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Table 7-1: DGRs and relevant Section in the EIS

Director-General's Environmental Assessment Requirements	Refer Section in EIS
General Requirements	
The Environmental Impact Statement (EIS) must be prepared in accordance with, and meet the minimum requirements of, Part 3 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (the EP&A Regulation) and include the following:	Statement of Validity
1. the information required under clause 6 of Schedule 2 of the EP&A Regulation; and	Statement of Validity Section 2.1 Section 4 Section 8
2. the content listed in clause 7 of Schedule 2 of the EP&A Regulation, including, but not limited to:	
• a summary of the environmental impact statement,	Executive Summary
• a statement of the objectives of the project, including a description of the strategic need, justification, objectives and outcomes,	Section 1.2 Section 4.12
• an analysis of feasible alternatives to the carrying out of the project, including an analysis of options considered having regard to the project objectives (including an assessment of the environmental costs and benefits of the project relative to alternatives and the consequences of not carrying out the project), the suitability of the chosen option and whether or not the project is in the public interest,	Section 4.12

Director-General's Environmental Assessment Requirements	Refer Section in EIS
• an analysis of the project, including an assessment, with a particular focus on the requirements of the listed key issues, in accordance with clause 7(1)(d) of Schedule 2 of the EP&A Regulation (where relevant),	Section 2 Section 4 Section 5 Section 8 Section 9
• an identification of how relevant planning, land use and development matters (including relevant strategic and statutory matters, such as relevant water sharing plans, State water environmental management plans, including Namoi Catchment Action Plan) have been considered in the impact assessment (direct, indirect and cumulative impacts) and / or in developing management / mitigation measures,	Section 5 Section 8
• a compilation of the measures proposed to mitigate any adverse effects of the project on the environment,	Section 9
• a justification for the preferred project taking into consideration the objects of the Environmental Planning and Assessment Act 1979, and	Section 4.11
• detailing how the principles of ecologically sustainable development will be incorporated in the design, construction and ongoing operation phases of the project.	Section 8.14
Key issues	
The EIS must address the following specific matters:	
Soil and Water - including but not limited to: • impacts on surface water flows, quality and quantity and risks to groundwater quality, with particular reference to impacts on surrounding (up and down stream) waterways, their habitats and environmental flows, and inclusion of baseline water quality and flow conditions; • flooding impacts and characteristics, with an assessment of the potential changes to flooding behaviour (levels, velocities and direction) and	Section 8.1

Director-General's Environmental Assessment Requirements	Refer Section in EIS
impacts on bed and bank stability, through flood modelling, including: o hydraulic modelling for a range of flood events, o description, justification and assessment of design objectives, o an assessment of afflux and flood duration (inundation period) on land, infrastructure, property and business operations, o consideration of the changes in rainfall frequency and/or intensity as a result of climate change; and o outline contingency measures for flooding events with potential for inundation and discharge through the spillway area during construction; • waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant), including temporary crossings, and measures to rehabilitate the waterways to pre-construction conditions or better, including fish passage requirements taking into account Policy and Guidelines for Fish Friendly Waterway Crossings (Department of Primary industries, 2004); and • identification and assessment of soil characteristics and properties that may impact or be impacted by the project and details of erosion and sedimentation control measures.	
Biodiversity - including but not limited to: • impacts on the biodiversity values of the site and adjoining areas, including terrestrial, riparian and aquatic habitats; • impacts on Endangered Ecological Communities, critical habitat, threatened and protected species, populations and their habitats, listed under both State and Commonwealth legislation that have been recorded or considered likely to occur on the site and surrounding land, and whether the proposal or specific aspects of the proposal constitute Key Threatening Processes in terms of the Threatened Species Conservation Act 1995; • targeted surveys of threatened flora and fauna species and their habitat that are known or likely to occur within the project's study area based on the presence of suitable habitat. Details of the survey methodology employed, including survey effort and timing and representativeness	Section 8.2 Appendix 8

Director-General's Environmental Assessment Requirements	Refer Section in EIS
for the species targeted, should be included; • the details of available offset measures to compensate the biodiversity impacts of the proposal where offset measures are proposed, consistent with the Principles for the use of biodiversity offsets in NSW; and • taking into account the Draft Guidelines for Threatened Species Assessment (Department of Environment and Conservation, 2005); Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna - Amphibians (DECCW, 2009); and Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft (D5C,2004).	
Heritage - including but not limited to: • impacts to Aboriginal heritage (including cultural and archaeological significance), in particular impacts to Aboriginal heritage sites identified within or near the project. Where impacts are identified, the assessment shall: o outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the measures), demonstrate effective consultation with Aboriginal communities in determining and assessing impacts and developing and selecting options and mitigation measures (including the final proposed measures) o demonstration that an appropriate archaeological assessment methodology, including research design, (where relevant) has been undertaken, including results, and o take into account the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (Department of Environment and Conservation, 2005) and be undertaken by a suitably qualified heritage consultant; and	Section 8.5 Appendix 9
• impacts to historic heritage (including archaeology, heritage items conservation areas and natural areas), in particular impacts to the Bowling Alley Point site should be assessed. Where impacts to State or locally significant historic heritage items are identified, the assessment shall: o outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures), o include a statement of heritage impact for heritage items (including significance assessment),	Section 8.5 Appendix 10

Director-General's Environmental Assessment Requirements	Refer Section in EIS
o demonstrate that an appropriate archaeological assessment methodology, including research design, (where relevant) has been undertaken, including results, and o take into account the guidelines in the NSW Heritage Manual (1996) and be undertaken by a suitably qualified heritage consultant.	
Traffic and Transport - including but not limited to: • construction traffic impacts, including: o the identification of construction traffic routes and the nature of existing traffic on these routes, o an assessment of construction traffic volumes, and o potential impacts to the State, regional and local road network (including safety and level of service) and potential disruption to existing public transport school bus services and access to properties and businesses. The assessment shall identify suitable mitigation and management measures; and • operational traffic and transport impacts to the State, regional and local road network, including changes to local road connectivity and impacts on local traffic arrangements, road capacity / safety and modified access to realigned roads. The assessment shall identify suitable mitigation and management measures.	Section 8.6 Appendix 11
Noise and Vibration - including but not limited to construction and operational noise and vibration impacts taking into account (where relevant) the Interim Construction Norse Guideline (Department of Environment and Climate Change, 2009), Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006) and the NSW Road Noise Policy (Department of Environment Climate Change and Water, 2011).	Section 8.7 Appendix 12
Air Quality - including but not limited to an assessment of the construction air quality impacts on sensitive receptors, including impacts from particulate matter, total suspended solids and other air pollutants generated by the project.	Section 8.8 Appendix 13

Director-General's Environmental Assessment Requirements	Refer Section in EIS
Visual Amenity - including but not limited to an assessment of the visual impact of the project on the landscape character of the area and details of landscaping treatment and design.	Section 8.9
Land Use, Property and Socioeconomic - including but not limited to: • impacts on directly affected properties and land uses, including impacts related to access and recreational uses of the dam, land use, mineral resources and exploration, property infrastructure, future development potential, property acquisition and land sterilisation; • impacts on Crown land, reserves and assets, and land reserved under the National Parks and Wildlife Act 1974; • impacts on natural resources, including mining and extractive resources utilisation; and • identification of services and utilities to be relocated.	Section 8.10 Section 8.10
Spoil and Waste Management - including but not limited to dredging impacts, an estimation of the likely spoil generation and type (including identification of known or potential contamination issues), disposal/recycling sites and management of all types of waste material.	Section 8.12
Hazards and Risk - including an assessment of the hazards and risk associated with the proposal including details of hazardous materials used or kept on the premises during the construction and operation phases. The assessment must refer to the Department's Guideline Applying SEPP 33 (DUAP, 1994), where relevant.	Section 8.13
Environmental Risk Analysis	
Notwithstanding the above key assessment requirements, the EIS must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the EIS.	Section 7.2 Appendix 14

Director-General's Environmental Assessment Requirements	Refer Section in EIS
Consultation	
You should undertake an appropriate and justified level of consultation with relevant parties during the preparation of the EIS, including but not limited to: • local, State and Commonwealth government authorities, including the: o Department of Primary industries (Agriculture, Forests, Fisheries, Minerals, Crown Land and Office of Water), o Heritage Council of NSW, o Office of Environment and Heritage (Environment Protection Authority), o Roads and Maritime Services, o Namoi Catchment Management Authority, o NSW Dams Safety Committee, and o Tamworth Regional Council; • specialist interest groups, including Local Aboriginal Councils, Aboriginal stakeholders and industry/ growers associations, mining and petroleum title holders and exploration licence holders; • utilities and service providers; and • the public, including community groups and adjoining and affected landowners.	Section 6 Appendix 6
The EIS must describe the consultation process and the issues raised, and identify where the design of the infrastructure has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.	Section 6 Appendix 6

Director-General's Environmental Assessment Requirements	Refer Section in EIS
Further consultation after 2 years	
If you do not lodge an EIS for the infrastructure within 2 years of the issue date of these DGRs, you must consult with the Director General in relation to the requirements for lodgement.	Not applicable

Table 7-2: Supplementary DGRs and relevant Section in the EIS

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
Key assessment requirements:	
The following matters must be addressed in the Environmental Assessment of the action: (1) Impacts on ecological communities and threatened species listed under Section 18 and 18A of the *Environment Protection and Biodiversity Conservation Act1999*;	Section 8.2
(2) Any relevant Commonwealth Government technical and policy guidelines;	Section 8.2.6 Section 9 Appendix 8
(3) Matters outlined in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulation 2000, included in the requirements below; and	Refer below
(4) The requirements outlined below:	Refer below

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
1. General information	
The background of the action including: a) the title of the action;	Section 1
b) the full name and postal address of the designated proponent;	Statement of Validity Section 0
c) a clear outline of the objective of the action;	Section 1.2
d) the location of the action;	Section 2
e) the background to the development of the action;	Section 3
f) how the action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action;	Section 2.3
g) the current status of the action; and	Section 4
h) the consequences of not proceeding with the action.	Section 4.12.1
2. Description of the action	
A detailed description of all components of the action, including: a) all construction, operational (including water uses) and (if relevant) decommissioning components of the action;	Section 4

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
b) the precise location of the preferred option for any works to be undertaken, structures to be built and elements of the action that may have impacts on matters of National Environmental Significance (NES); and	Section 4
c) how the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts (as per section 5(a)).	Section 4
3. Feasible alternatives	
Any feasible alternatives to the referred action, to the extent reasonably practicable, including: a) if relevant, the alternative of taking no action;	Section 4.12.1
b) a comparative description of the impacts of each alternative on the NES matters protected by controlling provisions of Part 3 of the EPBC Act for the action;	Section 4.11
c) sufficient detail to make clear why any alternative is preferred to another; and	Section 4.11
d) a description of short, medium and long-term advantages and disadvantages of the different options.	Section 4.11
4. Description of the existing environment and relevant matters of national environmental significance	
A description of the environment of the proposal site and the surrounding areas (upstream, within and downstream of the impoundment) that may be directly or indirectly affected by the action, including: a) quantification and description of, and maps showing, the location, nature, extent and where relevant, the condition, of all vegetation types occurring on and adjacent to the vegetation on site;	Section 2 Section 8.2

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
b) quantification and description of the quality, quantity and hydrological flow regimes of surface and groundwater- including seasonal dynamics (e.g. volume, timing, duration and frequency of flows)- and relevant water planning and allocation frameworks, including release strategies;	Section 4.8 Section 4.9 Section 8.1
c) quantification and description of, and maps showing, the distribution and abundance of EPBC Act listed threatened species and ecological communities within the site and in surrounding areas that may be impacted by the proposal. This should include, but not be limited to, up-to-date survey results for the Booroolong Frog[1], Murray Cod, Border Thick-tailed Gecko, Small Snake Orchid, Bluegrass, *Euphrasia arguta*, and the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community (and any other relevant listed species and ecological communities); 1 Booroolong Frog - in relation to 4c) and 4d) the survey methods must be appropriate for this species and ensure high probability of detection. For example, surveys in the Peel River catchment should be within the breeding period for the species (mid-November- mid-December), should identify known and potential breeding (and other) habitat and then survey a high proportion of those habitats for the species to determine distribution and relative abundance (e.g. breeding habitat is known to be areas of stream bank with cover of loose rock or bedrock containing rock crevices). Strict hygiene protocols should be implemented in any survey work, to prevent introduction or spread of Chycridiomycosis or any other harmful pathogen.	Section 8.2 Appendix 8
d) quantification and description of, and maps showing, the nature, location and extent of habitat for EPBC Act listed threatened species and ecological communities (as in 4(c)) within the site and in surrounding areas (including upstream, within and downstream of the impoundment) that may be impacted by the proposal; and,	Section 8.2

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
e) a detailed description of the methodology, timing, effort and results of all targeted surveys undertaken for all relevant EPBC Act matters and associated habitat, how the methodologies compare with any relevant guidelines or policies and a description of any limitations and constraints of the surveys undertaken.	Section 8.2
5. Assessment of relevant impacts	
An assessment of the relevant impacts of the action including: a) a detailed description and assessment of the nature and extent of all relevant impacts, including short-term and long-term direct, indirect, facilitated and cumulative impacts, that the action will have or is likely to have on threatened species and ecological communities listed under sections 18 and 18A of the EPBC Act during all stages of the project (e.g. before and during construction, operational and (if relevant) de-commissioning stages);	Section 8.2 Section 8.15 Appendix 8
b) whether any relevant impacts are likely to be unknown, unpredictable or irreversible;	Section 8.2 Appendix 8
c) analysis of the scale of the relevant impacts for each EPBC Act listed threatened species and ecological community - including in a local, regional and national context; and	Section 8.2 Appendix 8
d) any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Section 8.2 Section 11 Appendix 8

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
6. Proposed safeguards, mitigation and offset measures	
A description of changes to the action and feasible mitigation measures, that are intended to avoid, minimise or compensate for relevant impacts, including: a) a description of how the action has been designed to avoid impacts to threatened species and ecological communities;	Section 8.2 Section 9
b) a consolidated list of mitigation measures proposed to be undertaken to prevent or minimise the relevant impacts of the action, before, during and after construction and during operation;	Section 9
c) an assessment of the expected or predicted effectiveness of the mitigation measures, including a justification of the location and design of mitigation measures to be implemented to ensure their effectiveness. This analysis should be based on best available knowledge and baseline data for the relevant matters;	Section 8.2
d) a description of the objectives of the mitigation measures, thresholds for corrective actions, and the corrective actions to be implemented should these thresholds be exceeded;	Section 8.2 Section 9
e) any statutory or policy basis for the mitigation measures;	Section 8.2 Appendix 8
f) details of environmental management plans that set out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including the person or agency responsible for implementing these programs and provisions for independent environmental auditing;	Section 8.2 Section 9
g) the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;	Section 9

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
h) in the event that impacts cannot be avoided or mitigated, a description of any offsets to compensate for any predicted or potential residual impacts on threatened species and ecological communities. This should be in accordance with the EPBC Act Environmental Offsets Policy and include: i. an assessment of how any proposed offset compensates for the residual impacts on threatened species and ecological communities which remain following avoidance and mitigation measures to be implemented; ii. the location of any proposed offset; iii. the timing of the delivery of any offset; and iv. how the offset will be secured and managed in perpetuity.	Section 8.2.6
7. Other approvals and conditions	
Any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. Information must include: a) details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including: i. what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy; ii. how the scheme provides for the prevention, minimisation and management of any relevant impacts;	Section 1 Section 5 Section 8
b) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the EPBC Act), including any conditions that apply to the action;	Section 5

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
c) a statement identifying any additional approval that is required; and	Section 5.3
d) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.	Section 8 Section 9
8. Consultation	
A description of any consultation undertaken about the action, including: a) any consultation that has already taken place; b) proposed consultation about relevant impacts of the action; and c) if there has been consultation about the proposed action, any documented response to, or result of, the consultation; and d) identification of affected parties, including a statement mentioning any communities that may be affected and describing their views.	Section 6 Appendices 1 to 7
9. Economic and Social Matters	
The economic and social impacts of the action, both positive and negative, must be analysed. This analysis must include: a) details of any public consultation activities undertaken, and their outcomes;	Section 6 Appendix 6
b) projected economic costs and benefits of the project, including the basis for their estimation through cost/benefit analysis or similar studies; and	Section 8.11
c) employment opportunities expected to be generated by the project (including construction and operational phases).	Section 8.11

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
10. Environmental record of person proposing to take the action	
A description of the environmental record of the person proposing to take the action, including: a) details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: i. the person proposing to take the action; and ii. for an action for which a person has applied for a permit, the person making the application.	Section 0
b) if the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework.	Section 0 Appendix 8
11. Information sources	
For information given in the environment assessment, the assessment must state: a) the source of the information; b) how recent the information is; c) how the reliability of the information was tested; and d) what uncertainties (if any) are in the information.	All sections, as referenced and discussed Section 1 Section 11

Supplementary Director-General's Environmental Assessment Requirements	Refer Section in EIS
12. Conclusion	
An overall conclusion as to the environmental acceptability of the proposal must be provided, including discussion on compliance with principles of ESD and the objects and requirements of the EPBC Act. Reasons justifying undertaking the proposal in the manner proposed should be outlined. Measures proposed or required by way of offset for any unavoidable impacts on NES matters, and the relative degree of compensation, should be re-stated here.	Section 10

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7.2 Environmental Risk Analysis

In addition to the DGRs, an Environmental Risk Analysis was carried out for the Project to identify potential environmental impacts associated with construction and operation of the Project. The Environmental Risk Analysis also considered the proposed mitigation and management measures for the Project and residual risks following their implementation.

The Environmental Risk Analysis process for the Project involved the following steps:

- Identify Project risks, including Project Risk Workshop with selected stakeholders;
- Evaluate, analyse and prioritise risks into broad categories (i.e. extreme, high, medium and low risks), based on the likelihood of the risk occurring, and the consequences if it were to occur;
- Assess and treat critical risks – treatment can include actions to reduce either the likelihood or the consequences or both, the off-loading of risks to another party more suitable to accept such risks, or the acceptance and on-going management of a risk; and
- Identify opportunities by focusing on the possible additional benefits that could be extracted from the Project.

The purpose of the Environmental Risk Analysis was to ensure that:

- Potential environmental hazards and the risks associated with the Project are identified, prioritised and assessed;
- Mitigation actions needed to prevent or control environmental incidents are determined; and
- Appropriate documented procedures are planned and developed as required.

A risk register was developed to document the Environmental Risk Analysis and present the identified Project hazards (impacts), their consequence, likelihood and risk severity. The following risk tables were used to classify the consequence and likelihood of each hazard and to calculate the risk severity.

Table 7-3: Environmental Risk Analysis consequence categories

	Insignificant	Minor	Moderate	Major	Catastrophic
Safety and Health	First aid case.	Minor injury, medical treatment case with/or restricted work case.	Serious injury or lost work case.	Major or multiple injuries permanent injury or disability.	Single or multiple fatalities.
Environment	No impact on baseline environment. Localised to point source. No recovery required.	Localised within site boundaries. Recovery measurable within 1 month of impact.	Moderate harm with possible wider effect. Recovery in 1 year.	Significant harm with local effect. Recovery longer that 1 year.	Significant harm with widespread effect. Recovery longer than 1 year. Limited prospect of full recovery.
Financial	<$100,000	$100,000 to $500,000	$500,000 to $5M	$5M to 10M	>$10M
Schedule Slippage	< 3 days	3 days to 1 week	1 week to 1 month	1 to 6 months	> 6 months
Reputation	Localised temporary impact.	Localised, short term impact.	Localised, long term impact but manageable.	Localised, long term impact with unmanageable outcomes.	Long term regional impact.
Project Impact	Impact can be absorbed through normal activity.	An adverse event which can be absorbed with some management effort.	A serious event which requires additional management effort.	A critical event which requires extraordinary management effort.	Disaster with potential to lead to collapse of the project.

Table 7-4: Environmental Risk Analysis likelihood categories

Rare	Unlikely	Moderate	Likely	Almost Certain
Highly unlikely to occur on this project	Given current practices and procedures, this incident is unlikely to occur on this project	Incident has occurred on a similar project	Incident is likely to occur on this project	Incident is very likely to occur on this project, possibly several times

Table 7-5: Environmental Risk Analysis risk matrix

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost Certain	H	H	E	E	E
	Likely	M	H	H	E	E
	Moderate	L	M	H	E	E
	Unlikely	L	L	M	H	E
	Rare	L	L	M	H	H

Table 7-6: Environmental Risk Analysis severity ratings

Risk Severity Rating	Priority (1 is highest)	Action Required
E- Extreme	1	Immediate attention
H- High	2	Immediate attention
M- Moderate	3	Action as soon as practicable
L- Low	4	Low priority, possibly no action required

The Environmental Risk Analysis identified the following key risks for the Project:

- Soil and water;
- Biodiversity; and
- Aboriginal heritage.

These key risks are addressed in Section 8 of the EIS. The risk register developed to document the outcomes of the Environmental Risk Analysis is provided at Appendix 14.

8 POTENTIAL ENVIRONMENTAL IMPACTS

The potential environmental impacts of the Project in relation to the key issues identified through the DGRs and the environmental risk analysis are discussed in Sections 8.1 to 8.15. The potential construction and operational impacts of the Project are discussed in the context of the existing environment at the Project Site. Mitigation measures are also proposed to avoid or minimise identified Project impacts.

8.1 Soil and Water

An assessment of potential impacts to soil and water at the Project Site was carried out by WorleyParsons. The existing soil and water environment at the Project Site is described in Section 8.1.1. Potential construction and operational impacts are discussed in Sections 8.1.2 and 8.1.3, respectively. Mitigation measures proposed to manage identified soil and water impacts are provided in Section 8.1.4.

8.1.1 Existing Environment

The existing environment of the Project Site and surrounds in relation to soil and water is described below. The key components relevant to the Project described are geology and soil, groundwater, hydrology and water quality.

GEOLOGY AND SOIL

Chaffey Dam is located within the Peel River Valley, which covers an area of approximately 4,669 km^2 (NSW Office of Water 2010a). The Peel River Valley is a highland valley that drains onto the plains of the sedimentary basin of the Upper Namoi River and is part of the wider Namoi River Valley. The Peel River Valley is characterised by low peaked hills with a north-westerly alignment, moderate slopes and flat river valleys with deep fertile alluvial soils.

The region comprises five primary geological formations, of four geological ages, as follows:

- Colluvium; alluvial sand, clay and gravel (Quaternary age);
- Peel Serpentine (Permian age);
- Baldwin Formation (greywackes, rudites, mudstones) (Devonian age);
- Tamworth Group (argillite, greywacke, breccia, limestone and keratophyre) (Devonian age); and
- Woolomin Beds (phyllite, siltstone, greywacke, chert, jasper and minor tuff) (Devonian-Ordovician age).

Of these five regional geological formations, only two occur at the dam site, namely: Colluvium and Woolomin Beds (with no phyllite present) (Water Conservation and Irrigation Commission 1976).

Chaffey Dam is located on a steep to vertically dipping jasper and siltstone strata of the Woolomin Beds. The major bedrock lithologies comprise siltstone, jasper-chert and interbedded jasper-chert and siltstone in varying proportions. Minor amounts of greywacke, breccia, feldspathic tuff and spilite are also present. Strongly outcropping jasper bars occur and are comprised of massive jasper with closely interbedded chert and negligible siltstone (Water Conservation and Irrigation Commission 1976).

Broadscale soil mapping (AUSLIG 1990) shows that the Project Site lies within the Nandewar bioregion. The Nandewar bioregion is dominated by shallow and stony sandy loams, associated with the granites, sediments, red brown earths and black cracking clays, associated with volcanic substrate (DEC 2004). Less widespread soils include deep alluvial loams. Deeper, more fertile soils occur at lower elevations along the valley floors, while shallow and less fertile skeletal loams occur on of the steeper slopes and ridges (DEC 2004).

Soil landscapes in the vicinity of the Project Site are mapped as saline scalded lake bed clays, with deep alluvial loams to the west and southwest (Natural Resource Atlas 2012).

A number of studies undertaken in the 1970s indicate that over 60% of the catchment above the Chaffey Dam site has been affected by erosion and that during major runoff events, erosion of streambed and banks and river flats is likely to have caused siltation of the reservoir (MHL 2005).

MHL (2005) noted that while there are a variety of estimates of sediment yield, it is clear that there is still active erosion in the catchment and supply of sediment to the reservoir, especially during large runoff events. Molino Stewart (2011) identified the following downstream impacts caused by bank erosion:

- Varied flow releases from the dam which can cause a loss of riparian vegetation and associated fauna habitats; and
- Increased turbidity and smothering of benthic (streambed) habitats which in turn impacts on aquatic biota, such as macroinvertebrates and platypus.

Phosphorus-rich basalt soils in the catchment are identified as a major source of sediment-bound nutrients which can be delivered to the reservoir during large runoff events (MHL 2005). The filterable reactive phosphorus (FRP) can cause eutrophication, which results in the growth of algal blooms.

As indicated in MHL (2005), a broad range of recommendations to address the issues of sediment and nutrient delivery to the reservoir have previously been identified. These include the following:

- Soil conservation measures;
- River bed and bank works to reduce stream erosion;
- Appropriate management of land use developments including roads to control erosion;

- Management of logging practices and grazing including use of vegetated stock-free bufferstrips along streams to reduce erosion;
- Control of effluent and waste disposal;
- Control of herbicide and pesticide use;
- Appropriate use of fertilisers including decreased use of sulphate fertilisers;
- Identification of other sulphate sources in the catchment;
- Identification and control of catchment sources of FRP;
- Application of the Catchment Management Support System (CMSS) tool to develop better land management practices;
- Installation of wetlands and macrophyte beds to intercept nutrients; and
- Management of the reservoir foreshore to minimise erosion and to encourage interception of nutrients.

The extent of the previous investigations and the range of identified mitigation measures indicates that the control of sediment and nutrient inflow from the catchment to the reservoir is an important long-term management issue for water quality and for maintaining the environmental condition of Chaffey Dam.

GROUNDWATER

The groundwater sources in the Peel Valley include the Peel alluvial aquifer associated with the main Peel River and its tributaries and the Peel Fractured Rock aquifer. The fractured rock aquifer is part of the much bigger fractured rock aquifer system of the New England Fold Belt. This system contains water of variable yield and quality, unlike the alluvial areas that have a more reliable yield and generally more consistent quality (NSW Office of Water 2010a).

Alluvial groundwater and surface water are intricately linked in the Peel Regulated River and some of its major unregulated tributaries. The Peel Regulated River loses water to the Peel Alluvium along most of its length, although below Attunga at the bottom end of the valley, the river appears to gain water from alluvial aquifers. The general flow direction of groundwater is away from the Peel Regulated River and then down gradients parallel to the river (NSW Office of Water 2010a).

For the purposes of developing water sharing plans for inland aquifer systems in NSW, a highly connected surface water and groundwater system has been defined as a system in which "*70 per cent or more of the groundwater extraction volume is derived from stream flow within a single irrigation season*" (NSW Office of Water 2010a). Using the above definition of connectivity, the Peel Regulated River, Cockburn River, Goonoo Goonoo Creek and Dungowan Creek Alluvial Management Zones of the Peel Alluvium Water Source, are considered to be 'highly connected' systems. In contrast, the Attunga Creek, Duncans Creek and Moore Creek Alluvial Management Zones of the

Peel Alluvium Water Source and the entire Peel Fractured Rock Water Source, are considered to be 'not highly connected' systems.

HYDROLOGY

Chaffey Dam is located on the Peel River downstream of the village of Nundle. It is situated in the upper south-eastern section of the Namoi River Catchment (Figure 8-1). The dam has an upstream catchment area of 420 km^2 with the headwaters draining rugged topography of the Great Dividing Range (GHD 2007b).

The Peel River downstream of Chaffey Dam can be described as a low to moderate sinuosity gravel-bed river. Channel bed morphology is characterised by a pool-riffle sequence set within a relatively consistent channel that is typically 30 to 40 m wide and 3 to 6 m deep (GHD 2007b).

Three major tributaries enter the Peel River between Chaffey Dam and Tamworth. These are:

- Duncan's Creek, which enters the Peel River approximately 5 km downstream of the dam and has a catchment area of 93 km^2;
- Dungowan Creek, which enters the Peel River at Woolomin, approximately 15 km downstream of the dam and has a catchment area of 344 km^2; and
- Cockburn River which enters the Peel River just upstream of Tamworth and has a catchment area of approximately 1,130 km^2.

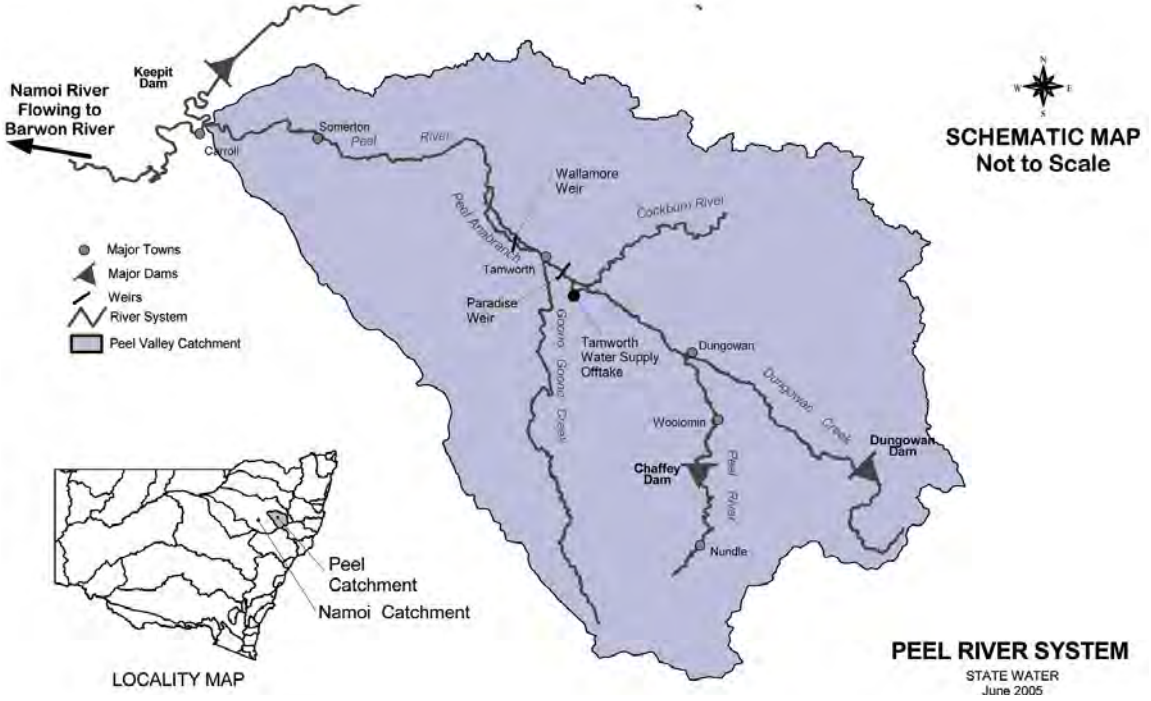

Figure 8-1: Peel River System (State Water 2005)

The Peel River, Cockburn River, Goonoo Goonoo Creek and Dungowan Creek are perennial streams in most years. All other creeks and streams within the Peel Valley are ephemeral.

WATER QUALITY

Water quality in the Namoi Catchment is affected by nutrients, in particular phosphorous and nitrogen. The following items have been identified as likely sources of nutrients within the catchment:

- Silt erosion;
- Natural phosphate deposits in the catchments;
- Recreational activities;
- Stormwater runoff; and
- Agriculture discharge (livestock waste and fertiliser).

The combination of heavy summer rainfall events and the steep, sparsely vegetated catchment create high rates of sediment erosion in the region.

High nutrient loading into Chaffey Dam from the upstream catchment has the potential to promote eutrophication. The dissolved phosphorous in the water column is predominantly orthophosphate

(PO_4), which is the most bio-available form to algae. Hence, algal blooms are often comprised of toxic cyanobacteria such as Anabaena and Microcystis, which can occur throughout the year (GHD 2008b; Molino Stewart 2011). This internal nutrient source occurs primarily during the summer with the development of anoxic conditions at the sediment-water interface.

The occurrence of algal blooms and the development of anoxic conditions are in large part driven by thermal stratification, which occurs throughout most of the year except during winter in Chaffey Dam (GHD 2008b).

A review of the Peel River catchment upstream of Chaffey Dam (MHL 2005) proposed the following management strategies to reduce nutrient loading:

- Identify and control effluent point sources;
- Control livestock waste to minimise bacterial load;
- Control use of herbicides, pesticides and fertilisers in catchment; and
- Control future changes in land use through planning.

Management of downstream water quality requires consideration of large scale reservoir activities to manage nutrients and algal blooms, as well as reservoir management to control oxygen levels and water temperatures (Molino Stewart 2011).

State Water currently implements actions to manage the foreshore of Chaffey Dam, as well as downstream water quality, in accordance with the recommendations of the *Report for Site Specific Action Plans Chaffey* (GHD 2010) (also known as the Chaffey Dam Foreshore Management Plan). The objective of this plan is to:

> *"Manage foreshore land to improve the water quality in our storages and to conserve and enhance native vegetation and environmental and heritage values of the land."*

The plan includes a list of assets and condition targets with schedules for monitoring and actions to maintain or enhance asset conditions. State Water also implements the *Chaffey Dam – Variable Offtake Management Protocols* to manage the transfer of algal blooms downstream of the dam. These protocols also contain provisions for water quality monitoring.

8.1.2 Potential Construction Impacts

Construction of the Project has the potential to result in impacts to soil and water in the Project Site, as well as downstream of Chaffey Dam. The primary potential construction impacts relate to:

- Inundation of upstream land and tributaries;
- Erosion and sedimentation;
- Construction waste; and
- Flood flows.

INUNDATION OF UPSTREAM LAND AND TRIBUTARIES

Augmentation of Chaffey Dam will raise the FSL by 6.5 m. As a result, there will be inundation of additional land above the existing full supply level. The extent, frequency and duration of inundation will depend on future operation of the dam and future inflows to the dam.

Raising the FSL of Chaffey Dam by 6.5 m will increase the reservoir surface area from 542 ha to 727 ha resulting in the inundation of an additional 185 ha of land. Inundation of additional land will result in the following:

- Reduction of land used for agricultural purposes;
- Submergence of soils;
- Submergence of existing terrestrial vegetation;
- Increase in reservoir perimeter;
- Increase in aquatic lake environment; and
- Decrease in aquatic stream environment.

The potential impacts of these changes are discussed in more detail below.

Reduction of land used for agricultural purposes

Freehold and leased agricultural land surrounding the reservoir is currently used for dairying and grazing. The Project will result in an increase in the FSL for the reservoir and the associated inundation of an additional area around the perimeter of the reservoir. This inundation will lead to a reduction in land available for dairying and grazing. If it is assumed that existing stocking rates will be maintained, it follows that the number of cattle that would graze this land post construction would reduce. Therefore, the loss of agricultural land due to raising of the dam will reduce the nutrient load and thereby improve water quality in the reservoir.

Submergence of soils

The area to be inundated contains some phosphorus-rich soils. Following inundation of these soils, there is potential for a marginal increase in the volume of bed sediments with the capacity for phosphorus release (MHL 2005). However, this is unlikely to provide a measureable increase in general reservoir-wide phosphorus levels. Notwithstanding, phosphorus in shallow areas of the reservoir could accumulate due to limited water circulation, thereby increasing the potential for localised algal blooms.

Submergence of existing terrestrial vegetation

Submerged terrestrial vegetation will decay and lead to an increase in nutrient concentrations within the reservoir. This may increase the risk of algal blooms.

The potential for increased nutrient concentration via this mechanism will depend on how quickly the reservoir fills. Following construction of the Project, the timeframe in which inundation from the

current FSL of 62 GL to the augmented FSL of 100 GL will be dependent on climatic conditions and rainfall events. Based on simulated 100 year reservoir volumes, the minimum duration over which the additional inundation will occur is expected to be between eight and 21 weeks, although inundation to the new FSL could take up to several years.

Once inundated, the breakdown and release of organic material and nutrients from grasses and tree leaves is expected to occur over a period of days to weeks, and from inundated tree timbers over a period of months to years and possibly decades. This expected rate of breakdown suggests that the increased risk of algal blooms will be highest during periods of initial inundation and will subsequently reduce to an acceptable level.

Increase in reservoir perimeter

A greater reservoir perimeter has the potential to increase the rate of shoreline erosion. Wave activity along the northern and eastern shoreline has the potential to cause erosion and increase the level of sediment and fine gravels deposited in the perimeter bed of the reservoir. However, sediment deposition from this mechanism would be minor compared to the sediment load from the upstream catchment (MHL 2005). Impacts resulting from an increase in the rate of shoreline erosion are therefore considered to be minimal.

Increase in aquatic lake environment

Given the variable topography surrounding the reservoir, augmentation has the potential to change the extent of the perimeter aquatic environment following inundation to the new FSL. This has the potential to increase the total available aquatic lake environment, including the photic zone (Figure 8-2). The photic zone is that area of the reservoir in which there is sufficient penetration of sunlight through the water column for photosynthesis to occur. In Chaffey Dam this occurs in areas that are less than 4 m deep and currently equates to about 80% of the reservoir's surface area (MHL 2005). Assuming that the photic zone increases linearly with increasing FSL[4], augmentation of the dam will increase the photic zone by 148 ha to 582 ha (MHL 2005).

The impact of an increased photically active substrate depends on the variation in reservoir water levels. According to MHL (2005), if water levels consistently fluctuate there is the possibility of increased algal blooms in these shallow areas. If water levels are held reasonably steady, macroalgae and macrophytes could establish around the perimeter of the reservoir and would 'take-up' these nutrients and reduce the potential for blue-green algal blooms.

[4] This assumption does not account for the topography of the additional area to be inundated following the augmentation of Chaffey Dam.

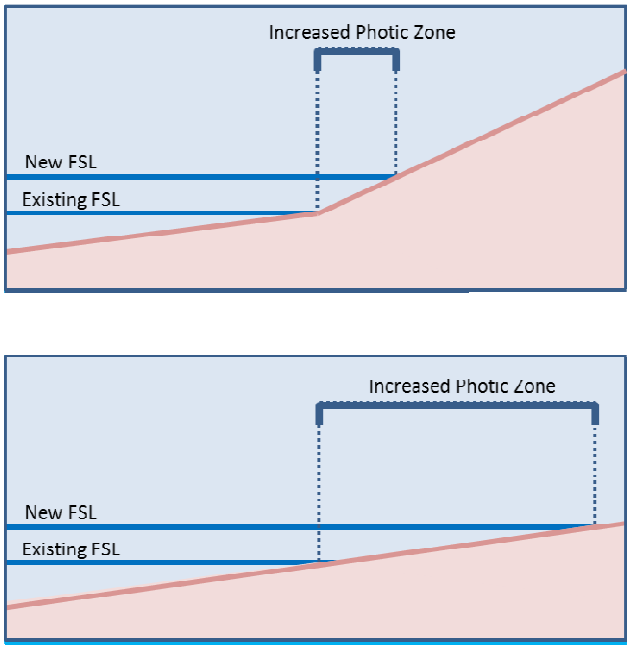

Figure 8-2: Comparison of the increase in photic zone in an area of steep topography (top) and gentle topography (bottom)

Decrease in aquatic stream environment

The Project will also result in the inundation of a section of the Peel River that extends about 1.2 km upstream from the existing reservoir as defined by the existing FSL. The affected section of river has a bed slope of approximately 1 m vertical in 200 m horizontal. Inundation of this section of the Peel River will modify the area from a stream environment to a lake environment. The upper Peel River is characterised by variable streamflows that create a pool and riffle sequence along the stream bed. By comparison, a lake environment will not experience the same flow regime. The associated reduction in flow velocity variation will reduce the capacity for sediment and gravels to be mobilised and will ultimately result in the ongoing deposition of sediment within the inundated section of the Peel River.

Although the pool and riffle sequence continues upstream at a similar gradient for approximately 12 km (Anna Cronin Namoi CMA *pers.comm.*), the Project will effectively reduce the length of this stream environment by about 10%.

EROSION AND SEDIMENTATION

All construction works around the perimeter of the reservoir, including work on the dam embankment and road realignments, will cause ground disturbance. This may involve damage to or removal of existing vegetative cover and create an increased risk of soil erosion. The impacts of soil erosion may include:

- A local loss of topsoil;
- Reduced slope stability, particularly where deep rooted vegetation is removed;
- Transfer of sediment into the reservoir, reducing the penetration of light through the water column and adversely impacting aquatic vegetation; and
- Release of sediment into the Peel River downstream of the dam.

Erosion is likely to occur, however the implementation of industry standard erosion and sediment control measures will significantly reduce its impact. Should sediment reach the reservoir, the potential for transport of sediment throughout the reservoir and subsequent release downstream is considered to be low due to the generally quiescent conditions within the reservoir. Chaffey Dam currently has an average retention time of 1.2 years and was estimated to have a sediment trap efficiency of 80% during the November 2000 flood event (GHD, 2008d). It is therefore expected that any sediment that reaches the reservoir is most likely to settle and be deposited locally within the reservoir.

CONSTRUCTION WASTE

Construction wastes may include soil, rock, concrete, steel and bitumen products. During works which are conducted away from the water's edge, construction waste will generally remain where it is deposited, however some wastes may be transported into the reservoir via wind or rain runoff.

Construction waste may enter the reservoir or its tributaries directly during construction activities conducted adjacent to or over water. Such activities may include construction of bridges, raising of the dam embankment and raising of the morning glory spillway.

Excess soil stored on-site may be subject to erosion and transported into the reservoir. The impacts of erosion and sedimentation are discussed in Section 8.1.2.

Waste rock, concrete and steel is expected to remain where it has been deposited until collected for disposal prior to completion of the works. However, the potential exists for these waste items to enter the reservoir, particularly where work is carried out over water. Rock and concrete are chemically stable and would be unlikely to impact on water quality if they were to enter the reservoir. Steel will gradually rust and release iron into the water; however the quantity of steel waste is expected to be so low relative to the reservoir volume as to result in negligible impact to reservoir water quality.

Loss of concrete during raising of the morning glory spillway has the potential to cause fouling of the trash racks and water offtakes. This has the potential to reduce the hydraulic capacity of the offtake structure, and make it more difficult to regulate the quality of water released from the dam.

Bitumen products used for road sealing will be contained by storage prior to their application, although the potential exists for run off containing bitumen products to be washed into the reservoir if rain occurs shortly after road sealing.

FLOOD FLOWS

During raising of the morning glory spillway, inflows to the reservoir may result in flood flows through the incomplete spillway structure. These flows have the potential to cause damage to formwork used to construct the new spillway and the loss of timber and metal formwork materials into the reservoir and potentially through the morning glory spillway. Timber and metal components of formwork that are distributed downstream during a flood will form a component of debris deposited along the banks of the Peel River. This will result in a negative aesthetic impact and could pose a safety hazard to recreational users after the flood has passed. Although the quantity of timber and metal deposited downstream in such an event is unlikely to result in significant water quality impacts, the CEMP for the Project will include provision for a post flood clean-up along the immediate downstream reaches of the Peel River.

The most significant impact of flood flows through the incomplete spillway structure is the risk of damage to the spillway structure itself resulting in lost time and unforseen reparation costs. The morning glory spillway is the primary spillway for any spills for flood events up to an annual exceedence probability (AEP) of 1 in 10,000. The construction of the raised bell mouth requires work below the current full supply level. Due to the timeframe in which Project funds have been allocated by the Federal and NSW Governments, the construction schedule will not allow the construction work to be programmed for a dry season when the storage may be below FSL.

State Water undertook storage behaviour analysis for a number of storms under scenarios in which the storage level was 1 m, 1.5 m and 2 m below the current FSL (Appendix 3). Lowering of the storage level by 2 m will provide the best opportunity to commence raising of the morning glory spillway and will provide a reduced risk to construction from flooding.

To enable construction activities to be carried out and to reduce the risk of flood flows discharging through the incomplete spillway, the reservoir will be required to be maintained at approximately 2 m or more below the current FSL. If the reservoir is at or near FSL at the commencement of construction, it is proposed to draw the reservoir down to 2 m below FSL immediately prior to and during works to construct the upgraded morning glory spillway.

During this period the inflows and any downstream demand will be managed by operating the valves within the morning glory structure to ensure environmental and riparian flows are maintained. Lowering of the storage level by 2 m will reduce the storage volume of Chaffey Dam by 11 GL (approximately 18%) and will be required for a maximum period of six months.

Based on the order of construction, raising of the morning glory spillway is not expected to commence before early to mid 2014. Start of this work will also depend on the storage behaviour at the time and the contractor's assessment of the weather forecast for the period of construction.

State Water has and continues to carry out consultation with the NSW Office of Water in regard to the required drawdown. On 21 November 2012, State Water sought formal approval from the NSW Commissioner for Water, NSW Office of Water, to maintain a temporary FSL 2 m below the current FSL for a period of six months, from May 2014 onwards (Appendix 3). This request has been made to enable construction of the raised morning glory spillway.

Similarly, flood flows could occur through the incomplete auxiliary spillway during reconfiguration of the fuseplug, potentially resulting in the loss of soil and rock downstream. The distribution of soil and rock downstream has the potential to infill the streambed and temporarily increase turbidity, thereby reducing the suitability of water for downstream consumptive uses and potentially resulting in impacts to aquatic ecosystems.

At the current FSL, a flood with a frequency of 1 in 1,000 years would be required for reservoir water levels to reach the sill of the auxiliary spillway (Black & Veatch 2012). This is considered to be an acceptably low level of risk. Therefore, the potential for the impacts associated with flood flows discharging through the auxiliary spillway during construction to manifest, is considered to be very low.

8.1.3 Potential Operational Impacts

Operation of the Project may result in a number of impacts to soil and water, as discussed in the following sections.

IN-RESERVOIR SEDIMENTATION

Augmentation of Chaffey Dam will increase the retention time of water in the reservoir, which may increase the proportion of sediment trapped and settled within the reservoir. This increased settling of sediment within the reservoir will decrease turbidity levels both in the reservoir itself and in water released through the morning glory spillway. The combination of clearer water and longer residence time does not impact algae levels, but can cause cyanobacterial blooms to persist longer into autumn, extending downstream taste, odour and toxic algal bloom problems (MHL, 2005).

