River and Riparian Land Management Technical Guideline* (Dixon et al. 2006). Aquatic plants were assessed along two 100 x 10 m belt transects at each site: one transect in the water (in-stream) and one transect on the bank (on bank). Both transects were parallel to the water's edge. At each site, in each transect, aquatic plants were identified and the following recorded:

- species richness
- growth form of each species (submerged, free-floating, attached-floating or emergent)
- total percent cover (% of substrate [bed / bank] covered by each species), and
- whether the plant was native or exotic to Australia.

The *Census of Queensland Flora 2010* (Queensland Herbarium 2010) was used to classify aquatic vegetation as native or exotic.

Turtle Survey Methodology

Turtle surveys were conducted as per the recommendations in the 2011 Survey Guidelines for Australia's Threatened Reptiles for Bell's turtles (DSEWPac 2011). At each site, five cathedral turtle traps, which allow turtles to surface and breathe, were baited with meat and set at each site for between six and ten hours.

In addition to traps, in September turtles were also surveyed using a combination of muddling, dip netting, snorkelling and / or spotlighting for 1 hour at each site. Fyke nets were used at site BRUS only. The sampling effort was lower in May than in September due to shorter days and less suitable conditions for turtle activity (i.e. colder water temperature).

All turtles sighted or captured (including species other than Bell's turtle) were identified and counted, and where practical their carapace length, weight and sex were recorded.

Fish Survey Methodology

Fish communities were surveyed using a combination of electrofishing and baited traps, where water levels were suitable. All available habitats (e.g. pool, riffle, run and bend) were fished at each site. Electrofishing was conducted using a Smith-Root LR-24 backpack electrofisher in shallow water in accordance with the Australian Code of Electrofishing Practice 1997. Where there was sufficient water, five small (2 mm mesh size) baited traps were set at each site for a minimum of two hours.

To avoid the re-capture of fish, all caught fish were kept in an aerated nally bin filled with water, on the shore, until the last trap was retrieved. The life-history stage, abundance and apparent health of every fish caught were recorded and fish were returned to the water.