The average retention time within Chaffey Dam is estimated to currently be 1.2 years. This is predicted to increase to 1.9 years after augmentation. Given that other sedimentation control measures such as wetlands aim to achieve a retention time of one to three days, the current retention time in Chaffey Dam is considered to be very high. Therefore, the change resulting from augmentation is considered to be of low consequence in terms of the relative impact on turbidity levels during and following a flood.

At the tenth percentile daily flow (the daily flow which is equalled or exceeded 10% of the time), augmentation will increase the retention time from 124 days to 200 days. Therefore, any further

increase in retention time is considered to provide a negligible change in sedimentation processes within the reservoir and will result in a negligible change to the persistence of cyanobacterial blooms. MHL (2005) confirm that the historic sedimentation rate in Chaffey Dam over the past 25 years of around 8 mm per annum is expected to remain unchanged.

STRATIFICATION

Chaffey Dam is subject to both thermal and oxygen stratification (MHL 2005; GHD 2007). Thermal stratification in Chaffey Dam results in a warm upper layer of water (the epilimnion) overlying a cold lower layer of water (the hypolimnion), separated by a transition layer (the thermocline). Thermal stratification promotes oxygen stratification, which results in a depletion of oxygen in the hypolimnion. This results in reduced water quality in the hypolimnion from anaerobic decomposition, including the production of hydrogen sulphide and the release of phosphorus. When water is released from the hypolimnion, both the cold temperature and reduced quality of the released water can reduce downstream water quality.

According to MHL (2005), augmentation of Chaffey Dam is predicted to:

- Increase the size of the epilimnion from 46 GL (78% of current reservoir volume) to 64 GL (64% of augmented reservoir volume);
- Increase the size of the hypolimnion from 13 GL (22% of current reservoir volume) to 36 GL (36% of augmented reservoir volume); and
- Extend stratification longer into autumn.

According to MHL (2005), the epilimnion is sufficiently large to supply current water demands and an increase in Tamworth's supply to its full entitlement of 16,400 ML (provided the epilimnion water is of sufficient quality).

The proposed works will raise the morning glory spillway offtake tower relative to the increase in FSL. The depth from surface and thickness of the thermocline will not change as a result of augmentation, because this is determined by local environmental factors such as seasonal weather variations and solar radiation. Therefore, as a result of raising the offtake tower, the current ability to withdraw from above, below or within the thermocline to access the highest quality water available will be retained.

Should the withdrawal of water through the multi-level offtake access colder, deeper water, MHL (2005) state that the relatively low flow and slow downstream propagation will result in an equilibration of downstream river temperatures to mean air temperature within a relatively short distance of the dam.

Therefore, it is considered that changes to the stratification layers within the reservoir will not result in a measurable reduction in downstream water quality.

DOWNSTREAM FLOWS

Outflows from Chaffey Dam through the morning glory spillway comprise unregulated spills and regulated releases via the multi-level offtake tower. The rate of unregulated spills through the morning glory spillway depends on its hydraulic characteristics, which are defined by the dimensions of the crest and throat. The rate of outflow for a given depth of water above the crest is characterized by a stage-discharge relationship. The raised morning glory spillway has been designed to achieve a stage-discharge relationship which is a close match to the existing (Black and Veatch 2012).

A hydrologic model was developed to simulate the operation of Chaffey Dam over the climatic sequence between 1892 and 2008. The model simulates river flows, dam storage, water extraction, losses and operation, irrigation demands and water sharing plan rules (NSW Office of Water 2010a). The model results assume operational rules which precede the Peel Valley Water Sharing Plan. However, they are useful in demonstrating the impact of augmentation alone on the downstream hydrologic regime.

The results are presented in Figure 8-3 for the Peel River in the form of a flow duration curve- for a site located downstream of Chaffey Dam at Piallamore . A flow duration curve shows the percentage of time that the range of flows in a stream are likely to be equalled or exceeded. The effect of river regulation is most significant in this reach of the Peel River due to the limited number of tributaries contributing to flows at this location and because many diversions of ordered water occur downstream of this point (NSW Office of Water 2010a).

The results show very little difference in flow regime between the current and enlarged dam configurations. For example, results for the current dam size show that a flow of 200 ML/day is equalled or exceeded approximately 20% of the time. This is also the case for the enlarged dam configuration.

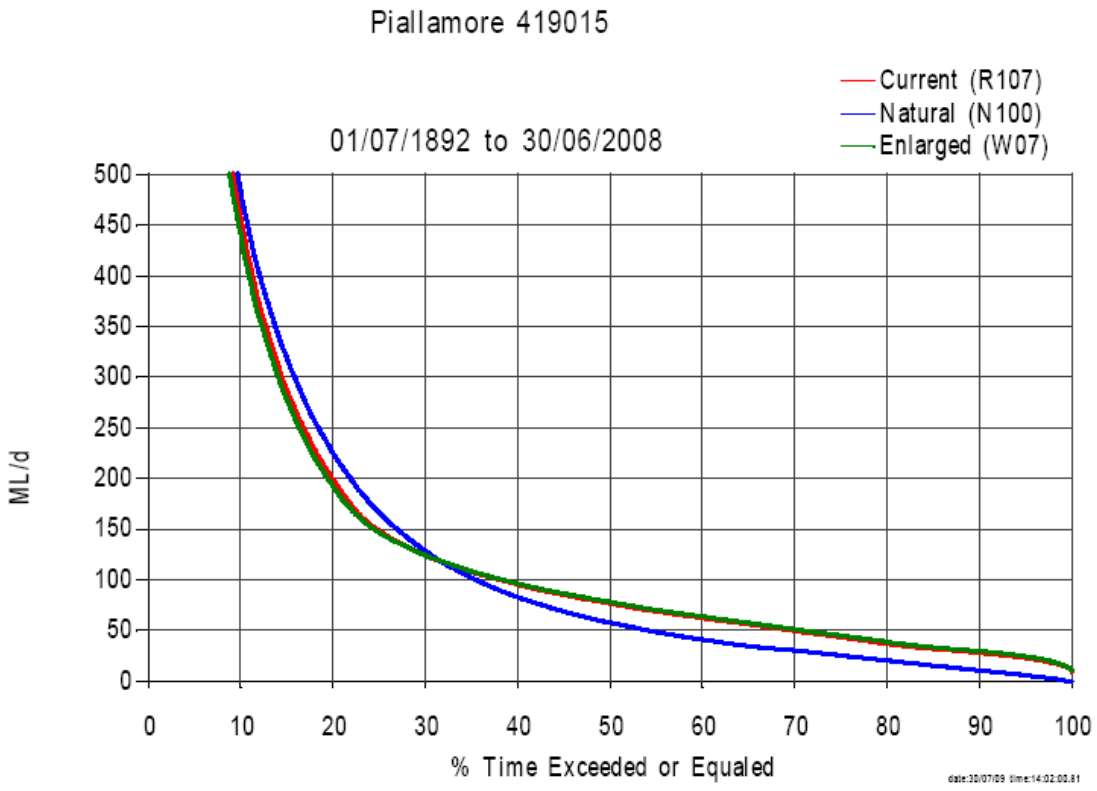

Figure 8-3: Impact of river regulation at Piallamore (all year flow) (Source: NSW Office of Water 2010a)

GEOMORPHOLOGY

The geomorphic response to the altered flow regime in the Peel River due to construction of Chaffey Dam has been largely limited to the development of in-channel benches and pool infilling in areas downstream of the confluence with Duncans and Dungowan Creeks (GHD 2007). The limited geomorphic change is attributed to a number of intrinsic factors that control the form of the Peel River downstream of Chaffey Dam. These include armoured gravel surfaces, well-vegetated cohesive banks, limited sediment inputs and the dissipation of floodwaters across relatively wide floodplains in comparison to channel width (GHD, 2007).

Due to the minimal difference in flow regime between the current and enlarged reservoir configurations, there is not expected to be further significant geomorphic change to the downstream river as a result of the Project.

RETURN FLOWS

Return flows are surface and groundwater flows from land following the application of irrigation water. Return flows generally contain elevated nutrient and chemical levels.

Implementation of the Project will reduce the area of available agricultural land surrounding the reservoir through inundation (as discussed in Section 8.10). However, none of this land is known to be irrigated and therefore, there will be no change to return flows.

Downstream of Chaffey Dam, the level of irrigation development is unlikely to change as growth is constrained by land suitability, market forces (NSW Office of Water 2010a) and the MDBC Cap Agreement (as enforced by the Peel Valley Water Sharing Plan). As a result, return flows from irrigated agriculture downstream of the dam are also not expected to change.

EXTREME EVENTS

Stream flows

The existing auxiliary spillway has a sill level of 525.9 m AHD and incorporates a 4.5 m high fuseplug which is designed to be triggered during the 1 in 10,000 year event. The current height of the dam wall ensures the auxiliary spillway conveys the 1 in 450,000 year event. During larger events the dam crest has the potential to be overtopped and the dam would be expected to fail.

As part of the Project, the dam embankment will be raised to ensure the PMF can be safely conveyed via the auxiliary spillway and thereby prevent dam overtopping and subsequent failure. In addition, the existing single fuseplug will be replaced by a two stage fuseplug that is designed to trigger when the reservoir levels reach the 1 in 10,000 and 1 in 20,000 year flood levels. The proposed fuseplugs are 7.93 m and 8.64 m high, respectively. Should a PMF occur, triggering of the fuseplugs prior to the peak water level in the dam being reached ensures the peak outflow during the PMF is reduced.

However, in order to ensure the PMF can be safely passed, the existing sill level will need to be maintained. The construction of higher fuseplug levels will therefore mean that a greater volume of water will be released if and when the fuseplugs are triggered.

Detailed modelling of the dam and the Peel River during extreme flood events has been undertaken to predict the change in downstream flood levels as a result of the works. The modelling indicates that (Black & Veatch 2012):

- During the 1 in 10,000 year event when the first fuseplug triggers, downstream flood depths in Woolomin (approximately 6 km downstream of Chaffey Dam) will be up to 0.3 m greater than for the current auxiliary spillway configuration. There will be no change to predicted flood levels in Tamworth.
- During the 1 in 20,000 year event when both fuseplugs have been triggered, downstream flood depths in Woolomin will be less than 0.5 m greater than for the current auxiliary spillway configuration. There is no change to predicted flood levels in Tamworth.

Following implementation of the Project, the risk of dam failure during the PMF will be minimised. Therefore any increase in flood levels downstream following triggering of the auxiliary spillway fuseplugs will be far less than would have occurred if the dam were to fail.

Detailed modelling has also been undertaken to determine whether the PMF causes submergence of the morning glory spillway outlet downstream of the dam (Black & Veatch 2012). The modelling shows that flood flows during the PMF do not encroach on the morning glory spillway outlet. Therefore there will be no impact on its operation.

Sediment transport

Flow through the auxiliary spillway has the potential to mobilise sediment comprising colluvium and alluvial material from the downstream spillway path (GHD 2007). The increase in downstream flood depths associated with the auxiliary spillway upgrade is likely to increase the volume of sediment mobilised. However, the volume of sediment mobilised from the spillway path during an event greater than the 1 in 20,000 year event is currently estimated to be less than 10% of the total volume of sediment that would pass through Chaffey Dam (GHD 2007). Erosion from spillway flows is therefore considered to be a relatively small proportion of the total volume of sediment that would be mobilised during an extreme flood event. As a result, any increase in erosion as a result of the works is likely to result in a small percentage increase in the total volume of sediment mobilised.

GROUNDWATER

Groundwater aquifers in the Peel Valley are primarily fractured rock or alluvial. The alluvial groundwater and surface water in the Peel Regulated River and some of its major unregulated tributaries are intricately linked. The Peel Regulated River loses water to the Peel Alluvium along most of its length, only gaining water from groundwater at the bottom end of the valley, below Attunga. The general flow direction of the groundwater is away from the river and then down gradients parallel to the river (NSW Office of Water 2010a).

The rock strata in the vicinity of Chaffey Dam is likely to be similar to the general description provided above for the broader Peel River Valley. Hence, there is potential for leakage from the dam to fractured rock aquifers. The Project will lead to a 30% increase in the surface area of the dam and will potentially increase the areal extent over which leakage could occur. However, most dams, and particularly those exposed to a sediment load from the upstream catchment, are “self-sealing”. That is, the potential for leakage to groundwater systems is reduced over time as a consequence of the sealing of available pathways by sediments carried to the dam in major runoff events. Accordingly, the increase in areal extent of the dam surface is only expected to present as an impact on groundwater systems during the first few years post completion of the dam upgrade works, and would progressively reduce over time.

Although the magnitude of this impact has not been quantified, it is unlikely to be significant in the context of the size and capacity of fractured rock aquifers in the upper and central Peel River Valley.

CLIMATE CHANGE

According to NSW Office of Water (2010a), work by CSIRO in 2007 has concluded that a best estimate of climate change by 2030 would reduce average surface water availability in the Murray-Darling Basin generally by five per cent and reduce surface water diversions by one per cent. In the Namoi catchment (in which Chaffey Dam is situated), the study predicted mean annual runoff to reduce by six per cent.

While CSIRO (2007) predicts a reduction in surface water diversions of one per cent, this would be outweighed by the reduction in mean annual runoff leading to an overall reduction in the security of supply. Since augmentation of Chaffey Dam will increase security of supply, the impact of augmentation will be to reduce the impacts of climate change.

The PMF will not be impacted by climate change, given that it is derived from the Probable Maximum Precipitation which is defined as "*the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends*" (WMO 1986).

8.1.4 Proposed Mitigation Measures

Although the Project has the potential to result in impacts to soil and water from erosion and sedimentation during construction, such impacts are readily managed, provided appropriate mitigation measures are implemented. A Sediment and Erosion Control Plan will be developed and implemented for the construction phase of the Project to ensure any such impacts are avoided or minimised. Additionally, the implementation of rehabilitation as soon as practicable, in areas no longer needed for construction or operation will assist in stabilising disturbed surfaces and minimising erosion and sedimentation.

Project wastes will be managed in accordance with the Contractor's CEMP for the Project and are not expected to result in any significant impacts to soil and water within the Project Site.

Careful management of hydrocarbons will be important where plant and equipment is being used near or over water. Floating booms will be utilised during activities adjacent to or over water where the potential exists for hydrocarbon leaks or spills to enter water.

Changes to the management of land surrounding the augmented reservoir, including exclusion of stock from accessing land below the 1 in 100 year ARI as well as revegetation and weed management of this area will assist in maintaining or improving water quality in the reservoir during operation of the Project.

The proposed mitigation measures are listed in Table 8-1.

Table 8-1: Proposed mitigation measures

Mitigation Measure	Project Phase
Existing cleared, disturbed and sealed areas will be identified and used preferentially for vehicle and machinery access, materials laydown and stockpiling wherever practicable to minimise disturbance to native vegetation, including areas of derived grassland (refer Figure 8-4).	Construction
The use of heavy machinery on areas that are outside of the area of direct impact and excavation works will be avoided during, and immediately following heavy rainfall events to protect soils from erosion and compaction.	Construction
Off road driving will be minimised as far as practicable and will be limited to within designated works areas.	Construction
Topsoil will be separated from subsoil during excavation and replaced as the top soil layer upon backfilling or reused elsewhere for rehabilitation.	Construction
Excavations will be backfilled as soon as practicable.	Construction
The extent of soil disturbance will be minimised and rehabilitation will be undertaken as soon as practicable following completion of works at each location.	Construction
Rehabilitation will incorporate revegetation with native species of local provenance to stabilise soils and reduce erosion.	Construction
A Sediment and Erosion Control Plan will be developed and implemented, and will include, as a minimum: • Use of silt fences, drains and sediment traps as relevant throughout ground disturbing works; • Use of silt curtains where ground disturbing works are being carried out near or adjacent to waterways; • Use of silt curtains where works are being carried out to the top or upstream embankment of the dam wall; • Regular checking of sediment and erosion control devices, including after heavy rainfall; and • Cleaning or replacement of sediment and erosion control devices as required.	Construction
All concrete pours and bitumen use will be appropriately supervised.	Construction
Placement of bitumen products will be restricted to periods where there is expected to be at least two days of dry weather after their application.	Construction

Mitigation Measure	Project Phase
If the reservoir is at or near FSL at the commencement of construction, the reservoir will be temporarily lowered to 2 m below FSL to provide construction access and flood protection, in accordance with any NSW Office of Water requirements.	Construction
The Foreshore Management Plan for Chaffey Dam (Report for Site Specific Action Plans Chaffey, GHD 2010) will be reviewed and revised as relevant. The Plan will be implemented throughout operation of the Project.	Operation
Selective withdrawal of water from the hypolimnion will be carried out to maintain or improve the quality of downstream water releases.	Operation
The vertical distribution of algal biomass and temperature within the reservoir will be monitored to determine the optimum level of draw-off.	Monitoring

8.2 Terrestrial Biodiversity

A Terrestrial and Aquatic Flora and Fauna Impact Assessment was undertaken by nghenvironmental Pty Ltd (nghenvironmental). This assessment included consideration of the life cycle of relevant species, populations, or communities, its local and regional distribution, the extent and quality of habitat available on the site, and the type and magnitude of impacts that may be expected.

The study area for the Terrestrial and Aquatic Flora and Fauna Impact Assessment comprised the area between the existing and augmented FSL and the proposed works areas, as well as within a 1 km radius of these areas. Areas upstream and downstream of Chaffey Dam were also investigated.

The key outcomes of the terrestrial biodiversity assessment are summarised in the following sections. The Terrestrial and Aquatic Flora and Fauna Impact Assessment is provided at Appendix 8. Additional information is also provided following a preliminary review of NWES (2009b) by WorleyParsons.

8.2.1 Existing Environment

A Flora and Fauna Impact Assessment was carried out to document the existing terrestrial biodiversity environment at the Project Site. As the Project has been development over a number of years, numerous studies have been carried out within and surrounding the Project Site, including those described in Table 3-1. The Flora and Fauna Impact Assessment included a comprehensive desktop review of existing available information to identify gaps in the existing literature. The field survey methodology was subsequently developed to address the identified gaps.

DESKTOP ANALYSIS

A desktop analysis and literature review was undertaken to identify biodiversity constraints with the potential to occur within the Project Site and to guide required field survey effort. This included an analysis of the existing literature relating to Chaffey Dam which was targeted toward ensuring that information from previous studies was utilised and built upon. Consultation with OEH (refer Appendix 7) was also carried out to establish the threatened flora, fauna and ecological communities known or likely to occur within the Project Site and to clarify the survey methodology.

Database searches revealed six threatened ecological communities with potential to occur within a 10 km radius of the study area. Four of these were considered unlikely to occur in the study area on the basis of absence of suitable habitat. Two of the communities were confirmed during Survey 1 to be present in the study area. The detailed descriptions and habitat preferences of these communities, along with an assessment of likelihood of occurrence and potential for impact, are provided in Appendix 8 (refer Pages B-I to B-XIX).

Threatened species database searches show that three trees, three shrubs, four forbs (including one orchid) and two grasses listed as threatened, are known to occur or have the potential to occur within 10 km of the study area. Threatened species evaluations following completion of Survey 1 determined that, of these threatened species, four were considered to have the potential to occur at the study area. The evaluations took into consideration the preferred habitat, including soils, and the current known distributions of the species and communities. Targeted surveys were carried out in suitable habitat for these species, as described in Table 8-2.

A search of threatened species databases showed that 42 threatened or migratory terrestrial fauna species and/or their potential habitats have previously been recorded within 10 km of Chaffey Dam. Of these species, 16 are listed under the TSC Act, and 25 under the EPBC Act. An evaluation of the likelihood and extent of impact on species potentially occurring within the Project Site was carried out (refer Page B-I to B-XIX of Appendix 8). The assessment was based on the known habitat preferences and distributions of the species, suitability of habitat on the study site, results of previous surveys and results of surveys conducted in 2012 for this report.

Five of these threatened fauna species and three of the listed migratory species have been recorded within the study area since 1990. Austeco (1990) recorded the Little Lorikeet (*Glossopsitta pusilla*), Brown Treecreeper and Rainbow Bee-eater (*Merops ornatus*) within the Project Site. Although the Little Lorikeet and Brown Treecreeper were not listed as threatened at the time of the surveys in 1990, these species are both now listed as vulnerable under the TSC Act. The Rainbow Bee-eater is listed as a migratory species under the EPBC Act.

Opportunistic observations by GHD (2007b) included the Brown Treecreeper, Little Lorikeet, White bellied Sea-eagle (*Haliaeetus leucogaster*) (EPBC-Migratory), and Great Egret (*Ardea alba*) (EPBC-Migratory). The Speckled Warbler (listed as vulnerable under the TSC Act), has also been recorded during past surveys (GHD 2008a, NWES 2009a).

The Border Thick-tailed Gecko and the Booroolong Frog have also been previously recorded in the study area.

North West Ecological Services (NWES 2009a[5]) conducted targeted searches at Chaffey Dam for the Border Thick-tailed Gecko, finding the species to be relatively common on the dam wall and in the larger Goat Mountain remnant to the to the immediate northwest of the dam wall.

Previous surveys for the Booroolong Frog within and adjacent to the Namoi catchment found the species to be present in 99 km of stream, with habitat upstream of Chaffey Dam mapped by NWES (2009b) as having a "high" habitat rating.

NWES (2009b) conservatively estimated the population of Booroolong Frogs in the Peel River catchment to be four Booroolong Frogs per 500 m transect. This estimate excluded a large population of Booroolong Frogs recorded immediately upstream of Chaffey Dam, which was considered to be an atypical population (NWES 2009a).

Three surveys immediately upstream of Chaffey Dam recorded more than 600 frogs, although NWES (2009b) noted that this would have included multiple sightings over the three surveys. A further 15 frogs were recorded in the Peel River above Chaffey Dam from Nundle to Wombramurra Creek.

The abundance of Booroolong Frogs immediately upstream of Chaffey Dam may be partly due to two large floods which occurred in November and December 2008, washing eggs, and possibly young tadpoles, downstream (NWES 2009b). NWES (2009b) found there to be a large recruitment of frogs between January 2009 and February 2009, with hundreds of metamorph and juvenile frogs emerging from the Peel River at its junction with Chaffey Dam.

It is also possible that the site is simply optimal habitat for Booroolong Frogs, capable of supporting large numbers of frogs and mass breeding events (NWES 2009b). The site contains an abundance of food sources, a range of rock sizes and large area of cobble riffles, rapids and shallow pools with high sunlight exposure. NWES (2009b) noted that the site's unique location at the junction of the Peel River and the reservoir, possibly through warmer temperatures resulting from the heat bank effect of the dam, is also likely to be having some influence that is beneficial to the frogs.

The species has a rapid life history, with males reaching maturity within one year and some surviving for a second breeding season, but with all dying before their third year. Females reach maturity in their second year, and some live on for a second breeding in their third year (D. Hunter, pers. com.

[5] A copy of NWES (2009b) was provided to **ngh**environmental and WorleyParsons by Namoi CMA under a data licence. The report contains precise location data for the Booroolong Frog. Given that collection of this species is a Key Threatening Process, Namoi CMA require clear knowledge of the parties to which this information is available and cannot allow this information to be made publically available. The report is available to agencies on request from Namoi CMA. The methodology for the surveys described in NWES (2009b) is summarised in Appendix 8.

2008 in NWES 2009b). This is also supported by observations from the Booroolong frog captive breeding program at Taronga Zoo (Michael McFadden, pers. com. 2009 in NWES 2009b).

Additionally, the species is an obligate stream dweller, living on the fringes of the streams. It is likely that it is exposed to cooler and moister conditions on average than the other riverine frogs that venture outside of the riparian zone. Such conditions are likely to favour frog infection by the water borne chytrid fungus (NWES 2009a).

It is suggested that chytrid fungus has a severe adverse impact on Booroolong Frog populations during winter, causing large declines, as low numbers of individuals are normally recorded in early summer (P. Spark, pers. comm.). Because the species is a very capable breeder, numbers seem to regenerate over summer (P. Spark, pers. comm.).

FIELD SURVEYS

Field surveys were carried out in the study area in May and October 2012 (Survey 1 and 2, respectively). Areas were chosen for survey based on existing aerial photographs, vegetation maps, and known records from previous studies. Site selection for targeted searches was further refined during the course of the surveys after determining the existing vegetation types and habitat resources.

The primary aim of Survey 1 was to assess vegetation types and condition to enable accurate mapping of vegetation community boundaries. Hollow-bearing trees in the study area were recorded during Survey 1.

Survey 2 comprised further assessment of vegetation communities to inform a BioBanking Assessment, in accordance with the BioBanking Assessment Methodology (BBAM) (DECC 2008a). The boundaries of threatened ecological communities (TECs) identified in the study area were also confirmed.

Targeted surveys were carried out during Survey 2 for the flora species listed in Table 8-2, following an evaluation of the likelihood and extent of impact on species potentially occurring within the Project Site (refer Pages B-I to B-XIX of Appendix 8). The searches were undertaken in accordance with the Draft Threatened Biodiversity Survey and Assessment Guidelines (DEC 2004), employing transects spaced approximately 5 m apart in all areas of suitable habitat within the areas expected to be impacted. The targeted surveys were conducted by two botanists for a total of 10 person hours.

The occurrence of Queensland Bluegrass (*Dichanthium sericium*) and *Euphrasia arguta* at the locations of nearby records of these species was also investigated in an attempt to validate the detectability of these species at the time of the survey. Survey timing was considered suitable for the Small Snake Orchid and Dungowan Star-bush. Although not optimal, it was also considered suitable for detecting *Euphrasia arguta* given that flowering has been recorded in October. Further, even if not flowering, it would have been possible to identify *Euphrasia arguta* in its vegetative state. The survey timing was not considered suitable for detecting Queensland Bluegrass which typically reproduces (and is identifiable) in summer and autumn.

Fauna surveys carried out in the study area included diurnal bird surveys, the use of Anabat detectors and spotlighting. Opportunistic observations were also recorded throughout Surveys 1 and 2. Targeted surveys were carried out for the threatened fauna species listed in Table 8-2, following an evaluation of the likelihood and extent of impact on species potentially occurring within the Project Site (refer Pages B-I to B-XIX of Appendix 8). Targeted searches were also carried out for the threatened River Snail, as discussed in Section 8.3.1.

Consultation with OEH (Appendix 7) regarding the proposed field survey methodology recommended that Booroolong frog surveys need not be undertaken, given the comprehensive surveys carried out in 2008 and 2008 (NWES 2009b) (refer Section 8.2.1).

Table 8-2: Targeted searches for the threatened species carried out during Survey 2

Common Name	Scientific Name	TSC Act Status	EPBC Act Status	Survey Effort (total person minutes)	Recorded during Survey 2?
Flora					
no common name	*Euphrasia arguta*	Critically Endangered	Critically Endangered	480	No
Dungowan Star-bush	*Asterolasia sp. "Dungowan Creek"*	Endangered	not listed	120	No
Queensland Bluegrass	*Dichanthium setosum*	Vulnerable	Vulnerable	300	No
Small Snake Orchid	*Diuris pedunculata*	Endangered	Endangered	480	No
Fauna					
Ananbat	*Threatened microbats*	Various	Various	N/A	Yes
Diurnal bird surveys	*Threatened birds*	Various	Various	300	No
Booroolong Frog[6]	*Litoria booroolongensis*	Endangered	Endangered	160	Yes

[6] It is acknowledged that this survey was outside the optimal timing for detecting the species and that summer surveys are required. This was an opportunistic survey and does not accord with Draft Guidelines for Threatened Species Assessment (DEC, 2005) and Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (DECCW, 2009).

Common Name	Scientific Name	TSC Act Status	EPBC Act Status	Survey Effort (total person minutes)	Recorded during Survey 2?
Border Thick-tailed Gecko	*Uvidicolus sphyrurus*	Vulnerable	Vulnerable	240	Yes
Koala	*Phascolarctos cinereus*	Vulnerable	Vulnerable	N/A	No
Squirrel Glider	*Petaurus norfolcensis*	Vulnerable	not listed	640	No

VEGETATION COMMUNITIES

Chaffey Dam is situated within a landscape which, apart from steeper slopes at the northern extent of the reservoir, is predominantly cleared or has been highly modified by past and current agricultural practices. The majority of the vegetation within the area of the increased FSL consists of highly disturbed, low diversity grassland. Small areas of higher diversity occur on the eastern bank of the reservoir, associated with regrowth woodland vegetation.

Within the area to be impacted by the Project, remnant treed vegetation is mostly comprised of scattered mature Yellow Box (*Eucalyptus melliodora*), Rough-barked Apple (*Angophora floribunda*) or Blakeley's Red Gum (*E. blakelyi*) individuals. Other more dense naturally occurring treed areas consist of mostly young regrowth vegetation with scattered mature individuals.

In the areas immediately surrounding the proposed increased FSL area, remnant vegetation occurs on the steeper upper slopes of the valley comprising mostly Silvertop Stringybark (*E. laevopinea*) dominated dry forest and White Box (*E. albens*) grassy woodland communities.

Seven vegetation communities were identified within the study area, as described in Table 8-3 and shown in Figure 8-4.

Table 8-3: Vegetation communities within the study area

Vegetation Community	Equivalent Regional Vegetation Community (RVC)	Equivalent Biometric Vegetation Type
Box-gum grassy woodland	Box – gum grassy woodlands, Brigalow Belt South and Nandewar (RVC 17)	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion (line 141)
Derived grassland	Silvertop Stringybark grassy open forests, eastern Nandewar and New England Tablelands (RVC 39)	Rough-barked Apple - Silvertop Stringybark - Manna Gum shrub/grass open forest of the southen Nandewar Bioregion

Vegetation Community	Equivalent Regional Vegetation Community (RVC)	Equivalent Biometric Vegetation Type
Silvertop Stringybark grassy open forest	Derived grasslands, Brigalow Belt South and Nandewar (RVC 28)	Bluegrass - Spear Grass - Redleg Grass derived grasslands of the Nandewar Bioregion
River Oak riparian woodland	River Oak Riparian Woodland, eastern NSW (RVC 71)	River Oak riparian woodland of the Brigalow Belt South and Nandewar Bioregions
Wetlands and marshes	Wetlands and marshes, inland NSW (RVC 70)	Semi-permanent open freshwater wetlands of the inland slopes and plains
Planted non-indigenous native vegetation	No equivalent.	No equivalent.
Exotic non-native vegetation	No equivalent.	No equivalent.

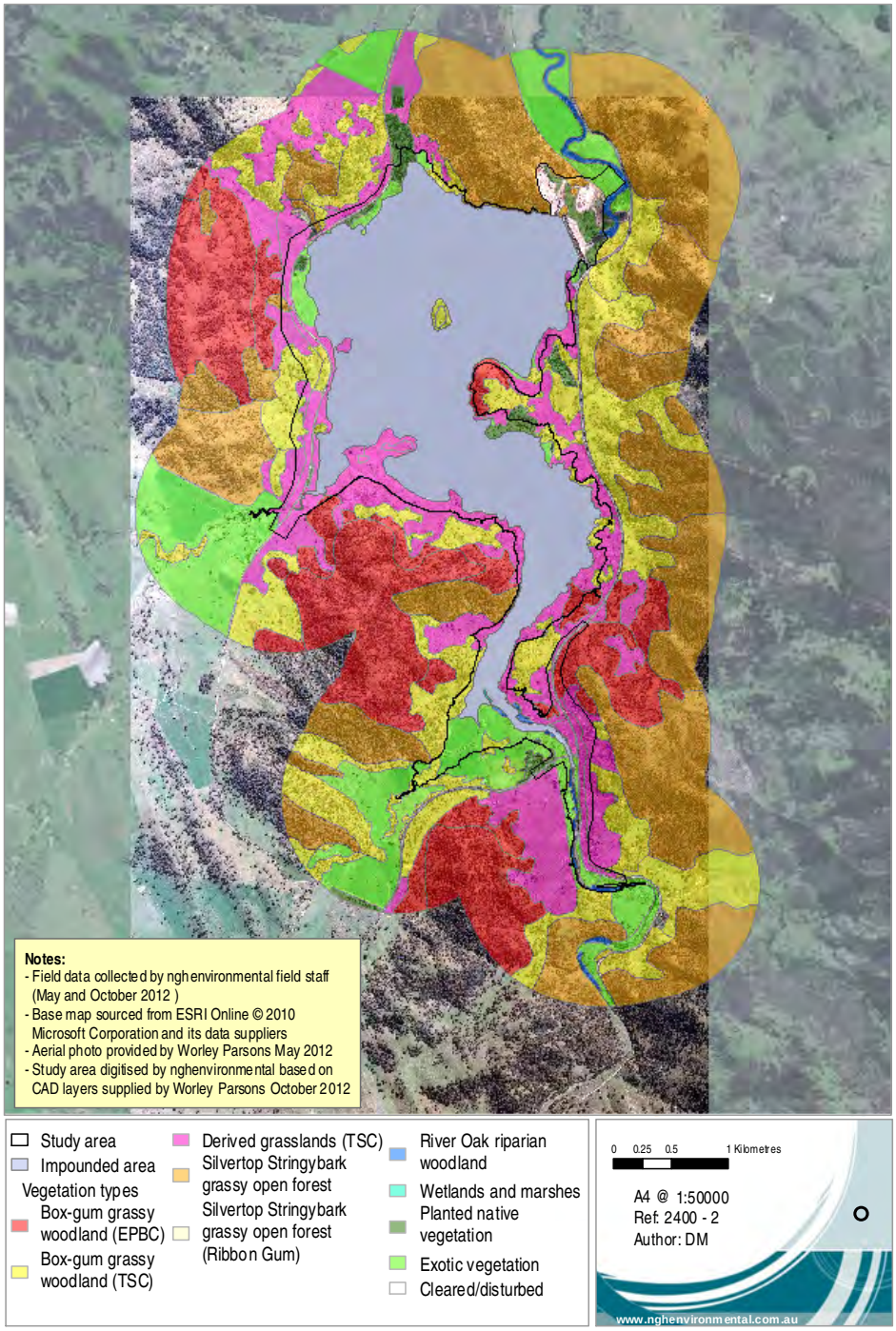

Figure 8-4: Vegetation communities within and surrounding the study area

Box-gum grassy woodland

The Box-gum grassy woodland community is the most common and widespread wooded community across the study area. It occurs primarily on the lower slopes and flats surrounding the reservoir and is dominated by Yellow-Box (*Eucalyptus melliodora*) and Blakely's Red Gum (*Eucalyptus blakelyi*) (Figure 4 1). Native Olive (*Notelaea microcarpa* var. *microcarpa*) is a common small tree particularly in the north of the site. A shrub layer may be present or more often absent with common species including Cough Bush (*Cassinia laevis*), Grey Guinea Flower (*Hibbertia obtusifolia*) and Urn Heath (*Melichrus urceolatus*).

The condition of the understorey is variable across the study area. Ground cover diversity is highest in the area north of the camping area on the eastern shore of the reservoir at the Bowling Alley Point Recreation Area. Common species in this area include Bulbine Lily (*Bulbine bulbosa*), Creamy Candles (*Stackhousia monogyna*), Tufted Bluebell (*Wahlenbergia communis*), Yellow Burr-daisy (*Calotis lappulacea*), Native Geranium (*Geranium solanderi*), Stinking Pennywort (*Hydrocotyle laxiflora*), Clustered Everlasting (*Chrysocephalum apiculatum*) and Twining Glycine (*Glycine clandestina*). The vegetation in this area is considered to be in good condition.

Another area in good condition occurs to the south of the camping area at the Bowling Alley Point Recreation Area, where Scaly Buttons (*Leptorhynchos squamatus*), Common Buttercup (*Ranunculus lappaceus*) and Smooth Rice-flower (*Pimelea glauca*) are common. A broad range of native grasses is present including Speargrasses (*Austrostipa scabra* subsp. *scabra*, *Austrostipa ramosissima*), Wallaby Grasses (*Rytidosperma* spp.), Purple Wire Grass (*Aristida personata*), Hedgehog Grass (*Echinopogon ovatus*) and Weeping Grass (*Microlaena stipoides*).

More commonly across the study area, the understorey of the Box-gum grassy woodland community is of a low diversity. This is most likely due to grazing pressures and vegetation is mostly in poor condition. However, areas of moderate condition occur in proximity to the higher diversity areas.

This community is listed as an Endangered Ecological Community (EEC) under the TSC Act (White Box Yellow Box Blakely's Red Gum Woodland). Better quality remnants in good condition also meet the definition of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as a Critically Endangered Ecological Community (CEEC) under the EPBC Act.

The plot data gathered for this community illustrates that the vegetation is generally below the ecological benchmarks published by the Namoi CMA (2012). These benchmarks were developed by the Namoi CMA specifically for Regional Vegetation Communities within the Namoi Catchment.

Derived grassland

The derived grassland vegetation community currently occurs within the study area as native pasture but is likely to have been derived from Box-gum grassy woodland that has been cleared of overstorey vegetation. This community is generally in poor condition across the site and exhibited a low diversity groundcover of native grasses dominated by Slender Rats-tail Grass (*Sporobolus creber*), Queensland Bluegrass (*Dichanthium sericeum*) and Red-leg Grass (*Bothriochloa macra*). Native forbs were generally absent and exotic species were common.

Despite its degraded condition, this community is also considered to comprise the EEC White Box Yellow Box Blakely's Red Gum Woodland, listed under the TSC Act.

As this vegetation community is derived from the clearing of a previous woodland vegetation type, there are no ecological benchmarks for this community.

Silvertop Stringybark grassy open forest

The Silvertop Stringybark grassy open forest vegetation community typically occurs on the upper slopes and ridge tops surrounding the reservoir and is characterised by the presence or dominance of Silvertop Stringybark (*Eucalyptus laevopinea*). On the northern shore of the reservoir to the west of the dam wall this community, which is co-dominated by Rough-barked Apple (*Angophora floribunda*) and Ribbon Gum (*E. viminalis*), occurs within a drainage line north of Silver Gully. In other areas this community also intergrates with Box-gum grassy woodland, with occasional occurrences of Bundy (*E. goniocalyx*).

The shrub layer of this community is generally sparse with common species including Sticky Daisy-bush (*Olearia elliptica* subsp. *elliptica*), Blackthorn (*Bursaria spinosa*), Native Olive and Grey Guinea-flower. However, Sticky Daisy-bush does form the occasional dense thicket in more disturbed areas. The understorey is generally grassy with characteristic species including Barbed-wire Grass (*Cymbopogon refractus*), Purple Wiregrass (*Aristida ramosa*) and Hedgehog Grass. A range of forbs are present including Bluebells (*Wahlenbergia* spp.) Native Geranium, Kidney Weed (*Dichondra repens*), *Acaena ovina*, Cotton Fireweed (*Senecio quadridentatus*) and Common Woodruff (*Asperula conferta*).

Occurrences of this vegetation type within the study area are considered to be in good condition, excluding areas of the south facing slope above the Ribbon Gum dominated area on the western foreshore, which are dominated by exotics and considered to be in poor condition. Large patches of Blackberry (**Rubus fruticosus* aggregate) also occur within this community to the east of the South Bowlo Fishing Club on the northern foreshore of the reservoir.

Within the study area, this vegetation community meets or exceeds the benchmark values. However, the number of trees with hollows is below the benchmark value, which is indicative of the predominately young age class of the overstorey.

River Oak riparian woodland

The River Oak riparian woodland vegetation community is distinguished by the dominance of River Oak (*Casuarina cunninghamiana*). Within the study area, this community mostly occurs as isolated patches along the shoreline of the upper reaches of the reservoir and the Peel River but also commonly occurs along the Peel River downstream of the dam. The understorey is mostly highly disturbed with a large component of exotic species. However, there are areas where native grasses, such as Weeping Grass and River Tussock (*Poa labillardieri*) and native sedges dominate.

This vegetation community is mostly in poor condition within the study area, with some patches in a moderate condition.

Excluding the species richness of the canopy (which solely consists of River Oak), the River Oak riparian woodland vegetation community within the study area generally falls well short of the benchmark values for this vegetation type, reflecting the highly disturbed nature of this community at the study area.

Wetlands and marshes

The wetlands and marshes vegetation community occurs as an isolated area on the southern shore of the reservoir. The community is dominated by rushes (*Juncus* spp.), with patches of Phragmites (*Phragmites australis*) and Broad-leaf Cumbungi (*Typha orientalis*). Groundcover below the rushes is generally sparse with Weeping Grass colonising areas on slightly higher ground. The inter-tussock spaces predominately consist of bare mud.

This community is considered to be in moderate condition at the site.

Of the two benchmark criteria relevant to this community, native ground cover slightly exceeds the benchmark value. However, native species richness is less than half of the benchmark for this community.

Planted non-indigenous native vegetation

Specific areas around the reservoir have been planted with native vegetation that is not naturally occurring at the site. This includes trees associated with the Dulegal Arboretum, demonstration plantings on the western shore of the reservoir and plantings around the Bowling Alley Point Recreation Area on the eastern shore of the reservoir.

The Dulegal Arboretum extends over an area of approximately 10 ha and contains a collection of mature planted native trees and shrubs from all around Australia. An untitled list by Barbara Graham in 1990 lists 232 species within the arboretum, however, there may be more. This list includes the following species currently listed as threatened in NSW.

- Pygmy Cypress Pine (*Callitris oblonga*);
- Spiked Rice-flower (*Pimelea spicata*);
- Silver-leafed Gum (*Eucalyptus pulverulenta*); and
- Wallangarra Gum (*Eucalyptus scoparia*).

None of the above threatened species are recorded as naturally occurring in the region around Chaffey Dam and none of the species were recorded in the study area outside the arboretum. They are species introduced to the locality solely for the purposes of establishing the Arboretum.

As an ecological function, the planted non-indigenous native vegetation community provides limited habitat resources to locally indigenous native flora and fauna due to its highly modified nature and the fact that the majority of species are not indigenous to the area. Given that these areas comprise non-indigenous vegetation, they were not investigated in detail.

The loss of these plantings is considered not to be significant in maintaining the natural distribution and occurrence of these species.

Exotic non-native vegetation

Exotic dominated vegetation commonly occurs as isolated patches around the reservoir and more extensively in the form of cropped paddocks on the southern foreshore of the reservoir. Patches are commonly associated with areas subject to disturbance from recreational or grazing pressures. Weeds such as Blackberry (**Rubus fruticosus* aggregate) have become extensively established in these areas. Around the dam wall, Coolatai Grass (**Hyparhenia hirta*[7]) forms almost pure stands. Coolatai Grass poses a major threat to natural biodiversity (Storrie, 2010).

FLORA SPECIES

A total of 220 vascular flora species were recorded during the flora and fauna assessment at the study area. A full list of the species recorded is provided at Appendix 8. No threatened flora species were detected during either Survey 1 or Survey 2.

It is considered unlikely that the threatened species Small Snake Orchid, Dungowan Star-bush or *Euphrasia arguta* occur within the study area. Queensland Bluegrass typically flowers (and is identifiable) in summer. A search of one previously recorded location of this species (recorded in 2003) within Bowling Alley Point Cemetery was carried out, however the species was not detected.

Queensland Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas and occurs in disturbed situations. Within the Namoi Catchment Management Area, Queensland Bluegrass is associated with 16 vegetation types within the following vegetation classes:

- North-west Slopes and Northern Tablelands Dry Sclerophyll Forests;
- Montane Lakes;
- Semi-arid Floodplain Grasslands;
- Western Slopes Grasslands;
- Floodplain Transition Woodlands;
- Western Slopes Grassy Woodlands;
- Brigalow Clay Plain Woodlands;
- North-west Floodplain Woodlands; and
- Riverine Plain Woodlands.

[7] The names of exotic species are proceeded by an * throughout this EIS

The soil types at the location of the known record are not the heavy basaltic black soils with which this species is typically associated. Instead, it consists of a red-brown loam which can also be associated with this species (OEH 2012). The habitat at this location is Box-gum grassy woodland similar to that of the higher quality areas within the study area. The soil type at the recorded location also appears to be similar to that of the soils within the Project Site. Although the species was also not recorded during targeted surveys in the Project Site, it is considered that this species may be present.

WEEDS

Common pasture weeds are prevalent throughout the area surrounding the existing reservoir. Noxious weeds listed for the Tamworth Regional Control Area are also present. Large infestations of Blackberry (**Rubus fruticosus aggregate*) occur around the existing foreshore. Other noxious weeds including Sweet Briar (**Rosa rubiginosa*), Prickly Pear (**Opuntia stricta*), St John's Wort (**Hypericum gramineum*), African Boxthorn (**Lycium ferocissimum*), Willows (**Salix spp*.) and Bathurst Burr (**Xanthium spinosum*) occur commonly as isolated individuals or patches. Blackberry, African Boxthorn, Prickly Pear and Willows (all except *Salix babylonica, S.x calodendron* and *S.x reichardtii*) are listed Weeds of National Significance (WoNS).

FAUNA HABITAT

Fauna habitats within and surrounding the study area comprise a range of microhabitat features, including tree hollows, fallen timber, ground litter layer, riparian and wetland habitats.

A large portion of the study area contains variable (mostly moderate to poor) quality habitat, including large areas of grassland, planted and exotic habitat. Woodland habitat within the study area is patchy and isolated. Several key habitat types were recorded within the study area, as described below. The potential for Koala habitat in the study area was also examined.

No areas of critical habitat have been declared under either the EPBC Act or TSC Act within or near the study area.

Riparian zone and reservoir

Riparian corridors form a transition zone between terrestrial and aquatic environments and perform a range of important environmental functions:

- Provide bed and bank stability and reduce bank and channel erosion;
- Protect water quality by trapping sediment, nutrients and other contaminants;
- Provide a diversity of habitat for terrestrial, riparian and aquatic flora and fauna species;
- Provide connectivity between wildlife habitats;
- Allow for conveyance of flood flows and control the direction of flood flows; and
- Provide an interface between developments and waterways.

Within the study area, the riparian zone comprises a diverse range of habitats, including the reservoir, Peel River, creek banks and drainage lines, narrow bands of aquatic vegetation, some patches of Eucalypt woodland and grassland along the reservoir foreshore. This habitat adjoins the River Oak riparian woodland habitat.

Large woody debris in these areas provides important habitat and shelter for native fish. Snags are often used for breeding and resting locations and they provide shelter from predators. Snags also support other aquatic organisms that fish species use as a food source. The removal of large woody debris adversely has the potential affect fauna species.

Common species observed in these areas include the Pacific Black Duck (*Anas superciliosa*), Little Pied Cormorant (*Microcarbo melanoleucos*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Eurasian Coot (*Fulica atra*), Black Swan (*Cygnus atratus*), Australasian Grebe (*Tachybaptus novaehollandiae*), and Australasian Darter (*Anhinga novaehollandiae*). Less common observations included the Azure Kingfisher (*Alcedo azurea*) and White-bellied Sea-eagle (*Haliaeetus leucogaster*). Other fauna that are likely to use these habitats include a range of reptiles, amphibians and mammals. The Platypus (*Ornithorhynchus anatinus*) has previously been recorded within the spillway outlet channel and further downstream of the dam (Grant, 2007).

These areas provide known habitat for the threatened Booroolong Frog and are likely to be an important foraging resource for microbats.

River Oak riparian woodland habitat

Stands of River Oak (*Casuarina cunninghamiana*) occur as isolated patches along the shoreline of the upstream reaches of the reservoir and the Peel Rive, as well as downstream of the dam wall.

This riparian woodland provides foraging and nesting habitat for small birds such as Thornbills (*Acanthiza spp*.) and the Red-browed Finch (*Neochmia temporalis*). An abundance of Needle-leaf Mistletoe (*Amyema cambagei*) provides foraging habitat for a large diversity of species, including the White-plumed Honeyeater (*Lichenostomus penicillatus*), Noisy Friarbird (*Philemon corniculatus*), and Mistletoebird (*Dicaeum hirundinaceum*).

These stands of River Oak and their association with water provide potential habitat for threatened fauna including the Brown Treecreeper (*Climacteris picumnus*), Regent Honeyeater (*Xanthomyza phrygia*), and Turquoise Parrot (*Neophema pulchella*) (Namoi CMA 2012).

The Booroolong Frog, listed as endangered under both the TSC Act and EPBC Act, is known to occur within the vicinity of this habitat type, upstream of Chaffey Dam on the Peel River. Shading created by the River Oaks along the river creates sub-optimal habitat for the frog by reducing basking sites for adult frogs and lowering stream temperatures, which may reduce larval growth (Bevitt et al. 1998).

Woodland habitat

Three woodland communities within the study area are considered to provide habitat for fauna, comprising:

- Box-gum grassy woodland;
- Silvertop Stringybark grassy open forest; and
- Stringybark woodland dominated by *Eucalyptus viminalis*.

These communities provide habitat for a range of birds recorded at the study area, including the Whistling Kite (*Haliastur sphenurus*), Musk Lorikeet (*Glossopsitta concinna*), and Red-rumped Parrot (*Psephotus haematonotus*).

Of the habitats present within the study area, these woodland communities are more likely to provide habitat opportunities for threatened fauna including the Squirrel Glider, Koala, microbats and woodland birds such as the Hooded Robin (*Melanodryas cucullata*), Diamond Firetail (*Stagonopleura guttata*), Speckled Warbler (*Chthonicola sagittata*), Brown Treecreeper and Varied Sittella (*Daphoenositta chrysoptera*).

Grassland habitat

Grassland habitat within the study area includes the derived grassland vegetation community, which has resulted from the clearing of woodland and occurs extensively as native pasture. This habitat is degraded, however it provides potential habitat for threatened species including the Diamond Firetail, Hooded Robin and Little Eagle. Evidence of rabbits in areas of Grassland habitat was high. The grassland also provides ample foraging opportunities for foxes and raptors.

Hollow-bearing trees

Fifty-seven hollow-bearing trees were recorded within the area surrounding the reservoir. These trees ranged in height from eight to 20 m, with a diameter at breast height (DBH) ranging from 30 to 150 cm. An even proportion of trees contained small and medium-sized hollows, with only seven trees observed with to have large hollows. Clusters of hollow-bearing trees, particularly along the eastern foreshore of the reservoir, provide potential habitat for arboreal fauna including the Squirrel Glider, which is listed as vulnerable under the TSC Act.

Spotlighting conducted in areas with clusters of hollow-bearing trees (Figure 4 10) did not detect any threatened fauna species.

Disturbed land habitat

Disturbed land habitat in the study area is comprised of the planted non-indigenous native vegetation and the exotic non-native vegetation communities. These areas are subject to disturbance from recreational or grazing pressures and heavy infestations of weeds such as Blackberry. These areas provide habitat for rabbits and foxes as well as habitat for small birds such as Superb Fairy-wrens (*Malurus cyaneus*). Coolatai Grass forms almost pure stands around the dam wall. This grass

species is one of the main threats to the Border Thick-tailed Gecko, which occurs on the dam wall and on Goat Mountain at the northern extent of Chaffey Dam (NWES 2009a).

Potential Koala habitat

The study area was assessed for the presence of Koala habitat during Survey 1. Two feed tree species, as listed in Schedule 2 of SEPP 44 (refer Section 5.2.15), occur within the new FSL: Ribbon Gum (*Eucalyptus viminalis*); and River Red Gum (*Eucalyptus camaldulensis*). Ribbon Gums occur on the western extent of the reservoir, however their distribution is not continuous and they are unlikely to provide valuable habitat for Koalas. River Red Gums occur on the eastern foreshore within the Bowling Alley Point Recreation Area, however these individuals are also isolated and were probably planted. The presence of these two species within the new FSL does not constitute 15% of the total number of trees in the upper or lower strata of the tree component, therefore this area does not qualify as Potential Koala Habitat as defined by SEPP 44.

Core koala habitat is defined in SEPP 44 as "*an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population*". No Koalas or signs of Koala presence were recorded during either Survey 1 or Survey 2. GHD (2008a) also conducted a Koala habitat assessment and found that the study area did not constitute potential Koala habitat as defined under SEPP 44. Therefore, it is considered unlikely that a resident Koala population occurs within the study area.

Corridors

Corridors can provide habitat linkages and important refuges for rare and threatened species, especially in landscapes where natural vegetation has been removed, or where linkages are the last remnants of vegetation types that have been selectively cleared (Bennett 1998; 2003). Areas of both Box-gum woodland and Stringybark forest occur within and around the study area and extend to the upper slopes and ridge tops. These areas provide connectivity for fauna, as they have been less impacted by agricultural and grazing practices around the dam. Specifically, these areas include Goat Mountain at the northern extent of the reservoir and vegetation adjacent to the south-western foreshore.

A planted corridor was created in late 2011 and early 2012 with the aim of linking Goat Mountain with the Peel River and habitat areas to the east. Once established, it is likely this will provide habitat for a range of native species protected under both State and Commonwealth legislation, particularly the Border Thick-tailed Gecko. It will take some years for the vegetation to become established and mature to the point where it would function as an effective wildlife corridor, and in its current state does not provide habitat connectivity and is susceptible to weed invasion due to the high levels of disturbance. The corridor is currently and will continue to be maintained by State Water, including implementation of weed management measures.

The Peel River also acts as a natural corridor. Despite the degraded quality of the riparian habitats both upstream and downstream of Chaffey Dam, their connectivity makes them a critical landscape component, particularly in maintenance or restoration programmes (Fisher and Goldney 1997).

TERRESTRIAL FAUNA SPECIES

A total of 104 fauna species were recorded at the study area during Survey 1 and Survey 2. Native fauna comprised 75 bird, 17 mammal, four reptile, two amphibian and three aquatic species. Introduced species included one bird and two mammals. A full list of fauna species recorded at the study area is provided in Appendix 8.

One migratory species listed under the EPBC Act, the White-bellied Sea-eagle, was recorded opportunistically during both Survey 1 and Survey 2. No threatened bird species were observed during the dedicated bird surveys or opportunistic observations.

Of the fauna species recorded, three threatened species were detected including one mammal, one reptile and one amphibian. The locations in which these species were recorded are shown on Figure 8-5.

One species of threatened bat was recorded during Survey 2. The Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), listed as vulnerable under the TSC Act, was recorded as from an Anabat detector located at the top of the dam wall. This species roosts in caves, derelict mines and man-made structures. It is likely that this species is roosting in the rocky habitats available on the upper slopes in the locality surrounding the reservoir using Chaffey Dam primarily as foraging habitat.

Three Border Thick-tailed Geckos were recorded during the current surveys on the crest of the dam wall (on the northern side) and one on Goat Mountain. Extensive suitable habitat for the Gecko is available on Goat Mountain and most likely in rocky surrounding areas. Targeted surveys carried out during Survey 2 detected one Booroolong Frog upstream of the reservoir on the Peel River (Figure 8-5). Low numbers of this species are expected at this time of year as the growth rate of chytrid fungus increases in colder temperatures, resulting in population declines and mass mortality events over winter (NWES 2009b). Hunter (2001) found that annual survival for this species is relatively low, with 10% annual survival for adult males and 20% annual survival for adult females (OEH 2012). European Carp (*Cyprinus carpio*) were also observed upstream of the reservoir. This species is predatory and it may have a significant adverse impact on Booroolong Frog populations by preying on eggs and tadpoles (DSE 2003; Gillespie and Hero 1999).

Survey 2 aimed to quantify and describe the area of suitable Booroolong Frog habitat to be impacted by the new FSL and the amount of suitable habitat that exists upstream, outside of the new FSL. Stretches of the Peel River totalling some 836 m in length, between the existing and the proposed FSL, were assessed, with 11 potential and known Booroolong Frog habitat locations identified (Figure 8-6). These 11 locations total approximately 505 m (0.27 ha) of Booroolong Frog habitat within the proposed FSL. A further 1.7 km was assessed upstream of the proposed FSL, in which an additional 16 potential habitat locations were identified. These 16 locations comprise a combined length of 930 m and an area of 0.53 ha of potential habitat for the Booroolong Frog (Figure 8-6).

Potential habitat, both within and outside the new FSL, is not necessarily optimal habitat, with some areas negatively impacted by shading, depth and substrate. Areas shaded by riparian overstorey vegetation along the Peel River creates sub-optimal habitat for the frog by reducing basking sites for

adult frogs, and lowering stream temperatures, which may reduce larval growth (Bevitt et al. 1998). Shading is predominantly created by River Oaks along the Peel River. Approximately four sites within the proposed FSL and four sites outside the proposed FSL provide optimal habitat for the Booroolong Frog with full sun conditions. The majority of locations were partially shaded, depending on the time of day.

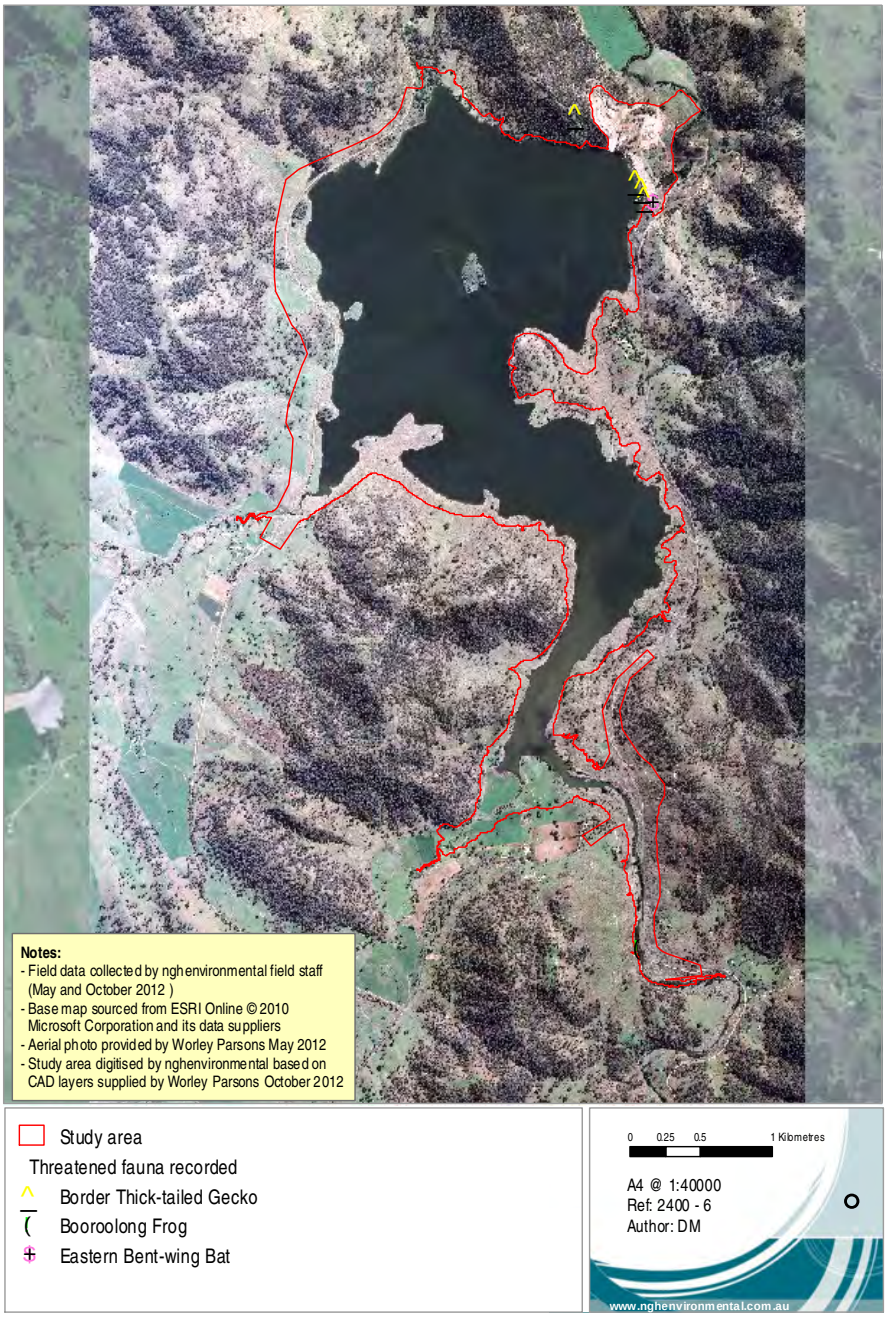

Figure 8-5: Threatened fauna species recorded in the study area during Surveys 1 and 2

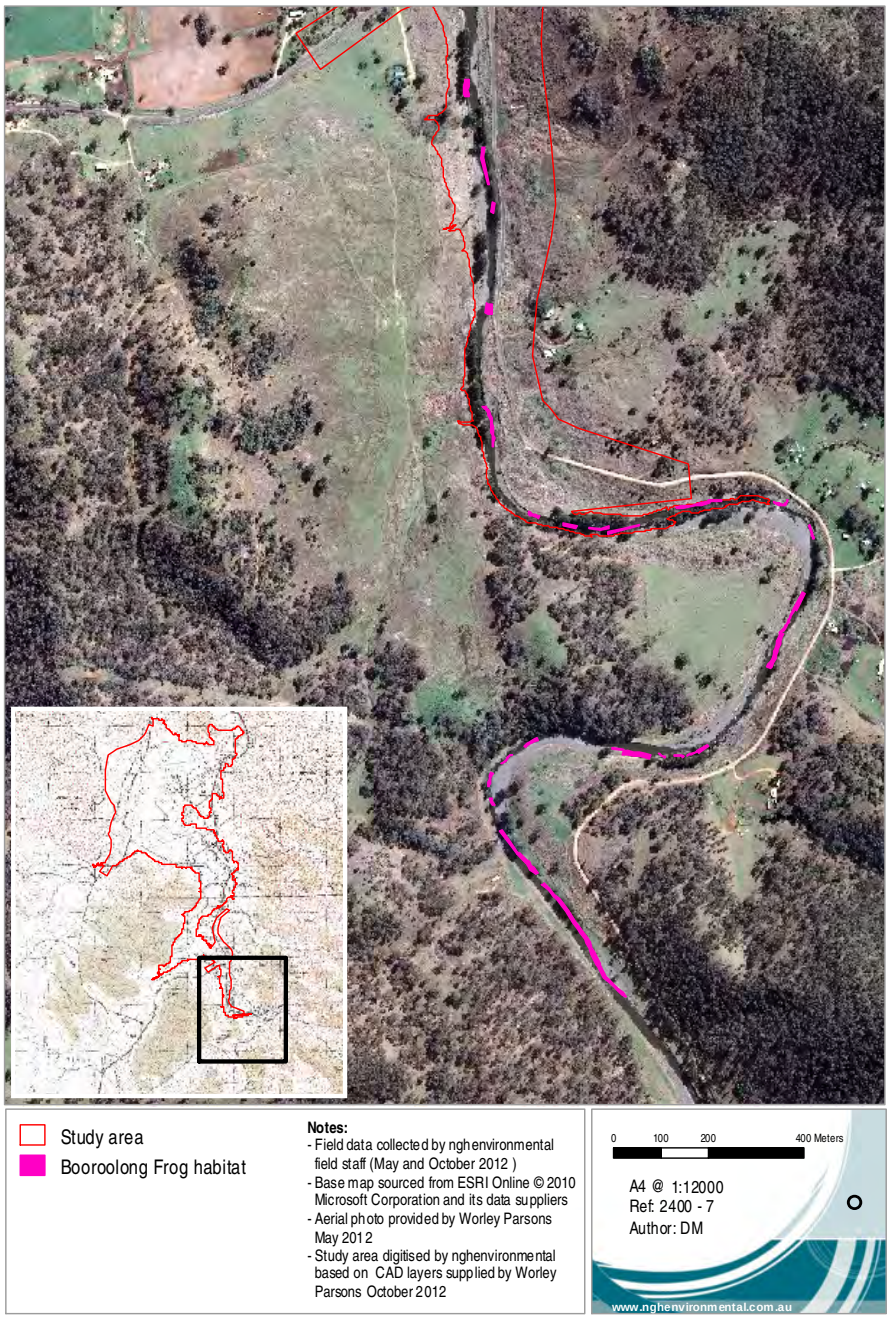

Figure 8-6: Known and potential Booroolong Frog habitat upstream of Chaffey Dam

8.2.2 Potential Construction Impacts

Construction of the Project has the potential to impact on biodiversity in the Project Site through vegetation clearing, inundation of vegetation and the introduction and spread of weeds. These potential impacts vegetation would also result in the loss of fauna habitat.

CLEARING OF VEGETATION

Works to the dam wall, as well as realignment of roads and bridges, will require the clearing of some vegetation. Land clearance and clearing of native vegetation are listed as key threatening processes under the EPBC Act and TSC Act, respectively.

Raising the dam wall will require rock fill to be placed in areas that are currently vegetated. The majority of the vegetation to be impacted around the existing dam wall is either colonising exotic grasses or was planted following the construction of the original wall. A small area of Silvertop Stringybark grassy open forest occurs immediately north of the wall and this may also be impacted. This vegetation type is common, has already been highly disturbed and was isolated from other areas following the construction of the auxiliary spillway. Impacts to this small patch of fragmented vegetation are unlikely to greatly contribute to the overall impacts of the Project.

The increased FSL will necessitate the realignment of existing roads along the western and eastern foreshore of the reservoir and the relocation of the South Bowlo Fishing Club. The establishment of new road alignments will require the clearing of Box-gum grassy woodland, derived grassland and Silvertop Stringybark grassy open forest vegetation. Approximately 16 ha, 47 ha and 5 ha respectively of these vegetation types occur within the works areas for the road realignments (outside of the new FSL).

It is not proposed to clear the whole of the works areas, rather they show the boundary of all works, including equipment laydown and stockpiling areas. Clearing will only be carried out within the construction footprint of roads and bridges. Vegetation within the works areas may also be affected by vehicle access and parking, materials laydown and spoil deposition and retrieval. Peripheral impacts may include soil compaction, soil erosion and sedimentation.

Areas of Box-gum grassy woodland and derived grassland to be impacted fall within the definition of the Box-gum grassy woodland EEC listed under the TSC Act (63 ha). This area of EEC is considered to be of low to moderate quality. Approximately 4 ha of Box-gum grassy woodland that meets the criteria for the community listed under the EPBC Act occur within the works areas. This area of EEC is considered to be of high quality. Clearing of vegetation within these works areas will be minimised.

The Flora and Fauna Impact Assessment concluded that a significant impact on the TSC Act and EPBC Act listed Box-gum grassy woodland is unlikely to occur as a result of the Project (refer Appendix 8).

It is currently unknown if a population of Queensland Bluegrass occurs within the area to be impacted by the Project, although the species was recorded in close proximity to the Project Site in 2003.

Similar habitat to that of the previous record occurs within the area to be impacted. As such, it is considered that a population could exist and potentially be impacted by the Project.

Approximately 4 ha of potential habitat for the Queensland Bluegrass associated with areas of high quality Box-gum woodland occurs within the works areas and will be potentially impacted by the Project. Although not detected within or near the Project Site since 2003, using the precautionary principle, it is assumed that a population of Queensland Bluegrass may exist at the Project Site and should it be present, there is the potential for a significant impact as a result of the Project.

Given that suitable habitat extends beyond the area of impact, it is also likely that should a population occur, then it would also extend beyond the area of impact.

Additional surveys during the flowering period for this species (summer) will further clarify the level of significance of impact on this species. If summer surveys find this species to be absent from the Project Site, the impact of the Project on this species is unlikely to be significant.

INUNDATION OF VEGETATION

The increase in the FSL will result in the inundation of vegetation that occurs immediately adjacent to the existing reservoir. Given that the Project will inundate approximately 185 ha of mostly grassed and agricultural land, the potential exists for a short to medium term impact on water quality through the decomposition of organic matter as inundation takes place. This could increase nutrient loadings and cause algal blooms.

The approximate areas of each vegetation type that would be inundated and the approximate extent of vegetation in a one kilometre radius above the area to be inundated are presented in Table 8-4. Values in brackets show the area within each community comprising listed EECs. The areas for the TSC Act and EPBC Act EECs overlap and as such do not add up to the total area of vegetation.

Table 8-4: Areas to be inundated by the increased FSL and within a one kilometre radius above the increased FSL by vegetation type

Vegetation Community	Area to be inundated (ha)	Area within a 1 km radius above FSL (ha)
Box-gum grassy woodland	30	1,014
(EPBC Act listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland)	*(6)*	*(506)*
(TSC Act listed White Box Yellow Box Blakely's Red Gum Woodland)	*(30)*	*(1,014)*
Derived grassland	87	293
(TSC Act listed White Box Yellow Box Blakely's Red Gum Woodland)	*(87)*	*(293)*

Vegetation Community	Area to be inundated (ha)	Area within a 1 km radius above FSL (ha)
Silvertop Stringybark grassy open forest	3	892
River Oak riparian woodland	6	15
Wetlands and marshes	0.25	0
Planted non-indigenous native vegetation	9	21
Exotic non-native vegetation	45	276
TOTAL	**180.25***	**2,510**

*This total area does not include existing cleared and disturbed areas

Impacts resulting from periodic or semi-permanent inundation are likely to substantially change the species composition of the community within the Project Site. Associated erosion and sedimentation impacts may also be part of this impact. Therefore, applying the precautionary principle, it has been assumed that by the periodic or semi-permanent inundation, all areas of vegetation within the new FSL will be modified to varying degrees by the Project.

Land clearance and clearing of native vegetation are listed as key threatening processes under the EPBC Act and TSC Act, respectively. Degradation of native riparian vegetation along NSW watercourses is also listed as a key threatening process under the *Fisheries Management Act 1994.*

The loss of riparian areas through the increased FSL is expected to increase bank and channel erosion, potentially impacting water quality, and changing the hydrology of the waterways.

The area to be inundated includes 117 ha of Box-gum grassy woodland and derived grassland considered to comprise the TSC Act listed EEC . Approximately 6 ha of these communities comprise the EPBC Act listed community.

The majority of the vegetation to be impacted by the increased FSL is in poor to moderate condition, with characteristics that fall below the ecological benchmarks for the relevant vegetation type. Exceptions include areas of Box-gum grassy woodland in good condition and Silvertop Stringybark grassy open forest, however only relatively small areas (approximately 6 ha and 3 ha respectively) of the areas in good condition will be inundated.

Field surveys conducted within the area of the new FSL and within a one kilometre buffer indicate that there are extensive areas of the impacted communities in similar or better condition within the locality. This includes approximately 1,300 ha of Box-gum woodland and derived native grassland that meets the definition of the TSC Act listed EEC, of which approximately 506 ha meets the criteria for the EPBC Act listed community. These areas will not be impacted by the Project.

The Flora and Fauna Impact Assessment concluded that a significant impact on the TSC Act and EPBC Act listed Box-gum grassy woodland is unlikely to occur as a result of the Project (refer Appendix 8).

As stated above, it is currently unknown if a population of Queensland Bluegrass occurs within the area to be impacted by the Project, although similar habitat to that of an adjacent previous record occurs within the area to be impacted. As such, it is considered that a population could exist and potentially be impacted by the Project.

Approximately 6 ha of potential habitat for the Queensland Bluegrass associated with areas of high quality Box-gum woodland will be inundated as a result of the Project. Although not detected within or near the Project Site since 2003, using the precautionary principle it is assumed that a population of Queensland Bluegrass may exist at the Project Site and should it be present, there is the potential for a significant impact as a result of the Project.

Given that suitable habitat extends beyond the area of impact around the reservoir, it is also likely that should a population occur, then it would also extend beyond the area of impact. Additional surveys during the flowering period for this species (summer) will further clarify the level of significance of impact on this species. If summer surveys find this species to be absent from the Project Site, the impact of the Project on this species is unlikely to be significant.

Introduction and Spread of Weeds

It is likely that the reservoir currently acts as a medium for dispersal of weed species. This is evidenced particularly by the widespread nature of Blackberry at a large number of locations immediately adjacent to the water's edge.

Inundation to the new FSL has the potential to result in the dispersal of weeds currently present in the area to be inundated. Rising waters will have the potential to inundate and kill existing infestations, however there is also the potential to dislodge and transport both reproductive and vegetative material from weed species to other, currently weed free areas, around the foreshore.

Coolatai Grass is abundant within the Project Site and while it is not listed as noxious under the control area of Tamworth Regional Council, in many parts of NSW it is declared a Class 3 noxious weed under the *Noxious Weeds Act 1993*.

Invasion of native plant communities by exotic perennial grasses is a key threatening process listed under the TSC Act.

Removal of Fauna Habitat

The removal of fauna habitat, including existing vegetation, through inundation will be gradual, allowing more mobile fauna species to relocate prior to direct impacts occurring.

Fifty-seven hollow-bearing trees were recorded within the study area containing predominantly small and medium-sized hollows, and seven trees observed with large hollows. Clusters of hollow-bearing trees, particularly along the eastern foreshore, provide potential habitat for arboreal fauna. Although

no threatened hollow-dependent fauna were observed during surveys, hollow-bearing trees provide an important resource for fauna in the Project Site. The loss of hollow-bearing trees comprises a key threatening process under the TSC Act.

The removal of bridges has the potential to impact on roosting microbat species, however inspection of the Bowling Alley Point Bridge and Hydes Creek Bridge gave no indication that bat species utilise these structures. The Eastern Bentwing-bat, listed as vulnerable under the TSC Act, was recorded during Survey 2 at the top of the dam wall. This species roosts in caves, derelict mines and man-made structures. It is likely that this species is roosting in the rocky habitats available on the upper slopes in the locality surrounding the reservoir, using Chaffey Dam primarily as foraging habitat. No significant impacts to threatened microbat species are anticipated to occur from construction of the Project.

The raising of the dam wall is likely to impact on the Border Thick-tailed Gecko, which is known to occur on the wall. Artificial habitat for the gecko that is provided by the large rocks of the existing dam wall will be removed during construction of the new dam wall. The removal will be gradual and will allow some opportunity for capture and relocation of geckos. There is ample suitable habitat on Goat Mountain to relocate geckos. Thus the habitat loss is considered to be temporary.

It is likely that the Border Thick-tailed Gecko will recolonise the wall post-construction, as the raised wall will comprise rocks of the same type and size as the existing wall.

The existing habitat on the upstream face of the dam wall will not be impacted, as the area of habitat created by raising the dam wall (approximately 3,000 m^2) will be greater than that lost by the increased FSL (approximately 2,600 m^2).

Given inundation to the new FSL will occur gradually, individuals are expected to relocate up the wall in response to the rising reservoir level.

Impacts to the Gecko may be direct, through loss of individuals during construction and indirect, through a temporary unavailability of habitat provided by the dam wall. NWES (2009a) found the species to be relatively common within the region, recording it many times in shrubby rocky remnants around Woolomin, including Goat Mountain, to the immediate northwest of the dam wall. The geckos on the wall are likely to be part of a much larger population in the remnant habitat of Goat Mountain (NWES 2009a). Once established, the wildlife corridor planted in late 2011 and early 2012 between Goat Mountain and the dam wall will facilitate movement of this species.

It is likely that the Border Thick-tailed Gecko will recolonise the wall post-construction, as the raised wall will comprise rocks of the same type and size as the existing wall. No significant impacts to this species from the Project are anticipated.

Construction of the Project has the potential to introduce or spread chytridiomycosis, a fatal disease of amphibians that is caused by the chytrid *Batrachochytrium dendrobatidis*. In NSW, chytridiomycosis has been reported from the Booroolong Frog. High altitude (>400 m) amphibian populations are more severely affected by chytridiomycosis. Stream-associated frog species are more likely to be infected because the pathogen is waterborne (DECC 2008b). Infection of

amphibians with chytrid fungus resulting in chytridiomycosis is listed as a key threatening process under the TSC Act and the EPBC Act.

Approximately 505 m (0.24 ha) of known and potential Booroolong Frog habitat occurs upstream of Chaffey Dam within the proposed FSL and will be impacted by the Project through inundation (Figure 8-6). A further 930 m (0.53 ha) of potential habitat for the Booroolong Frog is known to occur within 1.7 km upstream of the proposed FSL. Existing information suggests there is at least a further 8.5 km of suitable habitat for the species upstream of this area (Anna Cronin Namoi CMA pers. comm.). Additionally, NWES (2009b) mapped the Peel River upstream of Chaffey Dam as having a "high" habitat rating.

Some of the potential habitat, both within and outside the new FSL, is considered to be sub-optimal, with some areas negatively impacted by shading, depth and substrate. Areas shaded by riparian overstorey vegetation along the Peel River creates sub-optimal habitat for the frog by reducing basking sites for adult frogs, and lowering stream temperatures, which may reduce larval growth (Bevitt et al. 1998). The majority of locations were partially shaded, depending on the time of day. Shading is predominantly created by River Oaks along the Peel River. Approximately four sites within the proposed FSL and four sites immediately outside the proposed FSL provide optimal habitat for the Booroolong Frog with full sun conditions.

Potential habitat, both within and outside the new FSL, is not necessarily optimal habitat, with some areas negatively impacted by shading, depth and substrate. Areas shaded by riparian overstorey vegetation along the Peel River creates sub-optimal habitat for the frog by reducing basking sites for adult frogs, and lowering stream temperatures, which may reduce larval growth (Bevitt et al. 1998). Shading is predominantly created by River Oaks along the Peel River. Approximately four sites within the proposed FSL and four sites outside the proposed FSL provide optimal habitat for the Booroolong Frog with full sun conditions. The majority of locations were partially shaded, depending on the time of day.

Booroolong Frogs have been recorded upstream of Chaffey Dam to Wombramurra Creek. A large population of Booroolong Frogs was recorded approximately 1 km upstream of the existing FSL. NWES (2009b) noted that this population was "atypical". The presence of this population was not confirmed during surveys in 2012, although survey conditions were not ideal. Additional surveys will be carried in summer 2012 / 2013 to ascertain the local population numbers of Booroolong Frogs upstream of Chaffey Dam.

The area of inundation of the new FSL extends approximately 700 m upstream of the large population previously recorded by NWES (2009b). As a result, the Project may result in the loss of individuals within this population through inundation. Inundation to the new FSL will be gradual (from a minimum of eight to 21 weeks, up to several years, based on 100 year simulated dam volumes), which may facilitate upstream migration of the frogs.

Given the large number of individuals that may be impacted by inundation to the new FSL, the Flora and Fauna Impact Assessment concluded that the Project is likely to have a significant impact on the population of the endangered Booroolong Frog previously recorded immediately upstream of Chaffey

Dam on the Peel River. However, this impact will be on the local population. The impact to the species across its range is unlikely to be significant.

While it is acknowledged that the impact to the species across its range is unlikely to be significant, additional surveys will be carried out during the breeding season for this species (summer), when it is most detectable. The surveys will be used to further inform and clarify the level of impact, if any, on the local population and to guide consideration about the management of impacts, if any.

8.2.3 Potential Operational Impacts

The primary potential operational impacts of the Project on terrestrial biodiversity will be during extreme flood events.

The existing auxiliary spillway fuseplug will be modified to a two-bay design to enable a staged trigger of the fuseplug, at the 1 in 10,000 and 1 in 20,000 AEP events. During these extreme events, extensive flooding downstream of the dam will occur. Severe erosion and sedimentation associated with these events would impact instream habitats, flora and fauna, riparian zones and surrounding floodplains. However, significant impacts would occur during such extreme flood events regardless of the change to the existing auxiliary spillway fuseplug. Furthermore, the Project will improve the current condition and safety of the dam.

Based on observations made during Surveys 1 and 2, there appears to be no lasting detrimental effects on the vegetation communities surrounding the reservoir from past flooding events. Increasing the capacity of the dam would in fact, increase its ability to absorb and manage flood waters. Aside from minor sedimentation and erosion, no significant impacts to terrestrial and aquatic biodiversity are likely in the event of flooding above the new FSL.

8.2.4 Summary of Potential Impacts to Terrestrial Biodiversity

A summary of the potential impacts to terrestrial and biodiversity from construction and operation of the Project is provided in Table 8-5.

Table 8-5: Summary of potential construction and operational impacts to terrestrial biodiversity

Species or Community	Extent of impact from inundation (inside FSL)	Extent of impact from construction (outside FSL)	Total
Booroolong Frog	Approximately 600 individuals (may be revised following surveys in January 2013).	None	Approximately 600 individuals (may be revised following surveys in January 2013).

Species or Community	Extent of impact from inundation (inside FSL)	Extent of impact from construction (outside FSL)	Total
Booroolong Frog Habitat	Approximately 0.27 ha of known and potential Booroolong Frog habitat on the Peel River.	None	Approximately 0.27 ha of known and potential Booroolong Frog habitat on the Peel River.
Border Thick-tailed Gecko	None	Unknown number of individuals living within the artificial habitat of the dam wall.	Unknown number of individuals living within the artificial habitat of the dam wall.
Border Thick-tailed Gecko Habitat	0.26 ha (area of upstream face of dam wall to be inundated).	5 ha (area of downstream face of dam wall).	5.26 ha
Queensland Bluegrass	Extent of impact (if any) to be determined in January 2013 surveys. Potential habitat for Queensland Bluegrass of approximately 6 ha of high quality box gum woodland will be impacted.	Extent of impact (if any) to be determined in January 2013 surveys. Potential habitat for Queensland Bluegrass of approximately 4 ha[8] of high quality box gum woodland will be impacted.	Extent of Impact (if any) to be determined in January 2013 surveys. Potential habitat for Queensland Bluegrass of approximately 10 ha of high quality box gum woodland will be impacted.
White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland (EPBC Act CEEC) (high quality)	6 ha	4 ha[8]	10 ha

[8] This is the area of vegetation within the works areas. Not all of this vegetation will be cleared. This is likely to be a gross overestimate of the actual impacts of the Project however, is included here as a worst case scenario.

Species or Community	Extent of impact from inundation (inside FSL)	Extent of impact from construction (outside FSL)	Total
White Box-Yellow Box-Blakely's Red Gum Woodland (TSC EEC) (low to moderate quality)	117 ha	63 ha[8]	180 ha

8.2.5 Proposed Mitigation Measures

Avoidance of impacts to biodiversity associated with the increased FSL is considered unfeasible. The area to be inundated is associated with the existing topography of the land, which cannot in practice be changed.

Impacts associated with road and bridge realignments within the designated works areas will be avoided wherever practicable. This will comprise use of existing cleared or disturbed areas wherever possible for equipment and stockpile laydown and access. The locations of realigned roads have been designed to remain close to the existing alignments in order to minimise impacts.

Where impacts are unable to be avoided, mitigation strategies will be implemented to minimise impacts as far as practicable, as described in the following sections.

Potential impacts to biodiversity associated with sediment and erosion control, speed control, off-road driving and waste and spill management will be largely managed through the mitigation measures defined in Sections 8.1.4, 8.6.4, 8.12.4 and 8.13.4.

Inundation and Clearing of Vegetation

Although clearing of Box-gum woodland and derived grassland communities is not consistent with the draft national recovery plan, mitigation measures will be implemented to reduce identified impacts and establishment of offsets (refer Section 8.2.6) surrounding the reservoir would result in the long term management and security of the community in the locality. As such, a significant impact is considered unlikely and that a net positive 'maintain or improve' outcome can be achieved.

The loss of riparian areas through the increased FSL cannot be avoided, however there are opportunities to rehabilitate the riparian zone along the new FSL as part of the proposed works.

Weed Management

Good weed hygiene will be required to prevent the movement of weeds within and outside of the Project Site and to prevent the introduction of any new weeds to the Project Site. A Vegetation

Management Plan[9], including provisions for weed management, will be prepared and implemented during construction of the Project to ensure weeds are adequately controlled at the Project Site. Measures implemented through the Vegetation Management Plan will also be designed to assist rehabilitation of fauna habitats, primarily through weed control.

With the appropriate implementation of weed controls during and following construction, weed impacts within and off the Project Site are not expected to be significant.

FAUNA MANAGEMENT

State Water and Namoi CMA will undertake additional surveys in summer 2012 / 2013 to ascertain the local population numbers of Booroolong Frogs upstream of Chaffey Dam and to further quantify the impacts, if any, of the Project on the local population. The outcomes of these surveys will also further inform the development of appropriate mitigation and management measures for the local population. State Water has committed to contribute partial funding for these surveys.

Namoi CMA is currently proposing to conduct Booroolong Frogs surveys in summer 2012 / 2013 within the Namoi Catchment Area. State Water will work with Namoi CMA to maximise the efficiency of the surveys and the volume of data collected.

Namoi CMA is undertaking a full suite of summer surveys in late December 2012 to mid January.2013, which will map viable habitat, and determine the presence of Booroolong Frogs in the Peel River from Chaffey Dam upstream to the confluence with Wombramurra Creek. OEH has contributed to methodology design for the surveys.

The report generated from this work will be prepared by Namoi CMA is expected to be completed in February 2013.

These surveys are intended to increase understanding of the present status of Booroolong Frog populations on the Peel River upstream of Chaffey Dam and provide information to further tailor appropriate mitigation measures for the species. This will help inform appropriate mitigation actions in respect to the local population.

A Booroolong Frog Management Plan[9] will be developed and implemented, comprising extensive mitigation and offsets measures. The Plan would be developed in consultation with species experts and the Namoi CMA and could include a relocation program to move juvenile frogs to areas of suitable habitat upstream. Every effort will be made to contribute to the control and spread of chytrid through the Plan by adoption of protocols for persons, vehicles and equipment as detailed in the 'Hygiene protocol for the control of disease in frogs' (DECC 2008b). Offset measures to improve the habitat available for the species outside of the FSL can also be defined. Implementation of this plan is intended to contribute to the mitigation of impacts by the Project on the local population of the species.

[9] Specific management plans may be combined into a single Biodiversity Management Plan for ease of implementation.

The species is considered to be a capable breeder and currently goes through a natural cycle of winter die off and summer regeneration, suggesting that the population would have the capacity to build up to higher numbers given the amount of suitable habitat available upstream. Additionally, the rate of inundation to the new FSL will be gradual and occur over a period of time. This is an important positive factor in the mitigation of impacts, if any, on the local population as it ought to enable the upstream migration of the frogs. These factors indicate that the likelihood of success of proposed mitigation measures is high.

A Border Thick-tailed Gecko Management Plan[9] will be prepared and implemented to guide Project construction activities. The plan will include requirements for the relocation of individual geckos immediately prior to works to the dam wall as well as work methods to minimise impacts to remaining individuals. Ongoing management of the existing wildlife corridor currently undertaken by State Water will also be incorporated into the plan.

Table 8-6: Proposed mitigation measures

Mitigation Measure	Project Phase
Further surveys will be carried out in summer to determine the presence or absence of Queensland Bluegrass (*Dichanthium setosum*) within the Project Site to accurately determine the potential for a significant impact to this species. The results of these surveys will be provided in either a Supplementary Report to be submitted to the Department of Planning in January / February 2013, a submissions report or a Preferred Infrastructure Report (PIR) prepared for the Project.	Pre-construction
The design of the raised multi-level off-take tower should enable adequate management of cold water pollution and algal bloom impacts (i.e. allow for releases of water from various depths independently and/or concurrently to allow mixing of water if required to mitigate cold water pollution).	Construction
Existing cleared, disturbed and sealed areas will be identified and used preferentially for vehicle and machinery access, materials laydown and stockpiling wherever practicable to minimise disturbance to native vegetation, including areas of derived grassland (refer Figure 8-4).	Construction
The use of heavy machinery on areas that are outside of the area of direct impact and excavation works will be avoided during, and immediately following heavy rainfall events to protect soils from erosion and compaction.	Construction

Mitigation Measure	Project Phase
A Vegetation Management Plan[9] will be developed for the Project including but not limited to the following outcomes: • The control of noxious weeds recorded on the site prior to works commencing; • The management of Coolatai Grass around the dam wall and planted wildlife corridor; • Preventative measures for the spread or introduction of weeds with the aim of ensuring no weeds are spread or introduced as a result of the Project. Any increase in weed infestations should be managed to eliminate or reduce weed infestation; • Provisions requiring weed control measures employing chemicals to be conducted in a manner that does not impact on water quality within the reservoir; • Laydown sites for excavated spoil, equipment and construction materials will be weed-free or treated for weeds; • Sediment control materials should be weed free such as weed free hay bales or geotextiles; • Any imported materials such as sand and gravel will be sourced from sites which do not show evidence of noxious weeds or diseases that may be harmful to native vegetation. If any imported materials result in the occurrence of weeds, measures will be implemented to eliminate weeds before they have the opportunity to spread; and • Monitoring of measures and ongoing adaptive management to control weeds throughout construction and operation of the Project.	Construction Operation

Mitigation Measure	Project Phase
A Booroolong Frog Management Plan[9] to be developed and implemented for the Booroolong Frog population on the Peel River that will include provision for: • Information from a pre-construction monitoring program which includes frog surveys in summer 2012 / 2013 to ascertain the current numbers of frogs and to inform the relocation strategy. The results of these surveys will be provided in either a Supplementary Report to be submitted to the Department of Planning in January / February 2013, a submissions report or a Preferred Infrastructure Report (PIR) prepared for the Project; • Depending on the findings of the proposed Summer Survey and if considered appropriate and necessary, relocation of juvenile frogs within the new FSL to suitable habitat upstream on the Peel River, or elsewhere in the catchment to be decided in consultation with Namoi CMA and Philip Spark (or other suitable frog expert); • The relocation strategy will aim to sustain a viable local population. If at any time, this is unlikely to be met, alternative strategies will be developed; • Remediation and threat mitigation as required in receiving sites (e.g. stock exclusion, weed removal, removal of exotic shading vegetation, protection from fossicking, removal of Carp); and • Post-construction monitoring for a minimum of two years to monitor the success of the Management Plan. This will be dependent on the rate of inundation and consultation with the relevant parties (e.g. Namoi CMA).	Pre-construction Construction

Mitigation Measure	Project Phase
A Border Thick-tailed Gecko Management Plan[9] will be prepared and implemented to guide the construction phase activities, including the following considerations: • An ecologist will be engaged to locate and remove all fauna found on the dam wall to a safe location in the wildlife corridor or the Goat Mountain remnant prior to construction works on the dam wall. The timing of the relocation needs to occur as close as possible to the commencement of excavation works to minimise the chance of fauna recolonising the works site; • To avoid impacts to the Border Thick-tailed Gecko during the construction phase, works will follow a staged and strategic plan for the clearing and excavation. Clearing and rock removal will begin from the south-eastern end of the wall and work northwest along the ridge to enable all fauna in the impact area to escape along the ridge to the wildlife corridor; • The materials used to raise the dam wall will be the same as those currently present on the wall, where possible; and • Stock management measures to reduce the current adverse impacts of stock on the wildlife corridor including preventing stock from entering the wildlife corridor area and the habitat between the dam wall and Goat Mountain.	Pre-construction Construction

8.2.6 Offset Strategy

The Project will impact upon threatened species and vegetation communities listed under State and Commonwealth legislation. The implementation of mitigation measures coupled with the development and implementation of an Offset Plan, if necessary, will reduce the impacts anticipated to threatened flora, fauna and ecological communities as a result of the Project.

An Offset Plan will be developed for the Project by State Water, with input from SEWPaC, OEH and the Namoi CMA. The final Offset Plan will be submitted with the Preferred Infrastructure Report (PIR) or Response to Submissions (RtS) report and approved prior to determination of the Project.

The objective of the Offsets Plan will be to ensure that an overall 'maintain or improve' outcome is achieved for the Project. That is, where impacts cannot be either avoided or entirely minimised, the residual impact will be offset.

Additional surveys will be carried out in summer 2012 / 2013 to further quantify the impacts of the Project on Queensland Bluegrass and the Booroolong Frog. The outcomes of these surveys will enable calculation of specific offsets to satisfy relevant State and Commonwealth requirements.

This Offset Strategy is modified from the provided by nghenvironmental (Appendix 8). It aims to provide more certainty around:

- How offsets will be identified;
- How offsets will be managed;
- How offsets will be secured; and
- How the Principles for the use of Biodiversity Offsets in NSW and the EPBC Act Environmental Offsets Policy are addressed.

The key components in identifying offsets are:

- Calculating the areas to be impacted;
- Determining a suitable offset ratio; and
- Selecting the offset site.

IDENTIFYING IMPACTS

Through inundation and construction activities, the Project will impact on up to 180 ha of the TSC Act listed EEC, White Box-Yellow Box-Blakely's Red Gum Woodland, including 10 ha of this community which satisfies the criteria for the EPBC listed CEEC, White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland.

One threatened flora species, Queensland Bluegrass, has the potential to be impacted by the Project, if present at the site. This species is listed as vulnerable under the TSC Act and the EPBC Act. Potential habitat for Queensland Bluegrass of up to approximately 10 ha, associated with areas of high quality Box-gum woodland, may be impacted through inundation and construction activities.

The Project will impact upon two threatened species listed under the TSC Act and the EPBC Act, namely the Booroolong Frog and the Border Thick-tailed Gecko. Approximately 0.27 ha of known and potential Booroolong Frog habitat on the Peel River will be impacted through inundation. Approximately 5.26 ha of artificial Border Thick-tailed Gecko habitat (that is, the dam wall) will also be impacted. The Project will however, result in the reestablishment of this artificial habitat, with the area of this habitat increasing as a result of the Project.

DETERMINING THE OFFSET RATIO

The OEH BioBanking Assessment Methodology provides rules for the number and type of credits required in order to offset the impacts of a development. The OEH 'Credit Convertor' tool, which relies on the outputs of the 'credit calculator', can be used for estimating the offset areas required for the Project.

BioBanking plot data has been collated for the study area and will be employed in determining the suitability of proposed offsets for the Project. Employing the BioBanking methodology will ensure that an adequate offset to achieve a 'maintain or improve' outcome for TSC Act listed entities is realised.

Offset requirements will also be assessed against the EPBC Act Environmental Offsets Policy (October 2012) to ensure that matters of national environmental significance are adequately represented in any proposed offsets. An offsets assessment guide has been produced by SEWPaC which provides an assessment of the suitability of proposed offset areas to offset matters listed under the EPBC Act. The guide requires that data be entered for both the matters of national environmental significance to be impacted and the proposed offset site.

Matters of national environmental significance that may require offsets in accordance with the EPBC Act Environmental Offsets Policy are the White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland CEEC, the Booroolong Frog and potentially Queensland Bluegrass. As the artificial habitat of the Border Thick-tailed Gecko removed for the Project will be replaced and expanded and no significant impacts are anticipated, it is not expected that offsets will be required for this species.

A preliminary offset scenario for the White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland CEEC was prepared using the assessment guide. The preliminary offset scenario was prepared using the average quality of vegetation within a 1 km perimeter of the area to be impacted by the Project.

In constructing this scenario, the following assumptions were made:

- The vegetation at the offset site would contain the EPBC listed community;
- The quality of the White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland within the study area is 7/10;
- An offset site in similar condition (7/10) could be improved to a level of 8/10 over a period of five years; and
- That there was no risk of the loss of the offset and that there is 100% confidence in the result.

Incorporating these assumptions, the removal of the 10 ha of this community within the study area would require an offset of approximately 75 ha to completely offset the impacts to the community. It should be noted however, that this calculation is highly dependent on the assumptions above and that in reality there is likely to be at least some risk in losing the offset and some discrepancy in the confidence of the result.

The condition of the offset site, the practicalities associated with its improvement and the timeframe over which it can occur, are also highly site specific. The information above should be interpreted as a guide only. For example if an offset site of poorer quality (5/10) could be improved to a quality of 7/10 with the same assumptions, then the size of the required offset site would only be 40 ha. However, it would require much more intensive management.

Offsets specific to the Booroolong Frog and Border Thick-tailed Gecko will also be required under the EPBC Act Environmental Offsets Policy. Potential offset site data specific to the habitat requirements of these species is unknown and as such, it is not possible to run a potential scenario until a suitable offset site is proposed (refer Section I.2.3 below). These offsets would be additional to those determined above for the Box-gum grassy woodland CEEC.

Preliminary offset scenarios for Booroolong Frog and Queensland Bluegrass habitat were also prepared by WorleyParsons using the assessment guide. The preliminary offset scenarios were prepared using the average quality of habitat within and outside the area to be impacted by the Project.

In constructing the preliminary offset scenario for Booroolong Frog habitat, the following assumptions were made:

- The habitat at the offset site would comprise potential Booroolong Frog habitat;
- The quality of the habitat within the study area is 7/10;
- An offset site in similar condition (7/10) could be improved to a level of 8/10 over a period of five years; and
- That there was a 5% risk of the loss of the offset and that there is 100% confidence in the result.

Incorporating these assumptions, protection and management of an area of 0.50 ha of known and potential Booroolong Frog habitat immediately upstream of the new FSL would provide a direct offset of more than 100% for the removal of the 0.27 ha of Booroolong Frog habitat within the study area. As stated above, this calculation is highly dependent on the assumptions made.

In constructing the preliminary offset scenario for Queensland Bluegrass, the following assumptions were made:

- Queensland Bluegrass occurs at the Project Site and will be impacted by the Project;
- The habitat at the offset site would contain Queensland Bluegrass;
- The quality of the habitat within the study area is 7/10;
- An offset site in similar condition (7/10) could be improved to a level of 8/10 over a period of five years; and
- That there was no risk of the loss of the offset and that there is 100% confidence in the result.

Incorporating these assumptions, the removal of the 10 ha of this habitat within the study area would require an offset of approximately 17 ha to offset the impacts of loss of this habitat. As stated above, this calculation is highly dependent on the assumptions made.

SELECTING THE OFFSET SITE

State Water will ensure that the selected offset site (or sites) meets the requirements of the BioBanking Assessment Methodology and the EPBC Environmental Offsets Policy, including ensuring that the selected offset site is:

- Not already a type of biodiversity conservation reserve or an existing offset;
- Of sufficient size to achieve the requirements;
- Of appropriate type to achieve a 'like for like' or 'like for better' offset; and
- Complying with Principles for the use of biodiversity offsets in NSW guidance document.

Any areas of ambiguity will be clearly stated so that a decision can be made about the overall suitability of the site. For example, it may be that exact ratios and types are not achieved but the overall package is still considered to achieve an overall neutral or beneficial outcome. If so, this will be identified and justified.

In selecting the offset site vegetation communities, a principle aim will be to offset vegetation containing trees of similar or greater maturity to ensure that habitat for hollow dependant fauna is also incorporated into the offset. Connectivity to surrounding areas of similar vegetation will also be a priority.

A specific offset site (or sites) is yet to be identified, however there are opportunities for offsetting in a number of areas around Chaffey Dam. Advice from State Water indicates that around 1000 ha of land outside of the area of impact is owned by State Water within which an offset could potentially be located (Figure 8-18). These areas contain vegetation and habitats of a similar type and condition to those to be impacted by the Project.

At the Project Site, there is a good opportunity to formally conserve connecting habitat (vegetated corridors) nearby in the selection of an offset area and thereby achieve broader landscape scale benefits. Offsite offset areas may be required to achieve this.

Surveys and broad scale vegetation mapping within a one kilometre radius outside the FSL and work areas have identified areas in close proximity to the Project Site that are suitable as offset areas. In particular, areas that are considered to meet the criteria of the Box-gum grassy woodland listed under the EPBC Act will be considered as potential offset areas.

One such area includes the area surrounding the Bowling Alley Point Cemetery. This area exhibits a high diversity within the ground cover, an intact overstorey and extensive regeneration of the overstorey species. The cemetery also contains a known record for Queensland Bluegrass. Conservation of habitat surrounding the cemetery would have positive outcomes for the long term survival of this species should it be confirmed to occur there. Management of this area would assist in the protection of both the TSC Act and EPBC Act listed vegetation communities, as well as Queensland Bluegrass, should it be confirmed to occur there.

The proposed summer surveys will also help to inform and clarify impacts to the TSC Act and EPBC Act listed Booroolong Frog and enable a considered and appropriate approach to the calculation of specific offsets, especially having regard to the projected slow rate of inundation and the likely migratory activity or habits of the local population as well as the availability of already identified suitable habitat.

MANAGEMENT OF THE OFFSET SITE

State Water will be responsible for the management of the offset site during the operational life of the Project. State Water is likely to:

- Retain or obtain ownership of the offset site; or
- Finance the landowner of the site to undertake management actions but would retain responsibility for the management of the site.

This provides surety that the offset will be implemented and management actions undertaken. Specific management requirements for the offset site will be developed as part of the Offset Plan once a site is determined however, the following actions are likely to be required:

- Fencing and signage to ensure the site is protected from inadvertent impacts of nearby agricultural and/or recreational activities;
- A highly controlled light grazing regime (using biomass indicators to ensure adequate ground cover is maintained in all seasons) may be appropriate, if it can enhance native species diversity;
- Controlled burning may be appropriate as a strategy to enhance native seed germination;
- Weed control and monitoring;
- Feral animal control and monitoring; and
- Replanting native trees (species to be determined by an ecologist) to enhance landscape connectivity in specific areas.

At the end of the operational life of the dam, the ongoing management would become the responsibility of the landowner. It is expected that by this time the majority of the required management actions would have been undertaken and ongoing management tasks will largely coincide with routine agricultural activities. Land use restrictions will remain in place on the offset site so that any activities undertaken on the offset site must be compatible with the site's overall function: to improve biodiversity values.

The success of the management actions will be audited and reported for the duration of the Project, as part of an annual environmental report for the Project.

IN-PERPETUITY SECURITY OF THE OFFSET SITE

An appropriate management vehicle is required to provide security of the offset site in perpetuity that:

- Secures the site in perpetuity; and
- Allows for the ongoing management of the site (including how the designated management actions will be funded).

Four options may be considered for securing a long-term management arrangement at the offset site:

- BioBanking Agreement (Part 7A of the TSC Act);
- Conservation Property Vegetation Plan (CPVP) (Native Vegetation Act);
- Local Environmental Plan: Environmental Zone E2 or E3 (EP&A Act); and
- Plan of management with Section 88b covenant (EP&A Act).

It is likely that a CPVP would be established over the offset area that will be attached to the land title. To ensure that the CPVP is binding on successors in title, an abstract of the CPVP will be registered with the Land and Property Management Authority under the *Real Property Act 1900*. The CPVP would be a legally binding agreement under both the *Native Vegetation Act 2003* and the TSC Act. The CPVP would include management actions associated with the offset area that will apply in perpetuity.

PRINCIPLES FOR THE USE OF BIODIVERSITY OFFSETS IN NSW

The NSW OEH has provided 13 principles that can be used as a framework for considering environmental impacts and developing offset proposals. The Project is addressed against each of these principles below.

1. Impacts must be avoided first by using prevention and mitigation measures.

Offsets are then used to address remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.

Inundation impacts from the raising of the dam wall are unavoidable. Chaffey Dam provides a critical water resource to the human population of the area and is not considered adequate to meet future demands. The proposed augmentation capacity has been determined based on the water security needs of the region. The new FSL is dependent on the augmentation capacity and the topography of the land surrounding the existing FSL.

Measures have been recommended within the Terrestrial and Aquatic Flora and Fauna Impact Assessment to prevent offsite impacts.

2. All regulatory requirements must be met.

Offsets cannot be used to satisfy approvals or assessments under other legislation, for example assessment requirements for Aboriginal heritage sites, pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).

This Offset Strategy aims to satisfy the DGRs for the environmental assessment of the Project.

3. Offsets must never reward ongoing poor performance.

Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset. This can be addressed in two ways:

a. The offset site can be set up in perpetuity – this removes the incentive to degrade the offset site to facilitate development at a later date; and

b. The management measures can have clear targets and be set out to push most management to the beginning of the agreement, where successful accomplishment of targets would be rewarded by less intensive management in ongoing years. This suits measures such as weed control which are more easily achieved with intensive efforts than with small ongoing efforts.

This Offset Strategy proposes to address both in perpetuity security and management.

4. Offsets will complement other government programs.

The use of a range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.

The offset site has not yet been selected, although it has been established that it cannot be a site already used as a type of biodiversity conservation reserve. The establishment of an offset site on private land contributes to NSW Government's conservation objectives and would complement existing conservation areas.

5. Offsets must be underpinned by sound ecological principles.

Offsets must:

- Include the consideration of structure, function and compositional elements of biodiversity, including threatened species;
- Enhance biodiversity at a range of scales;
- Consider the conservation status of ecological communities; and
- Ensure the long-term viability and functionality of biodiversity.

Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of

ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.

These are features that need to be considered in the selection of the offset site as well as the management actions for the site. The ability to enhance landscape connectivity will be considered in selection of the offset site. The site will be managed through implementation of a site specific management plan. The success of management actions will be monitored and adapted as required to achieve their set objectives.

6. Offsets should aim to result in a net improvement in biodiversity over time.

Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site. Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset against the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation.

Offsets may include enhancing habitat, reconstructing habitat in strategic areas to link areas of conservation value, or increasing buffer zones around areas of conservation value and removal of threats by conservation agreements or reservation.

7. Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs.

As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or a private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.

The offset security for this development is required in perpetuity.

8. Offsets should be agreed prior to the impact occurring.

Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.

The Offset Strategy sets out a pathway to establish the offset site and its management. This strategy requires input from OEH and landholders prior to any impacts occurring. State Water will ensure that all offset arrangements are in order prior to construction. The Offset Plan will verify that the objectives set out in this strategy have been achieved.

9. Offsets must be quantifiable - the impacts and benefits must be reliably estimated.

Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on

the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include:

- The area of impact;
- The types of ecological communities and habitat/species affected;
- Connectivity with other areas of habitat/corridors;
- The condition of habitat;
- The conservation status and/or scarcity/rarity of ecological communities;
- Management actions; and
- Level of security afforded to the offset site.

The first five points have been addressed in the Terrestrial and Aquatic Flora and Fauna Impact Assessment. The final two points are addressed in this strategy. The best available information and data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where:

- They protect land with high conservation significance;
- Management actions have greater benefits for biodiversity;
- The offset areas are not isolated or fragmented; and
- The management for biodiversity is in perpetuity (e.g. secured through a conservation agreement).

Extensive field assessment by experts has ensured that the best information and data have been used in assessing the impacts of the Project. A similar level of detailed assessment would be afforded to the offset site once selected. The definition of the offset site will ensure like for like (or better) and will consider ways to enhance landscape connectivity.

Management actions must be deliverable and enforceable. A management plan will be implemented for the offset site. This guidance information is intended to ensure that the actions achieve their objectives, to improve biodiversity values at the offset site.

10. Offsets must be targeted.

Offsets must offset impacts on the basis of like-for-like or better conservation outcome. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.

Offsets will be selected based on biodiversity values and achieve a like for like or like for better outcome.

11. Offsets must be located appropriately.

Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.

Current options for offsetting include areas adjacent to the study site. Investigations undertaken within a 1 km radius of the area to be impacted as part of the Terrestrial and Aquatic Flora and Fauna Impact Assessment suggest that it is likely that the offset site would contain the same or similar ecological characteristics as the areas to be affected by the Project.

12. Offsets must be supplementary.

Offsets must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as National Parks, flora reserves and public open space cannot be used as offsets.

13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.

In-perpetuity security and management of the offset site will be established. Management actions may be shared between State Water (for the life of the impact) and the landowner (post development).

COMMONWEALTH OFFSET POLICY

The EPBC Act Environmental Offsets Policy (SEWPaC 2012) outlines the Commonwealth Government's approach to the use of environmental offsets under the EPBC Act. It replaces the draft policy statement *Use of environmental offsets under the EPBC Act* (2007). This policy relates to all matters protected under the EPBC Act and includes the EPBC listed White Box Yellow Box Blakely's Red Gum Grassy Woodland community, Booroolong Frog and Queensland Bluegrass that may be impacted by the Project.

Offsets are defined as measures that compensate for the residual adverse impacts of an action on the environment. Where appropriate, offsets are considered during the environmental impact assessment phase under the EPBC Act.

The offset principles outlined in the EPBC Act Environmental Offsets Policy will further guide the development of an Offset Plan. These principles are presented below.

Suitable offsets must:

1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action

The Project will impact on up to 10 ha of vegetation considered to comprise Box-gum grassy woodland CEEC. This area of CEEC also potentially provides habitat for Queensland Bluegrass. The areas within 1 km of the study site contain approximately 506 ha of this CEEC and potential Queensland Bluegrass habitat providing ample opportunity to deliver an overall conservation outcome that meets the requirements of the offset assessment guide. There are areas of the community within this 1 km radius that are in similar and degraded condition that would enable the Project, through appropriate management measures, to either maintain or improve the viability of the community in the locality.

At least 0.5 ha of known and potential Booroolong Frog habitat occurs immediately upstream of the proposed FSL. This area is currently subject to a number of threats including from stock access, exotic vegetation and introduced aquatic species. The protection and management of this area would be expected to provide an overall conservation outcome that improves or maintains the viability of this habitat.

2. Be built around direct offsets but may include other compensatory measures

Based on the preliminary scenarios run using the offset assessment guide, there is adequate offset area available to provide a 100% direct offsets for the matters of national environmental significance impacted by the Project.

3. Be in proportion to the level of statutory protection that applies to the protected matter

The offsets required for protected matters with higher conservation status must be greater than those with a lower status. For listed threatened species and ecological communities, this is calculated in the Offsets assessment guide by using International Union for Conservation of Nature data on the probability of annual extinction for different categories of threatened species. Based on the preliminary scenarios run using the offset assessment guide, there is adequate offset area available to provide a 100% direct offset for the level of statutory protection applied to Box-gum grassy woodland CEEC, Queensland Bluegrass and the Booroolong Frog.

4. Be of a size and scale proportionate to the residual impacts on the protected matter

As discussed above, there are sufficient offset areas available of a size and scale proportionate to the residual impacts on Box-gum grassy woodland CEEC, Queensland Bluegrass and the Booroolong Frog.

5. Effectively account for and manage the risks of the offset not succeeding

The potential offset areas for Box-gum grassy woodland, Queensland Bluegrass and the Booroolong Frog could provide a 100% direct offset. It is recognised in the EPBC Environmental Offsets Policy

that direct offsets present a lower risk than other compensatory measures as they are more likely to result in a conservation gain for a protected matter.

The direct offset will be managed in perpetuity for biodiversity under a legally binding agreement which provides surety of the offset succeeding for the long-term.

6. Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of State or Territory offsets that may be suitable as offsets under the EPBC Act for the same action)

An Offset Plan will be produced according to the BioBanking methodology which is a methodology endorsed by the NSW OEH. As stated in the EPBC Environmental Offsets Policy, a state or territory offset will count toward an offset under the EPBC Act to the extent that it compensates for the residual impact to the protected matter identified under the EPBC Act. The potential offset areas for Box-gum grassy woodland, Queensland Bluegrass and the Booroolong Frog could provide a 100% direct offset. No additional offsets are considered likely to be required to account for any residual impact.

7. Be efficient, effective, timely, transparent, scientifically robust and reasonable

An Offset Plan will be prepared in accordance with the requirements of the NSW OEH. The Offset Plan will be based on the BioBanking methodology, a scientifically robust and transparent methodology endorsed by the NSW OEH. This Offset Plan will also satisfy the direct requirements of the EPBC Environmental Offsets Policy.

8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced

A Conservation Property Vegetation Plan (CPVP) may be utilised for securing and managing the offset site. This ensures that the site is protected in perpetuity and that restrictions on land use that apply will be attached to the title, as will management measures.

During the operational life of the Project, the management of the offset site will be auditable through the Project's annual report, as the offset is likely to form part of the consent conditions of the approved development.

CONCLUSION

This Offset Strategy sets out a methodology to identify, manage and secure an offset site in perpetuity to offset the impacts of the augmentation of Chaffey Dam. Offset sites are yet to be formally identified, but there is adequate land of suitable type available for offsetting. This strategy addresses the Principle for the use of Biodiversity Offsets in NSW and the EPBC Environmental Offsets Policy and provides incentives, in the form of potential offset requirements, for the proponent to further minimise impacts and thereby reduce the offset requirement for the proposal.

8.3 Aquatic Biodiversity

A Terrestrial and Aquatic Flora and Fauna Impact Assessment was undertaken by nghenvironmental Pty Ltd (nghenvironmental). This assessment of impacts on biodiversity included a consideration of the life cycle of relevant species, population, or community, its local and regional distribution, the extent and quality of habitat available on the site, and the type and magnitude of impacts that may be expected.

The key outcomes of the aquatic biodiversity assessment are summarised in the following sections. The Terrestrial and Aquatic Flora and Fauna Impact Assessment is provided at Appendix 8.

8.3.1 Existing Environment

A flora and fauna assessment was carried out to document the existing aquatic biodiversity environment at the study area. As the Project has been in development for a number of years, numerous studies have been carried out within and surrounding the study area, including those described in Table 3-1. The Flora and Fauna Impact Assessment included a comprehensive desktop review of existing available information to identify gaps in the existing literature. The field survey methodology was subsequently developed to address the identified gaps.

DESKTOP AND FIELD SURVEYS

A desktop assessment for the study area revealed a large amount of recent data on aquatic species occurring within the Namoi Catchment, including Chaffey Dam and the Peel River system. As such, the likelihood of occurrence of all threatened species was clearly determined through database searches and the literature review, except for the threatened River Snail (*Notopala sublineata*).

An assessment of aquatic habitat types with the study area was conducted during Survey 1 and Survey 2. The quality of these habitat types and their suitability as threatened species habitat was also assessed.

The aquatic habitat for Chaffey Dam and upstream and downstream reaches was described, based on investigations carried out by Grant (2007), GHD (2008b) and nghenvironmental in 2012 (Survey 1 and Survey 2). Surveys were carried out at the locations shown on Figure 8-7.

Targeted surveys were carried out for the River Snail (*Notopala sublineata*), which is listed as endangered on the *Fisheries Management Act 1994*, as potential habitat for this species is present in the study area.

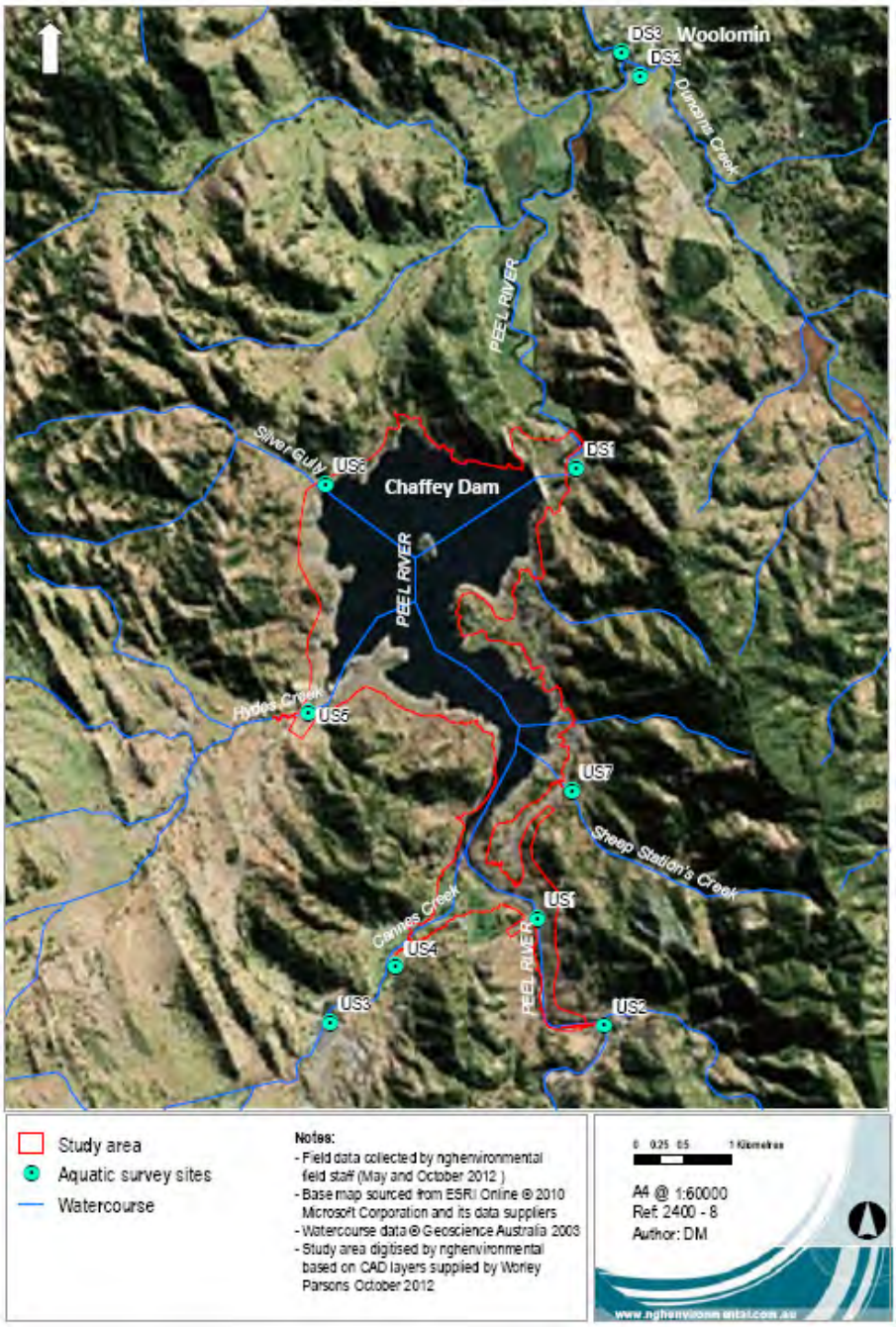

Figure 8-7: Aquatic sites surveyed within and surrounding the study area

AQUATIC FAUNA HABITAT

The aquatic habitat of the Chaffey Dam reservoir is open water with limited fringing and aquatic vegetation present. The minimal fringing and aquatic vegetation is likely due to the frequent fluctuations in the water level, which may prevent the establishment of such habitats. The reservoir is classified as a key fish habitat in accordance with the DPI Fisheries definition and mapping.

The Peel River upstream of the reservoir consists of a series of pools separated by boulder or bedrock riffles. Closer to the reservoir, the river is a run habitat with no riffles observed. The riparian zone in this area is generally cleared of vegetation or less than 10 m wide. Where present, riparian vegetation includes grassy ground cover and banks, which are generally consolidated by River Sheoak (*Allocasuarina cunninghamiana*). Boulder substrates are also present. In some areas, the river banks are disturbed by road crossings and or stock access.

No macrophytes were recorded by Grant (2007) and large woody debris was observed to be at flood level rather than in the stream itself. Grant (2007) found turbidity to be very low, with the substrate visible even in the deeper pools. This was also the case during Surveys 1 and 2.

Cannes Creek (refer Figure 8-5) includes a series of pools separated by narrow channels including reeds and rushes. The creek is generally degraded as a result of stock access and channel crossing. Riparian vegetation along Cannes Creek is sparse and includes willows (*Salix sp.*) and poplars (*Populus sp*.). Instream habitats included some sparse aquatic vegetation and large woody debris.

Hydes Creek (refer Figure 8-5) includes small pools separated by channels (Figure 8-5), which are prone to becoming dry during periods of low flow or when the reservoir is not at FSL. Reeds and rushes are present in various sections of the creek. As per other upstream reaches, riparian vegetation is limited.

The Peel River upstream of reservoir and other upstream tributaries of the dam include around 260 km of lotic (riverine) environment classified as a Key Fish Habitat in accordance with the DPI Fisheries definition and mapping.

Sites assessed along the Peel River upstream of the reservoir, as well as at Silver Gully, were considered Class 1 Waterway Types (Major Fish Habitat) in accordance with the classification scheme of Fairfull and Witheridge (2003). Sites at Hydes Creek, Cannes Creek and Sheep Stations Creek upstream of the reservoir were considered Class 2 Waterway Types (Moderate Fish Habitat).

The Peel River and its tributaries downstream of Chaffey Dam are classified as a Key Fish Habitat in accordance with the DPI Fisheries definition and mapping.

Two locations along the Peel River assessed downstream of the Chaffey Dam were considered Class 1 Waterway Types (Major Fish Habitat) in accordance with the classification scheme of Fairfull and Witheridge (2003). An unknown tributary was considered Class 2 Waterway Type (Moderate Fish Habitat).

A total of 162 structures, including but not limited to weirs, water gauges, bridges and causeways have been identified as potential barriers to fish passage within the Namoi Catchment (DPI 2006).

Thirty one are considered high priority (requiring immediate remediation), including five along the Peel River and/or its tributaries. Chaffey Dam is considered a high priority fish barrier, although there are currently no plans to reinstate fish passage at the dam.

It should be noted that other fish barriers of lower priority (less in need of remediation) occur within and surrounding the study area. Furthermore, instream vegetation or large woody debris may impact fish passage, especially during low flows and in smaller streams.

AQUATIC FAUNA SPECIES

The Sustainable Rivers Audit program (Murray-Darling Basin Commission 2008) identified the Namoi catchment fish community as being in poor condition, though the upland zone (which includes the Peel River and Chaffey Dam) was in good condition. Twelve native species (80% of expected) were recorded in the Namoi catchment. Five exotic species were abundant, constituting 61% of biomass and 37% of individuals (Davies et al. 2008).

Based on the literature review completed for the Project, 15 fish species have previously been recorded within and surrounding the study area, comprising 11 native and four exotic species. Two of the species are listed as vulnerable, the Silver Perch (*Bidyanus bidyanus*) under the *Fisheries Management Act 1994* and the Murray Cod (*Maccullochella peelii peelii*) under the EPBC Act. The Eel tail Catfish (*Tandanus tandanus*) has also previously been recorded. The Murray-Darling basin population of the Eel tail Catfish is listed under the *Fisheries Management Act 1994* as an endangered population.

The Namoi Valley macroinvertebrate community has been assessed as being in poor condition. Seventy-two percent of families expected to occur in the Namoi Valley were recorded. Six common families included freshwater shrimp, long-horned and ecnomid caddisflies and velvet water bugs. Five rare families included hawker and emerald dragonflies and midges (Davies et al. 2008).

The threatened aquatic fauna species known or likely to occur within or surrounding the study area are listed in Table 8-7. Targeted searches for the River Snail carried out during Survey 2 did not record any individuals of this species.

Table 8-7: Threatened aquatic fauna species known or likely to occur within or surrounding the study area

Common Name	Scientific Name	TSC Act Status	FM Act Status	EPBC Act Status	Occurrence
Silver Perch	*Bidyanus bidyanus*	not listed	Vulnerable	not listed	Known to occur
Murray Cod	*Maccullochella peelii peelii*	not listed	not listed	Vulnerable	Known to occur
River Snail	*Notopala sublineata*	not listed	Endangered	not listed	Potential to occur

Common Name	Scientific Name	TSC Act Status	FM Act Status	EPBC Act Status	Occurrence
The Murray Darling Basin population of the eel-tailed catfish (*Tandanus tandanus*)		not listed	Endangered Population	not listed	Known to occur
Aquatic Ecological Community in the natural drainage system of the lowland catchment of the Darling River (Darling River EEC)		Endangered Ecological Community	Endangered Ecological Community	not listed	Known to occur

8.3.2 Potential Construction Impacts

Inundation to the new FSL will alter the aquatic habitats available in the study area, resulting in an increase to the surface area covered by the reservoir and inundation of sections of the upstream reaches of the Peel River and its tributaries.

Temporary Reduction of Reservoir Level for Construction Purposes

Some construction activities may require the reservoir level to be temporarily lowered. This would only be required if the reservoir is at or within 2 m of the FSL during the construction period. Depending on timing and quantity of water released this may result in a number of potential downstream impacts including:

- Cold water pollution, as discussed further below. The quantity and timing of water to be released will depend on the level of the reservoir at the time of spillway construction activities. Cold water pollution impacts would be higher during summer periods when water temperature stratification occurs. Chaffey Dam has a multi-level offtake tower that can be configured to extract water from a range of reservoir depths to control the temperature of the released waters (see below for further information).
- Other water quality impacts through release of water downstream. This may include the release of anoxic water with high nutrient and/or metal concentrations during seasonal stratification, as discussed further discussed below.
- Increased flows and water levels. Numerous aquatic species, including threatened species, rely on increased flows and water levels as triggers to migrations or spawning. Timing and quantity of water released downstream has the potential to impact on the migration and breeding patterns of various species.

Earthworks and Other Construction Activities

Extensive earthworks will be required as part of the Project. These activities will include excavation and stockpiling of rock and soil, vegetation clearing and construction of roads and bridges. Most of

these earthworks will be undertaken in close proximity to the reservoir and/or its tributaries. Some works will also be carried out within the waterways themselves.

Impacts on aquatic habitats and aquatic flora and fauna as a result of potential erosion and sedimentation of waterbodies could include:

- Reduction of water quality such as increased turbidity and/or increased nutrient levels;
- Reduction of light penetration (as a result of increased turbidity) and subsequent reduction of aquatic macrophytes (loss of habitat);
- Increased potential for algal growth with potential for toxic algal blooms (as a result of increased nutrients) resulting in negative impacts on aquatic fauna; and
- Potential sedimentation of aquatic habitats including but not limited to rocky areas, riffles and macrophytes (loss of aquatic habitats).

These impacts have the potential to impact downstream areas as well as areas close to the earthworks or construction activities.

Construction activities also have the potential to impact water quality through accidental chemical and hydrocarbon spills.

The Project will require the construction of two bridges which would conform to the crossing types recommended in Fairfull and Witheridge (2003) for class 1 waterways. Neither the proposed Bowling Alley Point Bridge nor the Hydes Creek Bridge is likely to impact fish passage.

The Project may require the removal of large woody debris during construction should these be located within the construction areas. The augmentation of the reservoir will inundate the riparian zone which may provide additional habitat in the form of large woody debris. Removal of large woody debris from NSW rivers and streams is listed as a key threatening process under the *Fisheries Management Act 1994.*

UPSTREAM INUNDATION

The Project will increase the surface area of the reservoir and inundate sections of the upstream reaches of the Peel River and its tributaries. The reservoir is classified as a key fish habitat by DPI Fisheries. The area of potential key fish habitat will increase by 185 ha and 40 GL as a result of the augmentation.

The Peel River and its tributaries upstream (and downstream) of Chaffey Dam are also classified as key fish habitat by DPI Fisheries. These areas provide various habitat types, including some exclusively found in riverine environments such as riffles and rapids, which are important habitat components used by various aquatic species for foraging, refuge or breeding. The proposed increase in FSL will impact approximately 2.5 km of 260 km of riverine key fish habitat, which would account for around one per cent of the riverine key fish habitat upstream of the dam. This is unlikely to have a major impact on the availability of habitat in the upstream reaches.

Inundation to the new FSL will flood any fringing aquatic habitat currently present. This loss of habitat is likely to be temporary as new similar habitat is expected to become available along the new perimeter of the reservoir. Furthermore, the impact will be minor considering the currently limited availability of this type of habitat around the reservoir, most likely a result of the existing fluctuations in the reservoir water level.

Some riparian vegetation will also be lost along the edges of the reservoir and upstream reaches. Riparian zones are currently limited around the reservoir and in upstream and downstream reaches. The Peel River is considered an order 3 waterway with its upstream and downstream tributaries order 1 or 2 in accordance with the Strahler (1969) stream classification. According to riparian zone management guidelines, order 3 or above waterways warrant a 40 m wide core riparian zone, while order 1 and 2 waterways warrant riparian zones of 10 m and 20 m respectively.

The width of the current riparian zones is generally below 10 m along most sections of the waterways. The loss of riparian areas through the increased FSL will increase the impact of a key threatening process under the *Fisheries Management Act 1994*: the degradation of native riparian vegetation along NSW watercourses. The loss of riparian vegetation may increase bank and channel erosion, impact water quality, change the hydrology of the waterways. This loss cannot be avoided but there are opportunities to rehabilitate the riparian zone around the new perimeter of the reservoir. The inundation of the riparian zone has the potential to increase the availability of some important aquatic habitat sources such as large woody debris.

8.3.3 Potential Operational Impacts

The primary potential operational impacts of the Project on aquatic biodiversity are through changes to flow regimes (if the requirements of the Peel Valley Water Sharing Plan were not implemented), cold water pollution and other water quality impacts during water releases.

Flow Regimes

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is listed as a key threatening process under the TSC Act, while the installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams is listed as a key threatening process under the Fisheries Management Act 1994.

Chaffey Dam currently impacts natural flows along the Peel River below the dam wall. The Project (without implementation of the requirements of the Peel Valley Water Sharing Plan) would impact downstream flows to a minor degree. If current operational water releases were to continue following implementation of the Project (that is, if the requirements of the Peel Valley Water Sharing Plan were not implemented), data analysis suggests that annual average flows in the Peel River immediately below the dam would decrease by about two per cent compared to existing conditions (GHD 2008c).

In such a case, impacts to the Darling River EEC, located downstream of the dam, would include a reduction of annual flows by an average of two per cent. Cold water pollution may also result. Impacts due to modified flow regime and cold water pollution currently occur as a result of operation

of the dam and the changes resulting from augmentation of the dam are unlikely to significantly increase these impacts. The Project is unlikely to increase the impact of this key threatening process that it would substantially affect the Darling River EEC and other downstream environments.

The requirements of the Peel Valley Water Sharing Plan will be applied following implementation of the Project. Following completion of the Project, a permanent ECA will become available for environmental flow releases. The ECA is likely to be used as a stimulus flow over seven days with a day 2 peak of 1,200 ML/day, although it has the flexibility to be used for any purpose at the discretion of the NSW Environmental Water Manager. This flexibility would ensure that the ECA water is used to maximise environmental outcomes downstream of the dam. These releases have the potential to modify or remove habitat community if not adequately managed (appropriate timing and quantities). With adequate management, significant impacts to the Darling River EEC are unlikely.

The impact of these releases has been assessed and approved in the development of the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010.

COLD WATER POLLUTION

Cold water pollution has the potential to result from operation of the Project. As discussed in Section 8.1.3, Chaffey Dam is subject to thermal stratification, resulting in a warm upper layer of water (the epilimnion) overlying a cold lower layer of water (the hypolimnion), separated by a transition layer (the thermocline) (MHL 2005; GHD 2007). Cold water pollution is caused by cold water being released into rivers from large dams during warmer months and can reduce the growth, survival and breeding success of aquatic fauna.

A desktop assessment of NSW dams ranked Chaffey Dam as a low priority in terms of cold water pollution potential to downstream environments because of small discharge volumes and predominately an extraction from shallow depths (and hence warm temperatures) (Preece 2004). Cold water releases from Chaffey Dam were predicted by IESC Pty Ltd (1974) to lower the downstream temperature by 6 to 10°C with the potential for resultant fish kills. Bishop and Harris (1990) reported lower water temperatures later into summer and depressed temperatures for up to 50 km downstream of Chaffey Dam. Differences in water temperatures of the Peel River upstream and downstream of Chaffey Dam were simulated with a reservoir water quality model over two periods from 1995-1997 and 2005-2007. The simulated water temperature is often up to 10°C cooler during January and February because of extraction of hypolimnetic cool waters.

Chaffey Dam has a multi-level offtake tower that can be configured to extract water from a range of reservoir depths. In particular, water from the reservoir can be extracted from two different depths simultaneously through the multi-level offtake. Hence, there is opportunity to control the temperature of the released waters during the period of thermal stratification through extraction of cooler deep (hypolimnetic) waters, warmer surface (epilimnetic) waters or a blend. While the multi-level offtake tower is typically positioned within the thermocline there is some release from the hypolimnion and surface waters (Preece 2004).

Mitigating cold water pollution is an identified outcome under Objective 2 (monitoring water quality and manage operational impacts on aquatic habitat) of State Water's Environmental Management Plan (EMP 2011-2016). The multi-level offtake tower will be raised as part of the proposed works and therefore the potential to control the temperature of released waters will be maintained. However, it should be noted that management of cold water pollution has the potential to conflict with algal management (which requires the release of water below the algal bloom, potentially requiring release of colder waters).

Stage 1 of the NSW Cold Water Pollution Strategy (NSW Cold Water Pollution Interagency Group, 2012) has cold water mitigation actions including the implementation of improved operating protocols (including monitoring) and structural modifications recommended by the NSW Environmental Trust Project for the priority dams that already have selective offtake capability. This includes Chaffey Dam.

For Chaffey Dam, NSW Cold Water Pollution Interagency Group (2012) provides the following suggestions to meet the requirement of the *Water Management Act 2000* in regards to cold water releases:

- The licence holder is to prepare and submit an approved operating protocol for the management of cold water pollution in accordance with the Guidelines for managing cold water releases from high priority dams (NOW 2011);
- The licence holder is to use its best endeavours to operate the dam according to the operating protocol; and
- The licence holder will provide within three months of the end of each year or annually on agreed date a report to Office of Water detailing its performance against the protocol, including instances of and reasons for departure from the operating protocol, outcomes achieved (in accordance with NOW 2011) and proposals for improvement in performance.

Impacts due to cold water pollution currently occur as a result of operation of the dam and the changes resulting from augmentation of Chaffey Dam are unlikely to significantly increase these impacts.

OTHER WATER QUALITY IMPACTS

Heavy summer rainfall events and the steep, sparsely vegetated catchment, agricultural and recreational uses create high rates of sediment erosion in the region. Sediments and associated nutrients and contaminants end up in waterways and ultimately Chaffey Dam, which acts as a sediment basin. In terms of nutrients, elevated levels of total nitrogen and total phosphorous were recorded just below the dam compared to the upstream reaches and at Tamworth. This seems to indicate the dam acts as a nutrient source. Phosphorous is generally accepted as the most significant nutrient input into the Chaffey Dam reservoir (GHD 2008b).

The primary water quality issues of concern for the downstream aquatic ecosystem include oxygen content, temperature, nutrient levels and metals concentrations. Management of downstream water

quality requires consideration of large scale reservoir activities to manage nutrients and algal blooms, as well as withdrawal management to control oxygen levels and water temperatures.

The current and proposed multi-level offtake tower of Chaffey Dam provides scope to manage the water quality of downstream releases as previously discussed. Changing the withdrawal depths throughout the year to satisfy downstream environmental requirements can be undertaken. For example, epilimnetic withdrawal avoids the release of anoxic water with high nutrient and metal concentrations during seasonal stratification (spring and summer periods). In contrast, withdrawals from deeper waters during algal blooms will be prudent in the event of cyanobacterial blooms. Furthermore, withdrawal from the lower waters during winter can avoid the release of higher nutrient concentrated water sourced from the upstream catchment.

8.3.4 Proposed Mitigation Measures

Potential impacts to aquatic biodiversity associated with sediment and erosion control and waste and spill management will be largely managed through the mitigation measures defined in Sections 8.1.4, 8.12.4 and 8.13.4.

The removal of woody debris will be avoided wherever practicable. Where woody debris is required to be removed, appropriate management measures such as lopping or relocating woody debris instead of removal will be implemented to minimise any potential impacts.

Timing of water releases for to lower the reservoir level for construction purposes (if required) will need to be carefully considered to ensure the potential for cold water pollution and other downstream water quality and quantity impacts are minimised. The Chaffey Dam multi-level offtake tower will be configured to extract water from the appropriate range of reservoir depths to control the temperature and quality of the released waters.

The current Chaffey Dam – Variable Offtake Management Protocol, which includes cold water and algal management, will also need to be reviewed and possibly improved following implementation of the Project to ensure it is aligned with requirements from the Guidelines for managing cold water releases from high priority dams (NOW 2011) and to meet the requirements of the *Water Management Act 2000*.

Table 8-8: Proposed mitigation measures

Mitigation Measure	Project Phase
Protocols will be developed to ensure hydrocarbon and chemical spills are contained and treated immediately should they occur. Protocols will aim to ensure no soil or water contamination occurs, with any contaminated material removed and appropriately treated or disposed.	Construction

Mitigation Measure	Project Phase
Should large woody debris need to be removed for any construction activities the following will be implemented: • Lopping (trimming) will be considered as a first option; • Instream realignment will be considered as the next option; • If realignment is unfeasible, relocation within the river channel is preferable to removal; and • Removal should be considered as a last resort.	Construction
Laydown areas and stockpile sites should be located at least 40 m from any waterways where possible and should be adequately protected to avoid or minimise any potential pollution of waterways through adequate erosion and sediment controls.	Construction
Works should be staged so that construction activities that need to be undertaken within waterways (e.g. bridge construction) are undertaken during low reservoir levels.	Construction
A Water Release Management Plan will be prepared and implemented if water releases are required to reduce the reservoir level during construction. The Plan will be developed in consultation with relevant stakeholders including State Water, NSW Office of Water and DPI (Fisheries). The Plan will include consideration of the following: • Where possible use water releases will be undertaken as currently required under the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010; and • Adequate monitoring of water quality (temperature, algal blooms) should be undertaken to ensure water quality impacts due to release of water are avoided or minimised. The multi-level intake should be used in an effective manner to minimise potential water quality impacts; and	Construction
The riparian zone of the Peel River should be replanted at the new FSL along upstream waterways for a minimum of 10 m from the new FSL and along the shoreline of the reservoir where practicable, particularly in areas identified as having a high risk of erosion. Revegetation should be undertaken using natives species of local provenance.	Operation

Mitigation Measure	Project Phase
The release of water during operation will be undertaken in accordance with the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010. An adequate operating protocol for the use of the ECA will be developed to provide the best ecological outcome. The operating protocol should consider the Environmental Water Delivery: Namoi River (Barma Water Resources et al. 2012) which provides information on the environmental assets and potential options for environmental water use in the Namoi catchment including at Chaffey Dam. It should also include monitoring requirements, as described in Barma Water Resources et al. (2012), to assess the success of the releases. The operating protocol should be developed in consultation with all relevant stakeholders including but not limited to State Water, NSW Office of Water and DPI (Fisheries).	Operation
The existing Chaffey Dam – Variable Offtake Management Protocol will be reviewed and revised (as relevant) with the aim of avoiding or minimising cold water pollution. The Protocol should be prepared in accordance with the guidelines for managing cold water releases from high priority dams (NOW 2011) and should consider conflicting algal management. The water to be released should match as closely as possible the natural temperature regime, especially during the spring, summer and autumn periods. The natural seasonal temperature regime should be determined through effective monitoring of upstream and downstream reference sites.	Operation
The impact of water releases on temperatures downstream will be monitored through the selection of appropriately located downstream sites and comparisons with reference locations.	Monitoring

8.4 Aboriginal Heritage

Navin Officer Heritage Consultants Pty Ltd (Navin Officer Heritage Consultants) carried out an Aboriginal Cultural Heritage Assessment for the Project, including consultation with Aboriginal stakeholders and site investigations.

The outcomes of the assessment are summarised in the following sections. The existing Aboriginal heritage environment at the Project Site is described in Section 8.4.1. Potential construction and operational impacts are discussed in Sections 8.4.2 and 8.4.3 respectively. Mitigation measures proposed to manage Aboriginal heritage impacts are provided in Section 8.4.4.

A copy of the Aboriginal Cultural Heritage Assessment is provided at Appendix 9.

8.4.1 Existing Environment

The Project Site is located in the landscape transition between the Western Slopes and Western Plains regions of NSW, within the tribal boundaries of the Kamilaroi people (refer Appendix 9). The Kamilaroi were comprised of a group of tribes that all used a common language known as Gamilaraay. Present information indicates that Aboriginal occupation of the area dates back at least 3,600 years and possibly up to 20,000 years (Tamworth Regional Council 2005).

European land use practices over the past 150 years have potentially impacted the archaeological sites located within the region, reducing the number of sites and the integrity of those sites remaining. Few areas within the region could be considered as undisturbed by European landuse. The implications of this are that the majority of archaeological sites in the region have been disturbed and that some have been destroyed. Any sites identified in the region are therefore a sample of a smaller population than in pre-European times. Nevertheless, the general expanse of the region would ensure that a broad range of sites still exist.

An Aboriginal heritage survey of the Project Site and adjoining land was carried out by Navin Officer Heritage Consultants in July and August 2012 (Appendix 8). Representatives from the Nungaroo Local Aboriginal Land Council and the Tamworth Local Aboriginal Land Council were invited to attend the Aboriginal heritage survey. An Aboriginal Sites Officer from Tamworth Local Aboriginal Land Council participated in the survey, whilst Nungaroo Local Aboriginal Land Council declined to attend.

The Aboriginal heritage survey recorded 41 Aboriginal heritage items within the vicinity of Chaffey Dam (Figure 8-8 and Table 8-9), comprising:

- Seventeen previously recorded Aboriginal sites, 13 of which are listed on the NSW Aboriginal Heritage Information Management System (AHIMS) register;
- Four previously identified Potential Archaeological Deposits (PADs);
- Sixteen Aboriginal sites identified during the current investigation, comprising:
  - Eight isolated finds (two with associated PAD).
  - Seven artefact scatters (six with associated PAD).
  - One potential quarry.
- Four areas of PAD identified during the current investigation.

One previously identified PAD (CDPAD3) was also redefined in the current investigation.

The majority of Aboriginal heritage sites within the vicinity of Chaffey Dam are of low or moderate archaeological significance at a local level, although three sites (CDIF12, CDAS6, CQD1) are of moderate to high archaeological significance at a local level (Table 8-9).

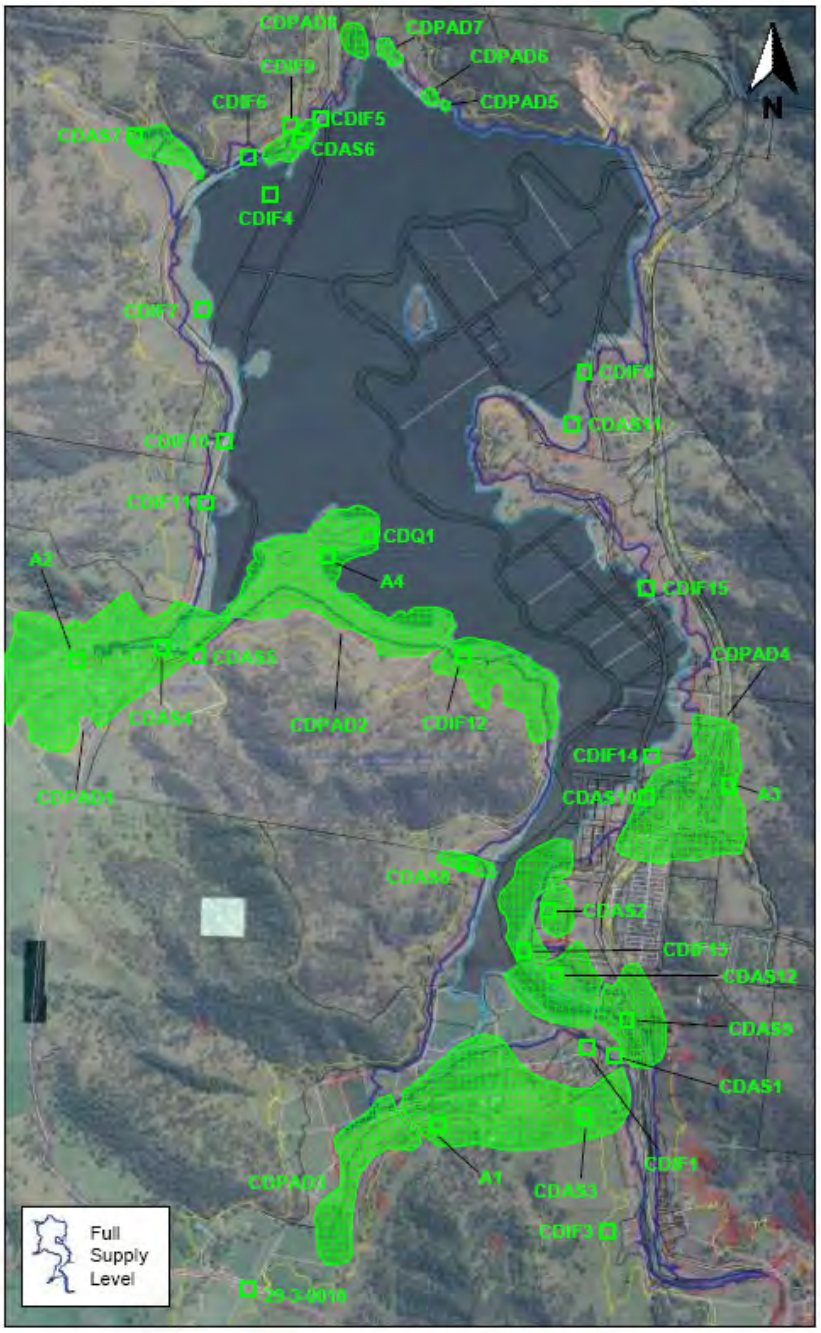

Figure 8-8: Aboriginal heritage items within and surrounding the Project Site

CONSULTATION

Consultation with Aboriginal stakeholders was carried out to assist in the assessment of impacts potentially resulting from the Project and the significance of such impacts. Consultation was undertaken in accordance with the then Department of Environment, Climate Change and Water (now OEH) *Aboriginal cultural heritage consultation requirements for proponents 2010* (the 2010 Consultation Guidelines; DECCW 2010).

The 2010 Consultation Guidelines supersede the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (the 2005 Draft Consultation Guidelines; DEC 2005b). Additionally, the 2010 Consultation Guidelines provide a more stringent process, which meets and exceeds the requirements under the 2005 Draft Consultation Guidelines. As such, the requirements under the 2005 Draft Consultation Guidelines have been satisfied.

In accordance with the 2010 Consultation Guidelines, notification of the Project and requests for registrations of interest were provided. An advertisement was placed in the Northern Daily Leader on 16 June 2012 (refer Appendix 8), while requests for potential Aboriginal stakeholders were sent to:

- Nungaroo Local Aboriginal Land Council;
- Tamworth Local Aboriginal Land Council;
- Tamworth Regional Council;
- Namoi CMA;
- OEH;
- Native Title Services Corporation Ltd; and
- Office of the Registrar Aboriginal Land Rights Act 1983.

Following advice received from these requests, letters were sent to a number of potential Aboriginal stakeholders, with registrations of interest received from 10 parties by the closing date of 12 July 2012, as follows:

- Bunda Consultants;
- Bawurra Consultants;
- DFTV Enterprises;
- Tommy Taylor;
- Waruu Consultation Group;
- Deslee Talbot Consultants;
- Len Waters;
- Heilamon Cultural Consultants;
- Breeza Plains; and

- Wunda Cultural Consultants.

The Chaffey Dam Augmentation and Safety Upgrade Aboriginal Cultural Heritage Assessment Draft Report, prepared for the Project by Navin Officer Heritage Consultants (2012) was provided to each of the registered stakeholders for comment, in accordance with the 2010 Consultation Guidelines. No comments were received.

On 28 September 2012, all registered stakeholders were also invited to attend an inspection of the Project Site. Representatives from each of the registered Aboriginal stakeholders attended the site visit. The following representatives attended the site visit:

- Colin Johnson;
- Clifford Johnson (Heilamon Cultural Consultants);
- Len Waters;
- Deslee Matthews (Deslee Talbot Consultants);
- Martin Salvador (Wunda Cultural Consultants);
- Terry Matthews (Breeza Plains); and
- Kevin Sampson (Bawurra Consultants).

All representatives requested that all impacted Aboriginal objects should be salvaged and collected prior to impact.

8.4.2 Potential Construction Impacts

Construction of the Project has the potential to result in direct and indirect impacts to Aboriginal heritage items. Construction activities at the dam wall and for the realignment of roads may directly impact on sites. Impacts associated with inundation by the new FSL will also result from the Project.

Aboriginal heritage sites within the footprint of road construction activities are also expected to be destroyed, through removal of surface artefacts and disturbance of subsurface, significantly reducing the significance and integrity of the sites. Inundation has the potential to disturb or destroy sites by moving surface artefacts or covering them in silt, which would reduce the significance and integrity of the sites. PADs would also be potentially disturbed due to the potential for the washing away of sediments and creation of lag deposits, reducing the significance of such PADs.

Of the 41 Aboriginal heritage sites recorded within and surrounding the Project Site, 26 items will be impacted via inundation. Five items will be impacted by construction of the Western Foreshore Road or Tamworth-Nundle Road realignment and/or inundation. Nine of the items will not be impacted directly or indirectly by the Project. A summary of the recorded items, significance and anticipated impacts is provided in Table 8-9.

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Table 8-9: Aboriginal heritage items within the Chaffey Dam area

Site	Site Type	Landform	Archaeological Significance of Site	Project Impact	Consequence of Impact
Nundle / Woolomin 1	Isolated find	Mid slope	Moderate archaeological significance at a local level	Not impacted	NA
Chaffey A1	Artefact scatter	Basal slope	Moderate archaeological significance at a local level	Not impacted	NA
Chaffey A2	Isolated find	Creek bank	Moderate archaeological significance at a local level	Not impacted	NA
Chaffey A3	Artefact scatter	Colluvial flat	Moderate archaeological significance at a local level	Not impacted	NA
Chaffey A4	Artefact scatter	Spur	Moderate archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDAS1	Artefact scatter	Mid slope	Moderate archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDAS2	Artefact scatter	Basal slope	Moderate archaeological significance at a local level	Not impacted	NA
CDAS3	Artefact scatter	Mid slope	Moderate archaeological significance at a local level	Not impacted	NA
CDAS4	Artefact scatter	Alluvial terrace	Moderate archaeological significance at a local level	Western Foreshore Road realignment and/or inundation	Potential destruction of whole or part of site
CDAS5	Artefact scatter	Alluvial terrace	Moderate archaeological significance at a local level	Western Foreshore Road realignment	Potential destruction of whole or part of site

Site	Site Type	Landform	Archaeological Significance of Site	Project Impact	Consequence of Impact
CDIF1	Isolated find	Gully	Low archaeological significance at a local level	Tamworth- Nundle Rd realignment	Potential destruction of whole or part of site
CDIF2	Isolated find	Mid slope	Now part of CDAS12	NA	NA
CDIF3	Isolated find	Mid slope	Low archaeological significance at a local level	Not impacted	NA
CDIF4	Isolated find	Mid slope	Low archaeological significance at a local level	Already inundated*	NA
CDIF5	Isolated find	Basal slope	Low archaeological significance at a local level	Already inundated*	NA
CDIF6	Isolated find	Drainage line	Low archaeological significance at a local level	Western Foreshore Road realignment and/or inundation	Potential destruction of whole or part of site
CDIF7	Isolated find	Mid slope	Low archaeological significance at a local level	Western Foreshore Road realignment and/or inundation	Potential destruction of whole or part of site
CDIF8	Isolated Find	Spur crest midslope	Low archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDIF9	Isolated Find	Basal slope	Low archaeological significance at a local level	Western Foreshore Road realignment	Potential destruction of whole or part of site

Site	Site Type	Landform	Archaeological Significance of Site	Project Impact	Consequence of Impact
CDIF10	Isolated Find	Spur crest basal slope	Low archaeological significance at a local level	Western Foreshore Road realignment and/or inundation	Potential destruction of whole or part of site
CDIF11	Isolated Find	Low gradient knoll	Low archaeological significance at a local level	Western Foreshore Road realignment and/or inundation	Potential destruction of whole or part of site
CDIF12	Isolated Find and PAD	Basal flats	Moderate to high archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDIF13	Isolated Find and PAD	Spur crest midslope	Low to moderate archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDIF14	Isolated Find	Spur crest basal slope	Low archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDIF15	Isolated Find	Spur crest midslope	Low archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDAS6	Artefact Scatter and PAD	Basal slope	Moderate to high archaeological significance at a local level	Western Foreshore Road realignment and/or inundation	Potential destruction of whole or part of site
CDAS7	Artefact Scatter and PAD	Alluvial terrace	Moderate archaeological significance at a local level	Inundation	Potential destruction of whole or part of site

Site	Site Type	Landform	Archaeological Significance of Site	Project Impact	Consequence of Impact
CDAS8	Artefact Scatter and PAD	Spur crest midslope	Moderate archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDAS9	Artefact Scatter	Spur crest midslope	Moderate archaeological significance at a local level	Potential inundation	Potential destruction of whole or part of site
CDAS10	Artefact Scatter and PAD	Basal slope	Moderate archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CDAS11	Artefact Scatter	Spur crest basal slope	Moderate archaeological significance at a local level	Iundation	Potential destruction of whole or part of site
CDAS12	Artefact Scatter and PAD	Alluvial flats	Low to moderate archaeological significance at a local level	Inundation	Potential destruction of whole or part of site
CQD1	Potential Quarry	Knoll	Moderate to high archaeological significance at a local level	Potential inundation	Potential destruction of whole or part of site
CDPAD1	PAD	Alluvial terrace	NA	Inundation	Potential destruction of part of site
CDPAD2	PAD	Basal slopes	NA	Inundation	Potential destruction of part of site
CDPAD3	PAD	Alluvial terrace	NA	Inundation	Potential destruction of part of site

Site	Site Type	Landform	Archaeological Significance of Site	Project Impact	Consequence of Impact
CDPAD4	PAD	Alluvial terrace	NA	Inundation	Potential destruction of part of site
CDPAD5	PAD	Spur crest	NA	Inundation	Potential destruction of part of site
CDPAD6	PAD	Spur crest	NA	Inundation	Potential destruction of part of site
CDPAD7	PAD	Spur crest	NA	Inundation	Potential destruction of part of site
CDPAD8	PAD	Alluvial terraces	NA	Inundation	Potential destruction of part of site

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8.4.3 Potential Operational Impacts

The normal operation of Chaffey Dam following implementation of this Project will not result in further impacts to Aboriginal heritage items with or adjacent to the Project Site.

Flood events have the potential to impact on Aboriginal heritage items by washing away artefacts or depositing sediment over sites or PADs.

8.4.4 Proposed Mitigation Measures

Mitigation measures will be implemented to minimise impacts to Aboriginal heritage within the Project Site. Avoidance of sites during construction activities, in particular road realignment works, will be carried out wherever possible. This will be achieved through fencing of sites adjacent to the construction footprint to exclude entry of equipment or personnel.

Targeted testing of representative landforms in areas of PAD expected to be directly impacted will be undertaken prior to commencement of construction in that area in order to determine their significance and arrange for further investigation or salvage where warranted.

Where impacts cannot be avoided to significant Aboriginal heritage sites, salvage of artefacts for relocation will be carried out in consultation with Aboriginal stakeholders.

A 'Back to Country' protocol will be developed in consultation with Aboriginal stakeholders to detail the location and methodology for the placement of salvaged Aboriginal objects.

An Unanticipated Discovery Protocol has been developed (Appendix 14) and will be implemented in the case that suspected Aboriginal objects or suspected human remains are uncovered during construction.

The proposed mitigation measures are listed in Table 8-10.

Table 8-10: Proposed mitigation measures

Mitigation Measure	Phase
Surface salvage and relocation of all known Aboriginal heritage sites to be directly impacted by the Project will be carried out. Surface salvage will entail the recording of each site by an Archaeologist and the collection of all visible artefacts.	Pre-construction
Targeted testing of representative landforms in areas of PAD that will be directly impacted by the Project will be undertaken prior to commencement of construction in that area. The results of these investigations will inform the need for further testing and/or salvage excavations.	Pre-construction

Mitigation Measure	Phase
A 'Back to Country' protocol will be developed that details the location and methodology to be used for the relocation of Aboriginal objects salvaged as part of the Project. The relocation area should be in close proximity to the Project Site, should be negotiated with Aboriginal stakeholders and can be an area identified by the proponent.	Pre-construction
The relocation area for salvaged objects will be recorded by an Archaeologist and placed on the NSW AHIMS as a new Aboriginal site.	Pre-construction
Known Aboriginal heritage sites adjacent to construction footprints will be fenced off during all construction works. Unauthorised access to these areas by personnel and equipment will be prohibited.	Construction
The Unanticipated Discovery Protocol provided at Appendix 14 will be implemented where any suspected Aboriginal objects or suspected human remains are uncovered during construction.	Construction

8.5 European Heritage

A European Heritage Impact Assessment was carried out for the Project by WorleyParsons. The assessment was prepared in accordance with the DGRs. This was taken to mean items that are listed on relevant statutory Inventories, Registers or Schedules. The assessment was also carried out in accordance with the guidelines in the NSW Heritage Manual (NSW Heritage Office 1996). The outcomes of the assessment are summarised below. A copy of the European Heritage Impact Assessment is provided at Appendix 10.

8.5.1 Existing Environment

The Peel Valley has generally been an agricultural and rural residential area for the last 150 years, with a focus on beef cattle, sheep, poultry, fodder crops, grain crops and local dairying. European settlement started in the Peel Valley in the early 1830s, when more than 300,000 acres of land was granted to the Australian Agricultural Company on the western side of the Peel River from Nundle downstream to Attunga (Tamworth Regional Council 2006). Tamworth was established in the 1840s as a centre for sheep, cattle and wheat.

Gold was discovered at Bowling Alley Point in February 1852, and later that year, there were 300 gold diggers camped at what is now Nundle. The gold was predominantly alluvial and during the gold rush virtually the whole of the floodplain and low terraces along the Peel River from Andersons Flat upstream for about nine kilometres, was dug over and sluiced to extract gold. The discovery of gold further supported the expansion of European settlement in the area (Tamworth Regional Council 2006).

A number of heritage studies have previously been carried out within or near the Project Site, including by Pearson and Manidis Roberts Consulting (1990), Tamworth Regional Council (2007) and Navin Officer Heritage Consultants (2008). These studies documented previously recorded and unrecorded heritage items in the area.

Since completion of these studies, Tamworth Regional Council has prepared the Tamworth Regional Local Environmental Plan 2010, which has now been gazetted. The Heritage Study commissioned by Tamworth Regional Council have identified more than 500 items of local heritage significance throughout the Tamworth Regional Local Government Area. These items are included in Schedule 5 of the Tamworth Regional Local Environmental Plan 2010. Of the items identified in previous heritage studies within or near the Project Site, only five were considered to be of local heritage significance and consequently listed on Schedule 5 of the Tamworth Regional Local Environmental Plan 2010.

A European Heritage Impact Assessment carried out for the Project (Appendix 10) identified that five listed heritage items occur within or adjacent to the Project Site. Chaffey Dam is also proposed to be reinstated to State Water's Section 170 Heritage and Conservation Register.

There are no archaeological sites on Schedule 5 on the Tamworth Regional Local Environmental Plan 2010 (or any other relevant heritage list) that are located either within the site or within the vicinity of the site of the proposed development. Accordingly, no archaeological assessment methodology was prepared as part of the European Heritage Impact Assessment.

No World Heritage Properties or Commonwealth Heritage Places occur within or near the Project Site.

Although the Bowling Alley Point Geological Site is listed on the Register of the National Estate, the Register was closed in 2007 and is no longer a statutory list. All references to the Register of the National Estate were removed from the EPBC Act on 19 February 2012.

Listed heritage items within the vicinity of Chaffey Dam of listed in Table 8-11. The location of these items is also shown in Figure 8-11. A brief description of each item is provided below. The items are also described further in Appendix 9.

Table 8-11: Listed heritage items within the vicinity of Chaffey Dam

Listing	Item Number	Item Name	Address	Location	Significance
Tamworth Regional Local Environmental Plan 2010	I099	Bowling Alley Point Cemetery	Andersons Flats	Lot 7013, DP 96292	Local
Tamworth Regional Local Environmental Plan 2010	I100	Bowling Alley Point School	Bowling Alley Point	Lot 56, DP 755324	Local

Listing	Item Number	Item Name	Address	Location	Significance
Tamworth Regional Local Environmental Plan 2010	I101	Iron Footbridge	Bowling Alley Point Recreation Area	DP 755324	Local
Tamworth Regional Local Environmental Plan 2010	I102	Uniting Church	Rivers Road	Lot 41, DP 755324	Local
Tamworth Regional Local Environmental Plan 2010	I103	Bowling Alley Point Geological Site	Rivers Road	Lot 282, DP 755324	Local
Proposed for reinstatement to State Water Section 170 Heritage and Conservation Register	N/A	Chaffey Dam	Tamworth-Nundle Road	Latitude: 31.20.828 Longitude: 151.08.300	Local

BOWLING ALLEY POINT CEMETERY

Bowling Alley Point Cemetery, previously known as the Dungowan Parish General Cemetery was first surveyed as a general cemetery in October 1874. It was officially dedicated as the general cemetery of Dungowan Parish on 15 June 1877 at Andersons Flat.

The cemetery was originally administered by a trust whose members were drawn from representatives of the Anglican, Catholic, Presbyterian, Wesleyan Churches, Jewish and Unsectarian faith traditions (Australian Cemeteries Index 2009). The cemetery plan shows that the area was divided into Anglican, Roman Catholic, Presbyterian, Wesleyan, Jewish, Unsectarian (Chinese) and Independent portions (Australian Cemeteries Index 2009). The cemetery is now administered by the Tamworth Regional Council.

A plaque is located within the Cemetery that lists all known burials at the cemetery, as compiled and inscribed by Australian author Tom McClelland (Australian Cemeteries Index 2009). The earliest original headstone found on the site is dated 1884 (Australian Cemeteries Index 2009).

BOWLING ALLEY POINT SCHOOL

Bowling Alley Point School was the first school at Bowling Alley Point and comprised a simple single storey weatherboard building. A teacher's residence was also incorporated into the building. The school was opened in March 1869 with an enrolment of 73 pupils.

The first teacher at Bowling Alley Point School was John Goold, who served at the school until 1877. He was assisted by his wife, who was employed by the Council of Education as an assistant teacher

from 1869 to 1871. The pupils were taught reading, writing, arithmetic, singing, grammar, geography, scripture, and 'object lessons'.

In 1912 the original school was replaced by a one-room single storey weatherboard building with corrugated iron gable roof and a separate teacher's residence. The Bowling Alley Point Public School was closed in December 1970 and is now occupied as a private residence (Tamworth Regional Council 2008).

IRON FOOTBRIDGE

In 1863 a four-span wrought iron footbridge across the Peel River at Bowling Alley Point was erected. According to local history, as recorded on the nearby commemorative plaque, six hotel keepers jointly financed the bridge. Construction of the footbridge was in the commercial interests of the hotel keepers, as the majority of miners were working on the Australian Agricultural Company (western) side of the Peel River, where it was forbidden to erect a public house.

It is understood that the footbridge is one of the earliest examples of Bessemer steel construction in the colony, being prefabricated at the steel works in Newcastle and shipped up the Hunter River to Morpeth, then transported by bullock dray over the formidable Crawney Pass (Tamworth Regional Council 2008).

In 1984, the bridge, its abutments and trestles were completely washed away downstream by floodwaters. Two spans of the bridge lay in the bed of the Peel River for three years until the Bicentennial Authority made $30,000 available to retrieve and restore these two spans. In late 1987 the two spans of the footbridge were restored and relocated to their present location on the eastern bank of Chaffey Dam, approximately 4 km north of its original location. The reconstruction was carried out in time for the Bicentennial Celebrations in 1988 (Figure 8-9).

Figure 8-9: The partially reconstructed Iron Footbridge at its current location within the Bowling Alley Point Recreation Area

UNITING CHURCH

The Bowling Alley Point Union Church (listed on Schedule 5 of the TRLEP 2010 as the "Uniting Church") was built in Bowling Alley Point in the early days of the gold rushes. The church catered for all denominations and was used by visiting clergy. The church served the community until a new brick church was built in 1906. This new church was constructed as a single storey red brick building with corrugated iron gable roof. The brickwork bond consists of one row of headers to three rows of stretchers. An honour roll was placed on the eastern wall inside the Union Church at Bowling Alley Point to commemorate persons who were involved in World War II.

BOWLING ALLEY POINT GEOLOGICAL SITE

The Bowling Alley Point Geological Site comprises an area of approximately 10 ha enclosing the northern slopes of Blackfellows Knob. Early geological reports indicated that thick veins of chromite (an ore from which chromium is recovered) were present at the site. The site was the first chromite mine in Australia, although only a small quantity of chromite was removed. The material is classed as a Type One chromite, characterised by single crystal chromite grains up to 1 cm in diameter. Abundant chromite ore and the serpentinite with which it is associated, remain scattered across the surface of the ground (SEWPaC 2012a).

CHAFFEY DAM

The following is extracted from the inventory sheet prepared in 2005 by State Water for Chaffey Dam:

> *Chaffey Dam Act was passed in 1974 authorising the erection of a dam on the Peel River 43 kilometres south-east of Tamworth, in order to supply irrigation water for landholders along the Peel and supplement the water supply for Tamworth. The dam was a rockfill embankment dam with a clay core. Much of the rock used to construct the dam wall is jasper, a semi-precious stone abundant in the vicinity.*
>
> *The selected contractors commenced work in August 1976. Excavation of the foundation of the main wall was half-complete in June 1977. Cofferdams were well advanced at that stage. A main office was also operational by then.*
>
> *In June 1978, the main cofferdam and the diversion of the Peel River were complete and the river diverted. Chaffey Dam used an unusual "morning glory" spillway. The circular "glory hole" spillway was only used on four dams in Australia. In the "glory hole" spillway, water flows down a hole into a shaft, which leads to a ski jump. Such spillways have been found useful where the steep abutments of the dam make other types of spillway difficult to use.*
>
> *The earth and rock fill embankment was complete in June 1979 and the spillway and its outlets were nearing completion. Water storage commenced in June 1979. The Chaffey Dam was completed in September 1979 (Figure 6-6). On 5 October 1979, it was officially opened by the NSW Premier, Neville Wran.*

The heritage significance of Chaffey Dam is considered to lie in the important role it plays in the provision of a secured and sustained water supply to the Tamworth residential and rural communities. The sustaining of the water supply makes an important contribution to the social and economic well wellbeing of those communities, including ensuring employment in the agricultural and other sectors. Further, from an engineering perspective the circular morning glory spillway design is quite rare. It has been used on only four dams in Australia. Finally, it makes a significant contribution to the conservation of an important early gold mining site by encouraging visitation to the Bowling Alley Point heritage sites that are listed in the TRLEP.

In February 2011, construction of a 35m wide auxiliary spillway with fuseplug on the left abutment of the dam was completed. This spillway allows extreme flood flows to pass around the dam.

Figure 8-10: View of the Chaffey Dam wall, morning glory spillway (centre) and auxiliary spillway (left)

322000

324000

6528000

6526000

N

IRON FOOTBRIDGE

BOWLING ALLEY POINT CEMETERY

BOWLING ALLEY POINT GEOLOGICAL SITE

BOWLING ALLEY POINT SCHOOL

UNITING CHURCH

LEGEND

- LISTED HERITAGE ITEM (TAMWORTH REGIONAL LOCAL ENVIRONMENTAL PLAN 2010)
- HERITAGE ITEM LOT (CADASTRE 05.07.2012)
- ROAD REALIGNMENT
- ROAD REALIGNMENT BATTERS
- WORKS AREA
- SW_Road_Works_Area_20120810
- PROPOSED BRIDGE
- EXISTING FULL SUPPLY LEVEL
- NEW FULL SUPPLY LEVEL
- NEW 1 IN 100 YEAR FLOOD LEVEL
- NEW PROBABLE MAX FLOOD LEVEL

AERIAL IMAGERY BY GEOSPECTRUM (TAKEN 29.08.2011). ALTERNATE IMAGERY BY BING

INFORMATION ONLY NOT TO BE USED FOR CONSTRUCTION

322000

324000

6528000

6526000

WorleyParsons

resources & energy

State water

N

0 0.25 0.5

Kilometres @ A3

Datum : GDA94
Map Grid of Australia
Zone 56

LOCATION PLAN

CHAFFEY DAM AUGMENTATION AND SAFETY UPGRADE

HISTORIC HERITAGE

DATE : 06 Sep 2012
SCALE : 1:12,000
CUSTOMER : STATE WATER
AUTHOR : RW
REF : 301015-02980-GIS-SKT-002.mxd
REV : A2

Produced By: ryan.wright@worleyparsons.com - Geomatics

Location: ..\301015-02980 CHAFFEY DAM\03Project\Workspace_SKT\301015-02980-GIS-SKT-002

8.5.2 Potential Construction Impacts

Construction activities will not directly impact on the listed heritage items near Chaffey Dam, except the dam wall itself, although minor visual impacts to the Bowling Alley Point School and the Uniting Church may occur during works to realign Rivers Road.

The existing Iron Footbridge is a reconstruction of components of the original bridge, retrieved from the riverbed after it was washed away by flood waters in 1984. In its current location within the existing Bowling Alley Point Recreation Area, the Iron Footbridge would be directly impacted through inundation of the reservoir to the new FSL.

Chaffey Dam is the main subject of the proposed development. The construction stage will involve the raising of the dam wall, morning glory spillway and reconfiguration of the auxiliary spillway fuseplug. These works are likely to have minor but temporary impacts during construction, in terms of views and vistas of the dam from the surrounding areas, including the public lookout and the ongoing use of construction sites, including such as movement of construction vehicles and stockpiling of materials.

There are no impacts expected to the Bowling Alley Point Cemetery and Bowling Alley Point Geological Site as a result of construction of the proposed Project.

Table 8-12 summarises the listed heritage items in the vicinity of the Project Site and the likely degree of impacts during construction.

Table 8-12: Summary of impacts of the Project to listed heritage items

Item Name	Impact	Degree of Impact
Bowling Alley Point Cemetery	None. Outside designated works areas and outside new FSL.	None
Bowling Alley Point School	Temporary visual impact during realignment of Rivers Road. Outside new FSL.	Minor (temporary visual impacts)
Iron Footbridge	Outside designated works areas, but within new FSL,	Significant (without mitigation)
Uniting Church	Temporary visual impact during realignment of Rivers Road. Outside new FSL.	Minor (temporary visual impacts)
Bowling Alley Point Geological	None. Outside designated works areas and outside new FSL.	None
Chaffey Dam (subject to listing)	Raising the dam wall by 8.4 m, raising the morning glory spillway by 6.5 m and reconfiguration of the auxiliary spillway fuseplug.	Minor (temporary visual and construction impacts)

8.5.3 Potential Operational Impacts

Minor impacts to Chaffey Dam will result from operation of the Project, comprising upgrades to existing structures and increase to new FSL. Normal operation of Chaffey Dam following implementation of the Project will not result in further impacts to European heritage items within or adjacent to the Project Site.

Provided the Iron Footbridge is relocated to the proposed location, it will be outside the new 1 in 100 year flood level, but within the new PMF. The Bowling Alley Point School also lies outside the 1 in 100 year flood level, but within the augmented PMF. The potential exists for impacts to these items during extreme flood events.

The Bowling Alley Point Cemetery, Bowling Alley Point Geological Site and Uniting Church are outside the new 1 in 100 year flood level and the new PMF level.

8.5.4 Proposed Mitigation Measures

Minor visual impacts to the Bowling Alley Point School and the Uniting Church during construction are expected to be readily managed through implementation of a CEMP for the Project. The CEMP should consider and implement as relevant, measures to minimise visual impacts to heritage items such as dust suppression, maintenance of tidy construction areas and the use of hoardings.

It is proposed to relocate the Iron Footbridge in order to maintain its heritage values and continue recreational use and appreciation of this heritage item. The Iron Footbridge will be moved to a location within the vicinity of its present location, above the augmented FSL, that aids in the interpretation of the footbridge with regard to its connection to the Bowling Alley Point settlement. It is expected that the footbridge will be relocated within the Bowling Alley Point Recreation Area, above the augmented FSL. It is further recommended that in the re-erection, new approach steps to the footbridge be constructed of an appropriate stone or timber material to assist in the interpretation of the footbridge.

Interpretative signage will also be installed at the new location of the Iron Footbridge. The interpretative signage should document the history of the footbridge, including its construction methods, original location and the role and function it had in serving the former Bowling Alley Point gold mining settlement. The importance of its historical, social, cultural and aesthetic significance to the current and future residents and to visitors should also be documented on the signage.

The study carried out by Navin Officer Heritage Consultants (2008) assessed impacts to heritage associated with the potential upgrade of Chaffey Dam and provided several recommendations, comprising the following:

1. If impact to the iron footbridge is to occur, it should be moved out of the impact area;
2. If impact to site CDHS12 (two commemorative plaques on the Bowling Alley Point Bridge) is to occur, further assessment is required including a heritage significance assessment;

3. The Australian Agricultural Company (AAC) commemorative plaque should be moved away from the raised FSL;
4. If impact to the Dulegal Arboretum is to occur, the extent of this impact should be further investigated; and
5. Site CDHS11 (possible remains of 'Lodhaver' homestead) would be affected by the full supply dam level. Following the comprehensive survey it may be considered that this site is amongst those historic sites identified that require subsurface investigation.

Impacts of the Project in relation to the iron footbridge are addressed in this section and relocation of the footbridge is recommended.

As described in Section 8.10, it is proposed to relocate the two commemorative plaques on the existing Bowling Alley Point Bridge to the new Bowling Alley Point Bridge. Additionally, the Australian Agricultural Company commemorative plaque will be moved to higher ground (outside the new FSL), within the proximity of its existing location. Impacts to the Dulegal Arboretum are also considered in Section 8.10.

The location of the remains of 'Lodhaver' homestead (CDHS11) is shown in Navin Officer Heritage Consultants (2008) to be within the existing FSL. As such, no further impacts to this site are anticipated from implementation of the Project.

In the case that a previously unidentified potential heritage object is uncovered during construction, measures will be implemented to avoid disturbance to the item, until an appropriate management strategy is implemented.

Where suspected human remains are uncovered, the protocol provided at Appendix 16 will be implemented.

The proposed mitigation measures are listed in Table 8-13.

Table 8-13: Proposed mitigation measures

Mitigation Measure	Phase
The Iron Footbridge will be carefully dismantled, transported and re-erected in a location within the vicinity of its present location that aids in the interpretation of the footbridge with regard to its connection to the Bowling Alley Point settlement (refer Appendix 10).	Pre-construction
Interpretative signage will be installed at the new location of the Iron Footbridge to document its history, including construction methods, original location and the role and function it had in serving the former Bowling Alley Point gold mining settlement. The importance of its historical, social, cultural and aesthetic significance to the current and future residents and to visitors should also be documented on the signage.	Pre-construction

Mitigation Measure	Phase
The Contractor's CEMP will include measures to minimise visual impacts to the Bowling Alley Point School and Uniting Church during road and bridge construction activities, such as dust suppression, maintenance of tidy construction areas and the use of hoardings.	Construction
In the case that a previously unidentified potential heritage object is uncovered during construction, the following will be implemented: measures will be implemented to avoid disturbance to the object, until an appropriate management strategy is implemented. 1. All works must halt in the immediate area of the object(s) and any further disturbance to the area of the object(s) prevented; 2. The discoverer of the object(s) will notify machinery operators in the immediate vicinity of the object(s) so that work can be halted; 3. The object(s) will be reported to the site supervisor and the Principal/Project Manager; 4. The approximate extent, nature, associated archaeological potential and likely significance of the object(s) will be determined by an appropriately qualified person or persons (such as the project archaeologist); and 5. An appropriate management strategy for recording and preservation of the object (if warranted) will developed, along with a strategy to return to work as far as possible.	Construction
Where suspected human remains are uncovered, the protocol provided at Appendix 16 will be implemented.	Construction

8.6 Traffic and Transport

Better Transport Futures prepared a Traffic and Transport Assessment for the Project. The outcomes of the assessment are summarised in Sections 8.6.1 to 8.6.4. A copy of the Traffic and Transport Impact Assessment is provided at Appendix 11.

8.6.1 Existing Environment

The Project Site is bounded by Tamworth-Nundle Road to the east and south and Western Foreshore Road to the west and north. Both roads are under the care control of Tamworth Regional Council. The main road in the vicinity of the Project Site is the New England Highway, a regional road, under the control of RMS. New England Highway connects to the Project Site via Garoo Road and Lindsays Gap Road then Tamworth-Nundle Road (Figure 8-12).

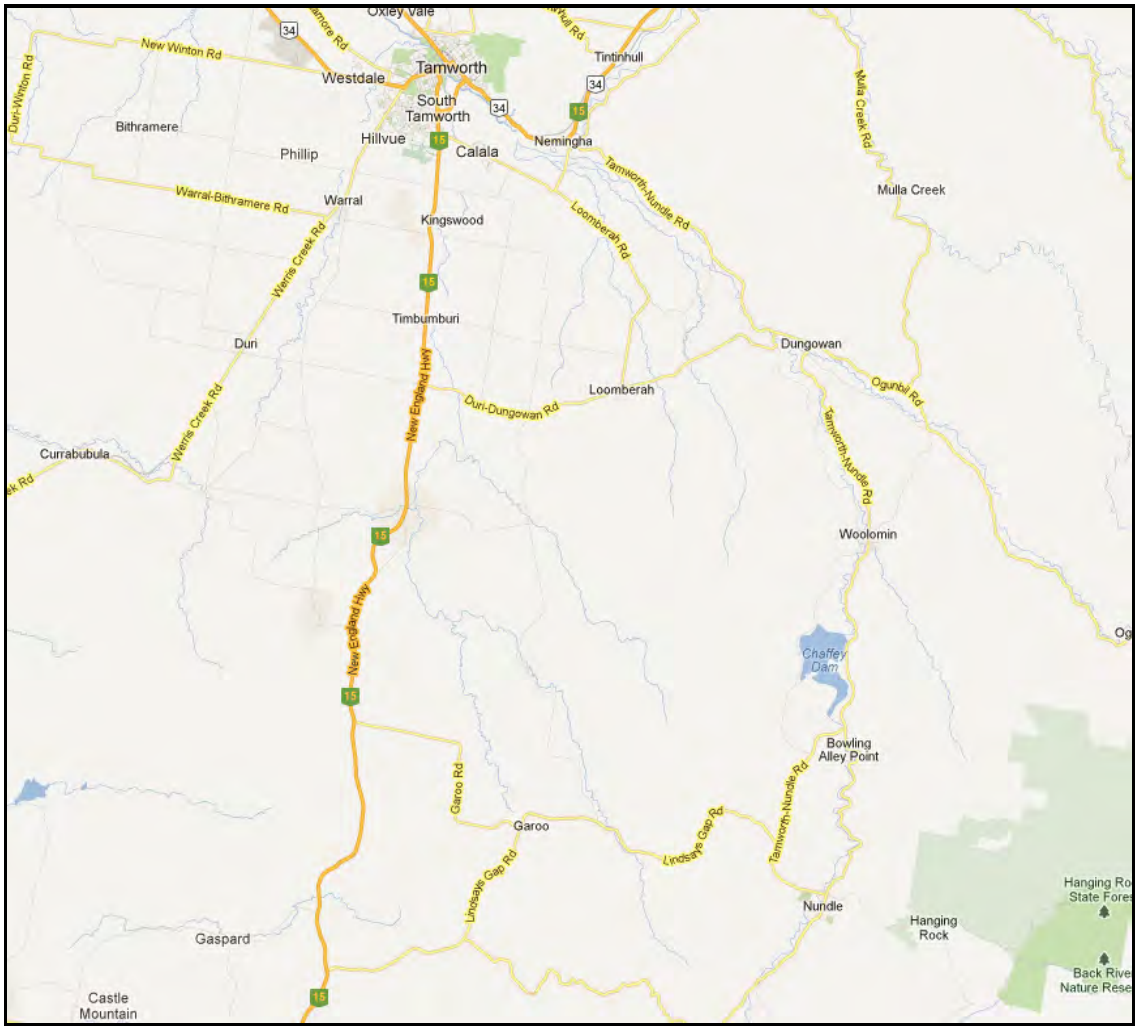


Figure 8-12: Road network in the vicinity of the Project Site (Google Maps)

TAMWORTH-NUNDLE ROAD

Tamworth-Nundle Road is a sealed road with a reserve width of approximately 7 m and a single lane in each direction. The road connects the town of Nemingha in the north and Nundle in the south. The Tamworth-Nundle Road traverses the eastern side of Chaffey Dam.

The quality of Tamworth-Nundle Road is variable with some sections appearing recently sealed while other sections have uneven surfaces and pot holes that have been patched. Painted road markings are inconsistent along the length of Tamworth-Nundle Road. .

There are no kerbs and gutters, shoulders, verges, footpaths or street lighting provided along the length of Tamworth-Nundle Road, which is reflective of the low volumes of vehicles that use the road, its rural nature and remote location.

To the south of Chaffey Dam at its intersection with Rivers Road, Tamworth-Nundle Road turns 90^{o} to the west, where Bowling Alley Point Bridge provides a crossing over the Peel River (Plate 8-1). At this intersection, vehicles travelling on Tamworth-Nundle Road are required to give way to vehicles on Rivers Road.

No posted speed limits were observed on Tamworth-Nundle Road, however, vehicles were observed to travel at up to 100 km/hour, which is consistent with the speed limit permitted on unmarked country roads.

Plate 8-1: Bowling Alley Point Bridge on Tamworth-Nundle Road over the Peel River at the intersection with Rivers Road

WESTERN FORESHORE ROAD

Western Foreshore Road extends from Tamworth-Nundle Road south of Chaffey Dam near Bowling Point, north along the western foreshore of the reservoir. Western Foreshore Road connects back to Tamworth-Nundle Road at Woolomin, approximately 10 km north of the dam wall.

Western Foreshore Road is a primarily unsealed road, with a variable reserve width of up to approximately 6 m. Some small sections of the road are currently sealed, including at the existing Hydes Creek crossing. No lane markings are provided on Western Foreshore Road.

NEW ENGLAND HIGHWAY

The New England Highway, which links NSW and Queensland, is 887 km long and carries high volumes of heavy vehicles. South of Tamworth, the New England Highway operates under a posted speed limit of 100 km/h. Further to the north, the speed limit reduces to 60 km/h within the urban limits of Tamworth.

South of Tamworth, the majority of intersections along the New England Highway are simple Give Way controlled junctions. This is reflective of the low traffic flows on the side roads as well as providing priority to north and south traffic flows on the New England Highway. Side roads typically provide access to nearby towns, such as Nundle and Woolomin, as well as adjacent rural land. Short right turn and left turn deceleration lanes are provided on the New England Highway at the intersections with Garoo Road and Lindsays Gap Road (Plate 8-2 and Plate 8-3). These lanes physically separate turning vehicles from through movements and provide a safer environment for intersection users. There are no kerbs and gutters or footpaths provided on the New England Highway in proximity to its intersections with Garoo Road and Lindsays Gap Road.

Unlike Tamworth-Nundle Road, New England Highway and Lindsays Gap Road are designated by RMS as being part of a restricted access vehicle route, capable of accommodating vehicles up to the size of a 26 m B-double truck.

Plate 8-2: Sight distances north on the New England Highway from Lindsays Gap Road

Plate 8-3: Sight Distances South on the New England Highway from Lindsays Gap Road

GAROO ROAD AND LINDSAYS GAP ROAD

Garoo Road and Lindsays Gap Road are sealed roads, each with a reserve width of approximately 6 m and single lanes in each direction. The roads intersect the New England Highway, Tamworth-Nundle Road and each other at priority controlled junctions. The quality of Garoo Road and Lindsays Gap Road is variable with some sections appearing recently sealed while other sections have uneven surfaces and pot holes that have been patched. Painted road markings on Lindsays Gap Road are inconsistent along the length of the road. .

There are a number of small bridges over streams on both roads that restrict travel to a single lane with vehicle movement controlled by Give Way signs on either side of the bridge. These bridges are able to accommodate the movement of cars and large heavy goods vehicles.

There are no kerbs and gutters, shoulders, verges, footpaths or street lighting provided along the length of Lindsays Gap Road or Garoo Road. This is reflective of the low volumes of vehicles that use the roads, their rural nature and remote location.

No posted speed limits were observed on Lindsays Gap Road or Garoo Road, however vehicles were observed to travel at up to 100 km/hour, which is consistent with the speed limit permitted on unmarked country roads.

TRAFFIC FLOWS

A traffic flow survey carried out at the intersection of New England Highway and Lindsays Gap Road on 15 May 2012 between 8:00am and 9:00am (assumed to be the morning traffic peak hour) showed low peak hour traffic volumes. Fifty five (55) northbound vehicles and 87 southbound vehicles were observed on the New England Highway, while seven eastbound vehicles and 10 westbound vehicles were observed on Lindsays Gap Road. Better Transport Futures (2012) considered that the traffic volumes identified on Lindsays Gap Road are indicative of the traffic volumes on Garoo Road and the Tamworth-Nundle Road, which were also observed to be negligible in terms of the capacity of these roads.

Based upon the traffic flow survey, daily traffic volumes of 550 northbound vehicles and 870 southbound vehicles on the New England Highway were calculated in proximity to the Project Site. Daily traffic volumes of 70 eastbound vehicles and 100 westbound vehicles were calculated for Lindsays Gap Road.

Traffic count data from north of Tamworth (RMS 2007: Count Station 92.325) indicates that the average annual daily traffic volumes on the New England Highway are higher than those calculated near the Project Site, at 3,352 vehicles . However, the RMS traffic count data also accounts for northbound vehicle trips from Tamworth.

Traffic count data from Tamworth-Nundle Road south of Nemingha (RMS 2007: Count Station 92.737), indicates annual daily traffic volumes of 1,596 vehicles, corresponding to approximately 160 two-way vehicles in the peak hour.

Traffic movements along the New England Highway comprise a reasonably high percentage of heavy goods vehicles, including B-doubles, associated with interstate movements of products. Survey data indicates that on New England Highway, 20% of the traffic consists of heavy goods vehicles, while 12% of traffic on Lindsays Gap Road comprises heavy goods vehicles.

Observations on site show that there are little if any delays for through traffic movements along the New England Highway at its intersection with Lindsays Gap Road. Traffic entering or exiting the side road also experiences minimal delay, with the majority of the delay only caused by drivers having to slow down and negotiate the intersection. Traffic flows at the intersection of the New England Highway and Lindsays Gap Road are below the *Austroads Part 5 Intersections at Grade* limits. As such, traffic effectively does not suffer from any delay and capacity modelling is not required.

Furthermore, the RMS *Guide to Traffic Generating Developments* (Table 4.5 Peak Hour Flow on Two-Lane Rural Roads, RTA 2002) indicates that the two-way capacity for rural roads with 10% heavy vehicle flows is 560 vehicles per hour. Hence the traffic flows on New England Highway, Lindsays Gap Road and the other rural roads in the vicinity of the Project Site operate within acceptable limits.

The existing traffic flows associated with the operation of Chaffey Dam are negligible. The primary activity associated with operation of the dam is routine maintenance, which generates in the order of two to three trips per day. Some recreational traffic associated with the dam also occurs. Access to the Nundle Fishing Club and the Bowling Alley Point Recreation Area is provided from Tamworth-

Nundle Road, while access to the and South Bowlo Fishing Club is provided from Western Foreshore Road. Each of these recreational areas is located away from the designated construction works areas. Typically, the majority of recreational traffic is likely to occur on the weekends and does not coincide with road network peak hours.

Intersection performances in the within and surrounding the Project Site are good and do not require modification for construction or operation of the Project.

TRAFFIC SAFETY

For roads with a design speed of 100 km/hour, minimum sight distances of 151 m and desirable sight distances of 179 m are required. Sights distances in excess of 200 m are present at all intersections measured near the Project Site. As such, sight distances comply with the relevant requirements and no modification of intersections are required for construction or operation of the Project. These intersections comprise:

- New England Highway and Garoo Road;
- New England Highway and Lindsays Gap Road;
- Garoo Road and Lindsays Gap Road;
- Lindsays Gap Road and Tamworth-Nundle Road; and
- Tamworth-Nundle Road and Rivers Road.

Accident data for the area shows that in 2009, two accidents occurred at the intersection of the New England Highway and Lindsays Gap Road. Both these accidents involved vehicles driving off the road and hitting an object. No injuries were caused in either of the accidents.

Additionally, four accidents have been recorded at the intersection of the New England Highway and Tamworth-Nundle Road at Nemingha, two of which occurred in 2007 and two in 2009. These accidents comprised a head on collision, a side swipe accident involving vehicles changing lanes, a rear end collision and the collision of two vehicles on adjacent approaches.

No accidents have occurred at either intersection in the last three years. No accidents have been recorded at the intersection of New England Highway and Garoo Road.

PARKING

At present, there is no on-street parking in the vicinity of the Project Site. Off-street parking is provided adjacent to Tamworth-Nundle Road at the Chaffey Dam Lookout, with approximately 25 parking bays. The minimal parking activity that occurs at the Chaffey Dam Lookout is expected to be associated with recreational users of the dam, typically occurring on weekends. Onsite parking associated with State Water office and administration facilities at Chaffey Dam is also present.

There are no set down or pick up areas in the vicinity of the Project Site.

PUBLIC TRANSPORT

There are no public transport facilities in the vicinity of the Project Site.

Peel Valley Coaches provides four school buses that utilise the Tamworth-Nundle Road as part of their route, these are:

- Tamworth to Woolomin;
- Tamworth to Dungowan;
- Tamworth to Ogunbil; and
- Tamworth to Nundle.

Each of these school bus routes operate once in the morning, departing to Tamworth between 7:00am and 7:30am and once in the afternoon, arriving from Tamworth between 4:30pm and 5:00pm. Given that the verges of Tamworth-Nundle Road are generally narrow, space for school buses to pull over may be limited. School bus stops Increased traffic, travelling at slower speeds, may be present in the vicinity of schools, particularly at school start and finish times.

8.6.2 Potential Construction Impacts

Construction of the Project will require the use of a variety of light and heavy vehicles. Vehicle trips generated by the construction phase of the Project are minimal and will have an acceptable impact upon the adjoining road network.

The number of light vehicles used is expected to peak in weeks 13 to 60 of the proposed construction program, when approximately 50 construction personnel will be onsite. Assuming two personnel per car, this equates to the movement of 25 vehicles for onsite personnel in the morning and afternoon peak hour period. Parking for 25 light vehicles onsite will also be required. The majority of personnel and service vehicles are expected to access and egress the Project Site to/from the north via Tamworth-Nundle Road.

The heavy vehicles expected to be used onsite are listed in Table 4-1 and summarised below:

- Mobile cranes;
- Dump trucks;
- Flatbed trucks;
- Excavators;
- Compactors; and
- Semitrailers.

Three primary works areas will be utilised during construction:

- At the dam wall (Figure 4-2);
- At Bowling Alley Point (Figure 4-4); and
- On Western Foreshore Road (Figure 4-5).

The size and design of each works area will allow for all vehicles to enter the site, manoeuvre internally and exit the site in a forward direction.

Raising of the dam wall requires the largest number of light and heavy vehicles onsite. Heavy vehicle traffic used for construction at the dam wall will remain within the works area throughout this phase of construction and as such will not impact on the local road network during this time. The primary impact of heavy vehicles on the local road network will be during mobilisation and demobilisation to and from the site.

There will likely be a requirement for a concrete batching plant on site as part of construction activities for the Project. The concrete batching plant has been excluded from this assessment as responsibility for any relevant approvals and licensing of the concrete batching plant will lie with the Construction Contractor. As a worst case scenario, therefore, traffic generation has been based on the need to deliver concrete by trucks from the supplier external to the site.

The maximum number of delivery vehicles on site is expected to occur during concrete pours associated with the raising of the Morning Glory spillway. During this phase, approximately 2,500 m^3 of concrete will be required and the onsite concrete pump will have a capacity of 80 m^3 per hour. Large concrete trucks with a capacity of approximately 7 m^3 would most likely deliver to the site with the number of trips limited by the capacity of the concrete pump with limited waiting time desired on-site.

The capacity of the pump of 80 m^3 allows for a maximum of 11 large concrete trucks to be emptied in one hour. This gives a two-way flow of 22 concrete trucks per hour between the concrete supplier and the site. These movements could occur over the full working day, so to complete a concrete pour of 2,500 m^3 at this rate would only involve four days at eight hours a day.

The existing hard rock stockpile from construction of the auxiliary spillway will be utilised in the raising of the dam wall. During this period, twelve 45 tonne articulated dump trucks are expected to arrive at the start of the work phase and depart at the end of the phase. During the working day, all movements of these vehicles will be internal to the site.

Other service vehicles used during this phase such as excavators, cranes and compactors will remain on site during construction, and will not access and egress the site on a daily basis. Thus their impact on the adjoining road network will be minimal.

The majority of heavy goods vehicles are expected to access and egress the site to/from the south via the New England Highway and Lindsays Gap Road, then Tamworth-Nundle Road. All parking will be accommodated within the designated works areas.

The transport of large equipment and plant for construction may require the use of oversized vehicles. This may include transport of a crane barge to and from the Project Site (refer Table 4-1) and potentially transport of precast components to the Project Site for construction of the morning glory spillway. Such oversized vehicle use will require relevant approvals to be in place.

The current intersection of Tamworth-Nundle Road and Rivers Road is expected to remain operational throughout the majority of realignment works in this area. This intersection will be closed upon completion of the realignment, which will occur prior to inundation of the reservoir to the augmented FSL.

Temporary closure of part of Western Foreshore Road is expected to be required during the proposed realignment of this road. Access to properties on Western Foreshore Road and the South Bowlo Fishing Club will be available from the north and from the south, however through traffic on the road is not expected to be maintained during construction. Part of the existing access track to the South Bowlo Fishing Club from Western Foreshore Road will be inundated by the implementation of the Project. Given the proximity of the Nundle Fishing Club and the Bowling Alley Point Recreation Area from the designated construction works areas, access to these areas will be maintained throughout the construction period.

8.6.3 Potential Operational Impacts

The implementation of the Project is not expected to result in changes to the volume or type of traffic within or surrounding the Project Site. Traffic resulting from the operation of Chaffey Dam will continue to be negligible.

Traffic safety in the vicinity of the Bowling Alley Point Bridge is expected to be improved, following the realignment of Tamworth-Nundle Road from the current 90^{o} turn to a sweeping bend following the primary flow of traffic.

Access to properties on Western Foreshore Road will be maintained following implementation of the Project. Access to the South Bowlo Fishing Club from Western Foreshore Road will also be maintained, utilising the access track created during the construction period.

8.6.4 Proposed Mitigation Measures

In order to avoid or minimise any detrimental traffic and transport impacts resulting from construction of the Project, the Contractor will be required to prepare and implement a Construction Traffic Management Plan (CTMP) for all Project construction activities, including provision for oversized vehicles where relevant. The CTMP will include specific provisions for traffic management during road realignment works, including safety provisions for workers, residents, recreational users and the general public. These provisions should maximise usage of the existing road network during road realignment works and minimise full road closures. The CTMP will also require the Contractor to inform heavy vehicle drivers of the presence of local schools and the schedules of school buses in the area, as well as inform local residents of upcoming temporary traffic diversions and road closures.

The Nundle Fishing Club, South Bowlo Fishing Club and the Bowling Alley Point Trust will also be informed of such upcoming temporary traffic diversions and road closures.

As described in Section 4.7, a new access track will be constructed to ensure adequate access is maintained to the Fishing Club following implementation of the Project.

Project works areas will be designed to allow for all vehicles to enter the works areas, manoeuvre internally and exit the works areas in a forward direction. Works areas will also accommodate all Project related parking, to ensure that the local road network is not unduly impacted.

No detrimental traffic and transport impacts are anticipated to result from operation of the Project and such, no mitigation measures are proposed for this Project phase.

The proposed mitigation measures are listed in Table 8-14.

Table 8-14: Proposed mitigation measures

Mitigation Measure	Phase
A Construction Traffic Management Plan will be developed and implemented for all Project construction activities, including: • Provision for oversized vehicles (where relevant); • Provisions for traffic management during road realignment works, including speed restrictions; • Safety provisions for workers, residents, recreational users and the general public; • Requirement to inform heavy vehicle drivers of the presence of schools and the schedules of school buses in the area, as well as the narrow verges and potentially limited space available for school buses to pull over; and • Requirement to inform local residents, Nundle Fishing Club, South Bowlo Fishing Club and the Bowling Alley Point Trust of upcoming temporary traffic diversions and road closures.	Construction
Works areas will be designed to allow for all vehicles to enter the works areas, manoeuvre internally and exit the works areas in a forward direction.	Construction
All parking will be accommodated on site within the designated works areas.	Construction
A new access track will be constructed to the South Bowlo Fishing Club from Western Foreshore Road.	Construction

8.7 Noise and Vibration

A Noise and Vibration Impact Assessment was carried out by SLR Consulting Australia Pty Ltd (SLR Consulting) for the Project. The noise assessment was prepared with reference to Australian Standards AS 1055:1997 Description and Measurement of Environmental Noise Parts 1, 2 and 3 and in accordance with the NSW Environment Protection Authority (EPA) NSW Industrial Noise Policy (INP), NSW Interim Construction Noise Guideline (ICNG) and NSW Road Noise Policy (RNP). The vibration assessment was prepared with consideration of German Standard DIN 4150-3 1999 *Structural Vibration Part 3: Effects of Vibration on Structures,* which provides guideline criteria for evaluating the short and long-term effects of vibration on structures and the NSW EPA interim guideline *Assessing Vibration: A Technical Guideline,* which provides guideline building vibration levels associated with a low probability of annoyance from occupants.

The outcomes of the Noise and Vibration Impact Assessment are summarised in Sections 8.6.1 to 8.6.4. A copy of the Noise and Vibration Impact Assessment is provided at Appendix 12.

8.7.1 Existing Environment

Chaffey Dam is located in a predominately rural setting. Background noise within the Project Site is considered to be 'rural' in nature, with little contributed noise from man-made sources.

Existing sources of noise around the Project Site primarily comprise vehicle noise on local roads, recreational activities and farming practices. Such an acoustic environment would typically have a Rating Background Level (RBL) of less than 30 dB(A). In accordance with the INP, '*where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)*'.

A sensitive receiver is a land use at which noise from a development can be heard (EPA 2000). Thirteen potential sensitive receivers were found to occur within the Project Site, comprising active and passive recreational, rural residential land uses and the State Water Storage Custodian's residence (Table 8-15 and Figure 8-13) The majority of these receivers are located within the Bowling Alley Point and Hydes Creek areas. It should be noted that, as R13 is a State Water employee's residence and directly related to the operation of Chaffey Dam, this receiver has not been considered as part of the noise and vibration assessment.

Table 8-15: Noise sensitive receivers within the Project Site

Receiver ID	Receiver	Receiver Type	Receiver Location	
			Easting	Northing
R1	Bowling Alley Point Recreation Area – Amenities Building	Passive Recreational	322503.0	6529076.8
R2	Bowling Alley Point Recreation Area – Camping Area	Passive Recreational	322307.9	6528947.5
R3	Nundle Fishing Clubhouse	Active Recreational	322467.7	6527028.9

Receiver ID	Receiver	Receiver Type	Receiver Location	
			Easting	Northing
R4	Bowling Alley Point Receiver	Rural Residential	323176.0	6526346.5
R5	Bowling Alley Point Receiver	Rural Residential	322754.2	6525856.8
R6	Bowling Alley Point Receiver	Rural Residential	322558.3	6526035.3
R7	Bowling Alley Point Receiver	Rural Residential	323055.3	6525258.0
R8	Western Foreshore Receiver	Rural Residential	320291.3	6528081.1
R9	Western Foreshore Receiver	Rural Residential	320119.0	6527971.6
R10	Western Foreshore Receiver	Rural Residential	320112.4	6527857.5
R11	Western Foreshore Receiver	Rural Residential	320057.2	6527758.5
R12	South Bowlo Fishing Club Clubhouse	Active Recreational	321675.8	6531119.5
R13	Storage Custodian's Residence	Project-related	322825.2	6529325.5

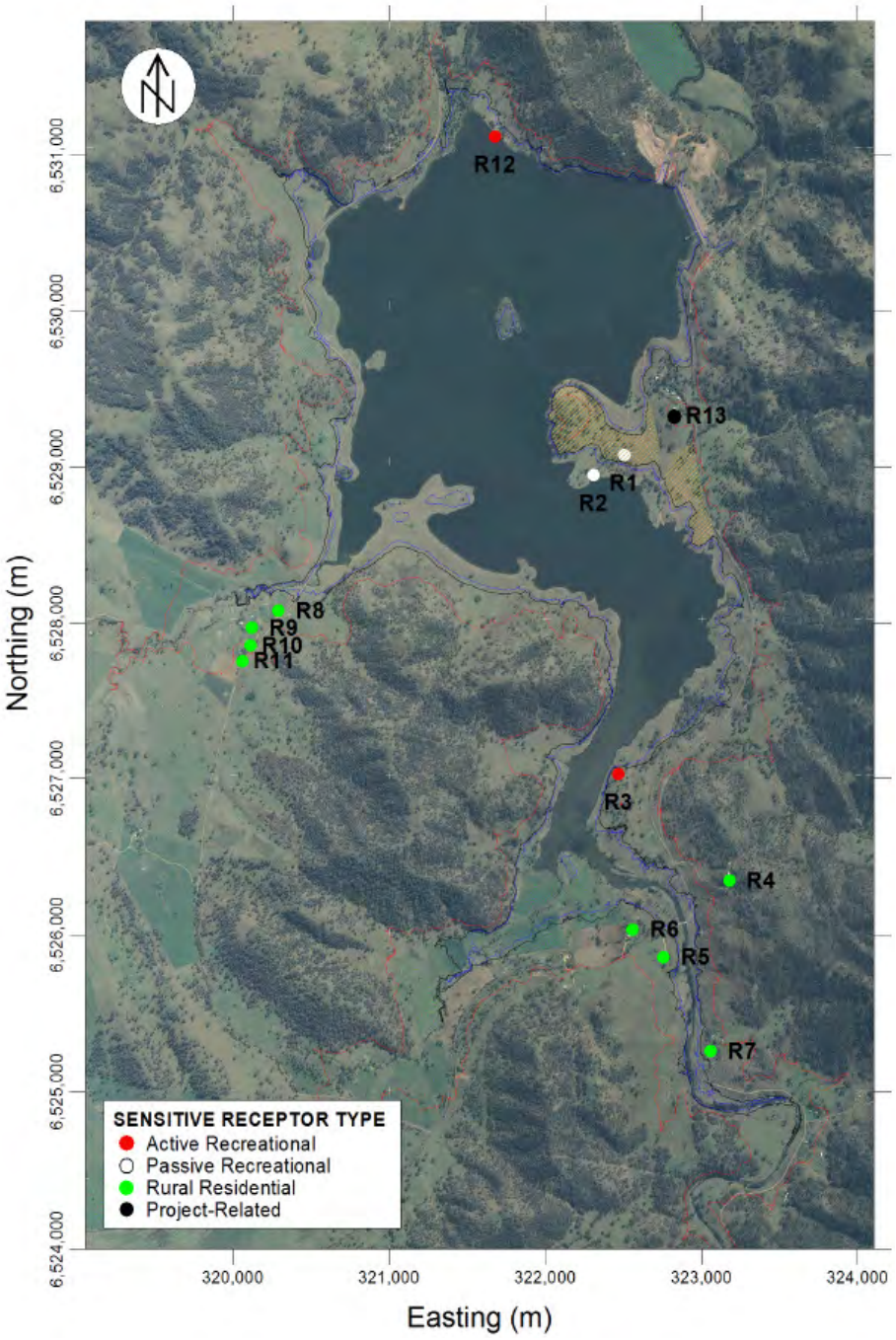


Figure 8-13: Location of noise sensitive receivers within the Project Site

8.7.2 Potential Construction Impacts

Construction of the Project has the potential to result in construction noise, road noise, vibration and noise impacts from blasting. These potential construction impacts are discussed in the following sections.

CONSTRUCTION NOISE

Construction of the Project has the potential to result in noise impacts to sensitive receivers within and surrounding the Project site. Construction activities, such as road realignments and works to the dam wall have the potential to create noise impacts.

A computer model was used to predict noise emissions from construction of the Project. The Environmental Noise Model (ENM) used was produced in conjunction with the EPA. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. The model used this map, together with noise source data, ground cover, shielding by barriers and/or adjacent buildings and atmospheric information to predict worst case noise levels at the nearest potentially affected receivers (Figure 8-13 and Table 8-16). Potential construction scenarios were selected based on the equipment proposed for use, as shown in Table 8-16.

The use of an RBL of 30 dB(A) requires the application of the minimum intrusive noise criteria set in the INP and NSW Interim Construction Noise Guideline (ICNG) (DECC 2009). The relevant criteria are summarised Appendix 11.

The outcomes of the modelling show that showed that peak construction noise levels will not be exceeded at the passive or active recreational receivers (R1, R2, R3 and R12) (Table 8-16).

Peak construction noise levels will be exceeded at all rural residential receivers (R4, R5, R6, R7, R8, R9, R10 and R11) (Table 8-16). Noise levels at rural residential receivers will be below the “Highly Noise Affected” level of 75 dB(A).

The main contributors to noise during construction of the Project are the construction works for the proposed realignments of Tamworth-Nundle Road, Rivers Road and Western Foreshore Road, as well as construction of the new Bowling Alley Point Bridge. Works at the dam wall are predicted to have a negligible impact on residential receivers.

Although the estimated construction timeframe for the road realignment and bridge construction is approximately one year, the predicted noise levels reflect concurrent construction activities at the closest proximity to the receiver. As such noise levels at the sensitive receivers are likely to be lower than those presented in Table 8-16 and Figure 8-13 for the majority of the construction period.

Table 8-16: Predicted construction noise levels - Recreational Receivers

Receiver	Predicted Noise Level L_{Aeq}(15minute) dB(A)							Management Level $L_{Aeq(15minute)}$ dB(A)
	Scenario						All Scenarios	
	Dam Wall works	Morning Glory Spillway works	Auxiliary Spillway works	Bowling Alley Point Bridge works	Hydes Creek bridge works	Tamworth-Nundle, Rivers and Western Foreshore Roads works[10]		
R1	39	34	39	32	<30	33	44	60
R2	32	<30	33	33	<30	32	39	60
R3	<30	<30	<30	<30	38	36	40	65
R12	<30	<30	<30	<30	<30	52	52	65

[10] Construction equipment is assumed to be operating at the nearest section of the road realignment to the receiver

Table 8-17: Predicted construction noise levels – Residential Receivers

Receiver	Predicted Noise Level LAeq(15minute) dB(A)							Recommended Hours Construction Noise Goal LAeq(15minute) dB(A)	
	Scenario						All Scenarios	Noise Affected	Highly Noise Affected
	Dam Wall works	Morning Glory Spillway works	Auxiliary Spillway works	Bowling Alley Point Bridge works	Hydes Creek bridge works	Tamworth-Nundle, Rivers and Western Foreshore Roads works[11]			
R4	<30	<30	<30	<30	**46**	**45**	**48**	40	75
R5	<30	<30	<30	<30	**63**	**66**	**68**	40	75
R6	<30	<30	<30	<30	**61**	**65**	**67**	40	75
R7	<30	<30	<30	<30	**48**	**71**	**71**	40	75
R8	<30	<30	<30	**63**	<30	**61**	**65**	40	75
R9	<30	<30	<30	**48**	<30	**48**	**51**	40	75
R10	<30	<30	<30	**50**	<30	**49**	**53**	40	75
R11	<30	<30	<30	**47**	<30	**46**	**50**	40	75

ROAD NOISE

Road noise generated by Project construction traffic also has the potential to impact on sensitive receivers. It is expected that construction personnel will access the Project Site from New England Highway, Garoo Road, Lindsays Gap Road then Tamworth-Nundle Road or from Tamworth-Nundle Road via Woolomin. For heavy construction vehicles it is expected that access to the site would primarily be via the New England Highway, Garoo Rd, Lindsays Gap Road then Tamworth-Nundle Road.

[11] Construction equipment is assumed to be operating at the nearest section of the road realignment to the receiver

These roads fall into the category of arterial/sub-arterial roads and therefore the noise criteria outlined for '*existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments*' in the RNP has been adopted.

Construction road traffic noise levels are predicted to meet the relevant NSW Road Noise Policy criteria on Lindsays Gap Road, Garoo Road and within the township of Woolomin. On the Tamworth-Nundle Road between Woolomin and Dungowan, existing noise levels are predicted to marginally exceed road traffic noise assessment criteria at the closest receiver to the roadway. A marginal increase of 0.3 dB above existing non-Project related traffic noise levels is predicted with the addition of Project related traffic during peak construction periods. An increase of up to 2 dB represents a minor impact that is barely perceptible for an average person. On this basis, the predicted increase of 0.3 dB is considered to be imperceptible.

Noise impacts associated with the initial movement of construction vehicles to site at the commencement of each Project stage and the final movement of construction vehicles away from the Project Site at completion of each stage are expected to be minimal, given the limited number of vehicles required for this function and the intermittent scheduling of such movements. Following mobilisation to site, heavy vehicle movements will generally be restricted to within each of the designated works areas.

VIBRATION

The use of heavy vehicles and equipment during construction of the Project has the potential to result in vibration. Energy from construction equipment is transmitted into the ground and transformed into vibration, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment);
- The frequency content;
- The stiffness of the medium (ground);
- The type of wave (surface or body); and
- The ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data.

German Standard DIN 4150-3 1999 *Structural Vibration Part 3: Effects of Vibration on Structures* provides guideline criteria for evaluating the short and long-term effects of vibration on structures. The interim guideline *Assessing Vibration: A Technical Guideline* (DEC 2006) provides guideline building vibration levels associated with a low probability of annoyance from occupants. The range of applicable damage and annoyance risk vibration velocity criteria provided in this guideline was used to assess expected vibration impacts during construction of the Project.

Impact piling rigs are anticipated for use during the construction of the Bowling Alley Point Bridge and Hydes Creek Bridge. Piling has the potential to generate the highest vibration levels of all proposed bridge construction activities. Vibratory rollers are anticipated to be used during the realignment of roads proposed as part of the Project. Vibratory rolling has the potential to generate the highest vibration levels of all proposed road construction activities.

All residences in the study area are located outside the required buffer distance for piling and vibratory rollers. The closest residential receiver (R5) is located approximately 200 m from impact piling activities associated with bridge construction, outside the maximum required buffer distance of 180 m for 100% Piling Capacity Annoyance Risk. The closest residential receiver (R7) is located approximately 65 m from vibratory rolling activities associated with road construction, outside the maximum required buffer of 43 m for Annoyance Risk. As piling and rolling represent the highest potential for vibration, the required buffer distances for all other road and bridge construction activities will also be met.

Given the significant distance from construction activities proposed at the dam wall, the risk of vibration related impacts is negligible.

BLASTING

The potential exists for blasting to be required for the Project. Any blasting required would be carried out on the existing exposed face of the quarry at the dam wall. Based on monitoring for both ground vibration and airblast conducted at the nearest residential location to the site, previous blasting at the site for construction of the auxiliary spillway complied with the relevant ANZECC guidelines.

Vibration and airblast associated with potential blasting to be carried out for the Project are therefore predicted to be within the adopted criteria, provided the blasts are of similar design to those carried out during the construction of the existing auxiliary spillway.

8.7.3 Potential Operational Impacts

Operation of the Project will not result in a change to existing practices at Chaffey Dam relevant to noise and vibration and will not increase the generation of noise or vibration. Noise modelling has indicated that the impact of noise emissions from the operation of the Project is expected to be negligible. As such, no noise or vibration impacts associated with operation of the Project are anticipated.

8.7.4 Proposed Mitigation Measures

Construction works will be carried out within standard working hours and residents will be kept informed of the timing, location and nature of noisy construction activities prior to and during construction. Appropriate maintenance and operation of equipment and vehicles will also assist in minimising noise impacts during construction, as well as road noise generated by Project-related traffic.

Although vibration impacts are not anticipated to be significant during construction, monitoring will be carried out at the commencement of relevant construction activities to ensure no significant impacts are occurring at sensitive receivers near the works.

Any blasting will be carried out consistent with blasting previously undertaken for construction of the auxiliary spillway. Monitoring of any blasting required will also be carried out to ensure compliance with relevant criteria.

The proposed mitigation measures are listed in Table 8-18.

Table 8-18: Proposed mitigation measures

Mitigation Measure	Phase
All work will be carried out within the following hours: • Monday to Friday 7:00am to 6:00pm; • Saturday 8:00am to 1:00pm; • Blasting Monday to Friday 9:00am to 5:00pm and Saturday 9:00am to 1:00pm only; and • No work on Sundays or public holidays.	Construction
Residents adjacent to works areas will be informed prior to and during construction, of the nature, duration and expected overall noise levels of construction activities. Relevant contact details for site personnel will also be provided.	Pre-construction Construction
Simultaneous operation of noisy plant will be avoided wherever practicable.	Construction
Maintenance work on construction plant and vehicles will be carried out away from identified sensitive receivers and confined to standard daytime construction hours, wherever practicable.	Construction
Wherever practicable, noisy equipment will be: • Positioned behind structures that act as barriers to identified sensitive receivers; • Positioned at the greatest distance from identified sensitive receivers; and / or • Oriented to directed noise emissions away from identified sensitive receivers.	Construction
All vehicles and equipment will be regularly serviced, maintained in proper working order and turned off when not in use.	Construction

Mitigation Measure	Phase
"Quiet" practices will be employed wherever practicable when operating equipment.	Construction
An effective Complaints Handling System will be developed and implemented throughout construction.	Construction
Vibration monitoring will be carried out at the nearest sensitive receiver on commencement of significant construction activities, as follows: • In the event that construction vibration is found to be significantly below construction vibration criteria, no subsequent monitoring of that activity is required; and • If monitored vibration levels are considered to be high-risk or close to the vibration criteria, unattended vibration monitoring will be carried out on a continuous basis at the nearest vibration sensitive receiver.	Construction
Any blasting required will be of similar to blast designs and Maximum Instantaneous Charge (MIC) (i.e. less than 209 kg) carried out during construction of the existing auxiliary spillway.	Construction
Monitoring will be carried out for any blasting required to ensure compliance with relevant criteria.	Construction

8.8 Air Quality

An Air Quality Impact Assessment was prepared by SLR Consulting for the Project. The air quality assessment focused on the quantification of worst case impacts on air quality from dust emissions for the construction phase of the Project. The assessment criteria utilised for the assessment comply with the approved methods for assessment of impacts of air pollutants, as set out in Part 5 of the Protection of the Environment Operations (Clean Air) Regulation 2010. Emissions from the proposed construction activities were modelled using the American EPA's CALPUFF (Version 6.267) modelling system. The outcomes of the air quality impact assessment are summarised in Sections 8.8.1 to 8.8.4. A copy of the Air Quality Impact Assessment is provided at Appendix 13.

8.8.1 Existing Environment

Air quality in the Tamworth region is generally described as 'good' (Tamworth Regional Council 2012). The major causes of air pollution in the area are:

- Vehicle emissions;
- Backyard burning;
- Smoke from solid fuel stoves and heaters;

- Dust from unsealed roads;
- Extractive and other industries; and
- Emissions from various licensed premises.

There is no site-specific air quality monitoring data available for the Project Site, however OEH operates an ambient air quality monitoring station at Tamworth, 34 km northwest of Chaffey Dam. The 24-hour average PM_{10} concentrations measured at this station over the last two years are presented in Figure 8-14. This plot shows that only one exceedance of the Ambient Air Quality National Environment Protection Measure (NEPM) Guideline of 50 µg/m^3 was measured during this period, occurring on 20 September 2011. The second highest 24-hour average concentration recorded by the station in 2011 was 37.8 µg/m^3 (19 September 2011).

Annual average PM_{10} concentrations measured from 2001 to 2011 are shown in Figure 8-15. The annual average PM_{10} concentration recorded in 2011 was 13.1 µg/m^3.

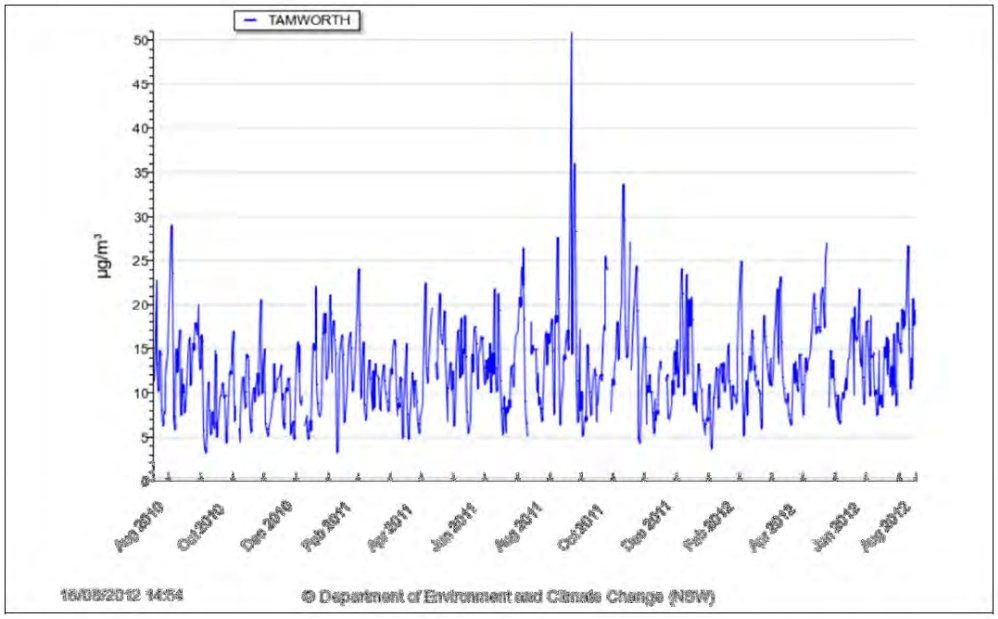


Figure 8-14: 24-Hour Average PM_{10} Concentrations Measured at Tamworth (August 2010 to August 2012)

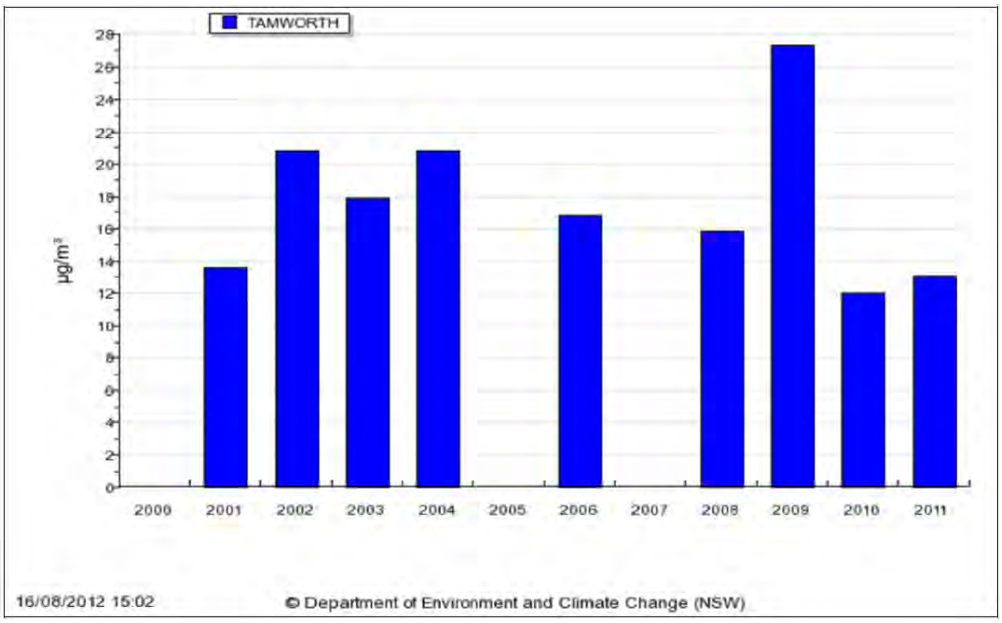


Figure 8-15: Annual Average PM_{10} Concentrations Measured at Tamworth (2001 to 2011)

Given the undeveloped nature and low population density of the surrounding area, the existing air quality at the Project Site is also expected to be good. There are no major industrial or commercial air emission sources in the area and domestic (e.g. wood burners) and vehicle emissions are also expected to be minimal.

As described in Section 2.2, winds predicted by the TAPM meteorological model for the Project Site have the following characteristics:

- Predominantly light to moderate (between 1.5 m/s and 8 m/s) and from the east;
- Infrequent winds vary in direction;
- Calm wind conditions (wind speed less than 0.5 m/s) occur just over 3.2% of the time;
- Annual average wind speed of 2.6 m/s;
- Winds stronger than 5.4 m/s (the threshold for dust pick-up) occur just over 5% of the time (518 hours/year);
- Stronger winds are generally associated with easterly winds during spring and summer;
- potential for the predominant wind directions at each construction area to be affected by localised channelling effects due to nearby hills and valleys; and
- Windroses for Bowling Alley Point show a much wider spread in wind directions than at the dam wall, with a predominance of westerly winds during the winter months.

Thirteen receivers potentially sensitive to air quality were identified as occurring within the Project Site, consistent with those identified as sensitive noise receivers (Table 8-15 and Figure 8-13). These receivers comprise recreational land uses, including the Nundle and South Bowlo Fishing Clubs, as well as the Bowling Alley Point Recreation Area, rural residential receivers located at Bowling Alley Point and Hydes Creek and the State Water Storage Custodian's residence, which is directly related to the operation of Chaffey Dam.

8.8.2 Potential Construction Impacts

Emissions from excavation, vehicle movements, wind erosion, and the handling of soils were addressed in the air quality assessment. Local meteorological conditions were predicted using TAPM for the year 2011. Topography and land use data were sourced from published databases. The assessment determined worst case scenario impacts, by assuming the following activities would be undertaken simultaneously:

- Excavation and stockpiling of material at toe of the dam wall;
- Hauling and placement of rock from the hard rock stockpile and clay from borrow area for dam wall raising;
- Reconfiguration of fuseplug embankment at the auxiliary spillway; and
- Road and bridge construction works.

It was also assumed that excavation of the dam crest would be carried out prior to the hauling of rock from the hard rock stockpile for the dam wall raising.

Table 8-17 shows the PM_{10} and $PM_{2.5}$ concentrations at each sensitive receptor, assuming a worst case scenario. The cumulative 24-hour average column includes background levels. The numbers in brackets are the number of days per year that concentrations are predicted to exceed the NEPM Advisory Reporting Standard. Results are shown in bold text where receptors are predicted to experience exceedances of the standard in addition to one exceedance included in the background data.

Table 8-19 Predicted 24-Hour and Annual Average PM_{10} and $PM_{2.5}$ Concentrations

Receiver	24-Hour Average PM_{10} Concentrations		Annual Average PM_{10} Concentrations		24-Hour Average $PM_{2.5}$ Concentrations		Annual Average $PM_{2.5}$ Concentrations	
	Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (µg/m³)	Cumulative * (µg/m³)
R1	17	52 (1)	0.7	14	2.7	25.6 (1)	0.1	6.7
R2	15	52 (1)	0.6	14	2.7	25.6 (1)	0.1	6.7
R3	4	53 (1)	0.4	14	1.0	25.5 (1)	<0.1	6.6

Receiver	24-Hour Average PM_{10} Concentrations		Annual Average PM_{10} Concentrations		24-Hour Average $PM_{2.5}$ Concentrations		Annual Average $PM_{2.5}$ Concentrations	
	Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (µg/m³)	Cumulative * (µg/m³)
R4	11	51 (1)	0.4	14	0.6	25.5 (1)	<0.1	6.6
R5	44	**57 (4)**	9.8	23	1.5	26.0 (1)	0.5	7.1
R6	31	51 (1)	4.6	18	1.1	25.5 (1)	0.3	6.9
R7	150	**155 (16)**	10.5	24	8.8	**30.5 (3)**	0.9	7.5
R8	46	**64 (6)**	9.0	22	3.6	26.0 (1)	0.6	7.1
R9	23	52 (1)	3.2	16	2.4	25.6 (1)	0.3	6.8
R10	12	54 (1)	1.4	14	1.8	25.8 (1)	0.2	6.7
R11	8	53 (1)	0.9	14	1.6	25.8 (1)	0.1	6.7
R12	39	51 (1)	7.8	21	5.2	25.5 (1)	1.1	7.7
Criteria	**-**	**50**	**-**	**30**	**-**	**25**	**-**	**8**

The assessment found that, for construction works to the dam wall and auxiliary spillway, total suspended particulates (TSP), dust deposition, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates are predicted to comply with relevant OEH guidelines. The greatest source of dust emissions in these areas is predicted to be the excavation and haulage of soils and rock.

The modelling indicates a potential for elevated PM_{10} and $PM_{2.5}$ concentrations at residential receivers located close to the road construction activities along Western Foreshore Road and Rivers Road. The most significant impacts are predicted at Receptor 7, located immediately east of Rivers Road, at the southern end of the proposed works area.

Assuming a worst case scenario where dust-producing construction activities are at their peak, all earthmoving equipment operating in the section of road immediately adjacent to residences and winds blowing from the construction works towards the residences, the potential exists for exceedances of PM_{10} levels at Receivers 7, 8 and 5 (in descending order of impact) (Table 8-17).

Based on the modelling carried out for the Project and excluding exceedances included in the background data, exceedances of the PM_{10} NEPM Advisory Reporting Standard may occur 4% of the time at Receiver 7, 1% of the time at Receiver 8 and less than 1% of the time at Receiver 5. Impacts are generally predicted to occur during winter and spring.

The potential for short-term elevated $PM_{2.5}$ concentrations and deposition also exists at Receiver 7, with exceedances of the NEPM Advisory Reporting Standard potentially occurring less than 1% of the time (Table 8-17).

As noted in Section 4.13, road and bridge realignment works are proposed to occur sequentially, rather than simultaneously. Additionally, the works at each location will not extend over a full year. Rather works at Bowling Alley Point will be approximately 27 weeks in duration. Given the percentage of time exceedances are expected to occur, this means that in worst case conditions, exceedances may occur on 7.5 days at Receiver 7 and less than two days at Receiver 5.

Realignment works on the Western Foreshore Road and Hydes Creek Bridge will occur over a period of up to approximately 25 weeks. As such, in worst case conditions, exceedances may occur at Receiver 5 on less than two days during construction.

Excavation was identified as being the most significant source of dust emissions for road and bridge construction activities at Bowling Alley Point, while wind erosion was identified as the most significant source of dust emissions on the Western Foreshore Road.

The annual average TSP concentrations predicted by the modelling are below the criterion at all identified sensitive receivers, even with background levels included. No adverse nuisance impacts from elevated TSP levels are therefore expected as a result of the proposed works.

The annual average dust deposition rates predicted by the modelling are below the incremental impact criterion at all identified sensitive receivers. No nuisance impacts from dust deposition are therefore expected at these locations as a result of construction of the Project.

Receiver R7, located adjacent to the Rivers Road realignment works, is predicted to experience dust deposition levels equivalent to the OEH guideline level, however as *peak* construction activities in this area will not occur for an entire one-year period it is not expected that actual annual average dust levels will be as high as predicted. Nonetheless, it is possible given the short distance between the road and this residence that short-term elevated deposition levels could occur when dust producing construction activities are at their peak near this location.

As the construction activities will be short-term (approximately one year for road construction activities) and variable in nature, the impacts on local air quality will also be short-term. Such impacts will also depend significantly upon the meteorological conditions experienced during the construction period.

8.8.3 Potential Operational Impacts

Operation of the Project will not result in a change to existing practices at Chaffey Dam relevant to air quality and will not increase the generation of emissions. As such, no air quality impacts associated with operation of the Project are anticipated.

8.8.4 Proposed Mitigation Measures

Construction activities will be carried out in a manner that minimises dust emissions wherever practicable, utilising best practice dust control measures. This will include minimising exposed areas, altering work practices to avoid or reduce dust generation and watering of potential dust sources

where relevant. The use of chemical dust suppressants, including the addition of chemical dust suppressants to water used for dust suppression, is not recommended as the construction activities will be carried out within a drinking water catchment.

Additional management of dust impacts will be implemented during road and bridge construction activities in the vicinity of Receivers 5, 7 and 8. Given that impacts are generally predicted to occur during winter and spring, construction activities with the potential to generate dust emissions in the proximity of Receivers 5, 7 and 8 will be carried out during the summer months where practicable.

Travel speed on unsealed surfaces in the vicinity of Receivers 5, 7 and 8 will be limited to 40 km/h. Unsealed surfaces in the vicinity of these receivers will be watered on a consistent routine basis under normal weather conditions, during construction activities with the potential to generate dust emissions. Under adverse conditions, particularly during strong westerly winds, additional watering of unsealed surfaces will be carried out when particulate matter is visible above the roof height of light vehicles.

Implementation of these additional measures is anticipated to reduce the frequency and magnitude of PM_{10} and $PM_{2.5}$ impacts to Receivers 5, 7 and 8 to an acceptable level.

The proposed mitigation measures are listed in Table 8-20.

Table 8-20: Proposed mitigation measures

Mitigation Measure	Phase
Residents adjacent to works areas will be informed prior to and during construction, of the nature, duration, expected overall dust levels and relevant contact details for site personnel.	Pre-construction Construction
An effective Complaints Handling System will be developed and implemented throughout construction.	Construction
Distance travelled on unsealed roads will be minimised by taking the most direct route to the destination.	Construction
Surface drainage will be optimised, particularly at intersections.	Construction
Vehicle speeds on unsealed roads within designated works areas will be limited to 40 km/hour or less.	Construction
Larger trucks will be utilised for material transport to minimise the required number of trips, where possible.	Construction

Mitigation Measure	Phase
Unsealed roads, other unsealed surfaces, dry, sandy materials and stockpiles (as relevant) within designated works areas will be watered, likely using water carts, when visible dust emissions can be observed travelling offsite (note it is important to not allow unsealed roads to become saturated as this will increase emissions once they dry out).	Construction
The extent of unsealed areas will be minimised by only clearing or unsealing areas required for the works and progressively rehabilitating disturbed areas as soon as possible after works are completed.	Construction
Stockpiles will be stabilised (e.g. by watering, covering or revegetating, as practical) and, wherever practicable, shielded from the prevailing wind using wind breaks or by positioning them in sheltered areas, screened from the nearest sensitive receivers by topography or existing trees.	Construction
Dump heights for the unloading and loading of soils will be minimised as far as practicable, particularly when dry, sandy materials are being handled.	Construction
Construction activities will cease or be modified on dry windy days, when significant visible dust emissions can be observed travelling offsite towards nearby sensitive receptors.	Construction
The Contractor will include in its CEMP, a copy of the modified version of the Beaufort Wind Scale, provided in Table 16 of Appendix 13, which is an empirical measure that relates wind speed to observed conditions. This table should be used as a practical guide for the need to implement dust control measures.	Construction
Construction activities with the potential to generate dust emissions in the proximity of Receivers 5, 7 and 8 will be carried out during the summer months where practicable.	Construction
Travel speed on unsealed surfaces in the vicinity of Receivers 5, 7 and 8 will be limited to 40 km/h.	Construction
Unsealed surfaces in the vicinity of Receivers 5, 7 and 8 will be watered on a consistent routine basis under normal weather conditions, during construction activities with the potential to generate dust emissions. Under adverse conditions, particularly during strong westerly winds, additional watering of unsealed surfaces will be carried out when particulate matter is visible above the roof height of light vehicles.	Construction

8.9 Visual Amenity

The potential impacts of the Project on visual amenity, during both construction and operation, were investigated by WorleyParsons. The assessment included preparation of photomontages to examine the visual impact of the Project on views to the dam wall and aerial views of the area.

The assessment is documented in Sections 8.9.1 to 8.9.4.

8.9.1 Existing Environment

Visual amenity impact refers to changes in a view experienced by a person observing a landscape. The visual quality of the area is dominated by the existing reservoir, as well as the dam wall. Agricultural land uses in the area also have a significant influence on the visual amenity of the area.

While the only residential property that has a direct view of the dam wall is the Storage Custodian's residence, and potentially residences at Hydes Creek, there are a number of visual receptors in the area including:

- Recreational users of Chaffey Dam (including those carrying out boating, fishing and camping activities);
- Tourists or visitors to the dam (including those using the public viewing area);
- Drivers along the Tamworth-Nundle Road, which follows the eastern edge of the dam and extends to the area immediately downstream of the dam; and
- Drivers along the Western Foreshore Road, which follows the western edge of the dam.

8.9.2 Potential Construction Impacts

Visual impacts during construction may detract from the natural and rural visual environment of the area. During the construction, three primary work areas will be established comprising the dam wall, the intersection of Rivers Road and Tamworth-Nundle Road and Western Foreshore Road. Numerous construction vehicles will be on site, including trucks, cranes, rollers and dozers as well as light vehicles and a barge mounted crane. These vehicles will be stored within the works areas when not in use, but will likely be visible to the public throughout construction.

Key factors that may impact on the visual aesthetics of the area during construction include stockpiling of materials, vegetation clearing, hoardings around works areas, sediment fences, temporary sheds, temporary toilets and Project components under construction.

The primary view points for construction activities will be to the dam wall when travelling south along the Tamworth-Nundle Road and while travelling near the work areas on Tamworth-Nundle Road, Rivers Road and Western Foreshore Road. The work area at the dam wall is expected to be somewhat obscured from view by existing vegetation from the north and by the existing dam wall from the south. The works areas will also be visible from the Chaffey Dam lookout.

The Project Site is relatively isolated, however there are eight rural residential developments in close proximity to Chaffey Dam, which will have a view of the works areas and construction activities. Construction will be carried out over a 24 month period and will create a temporary visual impact. Provided residents are informed and kept up to date with the progress of construction activities and works areas are maintained in a neat and orderly manner, no significant visual impacts are anticipated during construction.

8.9.3 Potential Operational Impacts

Operation of the Project will result in minor changes to the visual impact of the reservoir. Whilst the proposed new FSL will increase the amount of inundated land and the proposed modification to the height of the dam wall and morning glory spillway will increase the height of the existing structures, the Project is not anticipated to have a significant visual impact of on the Chaffey Dam area.

The visual amenity of Chaffey Dam following implementation of the Project will be generally consistent with the existing amenity of the area. Additionally, the reservoir will fill over time, resulting in a gradual increase in the water level and subsequent change to visual amenity, rather than an immediate transformation.

A photomontage of the view south to the dam wall from Tamworth-Nundle Road is provided at Figure 8-16. A figure showing the anticipated visual impact of the Project, when the reservoir is at the new FSL, is presented at Figure 8-17. The visual impact from these views is consistent with the existing visual amenity of the area.

WorleyParsons
resources & energy

State water

Datum : GDA94
Map Grid of Australia
Zone 56

LEGEND

CHAFFEY DAM AUGMENTATION AND SAFETY UPGRADE

VISUAL IMPACT - VIEW SOUTH TO DAM FROM TAMWORTH-NUNDLE ROAD

DATE : 06 Sep 2012
SCALE : N/A
CUSTOMER : STATE WATER
AUTHOR : RW
REF : 301015-02980-GIS-SKT-009.mxd
REV : A

Produced By: ryan.wright@worleyparsons.com - Geomatics

Location: ..\301015-02980 CHAFFEY DAM\03Project\Workspace_SKT\301015-02980-GIS-SKT-009

322000

6531000

6527500

N

AERIAL IMAGERY BY GEOSPECTRUM (TAKEN 29.08.2011). ALTERNATE IMAGERY BY BING

INFORMATION ONLY
NOT TO BE USED
FOR CONSTRUCTION

322000

WorleyParsons
resources & energy

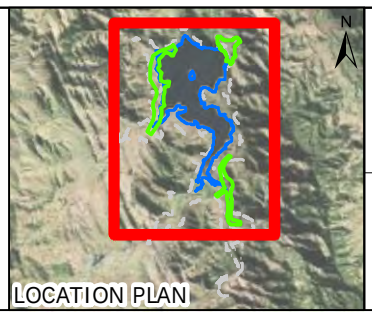
State water

N

0 0.25 0.5 1

Kilometres @ A3

Datum : GDA94
Map Grid of Australia
Zone 56



CHAFFEY DAM AUGMENTATION AND SAFETY UPGRADE

VISUAL IMPACT - AERIAL VIEW

DATE : 03 Sep 2012
SCALE : 1:20,000
CUSTOMER : STATE WATER
AUTHOR : RW
REF : 301015-02980-GIS-SKT-001.mxd
REV : A1

Produced By: ryan.wright@worleyparsons.com - Geomatics

Location: ..\301015-02980 CHAFFEY DAM\03Project\Workspace_SKT\301015-02980-GIS-SKT-001

8.9.4 Proposed Mitigation Measures

Potential visual impacts during the construction phase of the Project will primarily be managed through implementation of the Contractor's CEMP. The Contractor will be responsible for ensuring that all work areas are kept clean and tidy and that any waste is disposed of appropriately. It is expected that work areas will be fenced, with hoardings provided as necessary to minimise visual impacts.

Sediment and erosion controls will be regularly checked and cleaned or replaced as necessary. Rehabilitation of areas no longer required for construction or operation should also be carried out as soon as practicable to minimise visual impacts during construction.

To minimise the public curiosity, project information should be provided on site briefly explaining why the works are being carried out and the proposed duration of works. Such temporary signage could potentially be established in the Chaffey Dam Lookout car park, as well as on fences of works areas where it may be viewed by the public.

In consideration of the rural nature of the Project Site, landscaping treatment and design will be limited to rehabilitation of disturbed areas, with revegetation where practicable.

Given the visual impacts of the Project following its implementation will be consistent with those of the existing dam and reservoir, no specific visual amenity mitigation measures are proposed for operation of the Project.

The proposed mitigation measures are listed in Table 8-21.

Table 8-21: Proposed mitigation measures

Mitigation Measure	Phase
Trimmed and cleared vegetation should be spread over construction areas that are above the new FSL during rehabilitation to assist in stabilisation and revegetation of the area and to minimise visual impacts.	Construction
The extent of soil disturbance will be minimised and rehabilitation will be undertaken as soon as practicable following completion of works at each location.	Construction
Rehabilitation will incorporate revegetation with native species of local provenance to stabilise soils and reduce erosion.	Construction
The Contractor will maintain the works areas in a clean and tidy fashion.	Construction
Sediment and erosion control devices will be checked regularly, including after heavy rainfall and cleaned or replaced as required.	Construction

8.10 Land Use

Existing land uses at the Project Site and the potential impacts of the Project on those land uses, were examined by WorleyParsons, as discussed in Sections 8.10.1 to 8.10.4.

8.10.1 Existing Environment

The Project Site is zoned RU1 Primary Production under the *Tamworth Regional Local Environmental Plan 2010*.

There are currently no registered native title claims over the Tamworth Local Government Area.

The primary land uses around Chaffey Dam include rural residential properties, public recreation areas for boating, fishing, camping and picnicking and extensive agricultural land primarily used for grazing. Land uses in relation to the operation of the dam as a supply of potable and irrigation water also occur.

In summary, existing land uses around Chaffey Dam include:

- Land under private ownership and leasehold, including rural residential properties and land used for grazing and dairy farming;
- Roads and bridges;
- The existing dam and reservoir;
- Public viewing area and car park near the dam wall;
- Bowling Alley Point Recreation Area;
- South Bowlo Fishing Club;
- Nundle Fishing Club;
- Dulegal Arboretum; and
- State Water administration and maintenance facilities and Storage Custodian's residence.

Land tenure[12] within the Project Site comprises Crown land, freehold, leasehold and road reserve, as shown in Figure 8-18. Crown land on the foreshores of the reservoir is the subject of permissive occupancy leases, renewable every 12 months until completion of the Project. Existing road and bridge infrastructure within and surrounding the Project Site is discussed in Section 8.6.1.

[12] Cadastral data for the Project Site was provided by Tamworth Regional Council on 24 July 2012. Further cadastral information was provided by Tamworth Regional Council on 22 August 2012. Where discrepancies in the data were identified, cadastral details were confirmed with the Land and Property Information division of the NSW Department of Finance and Services via purchase of land titles, or where land titles were unavailable, via telephone.

Construction of Chaffey Dam was completed in 1979. The dam, which is owned and operated by State Water, supplies town water for Tamworth and irrigation water for the Peel Valley. Recreational uses of the existing reservoir include swimming, boating, fishing and water skiing. Access to the dam wall by both water and land is restricted to authorised personnel. A restricted zone is present adjacent to the dam wall and morning glory spillway, where no recreational boating is permitted. The area immediately downstream of the dam wall is currently utilised for the storage of hard rock material, sourced from the construction of the auxiliary spillway. The existing auxiliary spillway and morning glory spillway outlet channel are also present in this area.

The dam wall and reservoir can be viewed from a public viewing area. The Chaffey Dam lookout is located on the north eastern foreshore of the dam. Car park facilities are provided at the lookout, as well as a helicopter landing pad, which is expected to be used in emergencies only. Information signs are provided at the lookout, which provide information about Chaffey Dam, including its history and interim works carried out since its construction.

The Bowling Alley Point Recreation Area is located on the eastern foreshore of Chaffey Dam and is managed by the Bowling Alley Point Recreation Reserve Trust. The Recreation Area is located on Crown land, part of which is leased to the Bowling Alley Point Recreation Reserve Trust. The legal boundary of land leased to the Bowling Alley Point Recreation Reserve Trust is above the 1 in100 year flood level. Existing facilities in the Recreation Area include a boat ramp, picnic tables and chairs, barbecues, toilet facilities and unpowered grassed camping areas.

The South Bowlo Fishing Club is located on Crown land on the northern foreshore of Chaffey Dam. Existing facilities comprise a shed used as a clubhouse, toilet facilities and caravans. A boat ramp is also present at the site. The Nundle Fishing Club is located on the south eastern foreshore of Chaffey Dam.

The Dulegal Arboretum, located on the north western foreshore of Chaffey Dam, was established in 1982 by the now dissolved Dulegal Arboretum Association. The Arboretum was established as a botanic garden of trees and shrubs grown for their natural beauty, scientific and educational purposes and is thought to feature more than 500 planted trees and shrubs. The majority of these species, although native, are not of local provenance. The Dulegal Arboretum was noted for its scientific and recreational value, but the site has not been maintained and as such is currently in a neglected state.

A memorial plaque, commemorating the life of Pat Graham is located within the Arboretum. The remnants of old sheds, a simple toilet and other dilapidated small structures are present on site. Cattle were observed to graze within the Arboretum and appear to have contributed to degradation of some areas within the Arboretum.

At present, use of the Arboretum appears to be fairly restricted. Access to the Arboretum is via a locked gate from Western Foreshore Road or via boat. The access track through the Arboretum is currently utilised to access the South Bowlo Fishing Club. Although the Arboretum is not a listed heritage site, it is understood to be of some importance to the local community.

Two commemorative plaques occur at present on the existing Bowling Alley Point Bridge. Additionally, an Australian Agricultural Company commemorative plaque exists on the foreshore of Chaffey Dam.

State Water administration and maintenance facilities and Storage Custodian's residence occur on the north eastern foreshore of Chaffey Dam. Facilities comprise a small office building and two large maintenance sheds. The Storage Custodian's residence lies adjacent to these facilities.

In 2008 a draft Masterplan was prepared for Chaffey Dam to satisfy the requirements of the *Crown Lands Act 1989*. The draft Masterplan identified the need to better integrate land use to reduce negative environmental impacts, particularly on water quality (GHD 2008c). It also provides a practical framework for rehabilitation, management and integration of suitable land uses into the future. This draft Masterplan is not included on the Department of Primary Industry (Catchment and Lands) website as an adopted plan of management.

State Water currently implements a foreshore management plan for Chaffey Dam (Report for Site Specific Action Plans Chaffey, GHD 2010). The plan uses an integrated land management approach, with a focus on prevention rather than treatment. The objective of this plan is to:

> *"Manage foreshore land to improve the water quality in our storages and to conserve and enhance native vegetation and environmental and heritage values of the land."*

The area which contains the remains of the old community hall, tennis court and shop adjacent to Lot 56 DP 755324 is within a proposed works area, but not within the road realignment construction area.

318000

324000

6528000

6522000

N

LEGEND

ROAD REALIGNMENT

ROAD REALIGNMENT BATTERS

WORKS AREA

EXISTING FULL SUPPLY LEVEL

NEW FULL SUPPLY LEVEL

NEW 1 IN 100 YEAR FLOOD LEVEL

NEW PROBABLE MAX FLOOD LEVEL

LAND TENURE (CADASTRE, TAMWORTH REGIONAL COUNCIL, 05.07.2012)

OUTSIDE PROJECT SITE

CROWN LAND

FREEHOLD

CROWN LAND WITH LEASEHOLD

WATERFEATURE / UTILITY / ROAD

INFORMATION ONLY
NOT TO BE USED
FOR CONSTRUCTION

WorleyParsons
resources & energy

State water

N

0 0.25 0.5 1 1.5 2

Kilometres @ A3

Datum : GDA94
Map Grid of Australia
Zone 56

LOCATION PLAN

CHAFFEY DAM AUGMENTATION AND SAFETY UPGRADE

LAND TENURE

DATE : 06 Sep 2012
SCALE : 1:30,000
CUSTOMER : STATE WATER
AUTHOR : RW
REF : 301015-02980-GIS-SKT-007.mxd
REV : A2

Produced By: ryan.wright@worleyparsons.com - Geomatics

Location: ..\301015-02980 CHAFFEY DAM\03Project\Workspace_SKT\301015-02980-GIS-SKT-007

8.10.2 Potential Construction Impacts

Construction of the Project will result in the inundation of an additional 185 ha of land around the perimeter of the existing reservoir. The majority of this land comprises Crown land (Figure 8-18). Some Crown land leased to private lessees will also be inundated. This leasehold land includes land used for grazing and dairy farming. Part of four freehold properties will also be affected by the increased area of inundation, although no rural residential dwellings will be impacted.

Construction of realigned roads and bridges will also primarily be carried out on Crown land. Two freehold properties may be directly impacted during construction of Western Foreshore Road. Such impacts are expected to include access to the works area by construction equipment and personnel, as well as equipment laydown and stockpiling. Up to four freehold properties and four leasehold properties have the potential to be directly impacted by construction of realigned roads and bridges at Bowling Alley Point. Road construction activities, including excavation, road laying, access, equipment laydown and stockpiling may occur on these properties. Impacts associated with construction of realigned roads and bridges will extend over a period of approximately one year.

Potential indirect impacts to these properties associated with realignment of roads and bridges are discussed in Sections 8.6, 8.7, 8.8 and 8.9.

The Project will result in the inundation of some roads and bridges. Construction activities associated with realignment of roads and works to existing bridges is confined to sections of Tamworth-Nundle Road, Rivers Road, Western Foreshore Road, Bowling Alley Point Bridge and Western Foreshore Road. The main impact on land use activities during construction relates to reduced access to roads and bridges. Existing roads and bridges will be utilised as far as possible during construction of the realigned roads and bridges. As described in Section 8.6, a Construction Traffic Management Plan will be developed and implemented to minimise impacts associated with road closures, as well as construction traffic.

Construction of the Project will require the use of land at the base of the dam wall for construction activities and equipment laydown. All dam wall, morning glory spillway and auxiliary spillway construction activities, including the stockpiling and reuse of material, will be conducted within the Dam Wall Works Area (Figure 4-2). This area is currently utilised for stockpiling of hard rock materials and operation of State Water infrastructure. The temporary change to the use of this area over the two year construction period is not expected to impact directly on existing land uses in the area, although they will create a visual impact for the duration of the construction works (refer Section 8.9).

Use of the reservoir for recreational activities will be maintained throughout the construction period, except adjacent to the dam wall and spillway structures, where the existing restricted zone for boating will be extended. Given the size of Chaffey Dam, the extension of this restricted area is anticipated to have a negligible impact on recreational use of the reservoir during construction.

Minor impacts to visual amenity are expected to occur at the Chaffey Dam Lookout during construction of the Project. Such impacts are discussed further in Section 8.9. Public access to the Lookout will be maintained throughout construction.

Some existing facilities at the Bowling Alley Point Recreation Area and the South Bowlo Fishing Club will be inundated by the new FSL resulting from the Project. Inundation of these facilities is expected to occur over a period of months to years, as the reservoir fills to the new FSL. It is proposed to relocate these facilities as part of the Project. The relocated facilities will be established prior to removal of facilities, to enable continuity of use for these areas. However, a transition period will occur following removal of existing infrastructure and filling of the dam to the new FSL, given the timeframe over which inundation may occur. During this inundation period, the distance between the new facilities and the reservoir will be greater than at present.

The existing Nundle Fishing Club is outside the area to be inundated by the new FSL. No impacts to land uses in this area are expected during construction of the Project.

Approximately 3 ha of the 10 ha extent of the Dulegal Arboretum will be inundated as a result of the increased FSL. This will result in the eventual loss of vegetation within the inundated area. Other structures present in the Arboretum, including the memorial plaque and “Dulegal Arboretum” sign, may be lost if not relocated prior to inundation. The existing access track through the Arboretum will also be inundated.

If not relocated, the two commemorative plaques on the existing Bowling Alley Point Bridge and the Australian Agricultural Company commemorative plaque on the foreshore of Chaffey Dam are expected to be impacted by the Project.

Land uses at the State Water administration and maintenance facilities and Storage Custodian’s residence will not be impacted by construction of the Project.

8.10.3 Potential Operational Impacts

The augmented reservoir will potentially provide land use benefits through the increased area available for recreational uses, such as fishing, swimming and water-skiing. However, impacts to such recreational users may result from the presence of submerged vegetation within reservoir.

During flood events, additional properties surrounding and downstream of Chaffey Dam may be impacted. The 1 in 100 year AEP flood level surrounding the dam will increase from its present level. The majority of properties impacted by the new 1 in 100 year AEP flood level are the same as those impacted by the new FSL. The new PMF, which represents the largest flood that could reasonably be expected to occur, will impact on additional properties, comprising Crown land, freehold, leasehold and road reserve.

Following implementation of the Project, a 1 in 10,000 year AEP flood event will trigger the reconfigured fuseplug of the auxiliary spillway. During such an event, downstream flood depths in Woolomin will be up to 0.3 m greater than for the current auxiliary spillway configuration, although there will be no change to predicted flood levels in Tamworth (Black & Veatch 2012). During the

1 in 20,000 year AEP event when both fuseplugs have triggered, downstream flood depths in Woolomin will be less than 0.5 m greater than for the current auxiliary spillway configuration, with no change to predicted flood levels in Tamworth (Black & Veatch 2012).

Given that implementation of the Project will significantly decrease the risk of dam failure, the impacts of increased flood height in Woolomin (approximately 6 km downstream of Chaffey Dam) during the during the 1 in 10,000 and 1 in 20,000 year AEP events is considered to be an acceptable impact.

Any changes to insurance cover associated with flooding will be particular to specific insurance policies and will be a matter for property owners to discuss with their Insurance Company.

8.10.4 Proposed Mitigation Measures

State Water will consider acquisition of interests in land where there are significant adverse impacts, above the impacts due to natural events, according to the following guidelines:

- Where land is within the new FSL, State Water proposes to acquire that part of the land impacted by the new FSL;
- Where land is within the proposed road realignment boundary, State Water proposes to acquire that part of the land impacted by the road realignment;
- Where State Water expects land may be regularly affected in order to manage the storage and associated works, such that the ability of the landowner to engage in ordinary usage of the land is affected, State Water will seek to acquire easements or full title depending on the level of impact; and
- State Water will not acquire an interest where land might be affected by an extraordinary natural event.

Crown land on the foreshores of the reservoir is the subject of permissive occupancy leases, renewable every 12 months until completion of the Project. Following completion of the Project, land that is not affected by increased FSL will be leased with longer term lease conditions (5 to 10 years). State Water uses an open tender process to allocate leases and will consider the impact of the Project on affected landholders and lessees.

The Contractor's CEMP will include measures to minimise impacts to freehold and leasehold land during realignment of road and bridges. Crown land should be utilised for construction activities, including access, laydown and stockpiling, in preference to freehold or leasehold land.

Public access to the reservoir will be maintained throughout construction. The restricted zone adjacent to the dam wall and morning glory spillway will be extended during construction. Access to some areas of the reservoir is also expected to be temporarily limited during construction activities immediately adjacent to or over water.

No detrimental changes to the use of the Chaffey Dam Lookout are anticipated to occur. It is expected that information signage will be installed at the Lookout to inform the public of the Project during construction.

The two commemorative plaques on the existing Bowling Alley Point Bridge will be relocated to the new Bowling Alley Point Bridge. In accordance with discussion with the Tamworth Historical Society, the Australian Agricultural Company commemorative plaque will be moved from its existing location on the western foreshore of Chaffey Dam to higher ground (outside the new FSL), within the proximity of its existing location.

Given that the increased FSL will result in the inundation of some facilities at the Bowling Alley Point Recreation Area and the South Bowlo Fishing Club, impacted facilities in these areas will be relocated as part of the Project. State Water is currently negotiating with the Bowling Alley Point Recreation Trust and the South Bowlo Fishing Club to define the new locations for these facilities. State Water will also lease additional land to the Bowling Alley Point Recreation Trust to ensure sufficient land is available for the continued use of the Recreation Area and the continued generation of revenue by the Trust.

Access to the Bowling Alley Point Recreation Area and the South Bowlo Fishing Club will be maintained throughout construction of the Project.

The relocated sites will be established prior to removal of infrastructure from the existing sites, to enable continuity of use for these areas. A Recreation Continuance Plan will be developed and implemented to address and mitigate impacts on recreational users during construction as well as during the initial inundation period, when the distance between the new facilities and the reservoir will be greater than at present.

No impacts to the land use at Nundle Fishing Club are anticipated and as such no mitigation measures are proposed.

In order to mitigate impacts to the Dulegal Arboretum, it is proposed to develop an Interpretation Strategy for the site. The Interpretation Strategy will document the history of the site and will determine any items that require relocation and identify the appropriate location for these items. The memorial plaque present on site will also be relocated to above the new FSL.

It is also proposed to invite local environmental groups to the Arboretum to participate in seed collection activities. Such groups are expected to include Land Care, Tamworth Urban Group, Tamworth Garden Club and the National Parks Association of NSW Tamworth-Namoi Branch. All groups will be required to be appropriately licensed and insured to take part in the seed collection activities. State Water will liaise with these groups to organise the seed collection activities.

In order to avoid impacts to the remains of the old community hall, tennis court and shop adjacent to Lot 56 DP 755324, as well as other features such as water bores, that are within proposed works areas, but outside the road realignment construction area (including road realignment batters), a features survey will be carried out by the Contractor prior to commencement of work. The intent of this survey would be to identify particular features to be avoided by construction works.

It is recommended that a Boating Management Plan, which considers no go zones due to inundated perimeter vegetation and potential bank erosion issues, be developed and implemented following construction of the Project.

No impacts to land uses at the State Water administration and maintenance facilities and Storage Custodian's residence are anticipated and as such, no mitigation measures are proposed.

The proposed mitigation measures are listed in Table 8-22.

Table 8-22: Proposed mitigation measures

Mitigation Measure	Phase
An Interpretation Strategy will be developed for the Dulegal Arboretum.	Pre-construction
The memorial plaque present the Dulegal Arboretum will be relocated to above the new FSL.	Pre-construction
State Water will liaise with local environmental groups, including Land Care, Tamworth Urban Group, Tamworth Garden Club and the National Parks Association of NSW Tamworth-Namoi Branch, to organise seed collection activities within the Dulegal Arboretum. All groups will be required to be appropriately licensed and insured to take part in the seed collection activities.	Pre-construction
Carry out a features survey to identify features to be avoided during construction within proposed works areas, but outside the road realignment construction area (including road realignment batters).	Pre-construction
The two commemorative plaques on the existing Bowling Alley Point Bridge will be relocated to the new Bowling Alley Point Bridge.	Pre-construction
The Australian Agricultural Company commemorative plaque will be moved from its existing location on the foreshore of Chaffey Dam to higher ground (outside the new FSL), within the proximity of its existing location.	Pre-construction
A Recreation Continuance Plan will be developed and implemented to address and mitigate impacts on recreational users during construction.	Construction
The restricted zone adjacent to the dam wall and morning glory spillway will be extended during construction.	Construction
A Construction Traffic Management Plan will be developed and implemented to address and mitigate impacts to local residents and recreational users.	Construction
Impacted facilities at the Bowling Alley Point Recreation Area will be relocated in consultation with the Bowling Alley Point Recreation Trust.	Construction

Mitigation Measure	Phase
Impacted facilities at the South Bowlo Fishing Club will be relocated in consultation with the South Bowlo Fishing Club.	Construction
An Emergency Response Plan will be developed in collaboration with key stakeholders (e.g. ambulance, SES, police, Tamworth hospital) and implemented as relevant.	Construction
A Boating Management Plan should be developed and implemented, which considers no go zones due to inundated perimeter vegetation and potential bank erosion issues.	Operation
State Water will further assess impacts to landholders, as follows: • Where land is within the new FSL, State Water proposes to acquire that part of the land impacted by the new FSL; • Where land is within the proposed road realignment boundary, State Water proposes to acquire that part of the land impacted by the road realignment; • Where State Water expects land may be regularly affected in order to manage the storage and associated works, such that the ability of the landowner to engage in ordinary usage of the land is affected, State Water will seek to acquire easements or full title depending on the level of impact; and • State Water will not acquire an interest where land might be affected by an extraordinary natural event.	Operation

8.11 Socioeconomic

A socioeconomic assessment was carried out for the Project by WorleyParsons. The assessment identified the existing socioeconomic environment within and surrounding the Project Site (Section 8.11.1), as well as the potential construction and operational impacts associated with the Project (Sections 0 and 8.11.3 respectively). Mitigation measures were also proposed to avoid or minimise identified impacts (Section 8.11.4).

8.11.1 Existing Environment

Chaffey Dam is located on the Peel River in the Peel Valley area, 30 km south-east of Tamworth. Tamworth is the major urban area and social hub for the regional community. The population of the Peel Valley is approximately 47,900 with the majority of individuals (36,100) concentrated in Tamworth City (ABS 2006). The area has a relatively large proportion of indigenous persons (6.9 per cent) compared to the state average (2.1 per cent) (ABS 2006).

The closest settlements to Chaffey Dam are Bowling Alley Point, Woolomin and Nundle. Bowling Alley Point is located at the southern extent of Chaffey Dam. Woolomin is approximately 10 km north of Chaffey Dam and Nundle 10 km south, both are situated on the banks of the Peel River.

The agriculture, forestry and fisheries industry employs the largest proportion of persons located outside Tamworth City, comprising 16.5% of total employed population (ABS 2006). It is estimated that over 307,000 ha of land is devoted to agricultural production, with the gross value of production estimated at over $75 million (NSW Office of Water 2010a).

As discussed in Section 8.10, land tenure within the Project Site comprises Crown land, freehold, leasehold and road reserve. Freehold and leasehold land within the Project Site primarily comprises rural residential properties, as well as land used for grazing and dairy farming.

An Exploration Licence (EL 7489) under the *Mining Act 1992*, held by Gold of Ophir Pty Ltd for Group 1 (metallic minerals) over part of the Project Site expired on 25 March 2012. The Project Site is currently subject to three Exploration Licence Applications, as shown in Table 8-23.

Table 8-23: Exploration Licence Applications under the *Mining Act 1992* within the Project Site (MinView accessed 6 September 2012)

Application Number	Application Date	Company	Minerals
ELA 4577	15 May 2012	SOC1 PTY LTD	Group 1
ELA 4648	31 Aug 2012	IRGS NORTHERN GOLD PTY LTD	Group 1
ELA 4658	05 Sep 2012	PARNOSA PTY LTD	Group 1, Group 3

Chaffey Dam captures water during times of high flow and releases it during periods when natural Peel River flows are insufficient to meet demands for water. The overall effect of this is to dampen out flow variability immediately downstream of the dam. In the areas downstream of the dam, the proportion of time the river spends in flood and high flow is reduced, but the time it spends in very low flow is also reduced. Current usage of Chaffey Dam includes:

- Water conservation;
- Town water supply for Tamworth;
- Stock and domestic water;
- Irrigation;
- Environmental releases; and
- Recreational activities (e.g. boating and recreational fishing, camping, bush walking, swimming, gold panning and day trip activities).

Chaffey Dam is open to all boating activities and camping is permitted in designated areas on the shore. Small boats can be pulled up on the shore in the camping area when water levels permit. Facilities in the area include the Bowling Alley Point Recreation Area (including toilet facilities and boat ramp), a public viewing area, historic sites, the Dulegal Arboretum (which is currently unmaintained), the South Bowlo Fishing Club, the Nundle Fishing Club, land for grazing under private ownership and leasehold, dam infrastructure and State Water facilities including offices and the Storage Custodian's residence. These land uses are further discussed in Section 8.10.

The draft Masterplan prepared for Chaffey Dam (GHD 2008c) identifies the importance of the community having the opportunity to interact with Chaffey Dam over a long period of time. This interaction has led to the appreciation for the amenity of Chaffey Dam and embedded 'intrinsic values' within the community (GHD 2008c).

During the community consultation survey carried out for the Project (refer Appendix 6), respondents noted that they currently use Chaffey Dam for recreational activities as frequently as once a month, Such recreational activities include picnicking, walking camping and fishing.

8.11.2 Potential Construction Impacts

The Project is necessary to improve town water security for the city of Tamworth and surrounds, and to improve the reliability of water supply for irrigation and agricultural purposes. The other key driver for the Project is the need for Chaffey Dam to be upgraded to meet modern dam safety standards. The Project has strong strategic community support and has secure funding in the current State and Commonwealth electoral cycle. The Project is likely to have significant socioeconomic benefits at a regional level.

Construction of the Project has the potential to impact on the socioeconomic environment of the Project Site and lands and occupiers of lands in the vicinity. Construction activities, as well as the presence of construction traffic and personnel may result in both positive and negative impacts. The acquisition of land and modification of existing leases over Crown land also have the potential to result in socioeconomic impacts.

Construction of the Project will create employment opportunities for the area, both locally and regionally. Such opportunities will be through direct employment on the Project and through the provision of services for construction. Construction of the Project will require employment of approximately 50 construction personnel during each phase of work (refer Section 4.13). Provision of construction equipment and materials will also be required.

Maximum construction workforce estimates are illustrated in Figure 8-19. The construction workforce is expected to experience a peak of approximately 50 people during weeks 13 to 60. The construction workforce is likely to be drawn from the local area, such as Nundle, Woolomin and Tamworth, as far as possible. This would provide benefits to the local economy through employment of contractors. It is unlikely that construction workers will seek to buy houses in the local area for the purpose of accommodation during construction, however a small number of construction employees may move to the area and rent houses in Tamworth or elsewhere in the local area. Given the small

number of workers relative to the population of Tamworth the impact on the rental market is expected to be negligible.

Where part of the workforce is drawn from outside the local area, benefits to the local economy through increased patronage at local shops and restaurants, as well as provision of accommodation and entertainment would be expected to occur.

As few (if any) construction employees are likely to relocate to the area, the Project is not likely to generate additional demand for community services and facilities. The possible exceptions to this are demand for emergency services in the event of an accident or emergency onsite. It is recommended that an Emergency Response Plan be prepared and implemented for the Project in collaboration with key stakeholders such as the Tamworth Hospital, State Emergency Service, police and ambulance.

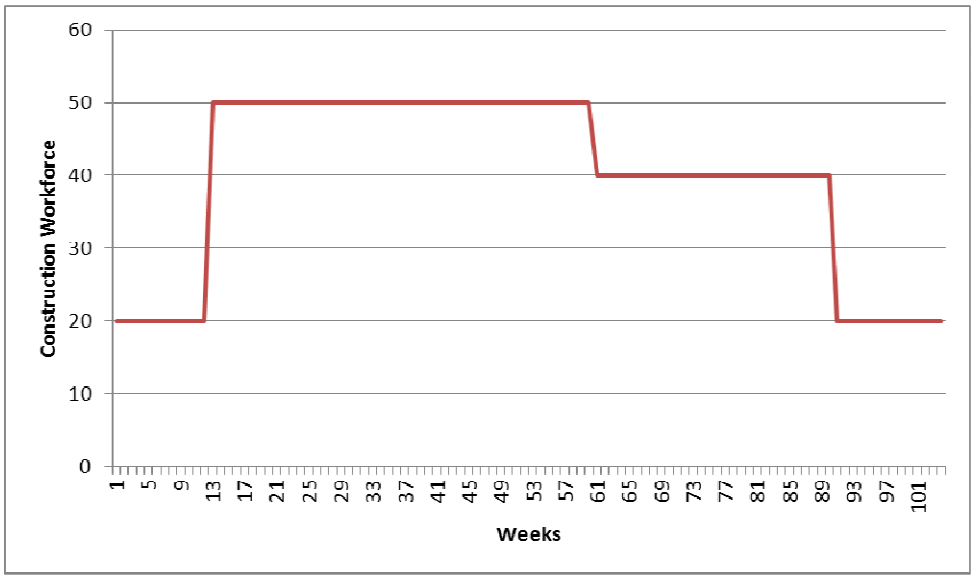


Figure 8-19: Approximate construction workforce numbers

Construction activities may cause some temporary socioeconomic impacts over the two year construction period, due to the potential for reduced recreational use of the area, particularly the Bowling Alley Point Recreation Area. Although access to the Recreation Area will be maintained throughout construction, the incentive for potential users to utilise the area may be reduced by the presence of construction activities in the area. The increased FSL will also result in the inundation of some facilities at the Bowling Alley Point Recreation Area.

Respondents to the community consultation survey carried out for the Project (refer Appendix 6), noted that the Project will impact on some areas favoured for camping through inundation to the new FSL. Notwithstanding this, respondents also recognised that the Project will provide benefits including increased water security, improved flood protection and an increase in the area available for water based recreation.

As discussed in Section 8.10, land tenure within the Project Site comprises Crown land, freehold, leasehold and road reserve. Freehold land within the new FSL will be acquired by State Water prior to construction of the Project. It is likely that existing leases over Crown land will be modified to take account of the new FSL and the new 1 in 100 year AEP flood level.

Freehold and leasehold land within the Project Site primarily comprise rural residential properties, as well as land used for grazing and dairy farming. Based on the outcomes of consultation with leaseholders, the viability of the existing dairy farm at the southern extent of the dam is expected to be compromised by the modification to the existing lease over the land. State Water has advised that the terms of the existing lease for use of this land allows State Water to terminate the lease at any time for specific purposes associated with Chaffey Dam, including inundation. State Water has also advised that these terms were known to the leaseholder at the time of establishing the dairy farm.

The Project will also result in a decrease to land available for grazing. As discussed previously, the majority of land to be inundated is owned by the Crown, with some Crown land leased to private leaseholders. If it is assumed that existing stocking rates will be maintained, it follows that the number of cattle that would graze this land post construction would reduce.

Construction of the Project and inundation of an additional 185 ha of land is not expected to have a significant impact on sterilisation of mineral resources. Although three ELAs lie in part over the Project Site, land within the Project Site comprises a small percentage of the overall area covered by the ELAs. Additionally, given the existing presence and use of Chaffey Dam, it is considered unlikely that the land to be inundated would otherwise be approved for exploration or mining purposes.

Access to the work areas will be limited to the construction workforce and suppliers from weeks 13 to 104 of the Project program, with no public access permitted within the enclosed construction area. This will not impact on recreational users as public access is not currently permitted within the major of this area.

Construction of the Project also has the potential to generate socioeconomic impacts as a result of traffic, noise and vibration, dust and visual amenity. An assessment of these impacts and proposed mitigation measures are provided in Sections 8.6 to 8.9.

8.11.3 Potential Operational Impacts

Normal operation of the dam is not expected to result in detrimental socioeconomic impacts. The augmented reservoir will provide socioeconomic benefits through improved water security for the region and potentially through the increased area available for recreational uses.

The Project will also provide positive socioeconomic impacts through increased water security for Tamworth residents and Peel Valley irrigators. Increased water security is expected to benefit the agriculture industry in the area, which together with the forestry and fisheries industries, employs the largest proportion of persons located outside Tamworth City, comprising 16.5% of total employed population (ABS 2006). The agricultural industry contributes significantly to the economy of the

Tamworth region, with the gross value of production estimated at over $75 million (NSW Office of Water 2010a).

The Project will also provide socioeconomic benefits by reducing the risk of dam failure. If the dam were to fail due to an extreme flood event, it has been estimated that up to approximately 150 lives would be lost and over $2.1 billion damage to property and agriculture would accrue (GHD 2007a).

During flood events, additional properties surrounding and downstream of Chaffey Dam may be impacted, as discussed in Section 8.10.3. Given the limited frequency of such events, the change from existing flood events is not expected to result in significant socioeconomic impacts. The Project will provide increased flood protection to downstream communities, which will provide positive socioeconomic impacts.

8.11.4 Proposed Mitigation Measures

The areas of the four freehold properties within the new FSL will be acquired by State Water prior to construction of the Project. It is likely that existing leases over Crown land will be modified to take account of the new FSL and the new 1 in 100 year AEP flood level. Crown land on the foreshores of the reservoir is the subject of permissive occupancy leases, renewable every 12 months until completion of the Project. Following completion of the Project, land that is not affected by increased FSL will be leased with longer term lease conditions (5 to 10 years). State Water uses an open tender process to allocate leases and will consider the impact of the Project on affected landholders and lessees.

State Water will consider acquisition of interests in land where there are significant adverse impacts, above the impacts due to natural events, according to the following guidelines:

- Where land is within the new FSL, State Water proposes to acquire that part of the land impacted by the new FSL;
- Where land is within the proposed road realignment boundary, State Water proposes to acquire that part of the land impacted by the road realignment;
- Where State Water expects land may be regularly affected in order to manage the storage and associated works, such that the ability of the landowner to engage in ordinary usage of the land is affected, State Water will seek to acquire easements or full title depending on the level of impact; and
- State Water will not acquire an interest where land might be affected by an extraordinary natural event.

Given that the increased FSL will result in the inundation of the some facilities within the Bowling Alley Point Recreation Area and the South Bowlo Fishing Club, impacted facilities in these areas will be relocated to higher ground, proximate to their existing locations, as part of the Project. State Water is currently liaising with the Bowling Alley Point Recreation Trust and the South Bowlo Fishing Club to define the new locations for these facilities.

Access to the Bowling Alley Point Recreation Area and the South Bowlo Fishing Club will be maintained throughout construction of the Project. Facilities at the Bowling Alley Point Recreation Area below the new FSL will be relocated as part of the Project. State Water is currently negotiating with the Bowling Alley Point Recreation Trust to define the new locations for these facilities. State Water will also lease additional land to the Bowling Alley Point Recreation Trust to ensure sufficient land is available for the continued use of the Recreation Area and the continued generation of revenue by the Trust.

The relocated sites will be established prior to removal of infrastructure from the existing sites, to enable continuity of use for these areas. A Recreation Continuance Plan will be developed and implemented to address and mitigate impacts on recreational users during construction as well as during the initial inundation period, when the distance between the new facilities and the reservoir will be greater than at present.

In order to maximise socioeconomic benefits to the local communities, personnel, equipment and materials should be sourced locally wherever possible. Where personnel from outside the local area are required, accommodation and associated services should be sought from the local area.

An Emergency Response Plan will be prepared and implemented for the Project in collaboration with key stakeholders such as the Tamworth Hospital, State Emergency Service, police and ambulance.

The proposed mitigation measures are listed in Table 8-24.

Table 8-24: Proposed mitigation measures

Mitigation Measure	Phase
A Recreation Continuance Plan will be developed and implemented to address and mitigate impacts on recreational users during construction.	Construction
The restricted zone adjacent to the dam wall and morning glory spillway will be extended during construction.	Construction
A Construction Traffic Management Plan will be developed and implemented to address and mitigate impacts to local residents and recreational users.	Construction
Impacted facilities at the Bowling Alley Point Recreation Area will be relocated in consultation with the Bowling Alley Point Recreation Trust.	Construction
Impacted facilities at the South Bowlo Fishing Club will be relocated in consultation with the South Bowlo Fishing Club.	Construction
An Emergency Response Plan will be developed in collaboration with key stakeholders (e.g. ambulance, SES, police, Tamworth hospital) and implemented as relevant.	Construction

Mitigation Measure	Phase
Following completion of the Project, land that is not affected by increased FSL will be leased with longer term lease conditions (5 to 10 years). State Water uses an open tender process to allocate leases and will consider the impact of the Project on affected landholders and lessees.	Operation
State Water will further assess impacts to landholders, as follows: • Where land is within the new FSL, State Water proposes to acquire that part of the land impacted by the new FSL; • Where land is within the proposed road realignment boundary, State Water proposes to acquire that part of the land impacted by the road realignment; • Where State Water expects land may be regularly affected in order to manage the storage and associated works, such that the ability of the landowner to engage in ordinary usage of the land is affected, State Water will seek to acquire easements or full title depending on the level of impact; and • State Water will not acquire an interest where land might be affected by an extraordinary natural event.	Operation

8.12 Spoil and Waste

Spoil and waste currently generated at the Project Site, as well as during implementation of the Project, was examined by WorleyParsons. Mitigation measures for spoil and waste were also recommended.

The existing environment, potential construction and operational impacts and proposed mitigation measures in relation to spoil and waste are provided in Sections 8.12.1 to 8.12.4.

8.12.1 Existing Environment

The operation of Chaffey Dam at present does not create any notable wastes. Small volumes of waste are collected from the trash racks within the morning glory spillway structure and some minimal waste would also be created by visitors and State Water personnel on site. Permanent on site personnel is limited to the Storage Custodian, located in a residential premise on the eastern bank of the reservoir.

Visitors to the site include those utilising the existing facilities at the Nundle and South Bowlo Fishing Clubs, as well as the Bowling Alley Point Recreation Area. These areas contain waste collection and toilet facilities. The public are also able to access Chaffey Dam Lookout and much of the area surrounding the reservoir via public roads. No additional public waste facilities or ablution blocks are

provided at present at Chaffey Dam. Excessive litter did not appear to be present on any site inspection during the EIA for the Project, although some rubbish, the remnants of old sheds, a simple toilet and other dilapidated small structures were observed within the Dulegal Arboretum.

Stockpiles of hard rock material are present on site at the base on the dam wall. These stockpiles were sourced form construction of the auxiliary spillway and will be utilised during construction of the Project.

8.12.2 Potential Construction Impacts

Inappropriate disposal of wastes has the potential to impact upon soil, water quality, vegetation and fauna. Increased reuse and recycling of wastes will also lessen the environmental impact of the Project, while a reduction in resource use will reduce the volume of waste created during construction.

Construction of the Project will result in the generation of general construction wastes, cleared vegetation and potentially excess spoil. These wastes are anticipated to primarily comprise general solid waste (putrescible and non-putrescible).

Construction wastes will be generated from the project, including packaging and minimal demolition wastes as well as garbage and sewage from workers on site. Waste hydrocarbons and oily waste such as used oil, fuel, grease, degreaser, emulsified oil, oily rags, oil filters and used absorbent materials may also be generated due to the use of construction equipment on site.

Minimal vegetation clearing (primarily comprising ground cover) required for road realignments will also result in the generation of vegetation waste.

A cut and fill balance is expected to be maintained for the realignment of roads as part of the Project. The entire volume of rock currently stockpiled on site is expected to be utilised in raising of the dam wall. Additionally, fill removed from the base of the dam wall and the concrete parapet walls will be reinstated following construction works to the wall. No or negligible excess spoil is expected to be generated by construction of the Project.

Existing facilities at the Bowling Alley Point Recreation Area and the South Bowlo Fishing Club that lie within the new FSL will be relocated as part of the Project.

Inundation of existing rubbish and dilapidated structures present on the land surrounding the existing reservoir has the potential to impact on water quality. The potential for reduced safety to recreational users of the reservoir from such items also exists following inundation.

No dredging is required for the Project.

8.12.3 Potential Operational Impacts

Wastes generated during operation of the Project are expected to be similar to those currently created at the site. The primary source of wastes will continue to be from material captured in trash

racks within the morning glory spillway structure, as well as general garbage from workers and visitors to the site.

8.12.4 Proposed Mitigation Measures

The Contractor will be required to maintain the site in a clean and tidy state and also ensure that any waste is disposed of appropriately and no items fall into the surrounding water. Appropriate receptacles will be required on site to accept and segregate wastes for recycling.

Procurement of materials should utilise recycled and or recyclable products wherever possible. Materials with minimal packaging and transport requirements should also be preference.

Existing structures and rubbish within the new FSL should be removed prior to inundation to ensure potentially polluting substance are not inundated. This includes removal of rubbish, toilets and shed remnants from areas of the to be inundated, including the Dulegal Arboretum, Bowling Alley Point Recreation Area and South Bowlo Fishing Club, as relevant.

The proposed mitigation measures are summarised in Table 8-25.

Table 8-25: Proposed mitigation measures

Mitigation Measure	Phase
The Contractor will maintain the construction site in a clean and tidy fashion.	Construction
The Contractor will ensure that waste is appropriately contained and disposed and no items fall into the surrounding water.	Construction
A waste collection and storage area will be established and maintained at each work area.	Construction
Water used to clean equipment should not be allowed to flow directly into the reservoir, instead it should be allowed to filter through hessian sacks or similar.	Construction
Recyclable materials and products made from recycled materials will be used where possible.	Construction
Materials with minimal packaging and transport requirements will be used where possible.	Construction
No burning of vegetation or waste is allowed under any circumstances.	Construction
General and putrescible waste and recyclable waste such as metal, plastic, glass, paper and timber will be segregated and collected in suitable waste containers positioned at convenient locations within each work area.	Construction
All waste containers will have secure lids in place to prevent water ingress and access to animals.	Construction
Waste storage areas will be kept away from drainage paths.	Construction

8.13 Hazards and Risks

The fuels and chemicals currently stored at the Project Site and those proposed to be stored during construction and operation of the Project are discussed in Sections 8.13.1 to 8.13.3.

Proposed mitigation measures relevant to the storage, handling and use of such fuels and chemicals are provided in Section 8.13.4.

8.13.1 Existing Environment

On site operation of Chaffey Dam is primarily managed by the State Water Storage Custodian, within a State Water facility on the eastern foreshore of the reservoir. This facility comprises several work sheds, as well as a State Water office and the Storage Custodian's residence. Light vehicles and a small boat are the primary vehicles currently stored and maintained on site. Minimal chemicals are required on site and all are stored within locked chemical storage cupboards within the existing work sheds.

A list of chemicals and associated volumes currently stored on site is provided in Table 8-26.

Table 8-26: Chemicals and associated volumes currently stored on site at Chaffey Dam

Chemical	Volume
Petrol	Maximum of 100 litres (L)
Diesel	Maximum of 2,000 L
Oil	200 L
Grease	30 kilograms (kg)
Weedicide (Glyphosate Bio choice frog safe)	200 L
Cleaning products (mainly detergents for cleaning hands and premises)	30 L

A search of the OEH Contaminated Land Record for the Tamworth Regional Local Government Area showed that no contaminated sites are recorded within the Project Site. Additionally, land uses within and surrounding the site are not expected to have caused contamination to the site. Although much of the surrounding area supports agricultural land uses, they do not comprise chemical intensive land uses, such as potentially excessive pesticide associated with market gardens and orchards. As such, the Project site is considered unlikely to be contaminated.

8.13.2 Potential Construction Impacts

No direct contamination of the Project site is anticipated to occur as a result of the Project. The potential exists for accidental hydrocarbon spills and leaks to result in contamination to soil, groundwater or surface water. The potential for theft or vandalism at the site also exists, with the

potential to result in loss of hydrocarbons to the environment. Any contamination from these sources is likely to be localised, but may require remediation to ensure no long-term impacts occur.

A barge mounted crane is also expected to be utilised during construction. Potential spills and leaks of hydrocarbons and hydraulic fluid will need to be carefully managed to avoid impacts to water quality.

Chemicals stored and utilised on site during construction are expected to comprise the following:

- Fuel (petrol and diesel);
- Oil;
- Grease;
- Cleaning products;
- Explosives for blasting;
- Cement;
- Bentonite for bore hole sealing; and
- Other chemicals commonly used during construction.

As discussed in Section 5.2.14, no bulk storage of hydrocarbons or other hazardous materials on site is proposed during construction and the Project is not considered to be a potentially hazardous or offensive industry.

8.13.3 Potential Operational Impacts

No changes to chemicals and associated volumes currently stored on site at Chaffey Dam will result from operation of the Project. A list of chemicals currently stored on site is provided in Section 8.13.1.

8.13.4 Proposed Mitigation Measures

Protocols will be developed to ensure hydrocarbon and chemical spills are contained and treated immediately should they occur. The protocols will aim to ensure no soil or water contamination occurs, with any contaminated material removed and appropriately treated or disposed.

All chemicals and fuel will be stored in appropriately secure and bunded areas within the designated works areas during construction. Any refuelling and scheduled vehicle maintenance will also be carried out within designated areas during construction.

Vehicles and equipment will be maintained in good working order to minimise the risk of leaks and spills. Spill kits will also be provided on site and relevant personnel trained in their use.

The proposed mitigation measures are summarised in Table 8-27.

Table 8-27: Proposed mitigation measures

Mitigation Measure	Phase
Protocols will be developed to ensure hydrocarbon and chemical spills are contained and treated immediately should they occur. Protocols will aim to ensure no soil or water contamination occurs, with any contaminated material removed and appropriately treated or disposed.	Construction
Emergency spill kits will be available on site and construction personnel trained in their use.	Construction
Chemical wastes will be collected in appropriately sized and labelled containers for disposal at an approved chemical waste facility.	Construction
Waste oil, solvents and hydrocarbons will be collected for reuse, recycling, treatment or disposal at an appropriately licensed facility.	Construction
Floating booms will be utilised during works near water and where the potential for hydrocarbon spills to water exist.	Construction
Material Safety Data Sheets (MSDSs) will be maintained on site for all hazardous substances, including fuels and chemicals, in a readily accessible location.	Construction
Fuels, lubricants and chemicals will be stored and handled within containment facilities, such as bunded areas or leak trays, designed to prevent the release of spilt substances.	Construction
All bunded areas will be designed to contain 110% of the volume stored within them.	Construction Operation
All storage and handling equipment for fuels, lubricants and chemicals will be maintained in good working condition.	Construction Operation

8.14 Principles of Ecologically Sustainable Development

Schedule 2 of the Environmental Planning and Assessment Regulation 2000 requires that an EIS have regard to the principles of ecologically sustainable development. Consideration of the principles of ecologically sustainable development in regard to the Project is shown in Table 8-28.

Table 8-28: Consideration of the principles of ecologically sustainable development for the Project

Ecologically sustainable development principle	Comment
The Precautionary Principle The precautionary principle, namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by: (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and (ii) an assessment of the risk-weighted consequences of various options	Specialists were engaged to carry out environmental assessments and evaluate key impacts for the Project. This helped to ensure a thorough understanding of the existing environment within the Project Site, identify the potential impacts associated with the Project and develop measures to avoid or mitigate identified impacts. An Environmental Risk Analysis was carried out for the Project to identify key potential environmental impacts associated with construction and operation of the Project. The Environmental Risk Analysis also considered the proposed mitigation and management measures for the Project and residual risks following their implementation. An assessment of 'worst case' impacts was carried out. It is anticipated that through the implementation of mitigation measures and through continuation of detailed design, the identified impacts will be further reduced. The precautionary principle has been implemented in determining the impact of the Project on the Booroolong Frog and Queensland Bluegrass.
The Principle of Inter-generational Equity Inter-generational equity, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations	The Project will contribute to inter-generational equity through increased water security and will also enable increased environmental releases. Mitigation measures are proposed to avoid or minimise identified impacts. Biodiversity offsets will be implemented to compensate for the loss of vegetation at the Project Site. The environmental assessment carried out for the Project has shown that the identified impacts will not result in a significant impact on the environment.
The Principle of Conservation of Biological Diversity and Ecological Integrity	The Project has been designed to utilise existing cleared areas as far as practicable.

Ecologically sustainable development principle	Comment
Conservation of biological diversity and ecological integrity, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration	Biodiversity offsets will be implemented to compensate for the loss of vegetation at the Project Site. The mitigation measures proposed aim to minimise impacts to biodiversity throughout implementation of the Project.
The Principle of Improved Valuation, Pricing and Incentive Mechanisms for Environmental Factors Improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as: (i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement, (ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, (iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.	The Project has been in development for many years and environmental issues have been investigated and considered throughout this development period. Mitigation measures have been incorporated into the development of the Project to minimise impacts during construction and operation. The Project will increase water security for Tamworth town water supply and irrigators in the Peel Valley. Augmentation of Chaffey Dam was shown to be the most cost effective supply option to augment water supplies within the Peel Valley (GHD 2006). Augmentation to 100 GL was shown to be cost effective, while maintain supply contingency for possible adverse events, including those associated with climate change.

8.15 Cumulative Impacts

The majority of potential environmental and social impacts resulting from the Project will occur during the construction phase of the Project. As no other major developments are known to be occurring at the time of Project construction, no cumulative impacts associated with other projects in the area are anticipated to occur.

Impacts that occur during construction, particularly those associated with traffic, noise, air and visual amenity, will be localised and temporary, only occurring during the construction phase of the Project. Assessments for the EIS have been carried out to examine the 'worst case' scenario, where it is

assumed that construction activities occur concurrently. Cumulative impacts from the various activities associated with the Project have been assessed and no significant impacts are anticipated to occur.

The majority of the land to be inundated has been cleared and / or grazed for many years. Biodiversity offsets will be implemented to account for the loss of native vegetation through inundation. This will minimise the cumulative impact of vegetation loss in the area.

Operation of the Project will increase water security and flood safety, but is not expected to result in any significant negative cumulative impacts.

9 SUMMARY OF MITIGATION MEASURES

A number of management plans and strategies will be developed and implemented for the Project. The plans and strategies will detail objectives and mitigation measures (including those identified in this EIS), to be implemented during construction and / or operation of the Project, as relevant. The plans and strategies will include corrective actions and relevant thresholds for implementation of such actions. Monitoring will also be detailed to ensure mitigation and corrective actions are being implemented as required and are achieving the intended environmental outcomes.

All management plans and strategies are required to be prepared by experienced and appropriately qualified personnel. All management plans and strategies are required to be reviewed and approved by State Water prior to commencement of the relevant components of work. State Water has overall responsibility for ensuring these management plans and strategies are effectively implemented. It is recommended that independent auditing of the management plans and strategies be carried out at appropriate and identified “witness points” during construction and operation.

Measures prescribed in each management plan and strategy should not be contradictory to measures prescribed in other managements plan and strategies for the Project. That is, the suit of management plans and strategies should complement each other and provide overarching environmental outcomes.

The management plans and strategies to be developed and implemented for the Project are discussed below.

9.1 Construction Environmental Management Plan

The Contractor will develop and implement a CEMP that includes mitigation measures described in the EIS and any additional measures considered necessary to manage environmental impacts during construction. The Contractor’s CEMP will also incorporate all relevant conditions issued for the Project by the Department of Planning and Infrastructure and SEWPaC.

The CEMP will be relevant to and implemented throughout the whole of the Project construction phase. All Project construction contractors and personnel will be required to comply with the CEMP. The overall purpose of the CEMP is to provide a basis for management of the environmental impacts of the Project construction phase in accordance with State Water and regulatory requirements.

9.2 Booroolong Frog Management Plan

The purpose of the Booroolong Frog Management Plan will be to minimise impacts on the local population of the Booroolong Frog and its habitat associated directly with the Project, minimise other threats to the species not directly associated with the Project and protect existing and potential Booroolong Frog populations and habitats near the Project Site.

The Booroolong Frog Management Plan will draw on the surveys in summer 2012 / 2013 to ascertain the current numbers of frogs and to inform a relocation strategy for the species. Namoi CMA is currently proposing to conduct surveys in summer 2012 / 2013 within the Namoi Catchment Area State Water will coordinate with Namoi CMA to maximise the efficiency of the surveys and the volume of data collected. These surveys are intended to increase understanding of the present status of Booroolong Frog populations on the Peel River upstream of Chaffey Dam and provide information to further tailor appropriate mitigation measures for the species.

The implementation of the Booroolong Frog Management Plan, comprising appropriate mitigation and offsets measures, is intended to manage the impact by the Project on the local population of the species. The Plan will be developed in consultation with species experts and the Namoi CMA and will include a relocation program to move juvenile frogs to areas of suitable habitat upstream. It is intended that the Plan will contribute to the control and spread of chytrid by the adoption of protocols for persons, vehicles and equipment as detailed in the 'Hygiene protocol for the control of disease in frogs' (DECC 2008b). Offset measures to improve the habitat available for the species outside of the FSL will also be defined.

As recommended in the Flora and Fauna Impact Assessment (Appendix 8), the Booroolong Frog Management Plan, as a minimum, will include provision for:

- Information from a pre-construction monitoring program, which includes frog surveys in summer 2012 / 2013, to ascertain the current numbers of frogs and to inform the relocation strategy;
- Depending on the outcome of the proposed summer survey, if considered appropriate, relocation of juvenile frogs within the new FSL to suitable habitat upstream on the Peel River, or elsewhere in the catchment to be decided in consultation with Namoi CMA and Philip Spark (or other suitable frog expert);
- The relocation strategy will aim to sustain a viable local population. If at any time, this is unlikely to be met, alternative strategies will be developed;
- Remediation and threat mitigation as required in receiving sites (e.g. stock exclusion, weed removal, removal of exotic shading vegetation, protection from fossicking, removal of Carp); and
- Post-construction monitoring for a minimum of two years to monitor the success of the Management Plan. This will be dependent on the rate of inundation and consultation with the relevant parties (e.g. Namoi CMA).

9.3 Border Thick-tailed Gecko Management Plan

A Border Thick-tailed Gecko Management Plan will be prepared and implemented to guide the construction phase activities, with the purpose of minimising impacts and enhancing habitat for this species within and near the Project Site.

The Plan will include the following considerations:

- An ecologist will be engaged to locate and remove all fauna found on the dam wall to a safe location in the wildlife corridor or the Goat Mountain remnant prior to construction works on the dam wall. The timing of the relocation needs to occur as close as possible to the commencement of excavation works to minimise the chance of fauna recolonising the works site;
- To avoid impacts to the Border Thick-tailed Gecko during the construction phase, works will follow a staged and strategic plan for the clearing and excavation. Clearing and rock removal will begin from the south-eastern end of the wall and work northwest along the ridge to enable all fauna in the impact area to escape along the ridge to the wildlife corridor;
- The materials used to raise the dam wall will be the same as those currently present on the wall, where possible; and
- Stock management measures to reduce the current adverse impacts of stock on the wildlife corridor including preventing stock from entering the wildlife corridor area and the habitat between the dam wall and Goat Mountain.

9.4 Vegetation Management Plan

A Vegetation Management Plan, including provisions for weed management, will be prepared and implemented during construction of the Project to ensure weeds are adequately controlled at the Project Site. Measures implemented through the Vegetation Management Plan will also be designed to assist rehabilitation of fauna habitats, primarily through weed control.

A Vegetation Management Plan will be developed for the Project including but not limited to the following outcomes:

- The control of noxious weeds recorded on the site prior to works commencing;
- The management of Coolatai Grass around the dam wall and planted wildlife corridor;
- Preventative measures for the spread or introduction of weeds with the aim of ensuring no weeds are spread or introduced as a result of the Project. Any increase in weed infestations should be managed to eliminate or reduce weed infestation;
- Provisions requiring weed control measures employing chemicals to be conducted in a manner that does not impact on water quality within the reservoir;
- Laydown sites for excavated spoil, equipment and construction materials will be weed-free or treated for weeds;
- Sediment control materials should be weed free such as weed free hay bales or geotextiles;
- Any imported materials such as sand and gravel will be sourced from sites which do not show evidence of noxious weeds or diseases that may be harmful to native vegetation. If any

imported materials result in the occurrence of weeds, measures will be implemented to eliminate weeds before they have the opportunity to spread; and

- Monitoring of measures and ongoing adaptive management to control weeds throughout construction and operation of the Project.

9.5 Offset Strategy

An Offsets Proposal will be implemented for the Project to ensure that where impacts cannot be avoided, or entirely minimised, the residual impact is offset. The Offsets Proposal will be developed in consultation with the Department of Planning and Infrastructure, SEWPaC, OEH and Namoi CMA and will be finalised prior to commencement of construction.

The Offsets Proposal will define offsets for the Booroolong Frog, Queensland Bluegrass, White Box Yellow Box Blakely's Red Gum Woodland EEC and the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC listed under the EPBC Act.

The objective of the Offsets Proposal will be to ensure that an overall 'maintain or improve' outcome is achieved for the Project. The offset site will be protected in perpetuity and appropriate management actions attached to the land title.

Offset Matters of national environmental significance that may require offsets in accordance with the EPBC Act Environmental Offsets Policy are the White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland CEEC, the Booroolong Frog and potentially Queensland Bluegrass. As the artificial habitat of the Border Thick-tailed Gecko removed for the Project will be replaced and expanded and no significant impacts are anticipated, it is not expected that offsets will be required for this species. Additional surveys will be carried out in summer 2012 / 2013 to further quantify the impacts of the Project on Queensland Bluegrass and the Booroolong Frog.

Preliminary offset scenarios for the White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland CEEC, Booroolong Frog habitat and Queensland Bluegrass show that the potential offsets areas are present within the vicinity of the Project Site.

9.6 Water Release Management Plan

A Water Release Management Plan will be prepared and implemented if water releases are required to reduce the reservoir level during construction. The purpose of the Plan will be to minimise downstream impacts associated with release of water from the reservoir for construction activities. The Plan will be developed in consultation with relevant stakeholders including State Water, NSW Office of Water and DPI (Fisheries) and will include consideration of the following:

- Where possible use water releases will be undertaken as currently required under the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010; and

- Adequate monitoring of water quality (temperature, algal blooms) should be undertaken to ensure water quality impacts due to release of water are avoided or minimised. The multi-level intake should be used in an effective manner to minimise potential water quality impacts.

9.7 Construction Traffic Management Plan

A Construction Traffic Management Plan will be developed and implemented to address and mitigate potential traffic impacts to local residents and recreational users. A Construction Traffic Management Plan will be developed and implemented for all Project construction activities, including:

- Provision for oversized vehicles (where relevant);
- Provisions for traffic management during road realignment works, including speed restrictions;
- Safety provisions for workers, residents, recreational users and the general public;
- Requirement to inform heavy vehicle drivers of the presence of schools and the schedules of school buses in the area, as well as the narrow verges and potentially limited space available for school buses to pull over; and
- Requirement to inform local residents, Nundle Fishing Club, South Bowlo Fishing Club and the Bowling Alley Point Trust of upcoming temporary traffic diversions and road closures.

9.8 Dulegal Arboretum Interpretation Strategy

An Interpretation Strategy will be developed for the Dulegal Arboretum. The Strategy will further examine the history of the Arboretum and detail management options and strategies to mitigate the Project impacts to the Arboretum.

9.9 Recreation Continuance Plan

A Recreation Continuance Plan will be developed and implemented to address and mitigate impacts on recreational users during construction. The purpose of the Plan will be to enable continued use of recreational facilities within the Project Site throughout construction of the Project, including during inundation to the new FSL.

9.10 Operational Environmental Management Plans

Existing State Water operational management systems and procedures will be reviewed and revised as required to ensure all operational mitigation measures described in the EIS are implemented. Any additional measures considered necessary to manage environmental impacts during operation of the Project will also be incorporated into State Water's operational management systems and procedures.

This includes the review, revision (as necessary) and continued implementation of the existing Chaffey Dam Foreshore Management Plan (Report for Site Specific Action Plans Chaffey, GHD 2010) and the existing Chaffey Dam – Variable Offtake Management Protocol.

9.10.1 Chaffey Dam – Variable Offtake Management Protocol

The existing Chaffey Dam – Variable Offtake Management Protocol will be reviewed and revised (as relevant) with the aim of avoiding or minimising cold water pollution. The Protocol should be prepared in accordance with the guidelines for managing cold water releases from high priority dams (NOW 2011) and should consider conflicting algal management. The water to be released should match as closely as possible the natural temperature regime, especially during the spring, summer and autumn periods. The natural seasonal temperature regime should be determined through effective monitoring of upstream and downstream reference sites.

9.10.2 ECA Operating Protocol

An adequate operating protocol for the use of the ECA will also be developed to provide the best ecological outcome. The operating protocol should consider the Environmental Water Delivery: Namoi River (Barma Water Resources et al. 2012) which provides information on the environmental assets and potential options for environmental water use in the Namoi catchment including at Chaffey Dam. It should also include monitoring requirements, as described in Barma Water Resources et al. (2012), to assess the success of the releases. The operating protocol should be developed in consultation with all relevant stakeholders including but not limited to State Water, NSW Office of Water and DPI (Fisheries).

9.10.3 Boating Management Plan

A Boating Management Plan should be developed and implemented, which considers no go zones due to inundated perimeter vegetation and potential bank erosion issues. The purpose of this Plan will be to ensure the amenity and safety of recreational users of the reservoir is maintained following implementation of the Project.

The proposed mitigation measures proposed to be implemented for the Project are summarised in Table 9-1.

Table 9-1: Summary of proposed mitigation measures

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
1	Soil and Water Terrestrial Biodiversity	Existing cleared, disturbed and sealed areas will be identified and used preferentially for vehicle and machinery access, materials laydown and stockpiling wherever practicable to minimise disturbance to native vegetation, including areas of derived grassland (refer Figure 8−4).	Construction	Section 8.1 Section 8.2
2	Soil and Water	Off road driving will be minimised as far as practicable and will be limited to within designated works areas.	Construction	Section 8.1
3	Soil and Water	Topsoil will be separated from subsoil during excavation and replaced as the top soil layer upon backfilling or reused elsewhere for rehabilitation.	Construction	Section 8.1
4	Soil and Water	Excavations will be backfilled as soon as practicable.	Construction	Section 8.1
5	Soil and Water Visual Amenity	The extent of soil disturbance will be minimised and rehabilitation will be undertaken as soon as practicable following completion of works at each location.	Construction	Section 8.1 Section 8.9
6	Soil and Water Visual Amenity	Rehabilitation will incorporate revegetation with native species of local provenance to stabilise soils and reduce erosion.	Construction	Section 8.1 Section 8.9

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
7	Soil and Water	A Sediment and Erosion Control Plan will be developed and implemented, and will include, as a minimum: • Use of silt fences, drains and sediment traps as relevant throughout ground disturbing works; • Use of silt curtains where ground disturbing works are being carried out near or adjacent to waterways; • Use of silt curtains where works are being carried out to the top or upstream embankment of the dam wall; • Regular checking of sediment and erosion control devices, including after heavy rainfall; and • Cleaning or replacement of sediment and erosion control devices as required.	Construction	Section 8.1
8	Soil and Water Visual Amenity	Sediment and erosion control devices will be checked regularly, including after heavy rainfall and cleaned or replaced as required.	Construction	Section 8.1 Section 8.9
9	Soil and Water	All concrete pours and bitumen use will be appropriately supervised.	Construction	Section 8.1
10	Soil and Water	Placement of bitumen products will be restricted to periods where there is expected to be at least two days of dry weather after their application.	Construction	Section 8.1
11	Soil and Water	If the reservoir is at or near FSL at the commencement of construction, the reservoir will be temporarily lowered to 2 m below FSL to provide construction access and flood protection, in accordance with any NSW Office of Water requirements	Construction	Section 8.1

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
12	Soil and Water Terrestrial Biodiversity	The use of heavy machinery on areas that are outside of the area of direct impact and excavation works will be avoided during, and immediately following heavy rainfall events to protect soils from erosion and compaction.	Construction	Section 8.1 Section 8.2
13	Soil and Water	The Foreshore Management Plan for Chaffey Dam (Report for Site Specific Action Plans Chaffey, GHD 2010) will be reviewed and revised as relevant. The Plan will be implemented throughout operation of the Project.	Operation	Section 8.1
14	Soil and Water Visual Amenity	The extent of soil disturbance will be minimised and rehabilitation will be undertaken as soon as practicable following completion of works at each location.	Construction	Section 8.1 Section 8.9
15	Soil and Water	Selective withdrawal of water from the hypolimnion will be carried out to maintain or improve the quality of downstream water releases.	Operation	Section 8.1
16	Soil and Water	The vertical distribution of algal biomass and temperature within the reservoir will be monitored to determine the optimum level of draw-off.	Monitoring	Section 8.1
17	Terrestrial Biodiversity	Further surveys will be carried out in summer to determine the presence or absence of Queensland Bluegrass (Dichanthium setosum) within the Project Site to accurately determine the potential for a significant impact to this species. The results of these surveys will be provided in either a Supplementary Report to be submitted to the Department of Planning in January / February 2013, a submissions report or a Preferred Infrastructure Report (PIR) prepared for the Project.	Pre-construction	Section 8.2

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
18	Terrestrial Biodiversity	The design of the raised multi-level off-take tower should enable adequate management of cold water pollution and algal bloom impacts (i.e. allow for releases of water from various depths independently and/or concurrently to allow mixing of water if required to mitigate cold water pollution).	Pre-construction	Section 8.2
19	Terrestrial Biodiversity	A Booroolong Frog Management Plan to be developed and implemented for the Booroolong Frog population on the Peel River that will include provision for: • Information from a pre-construction monitoring program which includes frog surveys in summer 2012 / 2013 to ascertain the current numbers of frogs and to inform the relocation strategy. The results of these surveys will be provided in either a Supplementary Report to be submitted to the Department of Planning in January / February 2013, a submissions report or a Preferred Infrastructure Report (PIR) prepared for the Project; • Depending on the findings of the proposed Summer Survey and if considered appropriate and necessary, relocation of juvenile frogs within the new FSL to suitable habitat upstream on the Peel River, or elsewhere in the catchment to be decided in consultation with Namoi CMA and Philip Spark (or other suitable frog expert); • The relocation strategy will aim to sustain a viable local population. If at any time, this is unlikely to be met, alternative strategies will be developed; • Remediation and threat mitigation as required in receiving sites (e.g. stock exclusion, weed removal, removal of exotic shading vegetation, protection from fossicking, removal of Carp); and • Post-construction monitoring for a minimum of two years to monitor the success of the Management	Pre-construction Construction	Section 8.2

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
		Plan. This will be dependent on the rate of inundation and consultation with the relevant parties (e.g. Namoi CMA).		
20	Terrestrial Biodiversity	A Vegetation Management Plan will be developed for the Project including but not limited to the following outcomes: • The control of noxious weeds recorded on the site prior to works commencing; • The management of Coolatai Grass around the dam wall and planted wildlife corridor; • Preventative measures for the spread or introduction of weeds with the aim of ensuring no weeds are spread or introduced as a result of the Project. Any increase in weed infestations should be managed to eliminate or reduce weed infestation; • Provisions requiring weed control measures employing chemicals to be conducted in a manner that does not impact on water quality within the reservoir; • Laydown sites for excavated spoil, equipment and construction materials will be weed-free or treated for weeds; • Sediment control materials should be weed free such as weed free hay bales or geotextiles; • Any imported materials such as sand and gravel will be sourced from sites which do not show evidence of noxious weeds or diseases that may be harmful to native vegetation. If any imported materials result in the occurrence of weeds, measures will be implemented to eliminate weeds before they have the opportunity to spread; and	Construction Operation	Section 8.2

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
		• Monitoring of measures and ongoing adaptive management to control weeds throughout construction and operation of the Project.		
21	Aquatic Biodiversity	A Water Release Management Plan will be prepared and implemented if water releases are required to reduce the reservoir level during construction. The Plan will be developed in consultation with relevant stakeholders including State Water, NSW Office of Water and DPI (Fisheries). The Plan will include consideration of the following: • Where possible use water releases will be undertaken as currently required under the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010; and • Adequate monitoring of water quality (temperature, algal blooms) should be undertaken to ensure water quality impacts due to release of water are avoided or minimised. The multi-level intake should be used in an effective manner to minimise potential water quality impacts; and	Construction	Section 8.3
22	Aquatic Biodiversity	Laydown areas and stockpile sites should be located at least 40 m from any waterways where possible and should be adequately protected to avoid or minimise any potential pollution of waterways through adequate erosion and sediment controls.	Construction	Section 8.3
23	Aquatic Biodiversity Hazards and Risks	Protocols will be developed to ensure hydrocarbon and chemical spills are contained and treated immediately should they occur. Protocols will aim to ensure no soil or water contamination occurs, with any contaminated material removed and appropriately treated or disposed.	Construction	Section 8.3 Section 8.13

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
24	Aquatic Biodiversity	Should large woody debris need to be removed for any construction activities the following will be implemented: • Lopping (trimming) will be considered as a first option; • Instream realignment will be considered as the next option; • If realignment is unfeasible, relocation within the river channel is preferable to removal; and • Removal should be considered as a last resort.	Construction	Section 8.3
25	Aquatic Biodiversity	The existing Chaffey Dam – Variable Offtake Management Protocol will be reviewed and revised (as relevant) with the aim of avoiding or minimising cold water pollution. The Protocol should be prepared in accordance with the guidelines for managing cold water releases from high priority dams (NOW 2011) and should consider conflicting algal management. The water to be released should match as closely as possible the natural temperature regime, especially during the spring, summer and autumn periods. The natural seasonal temperature regime should be determined through effective monitoring of upstream and downstream reference sites.	Operation	Section 8.3
26	Aquatic Biodiversity	The release of water during operation will be undertaken in accordance with the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010. An adequate operating protocol for the use of the ECA will be developed to provide the best ecological outcome. The operating protocol should consider the Environmental Water Delivery: Namoi River (Barma Water Resources et al. 2012) which provides information on the environmental assets and potential options for environmental water use in the Namoi catchment including at Chaffey Dam. It should also include	Operation	Section 8.3

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
		monitoring requirements, as described in Barma Water Resources et al. (2012), to assess the success of the releases. The operating protocol should be developed in consultation with all relevant stakeholders including but not limited to State Water, NSW Office of Water and DPI (Fisheries).		
27	Aquatic Biodiversity	The riparian zone of the Peel River should be replanted at the new FSL along upstream waterways for a minimum of 10 m from the new FSL and along the shoreline of the reservoir where practicable, particularly in areas identified as having a high risk of erosion. Revegetation should be undertaken using natives species of local provenance.	Operation	Section 8.3
28	Aquatic Biodiversity	The impact of water releases on temperatures downstream will be monitored through the selection of appropriately located downstream sites and comparisons with reference locations.	Monitoring	Section 8.3
29	Aquatic Biodiversity	Works should be staged so that construction activities that need to be undertaken within waterways (e.g. bridge construction) are undertaken during low reservoir levels.	Construction	Section 8.3
30	Aboriginal Heritage	Surface salvage and relocation of all known Aboriginal heritage sites to be directly impacted by the Project will be carried out. Surface salvage will entail the recording of each site by an Archaeologist and the collection of all visible artefacts.	Pre-construction	Section 8.4
31	Aboriginal Heritage	Targeted testing of representative landforms in areas of PAD that will be directly impacted by the Project will be undertaken prior to commencement of construction in that area. The results of these investigations will inform the need for further testing and/or salvage excavations.	Pre-construction	Section 8.4

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
32	Aboriginal Heritage	A 'Back to Country' protocol will be developed that details the location and methodology to be used for the relocation of Aboriginal objects salvaged as part of the Project. The relocation area should be in close proximity to the Project Site, should be negotiated with Aboriginal stakeholders and can be an area identified by the proponent.	Pre-construction	Section 8.4
33	Aboriginal Heritage	The relocation area for salvaged objects will be recorded by an Archaeologist and placed on the NSW AHIMS as a new Aboriginal site.	Pre-construction	Section 8.4
34	Aboriginal Heritage	Known Aboriginal heritage sites adjacent to construction footprints will be fenced off during all construction works. Unauthorised access to these areas by personnel and equipment will be prohibited.	Construction	Section 8.4
35	Aboriginal Heritage	The Unanticipated Discovery Protocol provided at Appendix 14 will be implemented where any suspected Aboriginal objects or suspected human remains are uncovered during construction.	Construction	Section 8.4
36	European Heritage	The Iron Footbridge will be carefully dismantled, transported and re-erected in a location within the vicinity of its present location that aids in the interpretation of the footbridge with regard to its connection to the Bowling Alley Point settlement (refer Appendix 10).	Pre-construction	Section 8.5
37	European Heritage	Interpretative signage will be installed at the new location of the Iron Footbridge to document its history, including construction methods, original location and the role and function it had in serving the former Bowling Alley Point gold mining settlement. The importance of its historical, social, cultural and aesthetic significance to the current and future residents and to visitors should also be documented on the signage.	Pre-construction	Section 8.5

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
38	European Heritage	The Contractor's CEMP will include measures to minimise visual impacts to the Bowling Alley Point School and Uniting Church during road and bridge construction activities, such as dust suppression, maintenance of tidy construction areas and the use of hoardings.	Construction	Section 8.5
39	European Heritage	In the case that a previously unidentified potential heritage object is uncovered during construction, the following will be implemented: measures will be implemented to avoid disturbance to the object, until an appropriate management strategy is implemented. 1. All works must halt in the immediate area of the object(s) and any further disturbance to the area of the object(s) prevented; 2. The discoverer of the object(s) will notify machinery operators in the immediate vicinity of the object(s) so that work can be halted; 3. The object(s) will be reported to the site supervisor and the Principal/Project Manager; 4. The approximate extent, nature, associated archaeological potential and likely significance of the object(s) will be determined by an appropriately qualified person or persons (such as the project archaeologist); and 5. An appropriate management strategy for recording and preservation of the object (if warranted) will developed, along with a strategy to return to work as far as possible.	Construction	Section 8.5
40	European Heritage	Where suspected human remains are uncovered, the protocol provided at Appendix 16 will be implemented.	Construction	Section 8.5

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
41	Traffic and Transport Land Use Socio-economic	A Construction Traffic Management Plan will be developed and implemented for all Project construction activities, including: • Provision for oversized vehicles (where relevant); • Provisions for traffic management during road realignment works, including speed restrictions; • Safety provisions for workers, residents, recreational users and the general public; • Requirement to inform heavy vehicle drivers of the presence of schools and the schedules of school buses in the area, as well as the narrow verges and potentially limited space available for school buses to pull over; and • Requirement to inform local residents, Nundle Fishing Club, South Bowlo Fishing Club and the Bowling Alley Point Trust of upcoming temporary traffic diversions and road closures.	Construction	Section 8.6 Section 8.10 Section 8.11
42	Traffic and Transport	Works areas will be designed to allow for all vehicles to enter the works areas, manoeuvre internally and exit the works areas in a forward direction	Construction	Section 8.6
43	Traffic and Transport	All parking will be accommodated on site within the designated works areas	Construction	Section 8.6
44	Traffic and Transport	A new access track will be constructed to the South Bowlo Fishing Club from Western Foreshore Road.	Construction	Section 8.6

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
45	Noise and Vibration	All work will be carried out within the following hours: • Monday to Friday 7:00am to 6:00pm; • Saturday 8:00am to 1:00pm; • Blasting Monday to Friday 9:00am to 5:00pm and Saturday 9:00am to 1:00pm only; and • No work on Sundays or public holidays.	Construction	Section 8.7
46	Noise and Vibration Air Quality	Residents adjacent to works areas will be informed prior to and during construction, of the nature, duration and expected overall noise and dust levels of construction activities. Relevant contact details for site personnel will also be provided.	Pre-construction Construction	Section 8.7 Section 8.8
47	Noise and Vibration	Simultaneous operation of noisy plant will be avoided wherever practicable.	Construction	Section 8.7
48	Noise and Vibration	Maintenance work on construction plant and vehicles will be carried out away from identified sensitive receivers and confined to standard daytime construction hours, wherever practicable.	Construction	Section 8.7
49	Noise and Vibration	Wherever practicable, noisy equipment will be: • Positioned behind structures that act as barriers to identified sensitive receivers; • Positioned at the greatest distance from identified sensitive receivers; and / or • Oriented to directed noise emissions away from identified sensitive receivers.	Construction	Section 8.7
50	Noise and Vibration	All vehicles and equipment will be regularly serviced, maintained in proper working order and turned off when not in use.	Construction	Section 8.7

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
51	Noise and Vibration	"Quiet" practices will be employed wherever practicable when operating equipment.	Construction	Section 8.7
52	Noise and Vibration Air Quality	An effective Complaints Handling System will be developed and implemented throughout construction.	Construction	Section 8.7 Section 8.8
53	Noise and Vibration	Vibration monitoring will be carried out at the nearest sensitive receiver on commencement of significant construction activities, as follows: • In the event that construction vibration is found to be significantly below construction vibration criteria, no subsequent monitoring of that activity is required; and • If monitored vibration levels are considered to be high-risk or close to the vibration criteria, unattended vibration monitoring will be carried out on a continuous basis at the nearest vibration sensitive receiver.	Construction	Section 8.7
54	Noise and Vibration	Any blasting required will be of similar to blast designs and Maximum Instantaneous Charge (MIC) (i.e. less than 209 kg) carried out during construction of the existing auxiliary spillway.	Construction	Section 8.7
55	Noise and Vibration	Monitoring will be carried out for any blasting required to ensure compliance with relevant criteria.	Construction	Section 8.7
56	Air Quality	Distance travelled on unsealed roads will be minimised by taking the most direct route to the destination.	Construction	Section 8.8
57	Air Quality	Surface drainage will be optimised, particularly at intersections.	Construction	Section 8.8
58	Air Quality	Vehicle speeds on unsealed roads within designated works areas will be limited to 40 km/hour or less.	Construction	Section 8.8

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
59	Air Quality	Larger trucks will be utilised for material transport to minimise the required number of trips, where possible.	Construction	Section 8.8
60	Air Quality	Unsealed roads, other unsealed surfaces, dry, sandy materials and stockpiles (as relevant) within designated works areas will be watered, likely using water carts, when visible dust emissions can be observed travelling offsite (note it is important to not allow unsealed roads to become saturated as this will increase emissions once they dry out).	Construction	Section 8.8
61	Air Quality	The extent of unsealed areas will be minimised by only clearing or unsealing areas required for the works and progressively rehabilitating disturbed areas as soon as possible after works are completed.	Construction	Section 8.8
62	Air Quality	Stockpiles will be stabilised (e.g. by watering, covering or revegetating, as practical) and, wherever practicable, shielded from the prevailing wind using wind breaks or by positioning them in sheltered areas, screened from the nearest sensitive receivers by topography or existing trees.	Construction	Section 8.8
63	Air Quality	Dump heights for the unloading and loading of soils will be minimised as far as practicable, particularly when dry, sandy materials are being handled.	Construction	Section 8.8
64	Air Quality	Construction activities will cease or be modified on dry windy days, when significant visible dust emissions can be observed travelling offsite towards nearby sensitive receptors.	Construction	Section 8.8

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
65	Air Quality	The Contractor will include in its CEMP, a copy of the modified version of the Beaufort Wind Scale, provided in Table 16 of Appendix 13, which is an empirical measure that relates wind speed to observed conditions. This table should be used as a practical guide for the need to implement dust control measures.	Construction	Section 8.8
66	Air Quality	Construction activities with the potential to generate dust emissions in the proximity of Receivers 5, 7 and 8 will be carried out during the summer months where practicable.	Construction	Section 8.8
67	Air Quality	Travel speed on unsealed surfaces in the vicinity of Receivers 5, 7 and 8 will be limited to 40 km/h.	Construction	Section 8.8
68	Air Quality	Unsealed surfaces in the vicinity of Receivers 5, 7 and 8 will be watered on a consistent routine basis under normal weather conditions, during construction activities with the potential to generate dust emissions. Under adverse conditions, particularly during strong westerly winds, additional watering of unsealed surfaces will be carried out when particulate matter is visible above the roof height of light vehicles.	Construction	Section 8.8
69	Visual Amenity	Trimmed and cleared vegetation should be spread over construction areas that are above the new FSL during rehabilitation to assist in stabilisation and revegetation of the area and to minimise visual impacts.	Construction	Section 8.9
70	Visual Amenity Spoil and Waste	The Contractor will maintain the works areas in a clean and tidy fashion.	Construction	Section 8.9 Section 8.12
71	Visual Amenity	Sediment and erosion control devices will be checked regularly, including after heavy rainfall and cleaned or replaced as required.	Construction	Section 8.9

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
72	Land Use	An Interpretation Strategy will be developed for the Dulegal Arboretum.	Pre-construction	Section 8.10
73	Land Use	The memorial plaque present the Dulegal Arboretum will be relocated to above the new FSL.	Pre-construction	Section 8.10
74	Land Use Socio-economic	State Water will further assess impacts to landholders, as follows: • Where land is within the new FSL, State Water proposes to acquire that part of the land impacted by the new FSL; • Where land is within the proposed road realignment boundary, State Water proposes to acquire that part of the land impacted by the road realignment; • Where State Water expects land may be regularly affected in order to manage the storage and associated works, such that the ability of the landowner to engage in ordinary usage of the land is affected, State Water will seek to acquire easements or full title depending on the level of impact; and • State Water will not acquire an interest where land might be affected by an extraordinary natural event.	Pre-construction	Section 8.10 Section 8.11
75	Land Use	Carry out a features survey to identify features to be avoided during construction within proposed works areas, but outside the road realignment construction area (including road realignment batters).	Pre-construction	Section 8.10

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
76	Land Use	State Water will liaise with local environmental groups, including Land Care, Tamworth Urban Group, Tamworth Garden Club and the National Parks Association of NSW Tamworth-Namoi Branch, to organise seed collection activities within the Dulegal Arboretum. All groups will be required to be appropriately licensed and insured to take part in the seed collection activities.	Pre-construction	Section 8.10
77	Land Use	The Australian Agricultural Company commemorative plaque will be moved from its existing location on the foreshore of Chaffey Dam to higher ground (outside the new FSL), within the proximity of its existing location.	Pre-construction	Section 8.10
78	Land Use	The two commemorative plaques on the existing Bowling Alley Point Bridge will be relocated to the new Bowling Alley Point Bridge.	Pre-construction	Section 8.10
79	Land Use Socio-economic	A Recreation Continuance Plan will be developed and implemented to address and mitigate impacts on recreational users during construction.	Construction	Section 8.10 Section 8.11
80	Land Use Socio-economic	The restricted zone adjacent to the dam wall and morning glory spillway will be extended during construction.	Construction	Section 8.10 Section 8.11
81	Land Use Socio-economic	Impacted facilities at the Bowling Alley Point Recreation Area will be relocated in consultation with the Bowling Alley Point Recreation Trust.	Construction	Section 8.10 Section 8.11
82	Land Use Socio-economic	Impacted facilities at the South Bowlo Fishing Club will be relocated in consultation with the South Bowlo Fishing Club.	Construction	Section 8.10 Section 8.11

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
83	Land Use Socio-economic	An Emergency Response Plan will be developed in collaboration with key stakeholders (e.g. ambulance, SES, police, Tamworth hospital) and implemented as relevant.	Construction	Section 8.10 Section 8.11
84	Land Use	A Boating Management Plan should be developed and implemented, which considers no go zones due to inundated perimeter vegetation and potential bank erosion issues.	Operation	Section 8.10
85	Land Use Socioeconomic	State Water will further assess impacts to landholders, as follows: • Where land is within the new FSL, State Water proposes to acquire that part of the land impacted by the new FSL; • Where land is within the proposed road realignment boundary, State Water proposes to acquire that part of the land impacted by the road realignment; • Where State Water expects land may be regularly affected in order to manage the storage and associated works, such that the ability of the landowner to engage in ordinary usage of the land is affected, State Water will seek to acquire easements or full title depending on the level of impact; and • State Water will not acquire an interest where land might be affected by an extraordinary natural event.	Operation	Section 8.10 Section 8.11
86	Socioeconomic	Following completion of the Project, land that is not affected by increased FSL will be leased with longer term lease conditions (5 to 10 years). State Water uses an open tender process to allocate leases and will consider the impact of the Project on affected landholders and lessees.	Operation	Section 8.11
87	Spoil and Waste	The Contractor will ensure that waste is appropriately contained and disposed and no items fall into the surrounding water.	Construction	Section 8.12

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
88	Spoil and Waste	A waste collection and storage area will be established and maintained at each work area.	Construction	Section 8.12
89	Spoil and Waste	Water used to clean equipment should not be allowed to flow directly into the reservoir, instead it should be allowed to filter through hessian sacks or similar.	Construction	Section 8.12
90	Spoil and Waste	Recyclable materials and products made from recycled materials will be used where possible.	Construction	Section 8.12
91	Spoil and Waste	Materials with minimal packaging and transport requirements will be used where possible.	Construction	Section 8.12
92	Spoil and Waste	No burning of vegetation or waste is allowed under any circumstances.	Construction	Section 8.12
93	Spoil and Waste	General and putrescible waste and recyclable waste such as metal, plastic, glass, paper and timber will be segregated and collected in suitable waste containers positioned at convenient locations within each work area.	Construction	Section 8.12
94	Spoil and Waste	All waste containers will have secure lids in place to prevent water ingress and access to animals.	Construction	Section 8.12
95	Spoil and Waste	Waste storage areas will be kept away from drainage paths.	Construction	Section 8.12
96	Hazards and Risks	Emergency spill kits will be available on site and construction personnel trained in their use.	Construction	Section 8.13
97	Hazards and Risks	Chemical wastes will be collected in appropriately sized and labelled containers for disposal at an approved chemical waste facility.	Construction	Section 8.13
98	Hazards and Risks	Waste oil, solvents and hydrocarbons will be collected for reuse, recycling, treatment or disposal at an appropriately licensed facility.	Construction	Section 8.13

Ref	Issue	Mitigation Measure	Phase	Relevant EIS Section
99	Hazards and Risks	Floating booms will be utilised during works near water and where the potential for hydrocarbon spills to water exist.	Construction	Section 8.13
100	Hazards and Risks	Material Safety Data Sheets (MSDSs) will be maintained on site for all hazardous substances, including fuels and chemicals, in a readily accessible location.	Construction	Section 8.13
101	Hazards and Risks	Fuels, lubricants and chemicals will be stored and handled within containment facilities, such as bunded areas or leak trays, designed to prevent the release of spilt substances.	Construction	Section 8.13
102	Hazards and Risks	All bunded areas will be designed to contain 110% of the volume stored within them.	Construction Operation	Section 8.13
103	Hazards and Risks	All storage and handling equipment for fuels, lubricants and chemicals will be maintained in good working condition.	Construction Operation	Section 8.13
104	All	The Contractor will develop and implement a CEMP that includes mitigation measures described in the EIS and any additional measures considered necessary to manage environmental impacts during construction. The Contractor's CEMP will also incorporate all relevant conditions issued for the Project by the Department of Planning and Infrastructure and SEWPaC.	Construction	Section 9
105	All	Existing State Water operational management systems and procedures will be reviewed and revised as required to ensure all operational mitigation measures described in the EIS are implemented. Any additional measures considered necessary to manage environmental impacts during operation of the Project will also be incorporated into State Water's operational management systems and procedures.	Operation	Section 9

10 CONCLUSION

The Project has been identified by the Minister for Planning and Infrastructure as a State Significant Infrastructure project. It is necessary to improve town water security for the city of Tamworth and surrounds and to improve the reliability of water supply for irrigation and agricultural purposes. The other key driver for the Project is the need for Chaffey Dam to be upgraded to meet modern dam safety standards. The Project has wide support from the community, irrigators and Tamworth Regional Council. Local, State and Commonwealth Governments have committed to fund the Project.

Construction of the Project will create employment opportunities for the area, both locally and regionally. Employment opportunities for up to 50 personnel will be created during the construction period through direct employment on the Project. Additional employment opportunities will also result from the provision of services for construction.

Operation of the Project will also provide positive socioeconomic impacts through increased water security for Tamworth residents and Peel Valley irrigators. Increased water security is expected to benefit the agriculture industry in the area, which together with the forestry and fisheries industries, employs the largest proportion of persons located outside Tamworth City, comprising 16.5% of total employed population (ABS 2006). The agricultural industry contributes significantly to the economy of the Tamworth region, with the gross value of production estimated at over $75 million (NSW Office of Water 2010a).

The Project will also provide socioeconomic benefits by reducing the risk of dam failure. If the dam were to fail due to an extreme flood event, it has been estimated that up to 150 lives would be lost and over $2.1 billion damage to property and agriculture would accrue GHD 2007a).

Although some detrimental socioeconomic impacts are expected to result by way of impact to existing land uses and property, where possible, the Project proposes to accommodate relocation of land uses and is anticipated to result in an overall socioeconomic benefit, both locally and regionally.

The EIS has assessed the key issues outlined in the DGRs and additional issues identified through the environmental risk analysis. Where impacts have been identified these are proposed to be mitigated in accordance with relevant State and Commonwealth environmental management requirements. All identified impacts, except those to soil and water, biodiversity and Aboriginal heritage are considered to be readily managed through standard mitigation measures, as described in the EIS.

The Project will have minor impacts on items of Aboriginal heritage and soil and water. Specific mitigation measures and management plans are proposed for these items.

In relation to potential significant adverse impacts of the project, the Project is likely to have a significant impact on the local population of the Booroolong Frog and, if present, Queensland Bluegrass. An Offsets Strategy has been prepared and an Offset Proposal to address the

requirements of State and Commonwealth legislation will be implemented to compensate for biodiversity impacts. No other significant adverse impacts are anticipated.

Having regard to the proposed mitigation measures, management plans and offset strategy it is considered that the Project will not give rise to any significant adverse socio, economic or environmental impacts and is in the public interest.

The Project satisfies the relevant Objects of the EP&A Act with regard to the

- The proper management and development of natural resources;
- The promotion and co-ordination of the orderly and economic use and development of land;
- The protection of the environment including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities and their habitat; and
- Ecologically sustainable development.

It is considered that the Project will have a significant socioeconomic benefit, both locally and regionally, through increased water security and dam safety.

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